SCIENCE SCHOLARS' PERCEPTIONS ON REARRANGEMENT OF SOME PHYSICS TOPICS AS A WAY OF ENHANCING PERFORMANCE: A CASE OF LUSAKA DISTRICT

Abel C. Kapata

A Dissertation submitted to the University of Zambia in fulfillment of the requirements for the degree of Master of Education in Science Education

THE UNIVERSITY OF ZAMBIA

LUSAKA

2017

COPYRIGHT

DECLARATION

I Abel C. Kapata do hereby declare that this is the original work of my hand and all the work by other people has been duly acknowledged and that it has not previously been submitted for a degree, diploma or other qualifications at this or any other University.

Signature: ________________________________ Date: ___________________________

APPROVAL

This dissertation of Abel C. Kapata has been approved as fulfilling the requirements for the award of the degree of Master of Education in Science Education by the University of Zambia;

Examiner's

Name: ……………………………………….Signature: …………………… Date: ………….....

Name: ……………………………………….Signature: …………………… Date: …………....

Name: ……………………………………….Signature: …………………… Date: …………....

ABSTRACT

This study was aimed at exploring the perceptions of science scholars on the rearrangement of some physics topics as a way of enhancing performance at grade 12 physics and science national examinations. A case of selected institutions in Lusaka district was considered.

The study was guided by the following objectives: To determine the perceptions of scholars (Science Specialists, Educators and Learners) on the rearrangement of some physics topics, to establish the general performance of grade 12 pupils in physics and science from 2003 to 2014 and to identify topics that can enhance the performance.

An exploratory research design was used in which purposive and simple random sampling procedures were employed. The sample comprised 312 respondents - 86 were college and university students who were studying physics, 59 were teachers who were either teaching or had taught physics or science, 116 were pupils from secondary schools, and 53 were science specialists from Examinations Council of Zambia, Curriculum Development Centre, National Technology and Science Council and the Zambia Bureau of Standards.

The study was situated in the frameworks of Gagne's model of instruction design and the attribution theory. Gagne's model of instructional design focuses on the learning outcomes and how to arrange specific instructional events to achieve those outcomes and consequently points out the need for prerequisite knowledge for the process of meaningful learning. The attribution theory suggests that success or failure may be attributed to internal or external factors which can be controllable or uncontrollable.

Data on scholars' perceptions was collected via structured questionnaire while the one on pupils' performance was accessed from the Examinations Council of Zambia. Data was quantitatively and qualitatively analyzed. Quantitative analysis was done descriptively using Statistical Package for Social Sciences (SPSS) software. The findings indicated that science scholars perceive the rearrangement of some physics topics as one of the ways which might enhance the performance. Relative to other selected compulsory subjects pupils performance in physics and science was lower and differed significantly ($p = 0.000$ for 2003, $p = 0.00145$ for 2009 and $p = 0.000$ for 2014). Finally, the results show that some topics where candidates performed poorly did not have adequate prerequisite coverage meanwhile some were repeated at both junior and senior secondary levels.

In view of the above, the study recommended that those topics where candidates performed poorly (radioactivity, electromagnetism or basic electronics) are the ones which might enhance the performance if they were rearranged and their prerequisites reconsidered.

DEDICATION

I dedicate this work of my hand to my beloved mother Eness Likonge Muwapa Kapata and my dearest daughter Sanselo Kapata. They gave me the reason to work hard and go on in life.

ACKNOWLEDGEMENTS

The author would like to sincerely thank the individuals and institutions which made it easier and possible for the study to be carried out successfully. The study would have been difficult without their involvement.

Personal gratitude goes to Dr. S. Mbewe the Head of Department of Mathematics and Science Education at the University of Zambia for his timely and remarkable supervision and for the professional guidance that was rendered throughout the research process.

The researcher would like to sincerely thank Dr. S. Haatwambo from the Department Of Physics at the University of Zambia for his insightful guidance and supervision during many stages of the research

Further appreciation goes to the Examinations Council of Zambia, Zambia Bureau of Standards, National Technology and Science Council and the Curriculum Development Centre for the valued support that was rendered during the data collection stage. Without consent and cooperation from these institutions data collection would have been difficult. Noted with thanksgiving is the first hand and reliable data which was provided by these institutions.

Without forgetting fellow students, the researcher would like to express appreciations for various contributions and support that they provided.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS

ANOVA	Analysis of Variance
CDC	Curriculum Development Centre
ECZ	Examination Council of Zambia
EOF	Educating Our Future
GRZ	Government of the Republic Of Zambia
JETS	Junior Engineers, Technicians and Scientists
MESVTEE	Ministry of Education, Science, Vocational Training and Early Education
MOGE	Ministry Of General Education
NISTCOL	National In-service Training College
NTSC	National Technology and Science Council
SPSS	Statistical Package for Social Sciences
UNZA	the University of Zambia
ZABS	Zambia Bureau of Standards
ZASE	Zambia Association for Science Education
ZECF	Zambia Education Curriculum Forum

DEFINITION OF TERMS

Curriculum stakeholders: Participants in the design, development and implementation of the school curriculum.

Cognitive equilibrium: A balance between reliance on prior information and openness to new information.

Curriculum: A broad outline of the educational experience and topics to be covered in order to complete a course and pass a certain level of education.

CT scan: Computed tomography – An imaging procedure using special x-ray equipment to create detailed pictures, or scans, of areas inside the body.

Ethics: Guidelines for the responsible conduct educating and monitoring the researcher in order to protect human subjects involved in the research project.

Extrapolation: The process (in mathematics) of estimating beyond the observation interval. Generalization of the findings to the entire population.

Hypothesis: A proposed explanation for a phenomenon. A specific statement of prediction.

Likert scale: An approach to scaling responses in survey research questionnaire. Respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements.

Purposive sampling: Choosing subjects that are believed to be able to provide important information.

Sampling procedure: Choosing part of a population to use to test hypotheses about the entire population. Used to choose the number of participants, interviews, or work samples to use in the assessment process.

Science scholar: A person who attends a school or studies under a teacher or a person who has done advanced study in a special field (science) (a learned person).

Science specialists: These are people with a background in physics and are applying it in the industry in specific and distinct fields.

Syllabus: An outline and summary of topics extracted from the curriculum to be covered in order to complete an education or a training course.

CHAPTER 1

INTRODUCTION

1.1 Background to the study

The progressiveness of a subject can be determined by the performance of the students in such a subject at a prescribed examination. Any activity driven by an outline or syllabus is expected to produce desirable and effective learning outcomes in the learners (Owolabi & Adedayo, 2012). When such an activity fails to produce a favorable change in the learners, then, there could be a problem. Such problems could be emanating from the nature of the curriculum or syllabus that is in use. When the learners perform poorly and do not have enough confidence to pursue further studies in a particular subject then the curriculum or syllabus should be thoroughly checked for possible flaws. It is therefore imperative to re-think and strengthen those factors that improve the standard of education. Such a mandate is upon the government of the day as stated in the national policy document, Educating Our Future,

> The Government has a bounden duty to promote the highest standard of education and learning for all. This entails giving attention to various interdependent factors, including the quality of the curriculum, teaching and assessment, the quality of teachers in schools, school and institutional arrangements, and planning processes (MOE, 1996, p. 4).

Adherence to such a mandate, in terms of the curriculum or syllabus, can be one of the ways to produce desirable and effective learning outcomes in the learners, thereby improving the performance. This study sought to illustrates topics that can enhance the performance and determines the perceptions of scholars (Science Specialists, Educators and Learners) on the rearrangement of some physics topics. The study further establish the general performance of grade 12 pupils in physics and science in secondary schools of Lusaka for a number of selected years from 2003 to 2014.

Poor performance can generally lead to some learners losing interest and probably even develop negative perceptions towards the subjects in question. Empirical evidence suggests that some higher learning institutions have had challenges in improving enrollment levels in particular fields due to poor performance in prerequisite knowledge in the subject areas. As observed by Askhia (2010), the trend in the enrolment and performance of secondary school students in science subjects, especially physics assumed threatening and frightening dimension. Consequently, poor performance in science may have a negative effect on achieving the aims of a course or study area at a higher level. For example, performance of grade 12 pupils in science should be very good to enhance great thinking and problem solving demanded in the field of engineering in institutions of higher learning (Kafata & Mbetwa, 2016). Therefore, the curriculum or syllabus structure in grade eight and nine integrated science may require re-arrangement so as to strengthen the background in physics and science studies in grade 10-12. Hence, the genesis of this study was dependent on the perceptions of science scholars for direction.

1.1.1 Background to Physics in Zambia

Physics is an embraced discipline that has evolved and whose impact to the society cannot be over emphasized. Many scholars have attempted to define physics in different but fairly comprehensive manner. Physics can be defined as the study aimed at unraveling the laws of nature and how they operate (Ahmed & Baseeb, 2005).

From a seemingly different perspective, physics may be thought of as knowledge that has been accumulated from observations of physical phenomena, systematized, and formulated with reference to general statements in the form of 'theories' or 'laws', which provide a grasp or a sense of greater understanding of the world in which we live (Hameed, 2005**).**

Physics is a scientific subject that has its origins in the need of human beings to understand and explain the world around them. Physics covers everything from the interaction of the smallest particles of matter to the origins and structure of the universe.

Physics in Zambia has been taught since independence in 1964. In early 1980s physics was taught to only form IV and form V as the curriculum demanded. By mid 1980s the curriculum changed from 2 years high school to 3 years (Maguswi, 2011). One would assume that these changes allowed more time for learners to prepare for physics and that is just considerably inevitable. Further Maguswi noted that the number of candidates sitting for the examinations had gradually increased. In more schools the enrollment levels in physics have been going up as evidenced in the 2014 examinations and more teachers have been trained in physics (ECZ, 2015). These interventions gave hope that performance in physics would improve. Alas, to date the situation has not improved at all (ECZ, 2016).

In the Zambian education system pupils learn Integrated Science at junior level. This Integrated Science has topics in physics, chemistry and biology. However, the topics are not clearly and distinctly labeled as physics, chemistry or biology topics. Instead they are taught as integrated science (see Appendix I) Physics is only taught as a separate subject at senior secondary level (Grade 10 to 12) (see Appendix II*)*.

There are two major ways in which physics is taught in Zambian schools. In some schools it is taught separately from chemistry but the final examination paper in grade 12 is a combination of both and it is termed science (subject code 5124). The "science syllabus is designed for grades 10-12. It is intended for pupils not taking chemistry and physics as separate subjects" (MESVTEE, 2013, p. vii).

The syllabus is structured with two parts. Part A comprises physics topics to be done from grade 10 to 12 and part B has chemistry topics that hare equally to be done from grade 10 to 12. Science (subject code 5124) grade 12 final examination paper comprised three papers: multiple-choice (paper 1) with an equal distribution of questions for physics and chemistry, physics structured theory questions (paper 2) and chemistry structured theory questions (paper 3). In the new curriculum this structure is now modified. Table 1 shows how the science 5124 assessment structure has been modified.

Table 1: Science 5124 final examination structure

Question paper	Old curriculum	New curriculum
Paper 1	Multiple choice [1]20 physics + 20 chemistry	Physics structured Three sections
Paper 2	Physics structured Three sections	Chemistry structured Three sections
Paper 3	Chemistry structured Three sections	Practical 2 physics + 2 chemistry

Source: (CDC, 2016)

The new assessment structure was first effected in 2016 final examinations.

In other schools physics is taught as a separate subject examinable in grade 12 and it is called pure physics (subject code 5054) with three papers: multiple choice (paper 1), structured theory (paper 2) and practical (paper 3). However, some schools have a combination of both science (5124) and pure physics (5054).

General observations indicate that pupils in grade 10 – 12 do not perform well in physics in comparison to other subjects. Many reasons have been stated as to why the performance in science and physics has been poor. From different studies carried out locally and globally, reasons or causes for poor performance have been; inadequate teaching materials, inadequacy of laboratories and apparatus, inadequate qualified teachers, lack of learners' interest, negative perceptions and many more.

In accordance to the study done in Zambia, some factors leading to pupils' underachievement in physics include differential teacher behavior towards males and females taking physics, lack of female role models, lack of properly trained teachers, physics is not taught from the practical point of view but theoretically, lack of teaching and learning materials, Syllabus is too wide to be completed in three years (Haambokoma, Nkhata, Kostyuk, Chabalengula, Mbewe, Tabakamulamu, Ndhlovu, Mushanga & Ntan, 2002).

[1] Refers to the number of questions in the paper

Some studies in Nigeria revealed that a number of reasons can be identified to be accountable for the poor performance of students in sciences. These include the science curricula, teachers' methods of teaching, parents, government, lack of science facilities and others (Ahiakwo, 2003).

On a global perspective, moreover students' poor performance in physics globally is basically due to lack of involving the students in the teaching learning activities right from the beginning of any new concept to be taught, lack of qualified teachers as well as experiences in teaching and unavailability and/or insufficiency of materials in the laboratories (Ango, 1990).

The Ministry of General Education, researchers, and science education support structures such as JETS and ZASE have made efforts to increase the number and content knowledge of teachers, by creating opportunities for advancement, researching on how to teach physics effectively, and emphasizing new physics teaching methods and encourage pupils to take up physics respectively. As regards the JETS of Zambia;

> Of special significance is the role of the Junior Engineers, Technicians and Scientists (JETS) of Zambia. Established in 1966, the main objectives of JETS include the popularization of science and technology among secondary school pupils. In pursuance of this, the JETS clubs have been established in secondary and primary schools (Akpan, 1994, p. 9).

Despite such efforts the performance of pupils in physics as well as science has remained relatively low. The 2014 examination analysis indicates that this situation of poor performance still lingers and it is a public concern.

> The analysis of performance at grade 9 and 12 in the 2014 examinations in environmental science and science shows that some candidates have poor in-depth understanding of the concepts in the subjects……….In science, the performance in the physics components was very poor (ECZ, 2015, p. 55).

A closer observation reveals that there could be some discrepancies between what the teacher instructs and what the pupils learn in physics which affects their performance. As it is confirmed in the examination analysis highlighted earlier that, the understanding of physics concepts still poses a challenge to learners. This should be food for thought for concerned stake holders and most importantly the researchers. It appears beyond some measure of reasonable doubt that the teachers attempt to teach effectively but pupils struggle to grasp the concepts and skills taught because the pupils may not have had the relevant foundation knowledge and skills. Therefore, the pupils' poor performance in physics could be due to the lack of pre-requisite knowledge emanating from inadequate preparation at the junior level of education (Grade eight and nine).

It is within the confines of this study to identify actions which might invoke suggestions for the reduction or possibly eradication of the mismatch in the physics concepts at junior level (grade eight and nine) and at senior level of education (grade 10 - 12) and to do away with the discrepancy between what the teacher instructs and what the pupils learn in physics.

1.2 Statement of the Problem

Physics concepts in grade eight and nine play an important role in preparing the pupils for physics and science in grade 10 to 12. This in turn is hoped to improve the performance at grade 12 physics and science examinations. The application of physics for industrial and technological advancement can be enhanced if more people take keen interest to study it and progressively perform better at successive stages of the learning experience.

Physics and science are highly regarded subjects in the Zambian curriculum. This is due to the fact that the country hopes to use scientific knowledge to enhance development of industries and propel the country to achieve many goals. In the national policy document of 'Educating Our Future' an emphasis is placed on the need to embrace science education in the curriculum. The document aims at formulating policies that build on the foundation laid in grade eight and nine. It is further highlighted in the document that from this level, the education is hoped to "promote extensive knowledge, exact skills, and accurate understanding of chosen areas in languages, mathematics, science and technology, the social sciences, practical subjects, and the arts" (MOE, 1996, P. 52). This entails that the curriculums (physics in particular) should be specially designed to make the hopes and objectives of the document, on behalf of the country, to come to reality. The physics or science curriculum has undergone revisions by the CDC in order to address the concerns alluded to in the national policy document that border on the enhancement of physics and science education. The CDC shades more light on the concern of curriculum revision which was designed to provide more guidance on the preferred type of the education for Zambia.

> This Zambia Education Curriculum Framework (ZECF), therefore, provides the curriculum guidelines as well as the structure at all the levels, from Early Childhood Education (ECE) to Tertiary Education and Adult Literacy…… The new curriculum has also been linked at all the levels, from ECE to tertiary education and adult literacy (CDC, 2013, p. iii).

This is as a result of the consideration that Zambia is undergoing rapid socio-economic development. Science education, being an agent of change and an economic tool for development in technology, is fully considered.

It is fully acknowledged and appreciated that the curriculum specialists take keen interest to design the curriculum and syllabi in such a way that new topics build upon previously learned concepts and skills. This is reflected in the grade eight and nine and 10 to 12 syllabi. It is also in line with policy formulation in the document 'Educating Our Future'. Emphasis is placed on the need for strengthening early stages of learning.

> The difficulties of many pupils with mathematics and science go back to the way they were introduced to those areas in primary school … In shorter term however it is still possible to provide considerable remediation and establish an adequate foundation for high school work in mathematics and science … it is too late trying to lay in grade 10 a foundation that should have been in place much earlier (MOE, 1996, p. 54).

Here it is pointed out that building upon prerequisite knowledge is essential for progressive performance at later and successive stages in the learning process. This study inclines the concept of prerequisites to physics topics. Certain topics such as density, pressure, light and electricity are basically covered in grade eight and nine in order to provide prerequisite knowledge for the pupils as they proceed to senior secondary level. In grade 10 to 12 the same topics are covered with a few more advanced concepts included. However, an observation is made that some of the topics do not have prerequisite coverage in grade eight and nine (See Table 21).

Despite the policy formulation in the 'Educating Our Future' document, one might observe that what is stipulated merely points to what is hoped to be achieved in the long run. The implementation solely depends on other factors such as further research and more publications. There is no direct impact of these policies to the actual performance of pupils in physics unless other factors are considered.

The curriculum changes that have recently been made are acknowledged and appreciated by the researcher. Some changes were made in the topics in grade eight and nine in order to enhance better understanding at senior secondary. This is in accordance to a component of the study done by Chilufya (2014). Thus:

> The number of topics for grade eight was reduced from ten to five, while that for grade nine was reduced from nine to five; new topics were added, others re-arranged and the content of some of the existing topics was highly modified in such a way that they properly addressed current economic, social, cultural and ecological problems (p. 28).

The latest analysis of the 2014 examinations by the ECZ shows that there is still a problem of poor performance particularly in physics and science.

Considering what is formulated in the policy document, Educating Our Future, and efforts made by some researchers and science structures such as ZASE and JETS, in reaction, it is still evident that the idea of upholding the concept of prerequisites especially for secondary school physics has not been fully exhausted. It is for this and many other reasons why the performance of pupils in secondary school physics and science has continued to be poor and below expected standards in comparison to other subjects. This constitutes a problem because, as it is, learners still complain of physics being too difficult to understand and they continue to perform poorly. If left unattended to, a negative attitude and misconception may continue to haunt physics education and in the long run the contribution made by science to technology and the society may be static. It is this aspect of prerequisites knowledge in physics that forms the pivot for this study and the main reason why it was carried out. It is hoped that the study may influence necessary actions that may bring about the smooth and better transition of physics concepts from grade 9 to grade 10 and beyond.

It is a concern of this research that the MOGE through the CDC may consider rearranging some physics topics further in the integrated science, science and physics syllabi so as to strengthen the background in the subject. This might improve the performance of pupils in physics. Trying to prepare or equip the young minds at junior level of education for further advanced instruction in physics at senior level could probably be one of the ways to address this problem of poor performance in physics. If pupils could be empowered and imparted with necessary pre-requisite knowledge of physics in grade eight and nine they could be well prepared for the physics in grades ten through to grade 12.

1.3 Purpose of the Study

The purpose of this study was to; investigate the perceptions of the science scholars (Specialists, Educators and Learners) in Lusaka District on the possible rearrangement of some physics topics at junior level of education (Grade eight and nine) in Zambian schools, establish the performance of pupils in O' Level Physics over a given period of some selected years between 2003 and 2014 and to identify topics which can enhance the performance at senior secondary level.

1.4 Objectives

The objectives of this study were:

1. To investigate the perceptions of the Science scholars (Specialists, Educators and Learners) in Lusaka District on possibility of rearranging some physics topics at senior and junior level of education in Zambian schools.
2. To establish the general performance of grade 12 pupils in physics with aid of empirical data.
3. To identify topics that can enhance the performance in physics at senior secondary level.

1.5 Research Questions

During the study the researcher was guided by the following questions:

1. What are the perceptions of the Science scholars (Specialists, Educators and Learners) in Lusaka District on the possibility of rearranging some physics topics in grade 10-12 and grade eight and nine in Zambia?
2. What is the general performance of grade 12 pupils in O' Level physics and science over a given period of years?
3. Which topics can enhance the pupils' performance in physics at senior secondary level (grade 10 to 12)?

1.6 Study Hypothesis

The null hypothesis for the study was generated and tested at the 0.05 level of significance.

Ho: There is no significant difference in the performance of pupils' in physics and in other selected compulsory subjects.

1.7 Significance of the Study

Since knowledge, skills and technological development change so rapidly, the education must also be renewed continually. Physics could also be considered to be at the helm of spinning the wheel of science and technological development. With this notion the study was carried out as a contribution to perfecting the picture of physics education in Zambia, surrounding regions and the world over.

Poor performance in science and physics in schools has brought about a huge challenge to the school authorities. Therefore, there is need to strive to bring about better performance of pupils. Keeping in mind the performance of secondary schools countrywide, it was necessary to assume that Lusaka district was not excluded from the poor performing schools in Zambia. The results of this study may provide school authorities with factors that are really impacting the poor performance of pupils in science and physics. Generally the study might also provide a clear articulation of the direction the Zambian education ought to take in this modern world. Therefore, the study is significant in many different ways:

This study can provide information about how the general performance of pupils in physics and Science in secondary schools has been.

The results of the study could help to find ways of providing, through well-designed studies of experimental and practical physics, a worthwhile educational experience for all pupils , whether or not they go on to study physics beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge.

It is hoped that the finding of this study will bring to limelight the concepts and topics which are considered difficult by pupils and teachers in physics curriculum. This awareness will make pupils pay more attention to those concepts. The teacher will be aware of those concepts in order to adopt appropriate teaching methods, learning materials and experiences that will reduce the level of difficulty of those concepts and topics. The textbook writers will be sensitized to use relevant examples and appropriate language that will help to boost the pupils’ understanding of those difficult concepts and topics. The curriculum planner will also be sensitized to include learning materials and experiences as they plan physics curriculum so as to reduce the level of difficulty of those concepts and topics.

The results can also provide basic information for the development and design of the school physics curriculum for junior and senior secondary schools. In order to develop a school curriculum, many stakeholders are consulted and a number of issues are considered such as latest information on insights on what is really obtaining on the ground concerning a particular subject. The information and insights from various stake holders on how the curriculum can be improved could be obtained from the results of this study.

Furthermore, the results of the study could help in finding more and better ways of improving the enrollment and participation levels of students in physics related courses at tertiary level of education. If the performance in physics becomes better, there could be more students opting to enroll in the physics related courses at tertiary level of education. Consequently, the enrollment levels at universities and colleges in physics related fields would improve.

Finally, this study could be a contribution to science education research in Zambia, particularly in terms of secondary school physics and its background. In this context the results of the study could be used to test the feasibility of undertaking a much larger and more elaborate study. It is critical not only to conduct relevant science education research to help science teachers improve their classroom practice and play better roles in enhancing scientific literacy, but also to understand what have been studied in the past in order to know what could be explored further in the future. Research in science education has been called to be conducted with an aim to critically ‘‘inform educational judgments and decisions in order to improve educational action’’ at different levels” (Bassey, 1995, p. 39).

Research is an important intervention at all levels of education. In the Zambia Education Curriculum Forum (ZECF), the MESVTEE (2013) sheds more light on the need for research in science education.

> There is need to find out what obtains and what needs to be adjusted or changed completely to suit the obtaining situations. Therefore, in curriculum design and development, it is cardinal to carry out both Action Research and Case Studies to help improve learning and cater for content and the learners (p. 95).

Educational surveys should form part of research work to alleviate all challenges in the education system and sectors.

1.8 Theoretical Framework

The theoretical framework in this study was guided by the need for strengthening the sequence in the delivery of instructions to learners and the causal attribution of pupils’ performance in physics. Therefor, the study hangs under two theories; Gagne's model of instructional design and the attribution theory.

1.8.1 Gagne's Model of Instructional Design

Robert Gagne is considered to be one of the foremost contributors to the systematic approach to instructional design and, according to Khadjooi, Rostami and Ishaq (2011, p. 116), "… his theory has provided a great number of valuable ideas for trainers and teachers". Gagne's model of instructional design is based on the information processing model of the mental events that occur when learners are presented with various stimuli and focuses on the learning outcomes and how to arrange specific instructional events to achieve those outcomes.

Instruction design may be termed "science" because it follows a set of theories and methods and it is concerned with inputs and outputs of information. Instruction design can also be called as an "art" because it is related with creativity and shows a designer's talent and capabilities. Piskurich (2006) affirms that instruction design is really a set of rules or procedures, you could say, for creating training that does what it is supposed to do.

Gagne's theories seemingly affirm that they can be applied to design instruction in several domains, such as the military, flying, leadership, engineering and healthcare. Suffice to mention that in the study of physics, these theories may be applied to make the physics education experience more meaningful and a success.

Essential to Gagne's ideas of instruction are what he calls "conditions of learning": internal conditions deal with what the learner knows prior to the instruction, external conditions deal with the stimuli that are presented to the learner, e.g. instructions provided by the teacher.

The first step in Gagne's theory is specifying the kind of outcomes to be achieved. He categorized these outcomes into five types: verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills.

The second step is to organize appropriate instructional events. According to Gagne (1985), there are nine events that provide a framework for an effective learning process. Gagne's Events of Instruction as adapted from Gagné, Briggs, and Wager (1992) consist of the following:

1. Gain attention of the students

   Ensure the learners are ready to learn and participate in activities by presenting a stimulus to gain their attention.

2. Inform students of the objectives

   Inform students of the objectives or outcomes to help them understand what they are to learn during the course.

3. Stimulate recall of prior learning

   Help students make sense of new information by relating it to something they already know or something they have already experienced.

4. Present the content

   Use strategies to present and cue lesson content to provide more effective, efficient instruction. Organize and chunk content in a meaningful way. Provide explanations after demonstrations.

5. Provide learning guidance

   Advise students of strategies to aid them in learning content and of resources available.

6. Elicit performance (practice)

   Activate student processing to help them internalize new skills and knowledge and to confirm correct understanding of these concepts.

7. Provide feedback

   Provide immediate feedback of students' performance to assess and facilitate learning.

8. Assess performance

   In order to evaluate the effectiveness of the instructional events, you must test to see if the expected learning outcomes have been achieved. Performance should be based on previously stated objectives.

9. Enhance retention and transfer to the job

   To help learners develop expertise, they must internalize new knowledge.

Of the nine steps, the third highlights major benchmarks for this study in terms of the need for upholding prerequisite knowledge. Associating new information with prior knowledge and personal experience and getting the learners to think about what they already know can facilitate the learning process.

Stimulating recall of prior knowledge allows the learners to use two important learning processes which are: retrieval practice that enhances learning by retrieval of specific mechanisms rather than by elaborative study process and is an effective tool to promote conceptual learning (Butler 2010; karpicke & janell, 2011) and scaffolding which is the support that a skilled performer gives their apprentices in carrying out a task (Collins, Brown & Holum, 1991). It is accomplished by building upon the student's prior learning.

Designing a curriculum and selecting topics for a physics syllabus may involve balancing many competing constraints, not least of which is prerequisite knowledge. When preparing for lessons, most of us focus tremendous effort on the content we will teach. Often, less planning and instructional time is dedicated to accessing preexisting knowledge. This oversight can have significant implications. Students need to integrate new material into their existing knowledge base, construct new understanding, and adapt existing conceptions and beliefs as needed. However, students who lack sufficient background knowledge or are unable to activate this knowledge may struggle to access, participate, and progress throughout the general curriculum.

Prerequisite knowledge here may be defined and explained as the skills and knowledge that are considered applicable and necessary to be acquired before proceeding to new instructions. Some have more complex definitions. For example, Biemans and Simons (1996, p. 6) conceive of prior knowledge as "all knowledge learners have when entering a learning environment that is potentially relevant for acquiring new knowledge".

The common assumption for education often shows the pupil as an empty vessel with the teacher filling their minds with knowledge. However, no matter what the pupils' age or experience, they will bring prior knowledge and experience to the learning process.

Ambrose (2010, para. 1) argue that;

> What students bring to the table may be perfectly suited for the course, it may be accurate but incomplete, it may be factually correct but just not relevant to the current topic, or it can be inaccurate. Based on this list it can be seen that a student's prior knowledge can either help or hinder the learning process.

In line with this argument it can still be noted that regardless of the kind of prior knowledge a pupil has, it is important that the teachers determine what that knowledge is. Equipped with the understanding of a pupil's prior knowledge a subject or lesson can be tailored for maximum effectiveness. Ambrose et al further highlight that accurate knowledge can be leveraged to act as a foundation, and inaccurate or inappropriate prior knowledge (misconceptions) can be targeted for correction.

In addition, Klymkowsky and Cooper (2012) argue that what we teach reinforces what was taught in previous courses, and will be solidified as students use the material in subsequent courses. This should motivate us to consider linkages between topics within the subject. As we teach, we must recognize what prior knowledge a pupil should draw upon to correctly understand the topic and make these connections explicit to the pupil. This approach may be made possible and easier if topics in the syllabus are arranged to consider appropriate linkages.

Since the pupils' prior knowledge can either help or hinder the learning process, it therefore follows that their performance in a prescribed examination can be directly influenced by the prior knowledge during the learning and preparation stages.

Here it can be deduced that: Whereas prerequisite knowledge is that which is specifically earmarked to prepare a learner for the new learning experience, prior knowledge on the other hand is generally all knowledge a learner brings to the learning environment. This study refers to prior knowledge which is accurate and relevant for the new learning experience.

Pupils build knowledge by adding onto their already existing mental framework. This suggests that comprehension and retention of prerequisite material is very important for classes. Prerequisite material can help the learners to connect new information. The importance of prerequisite knowledge is a variable in learning, and points to the fact that new nodes cannot be connected to existing structure (i.e. external connectedness) if the knowledge required to support new information does not exist in the learner (Mayer, 1975). Therefore, there should exist in the learner the ability to grasp new concepts and skills based on previously acquired knowledge.

Pradhan and Mody (n.d.) argue that it is hard to learn something we do not almost already know. Everything we learn is learned via interpretation within a context. In line with their argument it follows from context principle that much of our learning takes place step by step. Placing a thing in a context familiar to pupils makes it easy to grasp it. For this, we also use examples and analogies. For example, in electrostatics we use example of water stored at heights to explain concept of electric potential difference and in turning effects of a force we use an example of a see-saw, opening and closing of a door and screwing a bolt with a spanner to explain the turning effect of force and the principle of moments.

Additionally, Gagne (1985), in his theory of learning suggested that skills are to be learned at the lowest levels and mastered before proceeding, and that, each new skill should build upon previously acquired skills.

The physics topics included in the Integrated Science syllabus for Zambian schools at junior level (Grade eight and nine) are meant to provide prerequisite knowledge in physics for the pupils at senior level (Grade ten to12) taking either combined science (5124) or pure physics (5054).The process of assimilation and accommodation can be enhanced at senior level provided the construction of prerequisite knowledge is acknowledged at junior level.

In any educational set up, the curriculum is designed in such a way that the pupils learn the basic concepts at an early stage that can be applied at a later stage. This helps the pupils in the process of construction of knowledge based on the prior understood concepts. Learning outcomes depend, among other factors, on the prior-knowledge of the concepts.

1.8.2 Attribution Theory

Poor or good performance in physic may be attributed to lack of preparation in terms of background and prerequisite knowledge, among other factors. The attribution theory explains factors that may be considered responsible for the learners' success or failure. Causal attribution concerns how people understand the reasons for their successes and failures. This research was partly influenced by the attribution theory. Attribution theory is a social cognitive theory of motivation centered upon the belief that retrospective causal attributions have bearing on present and future motivation and achievement (Weiner, 1972).

Attribution theory is concerned with how individuals interpret events and how this relates to their thinking and behavior. Weiner developed a theoretical framework that has become a major research paradigm of social psychology. An overview of the attribution theory according to the Assessing Women in Engineering (AWE) Project (2005, p. 1) states that:

> Attribution theory locates all causal attributions along three dimensions: internal or external, stable or unstable, and controllable/ or uncontrollable. Those people attributing their success to internal, stable and controllable factors tend to be more highly motivated and hence continue to be more successful than those with alternative attribution styles.

In line with the claim in the AWE project it can be analyzed that:

Firstly, the cause of the success or failure may be attributed to internal or external factors. This implies that, learners may succeed or fail because of factors that are believed to have their origin within them or because of factors that originate in their environment.

Secondly, the cause of the success or failure may be attributed to either stable or unstable factors. If cause is believed to be stable, then the outcome is likely to be the same if we adhere to the same criteria on different occurrence. If it is unstable, the outcome is likely to be different on another occasion.

Thirdly, the cause of the success or failure may be attributed to either controllable or uncontrollable factors. A controllable factor is one which we believe we ourselves can alter if we wish to do so. An uncontrollable factor is one that we do not believe we can easily alter.

From this explanation it can be seen that some certainty exists that we can control or cannot control success or failure. These are subjective personal beliefs which are in accordance with locus of control by Rotter (1966). This is a concept which refers to the extent to which individuals believe that they can control events that affect them. Individuals with an internal locus of control believe that events result primarily from their own actions. Those with an external locus of control believe that others' (for example, teachers) fate, bad luck, actions or chance primarily determine outcomes (Weiner, 2000).

The theory of attribution applies to this study in many different ways. When the pupils perform poorly they can attribute their failure to external factors such as; the subject or certain topics being too difficult, the examination being too hard, inadequate learning materials and teachers not being serious to teach. When they perform well, however, they may attribute their success to internal factors such as; commitment, hard work, adequate preparation, studying hard, understanding the topics and finding the subject easy to understand. Moreover, their success or failure may be attributed to controllable factors such as prerequisite knowledge and uncontrollable factors such as the subject or particular topics being too abstract. If prerequisite knowledge is lacking, some measures may be taken to provide it and the outcome can be altered. Nevertheless, if the subject or a particular topic is abstract there is nothing that can be done. It will still be abstract. On a brighter side, hope should be manifest, given that the causes of failure can be changed, all of which, in turn, should lead to increased persistence and improved performance. Here it seems that controllable attributions for failure can produce expectations, emotions, and behaviors that might lead to scholastic success.

1.9 Limitations

The study could not ascertain the predictive aspect of the extent to which the performance in physics can change if the topics are rearranged and prerequisites are reconsidered. The concern of which could be a recommendation for future studies. This is so because the study comprised of a proposal of strategies that could be adopted for possible improvements in performance.

The study was mainly concerned with physics topics and as such, the findings may not be generalized or applied to other subjects in which candidates may have the similar performance. The factors that are attributed to the poor performance in physics may not be the same with the ones in other subjects where pupils have the similar performance.

In order for the data to be more reliable, there had to be as many respondents as possible. However, there were restrictions when it came to obtain data from the students and pupils who were in examination classes. This is because they were usually preoccupied with studies for examinations. This in turn narrowed the scope of the sample nature of the study. Out of all the questionnaires that were administered only a few were retrieved. The response gave a confidence interval of 95% consequently the generalizability of the findings was pushed to lower bounds.

Due to time and resource constraints, the data collected was not completely representative and the results could not be extrapolated.

Some respondents took too long to return the questionnaires and some never returned even after follow-ups were made. It's been difficult to obtain data from some institutions as it was not always released on time owing to bureaucracy. This restricted the sampling to fewer institutions. Nevertheless, with much persistence enough data was collected.

CHAPTER 2

LITERATURE REVIEW

The goal of this chapter was to gather information from many sources that are relevant to the subject in this study. It aims at showing current literature on the topic and forms the basis for another goal, such as the justification for future research in the study area. According to Hart (1998), a literature review is an objective, thorough summary and critical analysis of the relevant available research and non-research literature on the topic being studied. In this view it entails that the extent to which the literature summary and analysis is presented depends on the nature of the study. The literature review in this study is restricted to research and non-research work that pertains to the pupils' performance in physics and consideration of prerequisite knowledge for physics at senior secondary school level of education.

The review was divided into distinct categories. The policy on science education was initially highlighted and was further segmented into policy on science education and quality of education and teacher preparation. The importance of physics in various aspects of human life was considered for review as literature. Further the review brought to attention the record of how the performance in physics as recorded by various publications about a few selected schools and years. The review highlighted some topics in physics which are perceived to be difficulty or easy by some students. Finally the review explored some of the related studies which had an inclination on the importance of prerequisite knowledge and some efforts made to improve the performance in physics.

2.1 Policy on Science education

The policies outlined below were the ones formulated and undertaken by the Ministry of General Education in Zambia in a document that is cited herein. The policy on science education may be categorized into quality of education and teacher preparation for the meaningful educational experience for the learner.

2.1.1 Quality of Education

In order to attain most educational goals, focus on the quality of education provided is very important. Ensuring good quality of education in physics at junior level of education may provide a strong foundation for the learners so that as they proceed to senior secondary level, they have fewer difficulties in understanding advanced concepts in physics. In the national policy document an emphasis is placed on the provision of good quality education at junior level of education. This can imply provision of a strong foundation for the learners.

> If science, technology and practical subjects are to be properly taught and meaningfully learned in basic schools, they will require not only teachers who are competent to teach these fields, but also schools that are adequately supplied with equipment, apparatus and relevant books. Meeting the needs in this regard of the 400 or so existing basic schools will be a daunting task, but it is one that the Ministry must undertake if the education provided through these schools is to be of value to the pupils and to society (MOE, 1996, p. 28).

It is affirmative to note here that the MOGE is committed to ensuring that a strong foundation for the learners is provided through its endeavors to meet the demands for adequate learning materials and a conducive learning environment. Physics, like many others, is a practical subject that requires early exposure, for both the teacher and the learners, to hands-on experiments at junior level of education. In light of this, the school curriculum may be revisited for possible changes and rearrangement of physics topics. However, any of such alterations depend on thorough research and determination of what the curriculum stakeholders perceive.

2.1.2 Teacher Preparation

Qualified teachers of science are at the center of providing the necessary knowledge and skills in science. The quality of science education at basic level of education requires well trained and specialized subject teachers. The Ministry of General Education has set targets towards equipping teachers for science subjects so that pupils can adequately prepare for senior secondary level of education.

> A critical input for basic schools is teachers who are qualified for subject-based teaching in grades eight and nine. Currently, some primary-level teachers are being upgraded for this purpose at the National In-service Training College (NISTCOL) in Chalimbana……The output from NISTCOL will help to meet some of the current needs, but will not be adequate to respond to all of them. Neither will NISTCOL be able on its own to respond to future needs for a greatly increased number of teachers for grades eight and nine… In view of this…the Ministry will seek to mobilize resources for the development of a new college for the training of teachers for the complete range of basic education, from grade 1 to grade 9 (MOE, 1996, p. 28).

Teachers of science that teach at junior level are expected to be qualified so that they are able to examine science inquiry skills that learners need to develop and help the learners to develop familiarity and dexterity with laboratory apparatus and their value in real life situations.

2.2 Importance of physics

The importance of physics in our daily lives cannot be over emphasized. Whether we acknowledge it or not physics works for us and makes our lives easier in many ways.

Physics education in a school set up has several functions and benefits to offer to both the school and the pupils. According to Reif (1985, p. 148),

> Physics education must give the student a systematic training in careful observation, in experiment, and in the estimation for the relative value of results. It must provide, for all pupils knowledge of the material world and of the forces

of nature at the same time for the small proportion of pupils who would later become scientists or those who would become technicians. Physics education must lay a sound foundation for more advanced work in the field of science and technology.

The individual value of studying physics naturally leads to benefits to the country as a whole.

From Erinosho's perspective (2013), physics is basic for understanding the complexities of modern technology, and essential for technological advancement of a nation. This aspect of science is making significant contribution to many of the inventions that are shaping modern day, and has helped to explain many of the events being encountered in everyday life.

Erinosho's perspective brings to light a general outlook on the importance of physics in many aspects of human activities. The present age is different from all the previous eras only because of the scientific inventions which are in daily use of mankind. Hameed (2005) argue that the life of today's human being is completely dependent upon the machinery and industry. The bicycles, cars, motor vehicles, rails, aeroplanes, telephones, wireless, televisions, radios, electrical appliances in houses, hospitals and offices all are due to the application of the laws of physics. General observations may affirm that the industrial revolution is based on technology, which is the application of physics and other branches of science. These are the moments that physicists should live for. The importance of physics takes root in many aspects of our daily lives as highlighted hereunder.

In Sport

The application of physics in sports is observable. When watching athletes, all the principles of physics can be seen in action. The bat hitting the ball, the spiraling football, the bend in the vault's pole, and the tension of muscles as a weight is lifted illustrate some of the basic laws of physics, like momentum, equilibrium, velocity, kinetic energy, center of gravity, projectile motion, and friction. Knowing these principles of physics helps an athlete or coach improve performance and a driver of a sports car to understand the friction between the tyres and the road, velocity, kinetic energy and momentum of the car (Hameed, **2005).** It all streams from the basic building blocks of physics concepts to accumulate this knowledge with such an essential application in sports.

In Health Imaging Techniques

Looking inside the body without surgery is one of medicine's most important tools.
X-rays, computed tomography (CT) scans, and magnetic-resonance imaging are used to determine bone damage, diagnose disease, and develop treatment for various illnesses (Nadeem, 2005).

Technicians who use imaging equipment need to be familiar with the concepts of x-rays and magnetic resonance, and to be able to determine how much of this powerful technology to use. Imaging technicians work at hospitals, medical colleges, and clinics.

In environment

Environmental physicists are studying ozone-layer depletion and other problems involving the atmosphere. They use acoustics to try to reduce noise-pollution. They search for cleaner forms of fuel and renewable sources of energy which are environmentally friendly such as wind and solar energy. They devise ways in which to dispose of and store nuclear waste safely.

In agriculture

Like in many other areas of human activities, the importance and application of physics in agriculture is vast. Soil and water are the two fundamental resources of nature for agriculture. Akhter and Malik (2005) pronounce that the knowledge of physics played a significant role in the 'Green-Revolution' of agriculture in the 20th century. Green-revolution made tremendous contribution to food-production despite some environmental stress it caused in the developing countries.

The increasing role of physics in agriculture has its deep roots in the middle of the 19th century, at the time in which development and production of the agricultural machines was taken from the hands of craftsmen by the agriculture-industry. The invention of tractors; the knowledge of plant-fertilizer; as well as discovery of the simple genetic rules, formed the basis for miraculous development of agriculture in the 20th century. Physics contributed in finding solutions of nearly all the basic technological problems. This process also continued in the 20th century and physics found its permanent position among the agricultural engineers. The second part of the 20th century was accompanied by quick increase of the role of physics in agricultural sciences. The period from 1960s to1980s was mainly the "golden era" for development of physical properties of agricultural materials (Akhter & Malik, 2005).

Physics has its application in assessment of soil-salinity. Soil salinity is the content of salt in the soil. As the case may be, almost all irrigation-water contains salts. These salts remain in the soil as the plants use water. These salts accumulate if proper leaching is not applied and reduce crop yields (International Institute for Land Reclamation and Improvement [ILRI], 1989). According to ILRI (1989), leaching in agriculture refers to the loss of water-soluble plant nutrients from the soil, due to rain and irrigation. Periodic monitoring of soil-salinity is recommended where salinity is a potential problem. Measurement of salinity involves collecting soil-samples and taking saturated extracts of the soil and analysis of its chemical constituents. The most common way to assess soil salinity is by measuring electrical conductivity of the saturated extracts of soil (Akhter, Waheed, Aslam, & Malik, 1987).

Basic knowledge on electrical conductivity can be acquired at both junior and senior level of education.

In terms of water as fundamental resource in agriculture, physics is still applied. Akhter, Waheed, Haq, Malik, and Naqvi (1986) affirm that both stable and radioactive environmental isotopes are extensively used now-a-days to trace the movements of water in the hydrological cycle. Isotopes can be used to investigate underground-sources of water to determine their source, how they are recharged, whether they are at risk of saltwater intrusion or pollution, and whether they can be used in a sustainable manner.

In economic growth

The growth of an economy depends on several factors among which, is the application of physics. For the Zambian and other economies to grow and be rebalanced in favor of high-tech, knowledge intensive industries, there must be more and more-focused support for physics based businesses through innovative public procurement and more ready access to the capital essential for growth. Zambia Electricity Supply Company (ZESCO) has a mandate to generate and supply electricity throughout the country. Zambia Information and Communications Technology Authority (ZICTA) is empowered to regulate the provision of electronic communication services and products and monitor the performance of the sector, including the levels of investment and the availability, quality, cost and standards of the electronic communication services. These companies among others play a vital role in the economy of the country. Therefore, being able to employ physicists, electrical engineers, software programmers and mechanical engineers is important to these companies. The presence of skilled personnel can enhance the operations of these companies.

Just like in the United Kingdom (UK), Connor (2013) of the Institute Of Physics argues that:

> More than 500 000 people are employed in high-value physics-based manufacturing in the UK, contributing more than £20 billion to the UK economy directly, and creating products and devices that enable growth in the aerospace and electricity generation sectors. Physics technologies such as photonics and precision optics drive progress in the information economy and the life sciences.
>
> Physics drives employment across the UK. Large employers such as Seagate in Northern Ireland use physics to develop advanced computer hard drives; Oxford Instruments is a world-leading manufacturer and exporter of scientific equipment used in the development of novel materials. More people are employed in physics based businesses in the UK than in both the finance and construction sectors.
>
> The recent economic downturn affected physics-based sectors as much as the broader economy, but the signs are there that physics can lead the recovery.
>
> Exports from physics-based business amounted to more than £100 bn in 2009, physics-based business in the UK account for more exports as a share of the total

> than those in France. Physics-based sectors have increased their investment in research and development in the years following the crash (p. 2).

From the illustration above it can be seen that the role that physics plays in driving the economy not only in the UK but also across the world may not be overemphasized. The global economic recovery and progress has had its reliance partly on the application of physics, among other factors.

Physics is one of the most fundamental natural sciences. It involves the study of universal laws, and the behaviors and relationships among a wide range of physical phenomena. Through the learning of physics, students will acquire conceptual and procedural knowledge relevant to their daily life. In addition to the relevance and intrinsic beauty of physics, a study of physics also helps students to develop an understanding of the practical applications of physics to a wide variety of other fields. With a solid foundation in physics, students should be able to appreciate the intrinsic beauty and quantitative nature of physical phenomena, and the role of physics in many important developments in engineering, medicine, economics and other scientific and technological fields.

Furthermore, learning about the contributions, issues and problems related to innovations in physics will help students to develop a holistic view of the relation of science, technology and society. The contribution of physics to humanity is ongoing. During the American Physics Society meeting at the National Academy Of Science (April 27, 2009), the then President of the United States of America Barak Obama once articulated that:

> At such a difficult moment, there are those who say we cannot afford to invest in science. That support for research is somehow a luxury at a moment defined by necessities. I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been (Murray, 2009, p. 21).

The importance of physics as outlined in this section (though not fully exhausted) continues to improve and make life easier and more bearable.

2.3 Physics topics perceived easy or difficulty

A case study carried out in Kenyan secondary schools to ascertain difficult topics in the physics curriculum proved useful to various curriculum stakeholders. The performance and enrolment of students in physics has not been impressive. It appears that a fear of physics exists within students and this fear seems to be related to a level of difficulty the students associate with physics. Many students either opt to not take physics with the expectation of failure.

> The study, therefore, sought to identify the areas of Kenyan Physics curriculum that the teachers and students considered as posing difficulty and what accounts for this difficulty. Students were found to have difficulty understanding specific topics in the curriculum that are usually characterized as lacking concrete examples and requiring a lot of mathematical manipulation or visualization (Kiptum, 2015, para. 1).

The findings in their case study indicate the following in terms of the students' point of view.

Table 2: Perceived (%) level of difficulty in Form One topics indicated by students

Topic	Very easy	Easy	Difficulty	Very difficulty
Measurement	50.0	39.0	10.0	1.0
Force and moments	21.0	56.0	20.0	3.0
Equilibrium and center of gravity	17.0	60.0	20.0	3.0
Pressure	23.0	55.0	19.0	3,0
Particulate nature of matter	26.0	30.0	39.0	5.0
Thermal expansion	28.0	39.0	22.0	11.0
Transfer of heat	25.0	44.0	24.0	7.0

Light I	17.0	40.0	36.0	7.0
Electrostatics I	14.0	24.0	46.0	16.0
Current electricity I	12.0	39.0	33.0	16.0

Source: (Kiptum, 2015, p. 74)

From Table 2 it can be seen that measurements, force and moments, equilibrium and center of gravity, pressure and particulate nature of matter are the topics that were perceived as being easier by the students. On the other hand, the level of difficulty increased in the other topics.

Table 3: Perceived (%) level of difficulty in Form Two topics indicated by students

Topic	Very easy	Easy	Difficulty	Very difficulty
Mechanical properties of matter	21.0	47.0	26.0	6.0
Magnetism	18.0	45.0	31.0	6.0
Magnetic effect of an electric current	11.0	50.0	30.0	9.0
Force and moment II	17.0	55.0	23.0	5.0
Linear motion	12.0	56.0	27.0	5.0
Work energy power and machines	10.0	49.0	36.0	5.0
waves I	9.0	34.0	48.0	9.0
Sound I	16.0	38.0	33.0	13.0

Source: (Kiptum, 2015, p. 75)

According to Table 3 it can be seen that the level of difficulty was the highest in waves and sound. From this table of analysis, one would assume that the poor performance in physics is due to the topics that are perceived difficult. The learners' perceptions on the difficulty of certain topics in physics explains why the performance has been the way it is.

In the 2014 national examinations in Zambia, candidates' examination answer scripts were sampled in order to assess their performance in the physics component. Some candidates exhibited lack of understanding in some topics.

Most candidates that sit pure physics and chemistry are selected from those with strong science background and perform better. The ECZ (2015) points out thus:

> In science, the performance in the physics components was very poor. The sampled scripts show that most candidates have challenges that are related to the mastery of the concepts, mathematical manipulation and the interpretation of practical observation and skills in drawing graphs. Some topics like electronics, nuclear atoms in physics and mole concept and organic chemistry are either scantly covered or are not covered at all. These tend to give challenges to most candidates (p. 56).

The ECZ argued that the candidates did not have in-depth understanding of the topics where they faired poorly. Radioactivity, electromagnetism, electronics and nuclear atoms are covered later in grade twelve but were faired poorly. This is an indication that there could be inadequate preparation or at least a problem related to prerequisite knowledge in those topics.

This section has outlined different publications on how the performance in physics has been. Despite the importance of physics as outlined earlier, literature on the performance indicates that the performance in physics has continued to be poor.

2.4 Related Studies

Some researchers locally and from around the world have done similar studies. The related studies signal three categories that include the importance of prerequisite knowledge of physics, the introduction of physics in junior secondary schools and general efforts or measures to improve the performance in physics.

2.4.1 Importance of pre-requisite knowledge

Some studies have emphasized on the need for prerequisite knowledge of physics for a meaningful educational experience for the learners.

Jenaro (2005) stressed on the teaching-learning process in physics. He began by identifying the pupils' initial stage. What pupils knew and how they reasoned about physics while they were in an initial stage. He then looked at the desired final stage of intellectual achievement after instruction, and the underlying knowledge and thinking processes necessary to obtain the desired achievement. Finally he identified the final stage they would be required to attain and latter identifies the processes of educational transformation to make it possible for the pupils to get from the initial to the final stage. These methods might also apply at the lower levels of education. However, they can only be successful provided they are applied on the concepts that pupils can easily grasp. This study was mainly concerned with the possibilities of restructuring the integrated science and physics syllabi in attempt to provide the pupils with a background that may help to improve the performance in physics.

Prerequisite knowledge might also extend to background knowledge in mathematics as a supporting subject. Mathematics is an essential component of physics. It is a tool used to study, understand and apply physics. In his study, Kaulu (2008) highlighted the learners' need for mathematical skills in order to tackle some topics in physics, particularly kinematics. He articulated that:

> No matter how the teachers teach the topic of kinematics using traditional methods, the pupils' perception of kinematics has remained the same. They complain that kinematics has too many formulae and calculations and either no explanation is given to certain concepts by the teacher or the explanation given is not clear (p. 11).

This brings to light the possible hindrances, among others, which the pupils face in the process of learning physics. As highlighted, the background knowledge is a factor to reckon with and without which the ultimate performance may be affected. Further in his study Kaulu agued that the lack of prerequisite knowledge in mathematics has contributed to the poor performance in physics.

In the same vein, Andreas, Hansson, Hansson O. and Juter (n.d, Discussion Section) highlight the role of mathematics in teaching and learning of physics.

In the physics teachers' community there are many ideas about the role of mathematics in physics teaching. For example:

- Mathematics is the language of physics
- Students need some specific knowledge in mathematics to study physics

There is also talk about mathematics as a hindrance – the reason why physics studies are difficult. Students 'get stuck' in the mathematics. Hence, there are several reasons to investigate the role of mathematics in the physics teaching of today.

2.4.2 Efforts to improve performance in Physics

From a general point of view, some studies have been carried out in an attempt to find ways to improve the pupils' performance in physics by suggesting different measures in policy making and approaches in teaching.

Adeyemo (2010) discussed several issues in an endeavor to show ways of improving the performance in physics among which were: communication problems in physics teaching and learning and expected goals on physics teaching/learning in this century and beyond. He argued that physics which has been found to be the bedrock of scientific and technological development worldwide in both developed and undeveloped countries alike, has some features which are generally accepted and believed to widen the knowledge and increase the horizon of understanding of physics by the learners. These features are made essential because it is believed that if they are duly and critically followed and applied in any given situation and at any given period of time will be able to make this subject easy to comprehend by learners. As a result, they would nullify the misconception of people, students and teachers of physics, other subject teachers, parents and community at large about physics. Some of these essential features are as follows:

a. The method of teaching physics should be discovery method instead of the old and routine lecture method used in teaching the subject. This was recommended due to the fact that learning efficiency and effectiveness takes place during explanation, experimentation and discussion.
b. There should be interaction between the teacher of physics and the students. In this case, it is believed that it is genuine and helpful interaction between the teacher and students that the students will be able to expose their minds to their teachers and thereby reduce the difficulties they encounter.
c. Each topic should have to contribute and aid the understanding of the new topic. Topics should be sequentially arranged in logical order so that the knowledge gained could be retained, transferrable and applicable to any physical challenges.
d. Each topic should be taught in a way that it takes into consideration its relevance to the societal norms and values so that each student can appreciate the values and norms of the society in which they live.

Among others, these features discussed were aimed at improving the performance of students in physics.

In some countries publications to guide and effect the teaching of physics in junior high schools have been made and are already in use. A few of these publications are shown in this section.

Firstly, a popular and relatively new movement 'Physics First' was initiated, which sought to make the curriculum of the 9^{th} grade pupil to take a course with introductory physics. This was meant to enrich pupils' understanding of physics and allow for more detail to be taught in subsequent high school biology and chemistry classes; it also aimed at increasing the number of pupils who take physics at senior level of education. However, this movement was specifically in American schools where the curriculum was different from the Zambian curriculum.

Secondly, a Sourcebook for Teachers 'Physics is Fun' written by Roberto Trostli (1995), is a guide for teaching Physics in grade six, seven and eight. It has a compilation for demonstrations for the teacher and activities for the pupils.

In view of the above, it can arguably be stated that, the introduction and rearrangement of some physics topics at junior level of education is a possibility. The uncertainty here is that whether there could be success and improvement in performance if this approach was taken locally in Zambian schools. This may be left as a recommendation for future or further studies.

2.5 Summary

The chapter reviewed the literature of different studies and researchers on various aspects that include quality of education, teacher preparation, importance of physics, record of performance, physics topics perceived easy and difficult and related studies bordering on importance of prerequisite knowledge and efforts to improve performance in physics. Further, the chapter established the impact of the research as it has been done globally but very little has been conducted in Zambia particularly Lusaka district concerning the approach on prerequisites to physics topics. The chapter also reviewed how wide the problem of performance in physics is hence the importance of undertaking the research.

CHAPTER 3

METHODOLOGY

This chapter highlights a framework for the way the research project was conducted and shows the details for the procedures necessary for obtaining the information needed to structure or solve the problems in this research. It begins by explaining the research design which was used and later shows how the research instrument was tested in the pilot survey, the population which was targeted, the appropriate sampling procedures, research instruments used, methods of data collection, the actual sample size for the study, strategy for data analysis and finally some of ethics which guided the researcher throughout the study process.

3.1 Research Design

The study was a mixed methodology in that both qualitative and quantitative approaches were used. An exploratory research design was used because the study was inclined on coming up with ideas and insights from the science scholars concerning the research problems that were highlighted. According to Gal and Prigat (2004), in an exploratory research design the main objective is to provide insights and understanding. In characteristic, the information needed is defined only loosely, the research process is flexible and unstructured, the sample is small and non representative and the analysis of primary data is qualitative. The findings are tentative and the outcome is generally followed by further exploratory or conclusive research. The type of exploratory design used was the case and document analysis in that existing records were examined and the situation pertaining to performance in physics and science was analyzed. The major emphasis was on gaining ideas and insights from the respondents. It was not designed to come up with the final answer or decision but rather to provide the ideas and insight from the respondents on how the pupils' performance in physics and science can be improved. On the basis of this design, the researcher was guided on sampling procedures (see Section 3.4 Sampling Procedure) and methods of data analysis (see Section 3.8 Data Analysis).

The first row of the likert scale that was used had an instruction for the respondents and a key for the abbreviations used to state the extent of agreement. Beside each statement there are letters abbreviated to show the extent of agreement on which the respondents were requested to circle as per instruction. The abbreviations used where *SD* for strongly disagree, *D* for disagree, *U* for undecided, *A* for agree and *SA* for strongly agree. After circling the extent of agreement, each category of respondents was shown on how they responded to each statement in form of a frequency table. The frequency tables used in the result analysis are an extraction from the ones generated in the SPSS software. They are presented with only three columns: the response column which shows the extent of agreement, frequency column which shows the number of respondents for each extent of agreement and the percent column showing the percentage of respondents. This is explained in detail under the results in the next chapter.

3.2 Pilot Survey

Before the main study the researcher needed some form of assurance whether the process of sampling, data collection and analysis was not going to be repeated many times. In order to do this, a pilot survey was carried out so that the research instruments could be tested. It was a way of finding any flaws in the research questionnaire that might have been overlooked. The pilot survey provided an insight on how much data could be necessary and what sort of research design would give the most solid answers to the research questions. The questionnaire was redesigned based on the results from the pilot survey. This shaded more light on how the best information could be obtained from the respondents. Rugg and Petre (2007) stressed on the importance of undertaking a pilot survey. Thus:

> It's wiser still to pilot your study carefully, including piloting the data analysis, which will give you a much sounder idea of how much data you actually need, and what the best way is to collect and analyze it. You can then get a much more interesting and solid result from a much smaller amount of effort (p.82).

Only a few respondents were selected for the pilot survey and data was separately analyzed.

3.3 Study Population

The population in this study comprised science specialists, educators and learners from different institutions that were selected from within the delimitation. The researcher had access to population in the following institutions:

1. The Curriculum Development Centre (CDC)
2. The Examinations Council of Zambia (ECZ)
3. Zambia Bureau of Standards (ZABS)
4. National Technology and Science Council (NTSC)
5. Selected Colleges
6. Selected Secondary schools

Science specialists, educators and learners constitute the school environment. They are either involved or concerned about the assurance of delivery of good quality education. It was therefore essential for them to get involved in the study that concerns the school curriculum.

The ECZ is a unit of the Ministry of General Education with the responsibility of setting goals, objectives and standards of assessments. The council is responsible for certifying the students' credentials.

The CDC is a unit of the Ministry of General Education with the responsibility of coordinating curriculum process for schools. It is also, involved in the curriculum design and indirectly monitors schools.

The study population was categorized into three different groups of respondents that were purposively selected from the institutions. The categories were:

1. Science specialists. These are people working in the field of science and its application. They were selected from ECZ, CDC, ZABS and NTSC.
2. Educators. These comprised of teachers of science and/or mathematics from randomly selected secondary schools.
3. Learners. The learners comprised pupils from secondary schools and students from selected colleges which offer science or physics courses. Only three to five best

performing pupils were selected per class. They were identified with the help of the class teachers.

Table 4 shows the accessible study population from the selected institutions.

Table 4: Study Population

	Category	**Population (estimate)**
1	Science Specialists	60
2	Educators	400
3	Learners	1000
	Total	**1460**

3.4 Sampling Procedure

In this study the sampling procedure was non-probable and purposive. “Nonprobability sampling or judgment sampling depends on subjective judgment. The non-probability method of sampling is a process where probabilities cannot be assigned to the units objectively” (Salant, 1994, p. 62). The sample nature being pupils, students, teachers and science specialists were all purposively selected based on the judgment of their typicality.

Respondents who have information which is directly related to this study owing to their experience and /or close encounter with the subjects of interest were targeted. This is how the respondents’ typicality was judged. The sample therefore included respondents who were studying, teaching, had taught physics or science and those that were applying physics in their field of specialization.

3.5 Research Instruments

The main research instrument used to collect data in this research was the questionnaire. The questionnaires were administered to the respondents in the selected institutions. Pupils have a tendency of copying from one another and as such, their perceptions may have been replicated.

In order to avoid copying form one another and replication of perceptions, pupils were called to an empty class room in groups of five to ten and then questionnaires were administered to them. In order to answer the research questions and address the objectives as well as the research topic, a structured questionnaire was used because the data had to be quantified. In this study a questionnaire was the appropriate method of data collection. A thorough introduction was given for the respondents to understand the purpose for the research and the institution under which the research was carried out. The demographic data included in the questionnaire was in line with the purposive sampling procedure. A likert scale was included on which the respondents had to indicate their level of agreement and disagreement to the statements.

3.6 Data Collection Procedures

In order to accomplish the specific research objectives and questions with the instruments used data was systematically collected in three distinct ways.

The first set of data was on the respondents' perceptions on the rearrangement and introduction of some physics topics that may enhance the performance. This set of data was collected by the researcher with the help of a questionnaire developed to elicit responses relevant to achieve the aims and objectives. According to Burns and Grove (2001, p. 426), a questionnaire is a "printed self-report form designed to elicit information" and is developed with specific items to assist with the data collection. The development of the questionnaire involved deciding on the type of questions, compiling the questions, and refining the questionnaire. The demographic details did not require the identity of the respondents, thereby maintaining confidentiality. The questionnaire was structured and guided by the study problem, purpose and objectives.

The second set of data was on pupil's' performance in physics. Related studies on the performance of pupils in physics were cited in the literature review. The records compiled by the Examinations Council of Zambia on the general performance of pupils in various subjects were obtained on permission. For the purpose of comparisons in performance the compulsory subjects of interest were singled out. These were picked from different years and from a number of selected schools in Lusaka province. The performance analysis done by the Senior Planning Officer from the Ministry Of General Education was also consulted. This record of performance was for all the schools in the entire Lusaka province in English, mathematics and science for the year 2014.

The third set of data was inclined on document analysis. The researcher collected copies of the integrated science (grade eight and nine), and physics and science syllabi (grade 10 to 12) and the English grade eight and nine and ten to12 syllabi.

3.7 Sample Size

The sample size was determined from the questionnaires that the researcher managed to retrieve from the respondents. The breakdown is shown in Table 5.

Table 5: Sample size

	Sample Nature	**Sample Size**
1	Science Specialists	54
2	Educators	98
3	Learners	160
	Total	**312**

Source: (Field data, 2016)

Out of the 312 respondents 169 were male and 143 were female. Gender was considered in order to avoid gender bias in the presentation of respondents' perceptions.

Table 6 shows further demographic information of the sample.

Table 6: Demographic information

Education Status	**Number of respondents**	**Level at which they taught physics/science**	**Number of respondents**
Grade 1-12	156	Grade 1-9	27
Primary Teachers' Certificate	16	Grade 10-12	69
Diploma	93	College level	7
Bachelor's Degree	41	University level	5

Masters Degree	3	Not any	201
Other	3	Unanswered	3

Source: (Field data, 2016)

Being a purposive sampling procedure, the information in Table 6 was needed to countercheck how much experience and knowledge the respondents had in physics and/or science. The majority of respondents were pupils in schools followed by the diploma holders. This indicates that the targeted population was seemingly knowledgeable about the topic of study. Even though the majority of respondents (pupils and students) had never taught physics, their experience was considerable because they were actually studying physics/science, a fact which gave them a better standing in preferences on the perceptions.

3.8 Data Analysis

The analysis in this study depended on the nature of data set which was collected. The data on the pupil's performance in physics was analyzed descriptively using statistical methods. In order to present quantitative descriptions on pupils' performance in physics in a manageable form, Statistical Package for Social Sciences (SPSS) software was used.

The perceptions of teachers, students, pupils and science specialist on the rearrangement and introduction of some physics topics were categorized into different statements. Their extent of agreement or disagreement to the statements was quantified. The tables were drawn using data from the SPSS analysis. From the tables charts were drawn in order to show an aggregate of their responses to the statements.

In order to describe how the pupils performed in the selected years, only credit or better was considered. Table 7 shows how the grades are categorized.

Table 7: Grade categories

Grade	Category	Percentage %
1	Distinction	75 – 100
2	Distinction	70 – 74
3	Merit	65- 69
4	Credit	60 – 64

When a pupil scores grade 3 in six subjects, he/she is given a total of 18 points which are within division 1 of the basic requirements for entry into tertiary education. Some reputable colleges and other institutions of higher learning would require pupils to present at least five credits or better as a threshold for admission into school.

One-way ANOVA tests using SPSS were conducted to compare the pupils' performance in English, mathematics, biology physics and science. This was an effort to determine the significance in the deference in their performance. The pupils' performance in these subjects may differ to varying extents, but in order to attach the statistical significance to the way they differ, the ANOVA tests had to be used. The significance was expressed as p-value. If the p-value is less than 0.05 it implies that the difference is significant. This condition justifies the rejection of the null hypothesis. The *F* statistic is the ratio of the Between Group Variation divided by the Within Group Variation. A large *F* statistic is evidence against the H_O – the hypothesis that the means of all groups are equal.

The effect size in the performance mean differences among the subjects was calculated using eta squared:

$$\text{Eta squared} = \frac{\text{Sum of squares between groups}}{\text{Total sum of squares}}$$

(Brown, 2008, para. 3)

The calculation of effect size is usually not embedded in the SPSS software.

An updated edition of the Grissom and Kim work states that "whereas a test of statistical significance is traditionally used to provide evidence (attained *p* level) that a null hypothesis is wrong, an effect size (ES) measures the degree to which such a null hypothesis is wrong (if it is wrong)" (Grissom & Kim, 2012, p. 5).

Further post-hoc comparisons using Tukey's Honest Significant Difference (HSD) tests were carried out in order to ascertain which of the performance mean in particular differed significantly from the other means. According to Stevens (1999),

> Post-hoc tests are designed for situations in which the researcher has already obtained a significant omnibus F-test with a factor that consists of three or more means and additional exploration of the differences among means is needed to provide specific information on which means are significantly different from each other (p. 4).

The concern is how to determine which of the means are significantly different from the others.

The analysis on pupils' performance was based on the empirical data obtained from the ECZ the MOE. The data used on pupils' performance was not subjective to any conditions and, therefore, in the analysis there was no bias or skew. Empirical data is essential because it promotes objectivity. "Objectivism is the highest form of respect for the subjects we are studying. It respects their psychological reality as something meaningful and important which must be accurately comprehended" (Ratner, 2002, p.14).

Ratner further argued that:

> The researcher must organize his subjectivity appropriately. Hypothetical concepts must be well defined so that they can be identified unambiguously. An appropriate methodology must be adopted in order to solicit complete, meaningful evidence that can be used to test the validity of hypothetical concepts. And the evidence must be analyzed through sensitive, systematic procedures which can detect its features and compare them to the characteristics of hypothetical concepts (p. 15).

Therefore, the results obtained from the analysis of performance depict the true picture of how the candidate's performance had been for the selected number of years.

In order to identify and suggest topics that could enhance the performance of pupils in physics and science the integrated science for junior secondary and physics and science for senior secondary syllabi were studied. Appendices I and II were used to illustrate topics that could enhance the performance of pupils in physics. To begin with, the coverage of topics at both levels was compared. This step helped to identify which topics in the senior secondary syllabus had prerequisite coverage at junior secondary level. Once this was done, reference was made to the ECZ report and other publications which identified topics where the candidates' performance was low. These topics were counterchecked on the table if they had prerequisite coverage. Later the two syllabi were checked for topics that were partly or entirely repeated at both levels. The repeated topics were singled out and presented on tables for further comparisons. Based on the findings, the researcher suggested actions to be taken to identify the topics and how the performance could be enhanced. The analysis in this section was totally dependent on the review of necessary documents.

3.9 Ethical Considerations

A number of factors were considered on ethical grounds in order to avoid possible forms of infringement with the respondents and the methods of data collection and analysis. High standards of research ethics were maintained at all stages of the research. Participants' right to privacy was respected as their names were not disclosed. The ethics considered were those that address the plight of respondents and institutions from which data was to be collected and the treatment of data. These factors were addressed as follows:

a. *Respondents*

They were given necessary and adequate information when they demanded an explanation on why they were involved.

b. *Institutions*

An introductory letter was used in order to obtain consent in data collection from selected institutions.

c. *Data*

i. The data was not falsified or used selectively to fit or support any pre-conceived hypotheses and was not statistically manipulated for any reason.

ii. All conclusions were warranted by the research findings. No conclusion was drawn without reference to the results of the study.

Today, there are ethical principles for research to help ensure that people who participate are not harmed. If people are afraid that research is unethical, nobody will participate. Without participants, it will be impossible to develop scientifically. We all benefit from the advances made possible through science research. Research ethics are considered in order to uphold principles such as social value, scientific validity, fair subject selection, favorable risk-benefit ratio, independent review, informed consent and respect for enrolled subject (Emanuel, 2003, p. 4).

This chapter described the research methodology in detail. The researcher developed a questionnaire as the data-collection instrument designed to elicit those responses relevant and essential to the research problem. The researcher collected all the information in person and confidentiality was maintained throughout the study.

CHAPTER 4

RESULTS

This chapter presents the findings of the study. The pilot survey results were presented separately in order to provide a more and thorough comparison with results for the main study. Later in this chapter the perceptions of respondents on whether some topics in physics and science at secondary level could be rearranged and taught at earlier stages, are presented. In addition, performance of pupils in science and physics is presented for a number of selected years from 2003 to 2014. This includes a record of performance in physics and science from selected sources. The performance presented is in comparison with other selected core and compulsory subjects. Furthermore, the chapter presents the suggestions and identification of the topics that can enhance the performance in physics. The topics that can enhance the performance of pupils in physics and science are highlighted from the syllabi with respect to the analysis of performance.

4.1 Pilot Survey Results

The pilot survey was carried out in order to test the research instrument. The pilot survey results show the respondent's perceptions on whether some physics topics could be rearranged and some taught at earlier stages as an attempt to enhance pupils' performance. Table 8 shows the level at which the respondents taught physics or science.

Table 8: Pilot survey respondents who taught physics or science

Level of physics or science taught	Percentage of respondents
Grade 1 – 7	20
Grade 8 – 9	20
Grade 10 – 12	30
College level	Nil
University level	Nil

Source: (Pilot Field Data, 2016)

Table 8 shows that at least some percentage of respondents had taught physics or science up to grade 12.

The respondents rated the general performance of pupils at senior secondary level (grade 10 - 12) as follows: [N = 10]

Good	-	20%
Fair	-	30%
Poor	-	40%
Not sure	-	10%

Respondents predicted the general performance of pupils at senior secondary level if some physics topics were rearranged and taught at earlier stages as follows: [N = 10]

Good	-	40%
Fair	-	40%
Poor	-	Nil
Not sure	-	20%

Table 9 shows a summary of the respondents' perceptions on whether some physics topics could be rearranged and be taught at earlier stages.

Table 9: Pilot Survey respondents' perceptions

Serial	Institution	Sample nature	Gender	Extent of agreement
1	Twashuka Basic School	Teacher	F	Strongly agree
2	Tick School	Pupil	M	Strongly agree
3	Tick School	Teacher	M	Agree
4	Rusangu University	Student (BA)	M	Agree
5	KATEC Basic School	Pupil	F	Strongly disagree
6	National Institute of Public Administration (NIPA)	Student	F	Disagree
7	Libala Secondary School	Pupil	F	No opinion
8	Spring Fields Coaching Centre	Teacher	M	Strongly agree
9	Makeni College School of Nursing	Student	F	Agree
10	Rhodes Park School	Pupil	M	Strongly agree

Source: (Field data, 2016)

The results in Table 9 suggest that the majority of respondents were in favor of the idea of rearranging some physics topics and some to be taught at earlier stages. Since the sample size for the pilot survey was not adequately representative.

The pilot survey results revealed the following for the main study:

- The sample nature was to be maintained for the research questions to be answered.
- Oral interviews were not necessary. The questionnaire for the main study was to be designed in such a way that there were some open ended questions in place of the interview transcriptions.
- From their perspectives, all the respondents were capable of answering the questionnaire satisfactorily. Their responses were enough to answer the research questions. Therefore, they were subjected to the same questionnaire.
- Minor alterations were to be made in the questionnaire for the main study (see Appendix IV and V).

4.2 Respondents' perceptions

Out of the estimated population of 1460, only 312 questionnaires could be retrieved. This gave a confidence level 95% and margin error of 5%.

In light of the observations made on the analysis of results and the pupils' performance in certain topics, the study probed further to find out what the scholars perceive about the approach of rearranging the topics in physics at senior secondary (grade 10 to 12) and junior secondary level of education (grade eight and nine).

This section outlines the respondents' perceptions on the questionnaire statements. Their perceptions are quantified and presented in form of frequency tables that indicate their extent of agreement or disagreement to the statements. An aggregate of their perceptions is presented in form of a column chart.

Statement 1:

Pupils perform generally well in physics at senior level of education.

Statement 1 of the likert scale suggests that pupils performed generally well in physics at senior level of education. What respondents perceive about this statement is based on their experience and observations made throughout their encounter in the study of physics. However their response and perception on this statement may not be completely reliable because they were not referring to some empirical evidence.

Table 10: Respondents' perceptions on statement 1

Extent of agreement	**Respondents' perceptions (%)**				**Average (%)**
	Teachers	**Students**	**Pupils**	**Specialists**	
Strongly disagree	0.0	27.0	6.0	8.7	**10.4**
Disagree	37.5	35.1	38.0	30.4	**35.3**
Undecided	4.2	10.8	8.0	17.4	**10.1**
Agree	54.2	16.2	30.0	30.4	**32.7**
Strongly agree	4.2	10.8	18.0	13.0	**11.5**

Source: (Field data, 2016)

The implication of data in Table 10 is as follows:

Teachers' perceptions

Teachers, particularly those that teach science are on an implementation stage of the science/physics curriculum on daily basis. Their perception on this statement is dependent on the feedback or response they get from the learners during and after the implementation of the curriculum. The feedback is partly due to the cumulative, diagnostic and summative assessments administered to learners, and partly due to observations made by intuition.

The extent of agreement 'strongly disagree' was not responded to by all the teachers. The results indicate that there were more teachers who agreed than those who disagreed. This implies that there were more teachers who suggested that pupils perform generally well in physics at senior level of education.

Students' perceptions

These students had been through senior secondary level of education and have had experience in the physics at this level. There were more students who disagreed than those who disagreed. This implies that students suggested that pupils did not perform generally well in physics at senior level of education. Their perception may not refer to specific empirical data, but it probably appears that their suggestion was due to prevailing trends in the performance of pupils in physics and science.

Pupils' perceptions

There were almost an equal number of pupils who agreed and those who disagreed. According to the pupils' perceptions, there seems to be some uncertainty on their part whether the performance in physics was generally well or not. These pupils were either in Grade 10 or 11. This implies that they may not have had an encounter in the final O' Level physics examination to back up their perceptions.

Science specialists' perceptions

There was almost an equal representation of science specialists who agreed that pupils perform generally well in physics and those that disagreed.

In summary, the respondents’ perceptions on statement 1 can be presented on a column chart as shown in Figure 1.

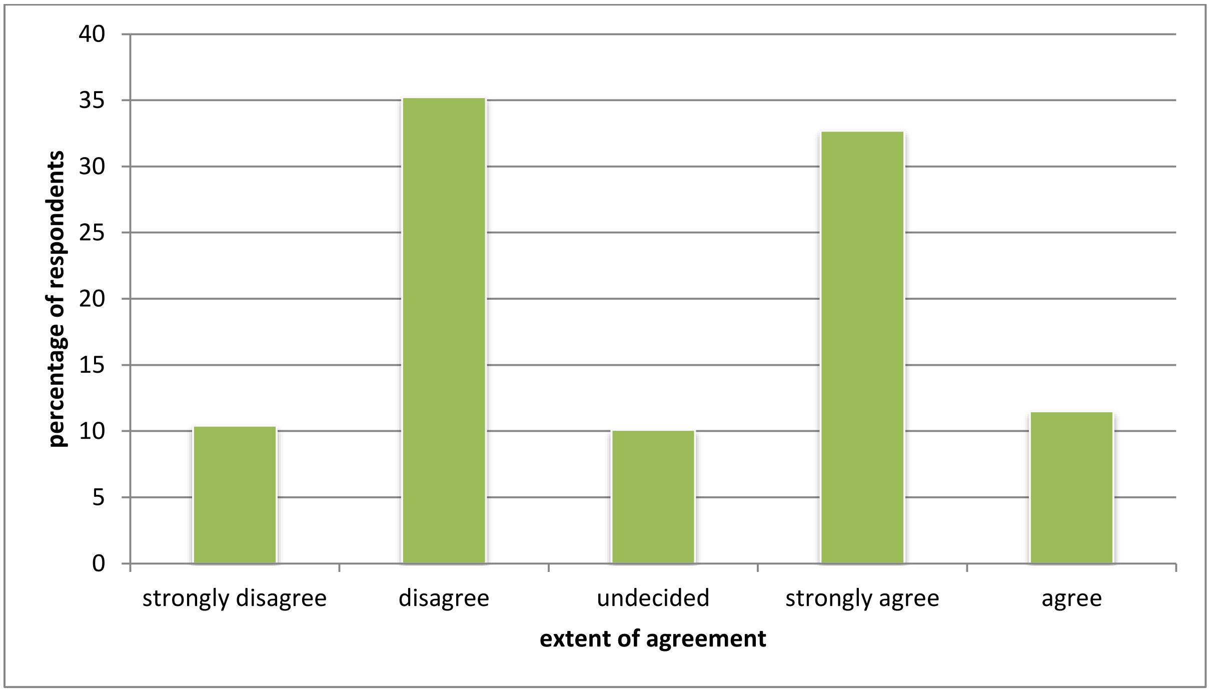

Figure 1: Respondents perceptions on whether pupils performed generally well in physics

Source: (Field data, 2016)

Figure 1 shows that there was almost an equal representation of those that agreed and those that disagreed that pupils performed generally well in physics. The results analysis show otherwise. This implies that some respondents were not preview to the empirical evidence to back up their extent of agreement.

Statement 2:

The physics topics in grade eight and nine Integrated Science are enough for preparation for physics in grade 10-12.

Statement 3 of the likert scale suggests that the physics topics in grade eight and nine Integrated Science are enough for preparation for physics in grade 10-12. What respondents perceive about this statement is shown in Table 11 that indicate their extent of agreement or disagreement to the statement. An aggregate of their perceptions is presented in form of a column chart.

Table 11: Respondents' perceptions on statement 2

Extent of agreement	**Respondents' perceptions (%)**				**Average (%)**
	Teachers	**Students**	**Pupils**	**Specialists**	
Strongly disagree	12.5	13.5	30.0	8.7	**16.2**
Disagree	45.8	27.0	28.0	26.1	**31.7**
Undecided	4.2	5.4	8.0	8.7	**6.6**
Agree	25.0	37.8	26.0	30.4	**29.8**
Strongly agree	12.5	16.2	8.0	26.1	**15.7**

Source: (Field data, 2016)

The implication of data in Table 11 is as follows:

Teachers' perceptions

There were more teachers suggesting that the physics topics in grade eight and nine Integrated Science were not enough for preparation of physics in grade 10-12. From the teachers' perspective, it implies that, even though pupils proceed to do physics in grade 10 their preparation is not enough.

Students' perceptions

More students agreed that the physics topics in grade eight and nine Integrated Science were enough for preparation of physics in grade 10-12. From the students' perspective it implies that the preparation for physics in grade 10 was enough.

Pupils' perceptions

There were more pupils who agreed that physics topics in grade eight and nine Integrated Science were enough for preparation of physics in grade 10-12. From the pupils' perspective it implies that even though pupils proceed to do physics in grade 10, their preparation is not enough. This perception could emanate from the notion that as the pupils encountered new concepts in physics some gaps were exposed which made them feel unprepared.

Science specialists' perceptions

There were more science specialists who agreed that the physics topics in grade eight and nine Integrated Science were enough for preparation of physics in grade 10-12. From the science specialists' perspective it implies that pupils prepare enough before they proceed to do physics in grade 10. In spite of some specialists' perceptions, the results suggest otherwise. This could suggest that the pupils' challenges spring from grade 10 – 12 before they sit for final examinations.

In summary, the respondents' perceptions on whether the physics topics in grade eight and nine Integrated Science were enough for preparation for physics in grade 10-12 are aggregated in the column chart in Figure 2.

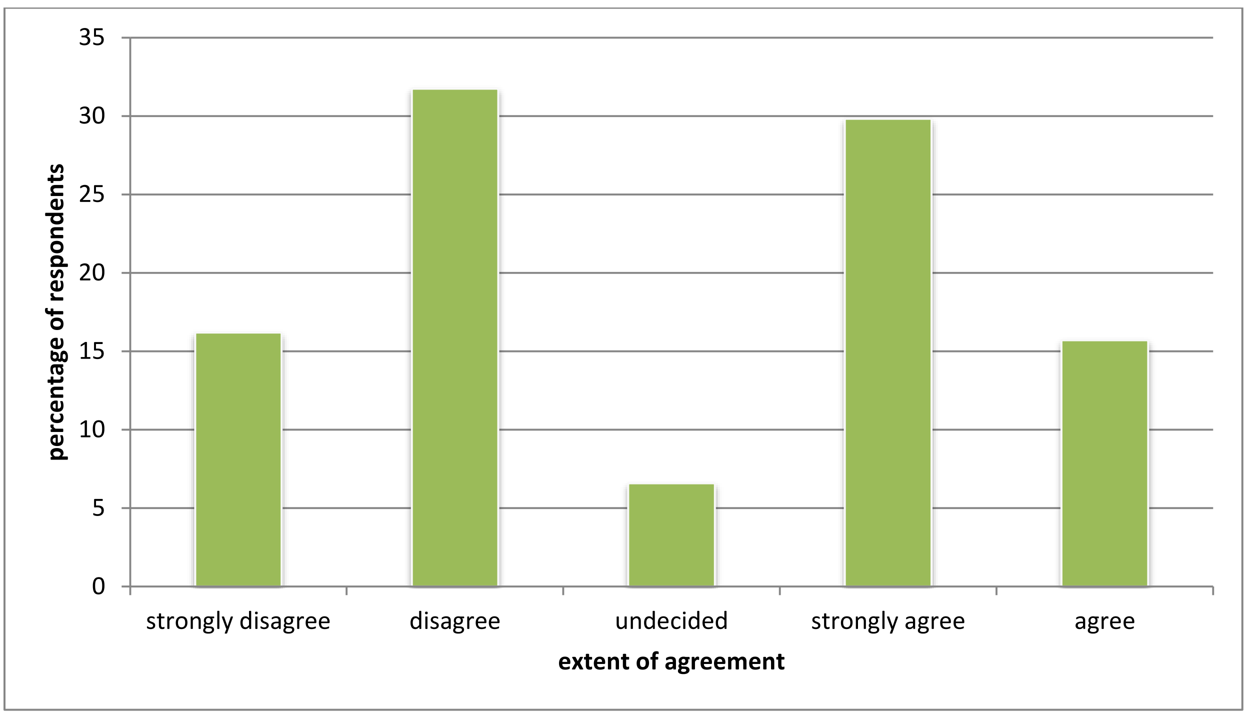

Figure 2: Respondents' perceptions on whether the physics topics in grade eight and nine Integrated Science were enough for preparation for physics in grade 10-12

Source: (Field data, 2016)

Figure 2 shows that there were slightly more respondents suggesting that the physics topics in grade eight and nine Integrated Science were not enough for preparation of physics in grade 10-12.

Statement 3:

Physics is better understood than most other subjects in grade 10 - 12.

What respondents perceive about this statement is shown in form of frequency tables that indicate their extent of agreement or disagreement to the statement. An aggregate of their perceptions is presented in form of a column chart.

Table 12: Respondents' perceptions on statement 3

Extent of agreement	**Respondents' perceptions (%)**				**Average (%)**
	Teachers	**Students**	**Pupils**	**Specialists**	
Strongly disagree	29.2	24.3	16.0	17.4	**21.7**
Disagree	20.8	40.5	32.0	52.2	**36.4**
Undecided	29.2	13.5	14.0	21.7	**19.6**
Agree	16.7	10.8	28.0	4.3	**15.0**
Strongly agree	4.2	10.8	10.0	4.3	**7.3**

Source: (Field data, 2016)

The implication of data in Table 12 is as follows:

Teachers' perceptions

There were more teachers who disagreed than those who agreed. From the teachers' perspective it implies that most other subjects are better understood than physics in grade 10 – 12.

Students' perceptions

There were more students who disagreed than those who agreed. From the students' perspective, it implies that most other subjects are better understood than physics in grade 10 - 12.

Pupils' perceptions

There were more pupils who disagreed than those who agreed. From the pupils' perspective, it implies that most other subjects are better understood than physics in grade 10 - 12.

Science specialists' perceptions

There were more science specialists who disagreed than those who agreed. From the science specialists' perspective, it implies that, most other subjects are better understood than physics in grade 10 - 12.

In summary, the respondents' perceptions on whether physics is better understood than most other subjects in grade 10 - 12 are summarized as shown in Figure 3.

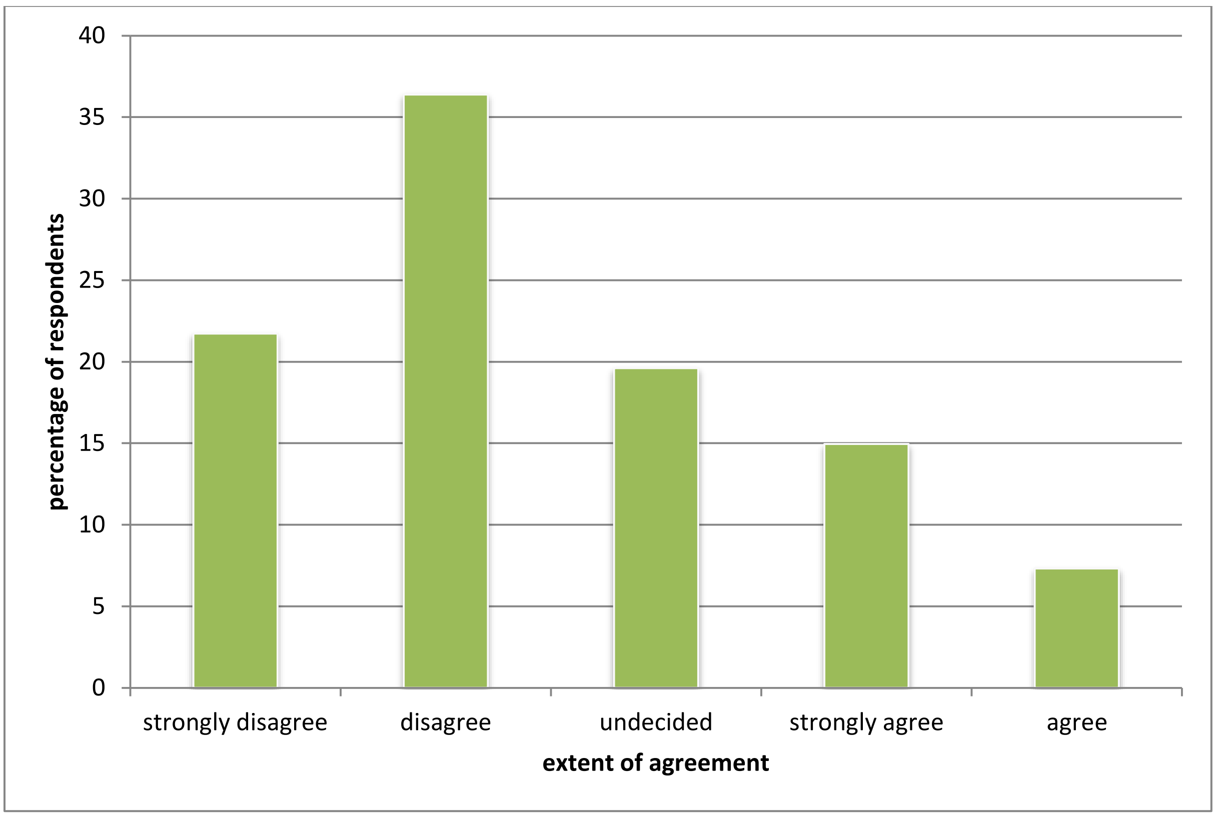

Figure 3: Respondents' perceptions on whether physics is better understood than most other subjects in grade 10 - 12

Source: (Field data, 2016)

Figure 3 shows that there were more respondents who disagreed than those who agreed. From the respondents' perspective, it implies that, other subjects in grade 10 – 12 are better understood than physics. Going by the frequency of those who agreed and those who disagreed, it can arguably be said that physics in grade 10 - 12 is more difficult to understand than most other subjects an assumption which is in tandem with what is depicted in the performance analysis.

Statement 4:

Some topics in grade 10 - 12 physics such as electromagnetism and electronics can be done at earlier stages.

What respondents perceive about this statement is shown in form of frequency tables that indicate their extent of agreement or disagreement to the statement. An aggregate of their perceptions is presented in form of a column chart.

Table 13: Respondents' perceptions on statement 4

Extent of agreement	**Respondents' perceptions (%)**				**Average (%)**
	Teachers	**Students**	**Pupils**	**Specialists**	
Strongly disagree	0.0	18.9	8.0	8.7	**8.9**
Disagree	12.5	10.8	4.0	8.7	**9.0**
Undecided	4.2	2.7	6.0	8.7	**5.4**
Agree	58.3	45.9	62.0	56.5	**55.7**
Strongly agree	25.0	21.6	20.0	17.4	**21.0**

Source: (Field data, 2016)

The implication of data in Table 13 is as follows:

Teachers' perceptions

There were more teachers who agreed than those who disagreed. From the teachers' perspective it implies that it is possible that some topics in grade 10-12 physics can be done at earlier stages.

Students' perceptions

There were more students who agreed than those who disagreed. From the students' perspective it implies that it is possible that some topics in grade 10-12 physics can be done in grade eight and nine.

Pupils' perceptions

There were more pupils who agreed than those who disagreed. From the pupils' perspective it implies that it is possible that some topics in grade 10-12 physics can be done at earlier stages.

Science specialists' perceptions

There were more science specialists who agreed than those who disagreed. From the science specialists' perspective it implies that it is possible that some topics in grade 10-12 physics can be done at earlier stages.

In conclusion, the perceptions of respondents on whether some topics in grade 10-12 physics can be done in grade eight and nine are summarized in the bar graph shown in Figure 4.

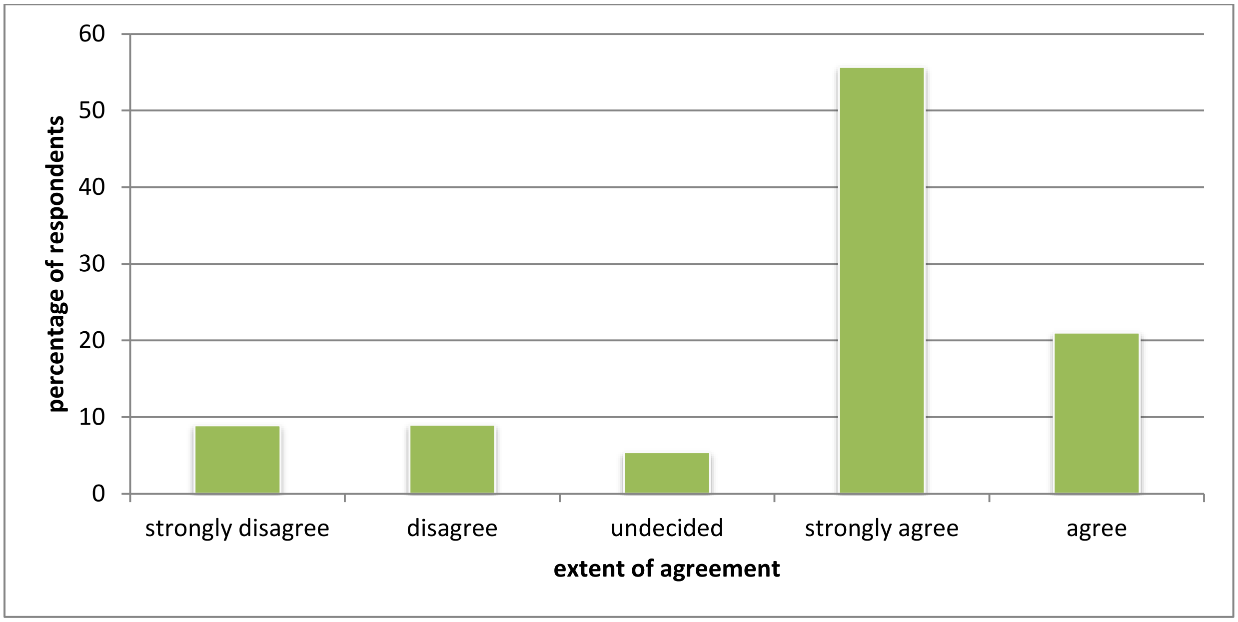

Figure 4: Perceptions of respondents on whether some topics in grade 10-12 physics can be done in grade eight and nine

Source: (Field data, 2016)

Figure 4 shows that there were more respondents who agreed than those who disagreed. From the respondents' perspective it implies that it is possible that some topics in grade 10-12 physics can be done at earlier stages.

Statement 5:

It is easier to understand physics in grade 10-12 if some topics were covered at earlier stages or in grade eight and nine.

What respondents perceive about this statement is shown in form of frequency tables that indicate their extent of agreement or disagreement to the statement. An aggregate of their perceptions is presented in form of a column chart.

Table 14: Respondents' perceptions on statement 5

Extent of agreement	**Respondents' perceptions (%)**				**Average (%)**
	Teachers	**Students**	**Pupils**	**Specialists**	
Strongly disagree	0.0	10.8	0.0	8.7	**4.9**
Disagree	8.3	16.2	4.0	13.0	**10.4**
Undecided	4.2	2.7	8.0	8.7	**5.9**
Agree	41.7	40.5	50.0	56.5	**47.2**
Strongly agree	45.8	29.7	38.0	13.0	**31.6**

Source: (Field data, 2016)

The implication of data in Table 14 is as follows:

Teachers' perceptions

There were more teachers who agreed than those who disagreed. From the teachers' perspective it implies that it is easier to understand physics in grade 10-12 if some topics were covered at earlier stages.

Students' perceptions

There were more students who agreed than those who disagreed. From the students' perspective it implies that it is easier to understand physics in grade 10 if some topics were covered at earlier stages.

Pupils' perceptions

There were more pupils who agreed than those who disagreed. From the pupils' perspective it implies that it is easier to understand physics in grade 10 if some topics were covered at earlier stages.

Science specialists' perceptions

There were more science specialists who agreed than those who disagreed. From the science specialists' perspective it implies that it is easier to understand physics in grade 10 if some topics were covered at earlier stages.

In conclusion, the perceptions of respondents on whether it would be easier to understand physics in grade 10 if some topics are covered in grade eight and nine are summarized shown on the column chart in Figure 5.

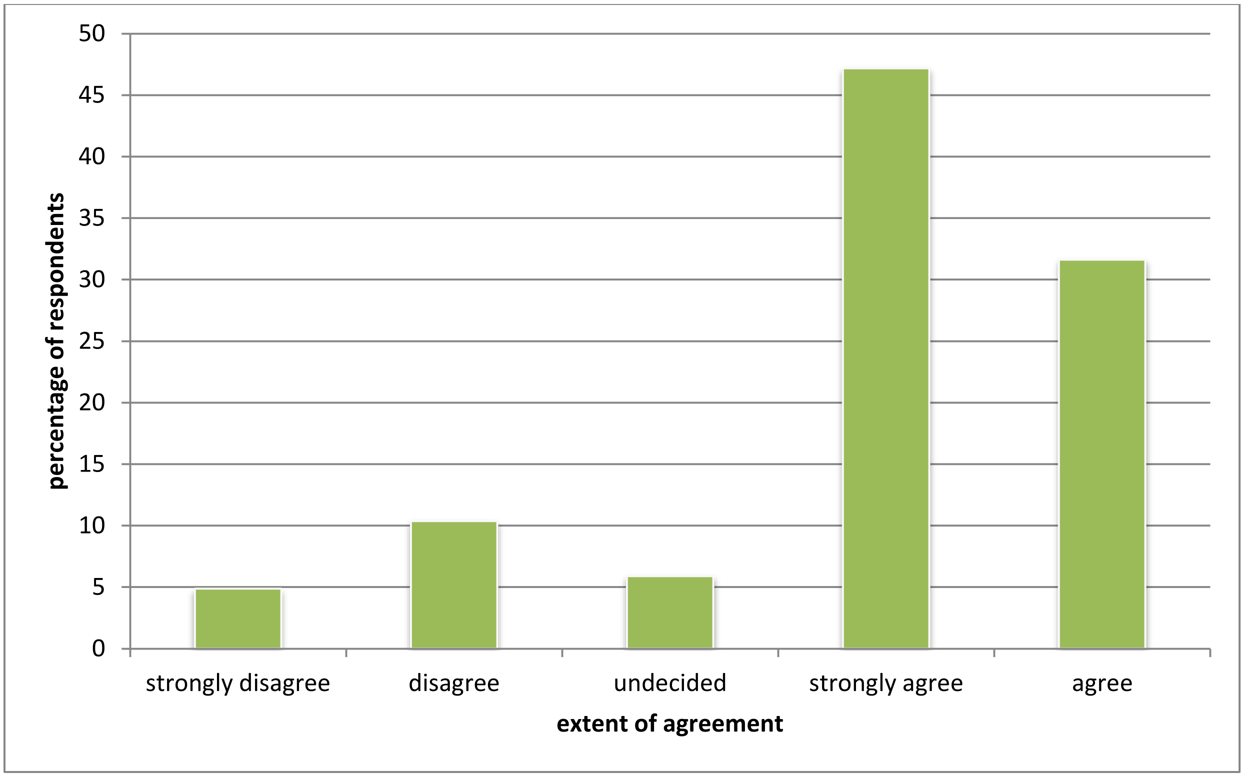

Figure 5: Perceptions of respondents on whether it would be easier to understand physics in grade 10 if some topics were covered at earlier stages

Source: (Field data, 2016)

Figure 5 shows that there were more respondents who agreed than those who disagreed. From their perspective it implies that it is easier to understand physics in grade 10 if some topics are covered in grade eight and nine.

Statement 6:

If some physics topics are taught at earlier stages or in grade eight and nine, pupils can perform better in grade 10-12 physics.

This is a predictive statement stemmed on the need and importance of prerequisite knowledge in physics. What respondents perceive about this statement is shown in form of frequency tables that indicate their extent of agreement or disagreement to the statement. An aggregate of their perceptions is presented in form of a column chart.

Table 15: Respondents' perceptions on statement 6

Extent of agreement	Respondents' perceptions (%)				Average (%)
	Teachers	Students	Pupils	Specialists	
Strongly disagree	0.0	13.5	0.0	8.7	**5.6**
Disagree	12.5	8.1	0.0	8.7	**7.3**
Undecided	0.0	0.0	4.0	21.7	**6.4**
Agree	45.8	40.5	42.0	30.4	**39.7**
Strongly agree	41.7	37.8	54.0	30.4	**41.0**

Source: (Field data, 2016)

The implication of data in Table 15 is as follows:

Teachers' perceptions

There were more teachers who agreed than those who disagreed. From the teachers' perspective it implies that if some physics topics are taught in grade eight and nine, pupils can perform better at senior level of education.

Students' perceptions

There were more students who agreed than those who disagreed. From the students' perspective it implies that if some physics topics are taught in grade eight and nine, pupils can perform better at senior level of education.

Pupils' perceptions

There were more pupils who agreed than those who were undecided. None of them disagreed. From the pupils' perspective it implies that if some physics topics are taught in grade eight and nine, pupils can perform better at senior level of education.

Science specialists' perceptions

There were more science specialists who agreed than those who disagreed. From the science specialists' perspective it implies that if some physics topics are taught in grade eight and nine, pupils can perform better at senior level of education.

In conclusion, the respondents' perceptions on whether pupils could perform better at senior level if some physics topics are taught in grade eight and nine are summarized in Figure 6.

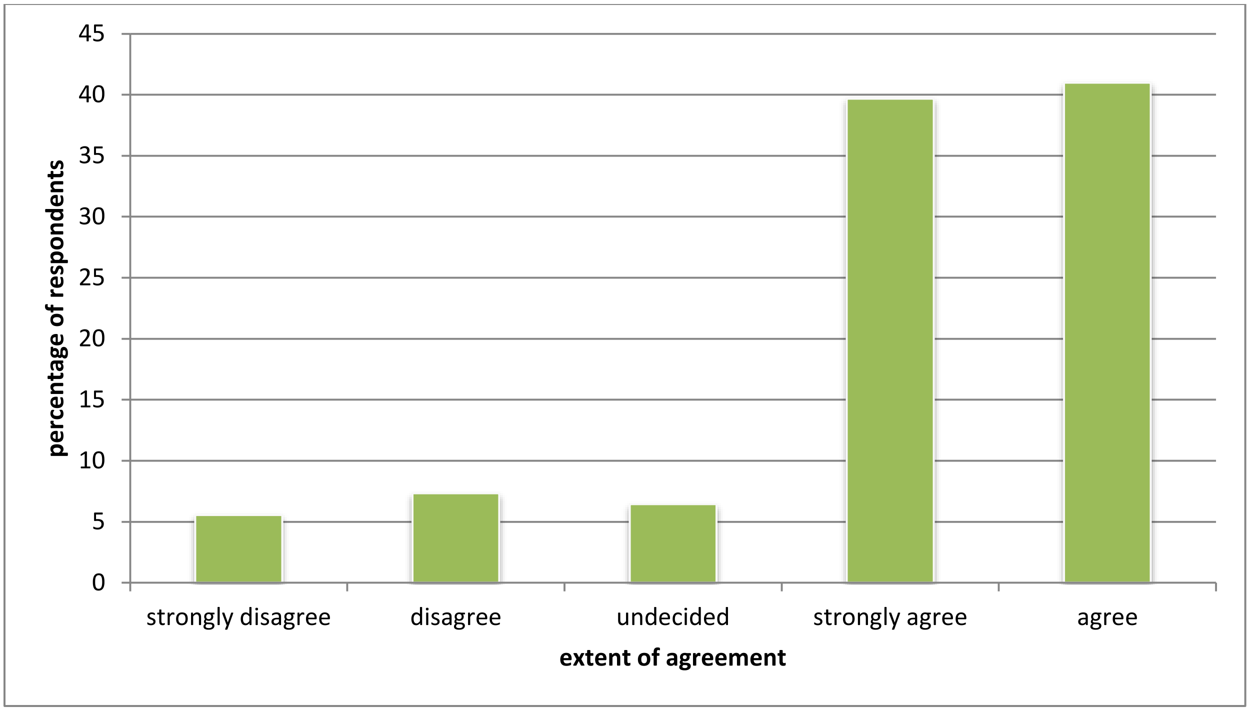

Figure 6: Respondents' perceptions on whether pupils could perform better at senior level if some physics topics are taught in grade eight and nine

Source: (Field data, 2016)

Figure 6 shows that there were more respondents who agreed than those who disagreed. From the respondents' perspective it implies that if some physics topics are taught in grade eight and nine, pupils can perform better at senior level of education.

Generally, the scholars perceive that:

- Pupils do not performed generally well in physics.

- The physics topics in grade eight and nine Integrated Science were not enough for preparation for physics in grade 10-12.
- Physics in grade 10 - 12 is more difficult to understand than most other subjects.
- Some topics in grade 10-12 physics can be done in grade eight and nine.
- It is easier to understand physics in grade 10 if some topics are covered in grade eight and nine.
- If some physics topics are taught at junior level (grade eight and nine), pupils can perform better at senior level of education (grade 10 - 12).

This chapter has revealed that pupils' performance in physics and science has generally and consistently been poor even when compared with other selected core subjects such as biology, mathematics and English. It has also been shown that the candidates performed poorly owing to lack of in-depth understanding especially in those topics which did not have adequate prerequisite coverage at earlier stages. Most respondents seem to agree that the pupils do not generally have adequate preparation for the physics at secondary school level. Moreover, the respondents are in agreement that pupils' performance in physics could be better if some topics had prerequisite coverage at earlier stages. In light of these findings, Gagne's model of instruction design affirms the importance of instructional design in aligning physics topics for better performance. Failure to acknowledge the role that prerequisite knowledge plays in the instruction design could be attributed to the poor performance in physics as exhibited by candidates.

4.3 Performance of pupils in Science relative to other selected subjects

The performance of pupils in physics and science was compared with other core subjects from a few selected schools that offer physics and science as a single subject. The analysis of performance was done for the years 2003, 2009 and 2014 from selected schools in Lusaka province.

Table 16 shows the performance of pupils from selected schools in Lusaka province in 2003.

Table 16: Performance in science and physics (2003) – credit or better

#	School	Credit or better %				
		English	Mathematics	Biology	Physics	Science
1.	**A**	93.71	90.55	97.78	65.79	100
2.	**B**	60	22.92	55.44	[2]N/A	38.19
3.	**C**	86.29	50.73	61.23	40.42	63.32
4.	**D**	75.29	58.81	48.87	18.42	75.39
5.	**E**	50.66	21.71	30.87	29.41	11.96
6.	**F**	98.75	60	85.36	34.61	85.18
7.	**G**	92.46	32.2	65.6	23.59	36.52
8.	**H**	98.94	87.23	97.87	63.63	96.37
9.	**I**	80.96	30.54	62.26	13.79	49.46
10.	**J**	99.99	69.87	97.59	75	85.11
11.	**K**	83.02	49.63	62.8	60	76.65
12.	**L**	87.93	65.77	84.03	27.28	76.23
13.	**M**	86.63	57.37	75.5	26.4	60.47
14.	**N**	83.35	82.29	77.89	N/A	77.08
15.	**O**	51.71	28.65	47.45	N/A	76.82
16.	**P**	99.54	93.95	98.15	84.33	N/A
17.	**Q**	100	45.45	51.51	N/A	60.6
18.	**R**	89.76	38.53	75.17	N/A	64.31
19.	**S**	81.11	59.47	82.47	47.27	89.37
20.	**T**	93.91	64.64	86.95	46.35	N/A

Source: (ECZ,2008)

Table **16** shows that some schools performed exceptionally well in physics and science. School A with 100% in science and school P with 84% in physics were exceptionally outstanding. Other

[2] N/A – Not Applicable: The subject is not offered at the particular school.

schools performed fairly well. However, most schools did not perform well in physics and science.

In order to explore the mean differences in performance among the subjects, a one-way ANOVA was carried out. The results of the ANOVA revealed that there was a statistically significant difference in the performance among the subjects at the $p < .05$ level. F (4, 88) = 10.6, p = .000. In addition to reaching statistical significance, the actual difference in mean scores among the subjects was large. The effect size calculated using eta squared, was .32. Post-hoc comparisons using Tukey's HSD test indicated that the mean score for physics (M = 43.75, SD = 21.72) was the least and significantly different from English (*M* = 84.70, *SD* = 15.10).

Another selection of schools was done in order to ascertain how the performance has been after 2003 analysis. The performance of pupils from selected schools in Lusaka province in 2009 is shown in Table 17.

Table 17: Performance in science and physics (2009) – credit or better

#	School	Credit or better (%)				
		English	**Mathematics**	**Biology**	**Physics**	**Science**
1.	**A**	94.53	87.60	95.31	80.76	75.48
2.	**B**	74.91	24.00	28.82	N/A	20.26
3.	**C**	77.43	39.16	28.03	11.36	23.61
4.	**D**	100	92.5	100	100	100
5.	**E**	59.87	17.31	17.2	5.00	9.39
6.	**F**	100	82.5	83.75	42.10	61.89
7.	**G**	88.41	23.77	13.24	9.38	9.18
8.	**H**	100	84.71	84.89	85.71	62.49
9.	**I**	85.3	21.63	18.63	22.22	8.64
10.	**J**	96.33	75.61	81.72	66.68	73.02
11.	**K**	85.21	39.82	33.46	39.27	24.94
12.	**L**	92.89	60.35	46.28	30.76	32.67
13.	**M**	75.94	41.52	46.70	37.33	20.12

Source: (ECZ, 2010)

The results presented in the Table 17 show that some schools have consistently been performing well in physics and science. School A and D performed well in science. In physics the performance was good for school D and H. Some schools performed fairly well. However, the majority of schools presented performed poorly in physics and science compared with other subjects.

In order to explore the mean differences in performance among the subjects, a one-way ANOVA was carried out. The results of the ANOVA revealed that there was a statistically significant difference in the performance among the subjects at the $p < .05$ level. $F(4, 55) = 5.106$, $p = .001$. In addition to reaching statistical significance, the actual difference in mean scores among the subjects was large. The effect size calculated using eta squared, was .27. Post-hoc comparisons using Tukey's HSD test indicated that the mean score for science ($M = 41.79$, $SD = 31.20$) followed by physics ($M = 44.21$, $SD = 31.97$) were the least and significantly different from English ($M = 87.99$, $SD = 12.18$).

Table 18 shows the performance of pupils in Science relative to English and Mathematics. This table is extracted from the analysis done for Lusaka Province by the Senior Planning Officer.

Table 18: Percent of pupils who got credit or better - 2014

	English		**Mathematics**		**Science**	
#	School	Credit or Better %	School	Credit or Better %	School	Credit or Better %
1	Kasisi	100.0	St. Mary's	98.6	St. Mary's	100.0
2	Roma	100.0	Kasisi	96.2	Katondwe Girls	100.0
3	St. Mary's	100.0	Kafue Boys	92.4	Kasisi	100.0
4	Malundu	100.0	Matero Boys	90.9	Makeni Islamic	90.9
5	Makeni Islamic	100.0	Mary Queen Of Peace	90.3	Kafue Boys	85.7
6	Mary Queen Of Peace	100.0	Makeni Islamic	89.5	Mary Queen Of Peace	85.2
7	Lake Road	100.0	Malundu	86.2	Matero Boys	82.3
8	Rhodes Park	99.0	Lake Road	84.6	Roma	77.1

9	Kafue Boys	98.5	Katondwe Girls	82.1	Malundu	72.4
10	Crested Crane	97.8	Roma	81.5	Lake Road	70.8
11	Matero Boys	97.0	Rhodes Park	80.2	Thornhill	57.7
12	Kings Highway	96.8	Thornhill	73.2	Crested Crane	54.8
13	Tick	96.4	Crested Crane	71.1	Kasamu	52.2
14	Thornhill	95.8	Rosebank	61.3	Rosebank	50.8
15	Herman Gmeiner	95.6	Kasamu	56.5	Herman Gmeiner	48.9
16	Rosebank	95.2	Pestalozzi	53.8	Tick	47.3
17	Pestalozzi	94.9	Dk	53.5	Pestalozzi	47.1
18	Katondwe Girls	94.9	Herman Gmeiner	53.3	Highland	38.8
19	Longridge	94.4	Luangwa	52.9	Libala	38.1
20	Kasamu	87.0	Mukamambo	52.1	Arakan Boys	37.1
21	Luangwa	86.7	Chudleigh House	51.4	Lumumba	35.7
22	Libala	83.1	Munali Boys	50.3	Luangwa	34.4
23	Dk	83.0	Lumumba	46.4	Firstrate	33.3
24	Chilenje South	82.6	Chilenje South	46.4	Mukamambo	32.3
25	Arakan Girls	81.3	Highland	45.3	Munali Boys	30.5
26	Highland	80.0	Arakan Boys	45.2	Longridge	29.4
27	Firstrate	76.9	Libala	44.8	Chilenje South	29.1
28	Lusaka Sec	76.8	Chitende	44.4	Chunga Sec	27.5
29	Kabulonga Girls	75.9	Kabulonga Boys	43.8	Tina Trust	26.5
30	Mikango	74.3	Chunga Sec	43.5	Parklands	26.4
31	Mukamambo	73.6	Kamwala Sec	43.0	Kamulanga Sec	25.7
32	Chelstone Sec	72.9	Kamulanga Sec	42.5	Kamwala Sec	25.0
33	Kamwala Sec	72.6	Kings Highway	41.9	Naboye	24.8
34	Munali Boys	71.1	Tina Trust	41.2	Chitende	24.7
35	Kamulanga Sec	70.4	Tick	41.1	Chudleigh House	24.3
36	Matero Girls	70.3	Naboye	39.0	Gospel Outreach	23.9

37	Naboye	70.0	Longridge	38.9	Don Gordon	23.6
38	Arakan Boys	69.7	Olympia Sec	38.2	Mwavi Sec	22.9
39	Gospel Outreach	69.4	Mwavi Sec	36.1	Lusaka Sec	22.7
40	J.M. Academy	69.0	Firstrate	36.0	Kings Highway	22.2
41	Olympia Sec	68.3	Lusaka Sec	35.1	Mikango	22.0
42	Mwembeshi Sec	66.2	Parklands	34.9	Kabulonga Boys	21.6
43	Tina Trust	63.2	Chongwe	34.2	Mutema-Chime	21.4
44	Mwavi Sec	63.2	Chirundu	34.2	Olympia Sec	19.8
45	Chirundu	62.5	Don Gordon	33.5	Chelstone Sec	19.3
46	Munali Girls	60.3	Mikango	33.3	Chinika Sec	19.2
47	Dolly Dolar	59.1	Chinika	32.5	Dk	19.0
48	Kabulonga Boys	57.0	Gospel Outreach	31.0	Munali Girls	18.3
49	Mutema-Chime	55.8	Mutema-Chime	27.9	Kafue Day	18.1
50	Tum	55.6	Kabulonga Girls	27.1	Chongwe	18.0
51	Chudleigh House	55.3	Munali Girls	26.9	Willows	17.5
52	Zipas	54.4	Zipas	26.8	Arakan Girls	16.8
53	Willows	53.1	Nampundwe	26.6	J.M. Academy	16.7
54	Parklands	52.5	Kafue Day	26.4	Mwembeshi Sec	16.5
55	Chongwe	50.8	Lady Diana	26.2	Kabulonga Girls	15.5
56	Lumumba	50.0	Arakan Girls	26.0	Chirundu	15.0
57	Taonga	50.0	J.M. Academy	25.4	Zipas	14.4
58	Kafue Day	48.9	Chelstone Sec	25.2	Dolly Dolar	14.3
59	Chitende	43.3	Willows	24.4	Nampundwe	14.2
60	Don Gordon	41.2	Lusitu	24.3	Taonga	12.8
61	Chunga Sec	40.6	Mwembeshi Sec	20.8	Lusitu	12.2
62	Lady Diana	40.5	Matero Girls	20.6	Lady Diana	12.2
63	Lusitu	39.8	Taonga	20.1	Matero Girls	11.9
64	Chinika	39.0	Dolly Dolar	18.2	Tum	9.0
65	Nampundwe	29.9	Tum	16.9	Rhodes Park	0.0

Source: (MESVTEE, 2014)

According to Table 18 above, 65 schools were analyzed. In English the table shows that out of 65 schools, only three had below 40 percent of the pupils who got credit or better. This implies that the performance in English for this particular year was good in most schools in Lusaka province. On the other hand, in Mathematics, out of the 65 schools presented, there were 26 of them which had below 40 percent of pupils who got credit or better. This implies that the pupils' performance in English was better than in mathematics. Furthermore, in Science, out of the 65 schools analyzed, 48 of them had less than 40 percent of pupils who got credit or better. There are more schools with pupils who performed well in English than in mathematics and science.
Going by the statistics depicted in the table one can conclude that the performance in science is poorer than in other subjects. Nevertheless, this may not be generalized to all the subjects and in all the years. What is shown is some empirical basis to ascertain that the performance in science is relatively lower than in other subjects.

In order to explore the mean differences in performance among the subjects, a one-way ANOVA was carried out. The results of the ANOVA revealed that there was a statistically significant difference in the performance among the subjects at the $p < .05$ level. $F\ (2, 192) = 48.06$, $p = .000$. In addition to reaching statistical significance, the actual difference in mean scores among the subjects was large. The effect size calculated using eta squared, was .33. Post-hoc comparisons using Tukey's HSD test indicated that the mean score for science ($M = 35.04$, $SD = 25.25$) was the least and significantly different from English ($M = 73.12$, $SD = 20.11$).

The results analysis shown indicates that the performance of pupils in physics and science was generally below the expected standards and with respect to other selected core subjects. This finding shows a rejection of the null hypothesis. This further reveals that the trend of poor performance has continued for a range of years 2003 to 2014.

4.4 Record of performance in physics and science from selected sources

Many studies and analyses have been done throughout the world to show how the performance in physics and science has been. Attributions have been stipulated as regards the poor or good performance. Conclusions and recommendations have been drawn based on various findings on the performance of candidates in physics and science examinations. This section provides an in-depth record of how the performance in physics and science has been according to the available empirical information and possibly in tandem with the scope of the study.

Maguswi (2011) carried out a study on the performance in physics that had an inclination on the gender aspects of pupils. Her study brings to light a fraction of the picture on the performance in physics from selected schools in central province. The study sought to investigate the factors that have been inhibiting female learners in performing to expected standard during Ordinary Level (O'level) physics examinations despite having been accorded the same learning opportunities with their male counterparts. Findings of the study were that:

Most candidates in 2006 obtained grades seven, eight and nine in physics representing 56% quality pass for males and 35% for the females. This demonstrates a higher failure rate for the female learners in physics at O-Level because the failure percentage for the females was 65% where as for the males it was 44%.

In 2007 most candidates obtained grades seven, eight and nine in physics representing 42% quality pass for males and 33% for the females. This demonstrates a higher failure rate for the female learners in physics at O-Level because the failure percentage for the females was 67% and 58% for the males.

In 2008 most candidates obtained grades seven, eight and nine in physics representing 57% quality pass for males and 28% for the females. This demonstrates a higher failure rate for the female learners in physics at O-Level because the failure percentage for the females was 43% where as for the males was 72%.

Cumulatively, Maguswi established that the majority of candidates who sat for the examination in O'level physics in the years 2006 – 2008 obtained grades seven, eight and nine. She concluded that "… out of 190 candidates 51% (N=96) obtained 7 and 8 leaving 49% (N=94) with quality grades". However, the results of her study reflected only a case of selected schools in central province of Zambia. Therefore the conclusions may not be generalized as the case is.

On the other hand the general performance analysis done by the ECZ in 2015 based on the 2014 national examination results shows that Mathematics also recorded the highest proportion of candidates who failed the examination (51.68 %) followed by Science at 46.64 %. The column chart shown in Figure 7 is an extract of the grade distribution for the School Certificate and General Certificate of Education as shown in the ECZ report.

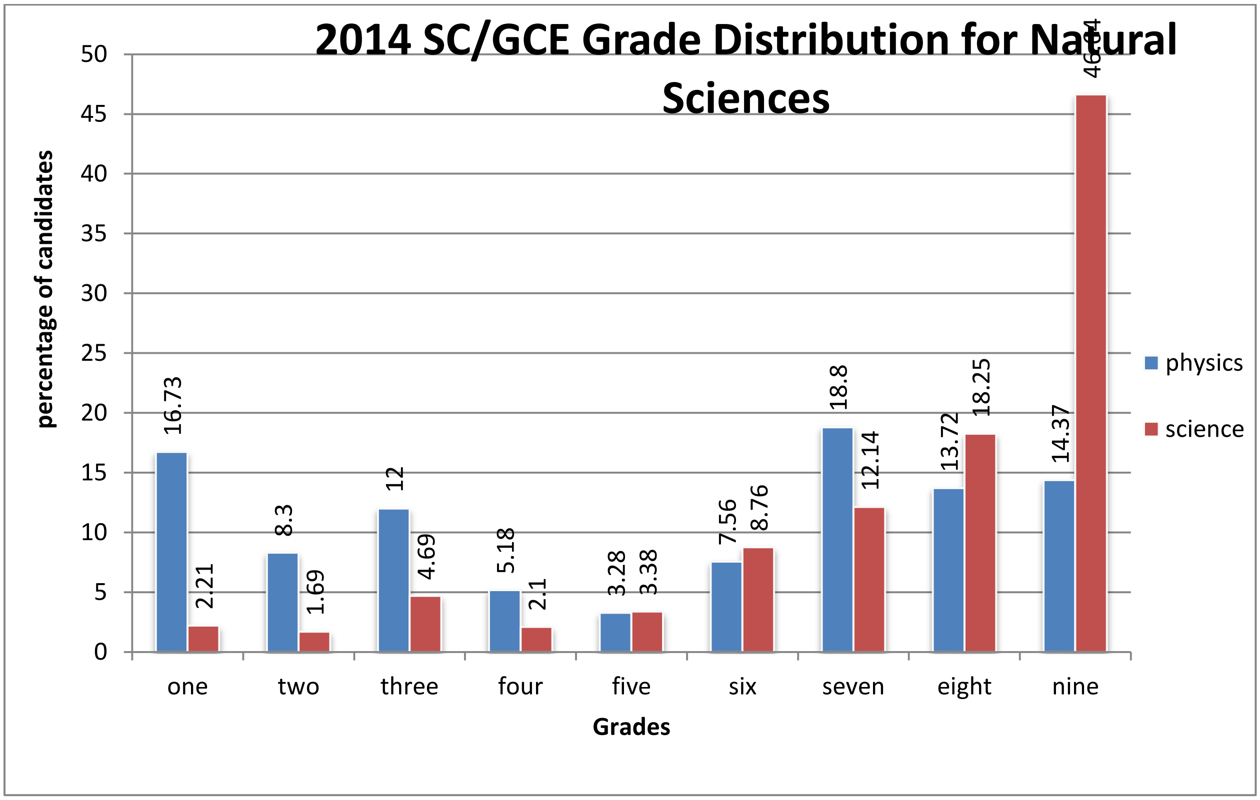

Figure 7: Grade Distribution in Selected Subjects - 2014

Source: (ECZ, 2015, p.16)

The results in Figure 7 indicate that the majority of candidates scored grades seven, eight and nine. Science had the highest percentage of candidates who scored grade nine.

Performance by province was analyzed using an aggregated mean percent score for four subjects namely English, Mathematics, Biology and Science. Table 19 shows the comparison in mean scores as extracted from the ECZ report for 2014 examinations.

Table 19: Performance Ranking by Province in Four Selected Subjects - 2014

	Mean score in %				
Province	**English**	**Mathematics**	**Biology**	**Science**	**Average**
Lusaka	37.8	19.17	23.27	18.32	24.64
Southern	37.09	18.36	23.5	17.79	24.19
Eastern	34.68	19.74	21.81	17.42	23.41
Central	34.91	17.29	22.3	17.93	23.11
National	**34.71**	**17.28**	**21.36**	**17.77**	**22.78**
Luapula	31.95	14.56	20.3	24.25	22.77
Muchinga	33.38	17.28	21.18	17.6	22.36
Northern	32.5	17.78	20.21	16.78	21.82
Northwestern	32.31	15.04	20.79	18.18	21.58
Copperbelt	33.48	15.92	19.57	16.51	21.37
Western	31.71	14.53	19.49	16.14	20.47

Source: (ECZ, 2015, p.17)

Table 19 shows that mathematics and science had the lowest average scores nationwide.

In 2015 a similar performance was exhibited. This is as compiled and reported by Kiwala, Nachibinga and Macwani (2015). Figure 8 shades more light on this.

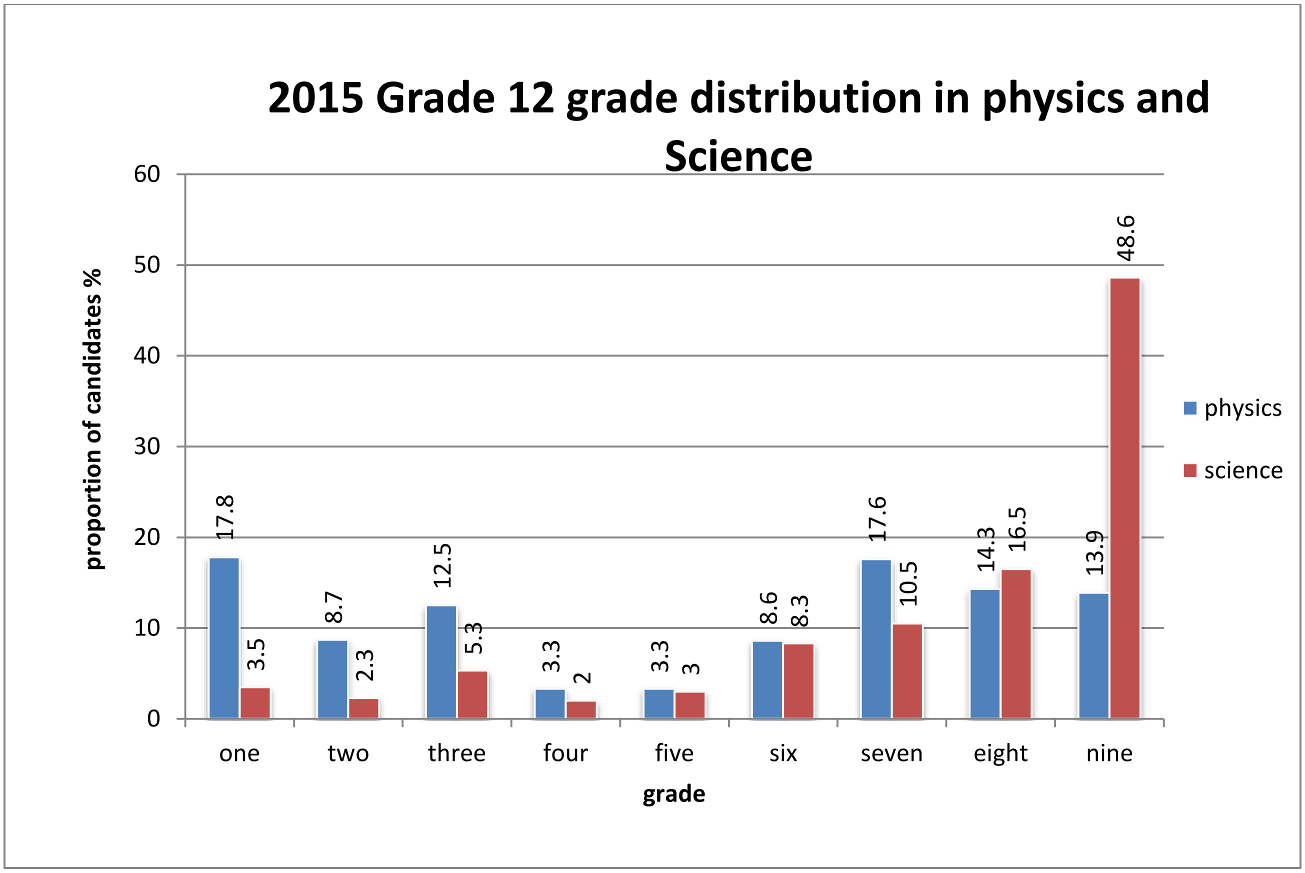

Figure 8: Grade12 grade distribution in physics and sciences - 2015

Source: (ECZ, 2015)

Figure 8 shows that grades seven, eight and nine had the largest percentage of candidates. This kind of performance was exhibited in both physics and science.

4.5 Suggestion of topics that can enhance performance in physics

A scrutiny was made on the syllabi for grade eight and nine and grade 10 – 12 in order to ascertain how the physics topics were covered. Certain topics are reconsidered in grade 10 from grade 9 for the purpose of prerequisite and enrichment of the background knowledge. Table 20 shows the coverage of certain physics topics in grade eight and nine.

Table 20: Physics topics covered in grade eight and nine

Topic	**Sub topic**
Materials and energy	Heat transfer
	Heat and expansion of substances
	Mass and weight
	Density
	Light and its nature
	Electric current and voltage in circuits
	Pressure
	Energy and its conservation
	Communication
	Digital and analogue transmission
	Satellite communication

Source: Grade eight and nine Integrated Science Syllabus

Table 20 is an extract of the integrated science syllabus with an emphasis only on the physics topics.

Table 21 shows the topics that are covered at senior secondary level as they relate to the grade eight and nine topics.

Table 21: Prerequisite coverage of some physics topics

PHYSICS TOPICS G10-12		PRE-REQUISITE COVERAGE
Topic	**Subtopic**	**G8-9**
Unit 1 Measurements	International System of Units (SI)	C
	Length and time	C
	Mass and weight	C
	Density	C
Unit 2 Mechanics	Linear motion	NC
	Forces	NC
	Moment of forces	NC
	Work, Energy and Power	NC
	Simple machines	NC
	Pressure	C
Unit 3 Thermal Physics	Simple kinetic theory of Matter	C
	Measurement of temperature	C
	Expansion of solids, liquids and gases	C
	Heat transfer by conduction, convection and radiation	C
	Measurements of heat	C
Unit 4 Wave motion	Simple ideas of the wave motion theory	C
	Propagation of waves	NC

	Electromagnetic spectrum	NC
Unit 5 Sound	Properties of sound	C
Unit 6 **Light**	Rectilinear propagation of light	C
	Refraction of light	C
	Thin converging and diverging lenses	C
Unit 7 **Magnetism**	Simple phenomenon of magnetism	C
Unit 8 **Static Electricity**	Static Electricity	C
Unit 9 **Current electricity**	Electric charge, current, and potential difference	C
	Electric cells	C
	Electrical resistance	C
	Magnetic effects of electric currents	NC
Unit 10 **Electromagnetic induction**	The phenomenon of electromagnetic induction	NC
	The simple a.c. and d.c. generators	NC
	Transformers	NC
Unit 11 **Basic Electronics**	Thermionic emission and electrons	NC
	Circuit components	NC
	Simple electronic Systems	NC
	Impact of electronics on society and industry	NC

Unit 12 **Atomic physics**	Nuclear atom	C
	Radioactivity	NC

Source: Integrated Science and Physics Syllabi

Key: C – Covered
NC – Not Covered

From Table 21 it can be seen that some topics in grade 10 – 12 have prerequisite coverage in grade eight and nine. The ECZ reports that for 2013 and 2014 the candidates' performance in these topics was medium and low.

The report compiled by ECZ (2014) showed analysis of candidates' performance in physics topics. The summary is shown in Table 22.

Table 22: Analysis of performance in physics topics

s/n	Topic	Comment on Performance
1	Measurements	Good performance
2	Motion	Good performance
3	Energy, work and power	Good performance
4	electricity	Good performance
5	Wave motion and sound	Good performance
6	Mass	Fairly good performance
7	Forces	Average performance
8	Radioactivity	Average performance
9	Thermal physics	Average performance
10	weight	Fairly good performance
11	Electromagnetism	Poor performance
12	Electronics	Poor performance
13	Nuclear atoms	Poor performance

Source: (ECZ, 2014, p. 83)

Some topics such as measurements and mass had prerequisite coverage at earlier stages and the candidates' performance was good. Other topics (forces, electromagnetism and electronics) did not have prerequisite coverage and the candidates' performance was average and poor. Topics such as thermal physics and nuclear atoms had prerequisite coverage but the performance was average and poor respectively. On the other hand, some topics such as linear motion did not have prerequisite coverage but the candidates' performance was good. This odd could be attributed to the nature of the topics.

The ECZ (2014) confirmed that candidates showed lack of in-depth understanding in certain topics. Thus,

> Candidates performed better in the topics measurements, motion, energy, work, power, light, wave motion, sound and electricity. In the topics mass, weight, forces and thermal physics, the candidates' performance was medium. The performance was low in radioactivity, electromagnetism, and introduction to electronics (p. 48).

Most of the physics topics done at junior level are not related to most of the core topics done in physics at senior level even though they are meant to provide pre-requisite knowledge for senior level physics. For example, most of the sub-topics under mechanics are not done in physics related topics at grade eight and nine. Meanwhile, mechanics is one of the first topics done in the first term of grade 10.

A further check reveals that some topics in grade eight and nine are almost entirely repeated in grade 10 – 12. These include: Mass and weight and density. Table 23 shows the coverage of the topic of 'mass and weight' in grade eight and nine and in grade 10.

Table 23: Coverage of mass and weight in grade eight and nine and ten

Grade 8 **Knowledge content**	**Grade 10** **Knowledge content**
➢ Mass as the amount of matter in a substance ➢ Recording mass and its units(flour, rice, salt) in Kg and g ➢ Weight as the pull of gravity on a mass(Weight=mass x acceleration due to gravity) ➢ Note that the acceleration due to gravity is 10N/kg on earth ➢ Recording weight and its units in Newton(N) ➢ Calculating the weight of different substances given the masses ➢ Difference between mass and weight in terms of; nature, measuring instruments, units, and mass is constant while weight varies from place to place	➢ Differences between mass and weight in terms of units, measuring instrument and quantities ➢ Instruments for measuring mass and weight: Using Triple beam balances and spring balances to measure mass and weight ➢ Locating the center of mass of an object: Use of lamina to locate center of mass of an object ➢ Stability of objects in terms of the position of the center of mass e.g. equilibrium (stable ,unstable and neutral)

Source: Integrated Science and Physics Syllabi

In order to create space for other topics and respective prerequisites, the coverage of the topic of ‘mass and weight’ in grade 10 may be focused on new concepts such as ‘center of mass’ and the practical aspect of it. This approach may be feasible to some extent since the pupils come to class with a background on prerequisite knowledge of ‘mass and weight’.

Table 24 shows the coverage of the topic of density in grade eight and nine and grade 10.

Table 24: Coverage of density in grade eight and nine and 10

Grade 8 Density **Knowledge content**	**Grade 10 Density** **Knowledge content**
➢ Density as mass per unit volume: Mass/volume and its units(cubic centimeter) ➢ Factors of density such as mass and volume to calculate densities of: stone, wood water ➢ Sinking and floating: Denser objects sink and less denser objects float in relation to the density of liquid ➢ How vessels float: Larger volume-less dense ➢ Effects of overloading vessels: sinking, accidents	➢ Density of floating objects: e.g. cork ➢ Density of miscible liquids: e.g. alcohol and water ($þ=(m_1+m_2)/(v_1+v_2)$) ➢ What relative density is: Relative density as ratio without units ➢ Calculation of relative density: Use of formula; Relative density of substance (relative density =density of substance/density of water)

Source: Grade eight and nine integrated science & grade 10 physics syllabi

With reference to Table 24 it can be seen that the candidates' performance in these topics was good.

In order to create space for other topics and respective prerequisites, the coverage of the topic of 'density' in grade 10 may be focused on new concepts such as 'relative density' and the hands-on laboratory experience. This approach may be feasible to some extent since the pupils come to class with a background on prerequisite knowledge of 'density'.

Another topic which has a repetition of concepts is that of thermal physics. Table 25 shows the knowledge content for thermal physics as covered in grade eight and in grade 10.

Table 25: Coverage of thermal physics in grade eight and ten

Grade 8 **Knowledge content**	**Grade 10** **Knowledge content**
➢ Types of heat transfer: conduction, convection and radiation ➢ Movement of heat in solid (conduction), liquid (convection) and air (convection) ➢ The application of heat transfer; How a vacuum flask works: Maintaining temperature constant, etc.	➢ Heat transfer methods :Conduction, convection and radiation ➢ Relationship between kinetic theory and heat transfer ➢ Heat conduction in different substances ➢ Uses of conductors ➢ Good conductors; pans, kettle, pots etc. ➢ Bad conductors; plastic handles, wooden handles etc. ➢ Heat transfer in fluids through Convection current ➢ Differences between good and bad absorbers of heat: e.g. shiny(white or silver) and dull(black) surfaces ➢ Differences between good and bad emitters of heat such as shinning (white or silver) and dull (black surfaces) ➢ Application of knowledge on the processes of heat transfer: e.g. thermos flask, electric kettle ,land and sea breeze, green house effect

Source: Grade eight and nine Integrated Science & grade 10 physics Syllabus

The candidates' performance in this topic with reference to Table 22 was average. From Table 25 it can be seen that most of the knowledge content in grade eight is repeated in grade 10. In place of those topics that are repeated at junior and senior secondary, the introductory part or the entire topic of radioactivity, electromagnetism or basic electronics can be covered.

The prerequisites to radioactivity, for instance, are covered in integrated science, chemistry, mathematics and physics according to the respective syllabi way before starting grade 12 topics. Using the space created in place of the repeated topics, radioactivity can be introduced in grade 11 and fully covered before entering introducing grade 12 topics. Using this approach, other topics where candidates perform low can be rearranged and introduced at earlier stages.

On the other hand, English had the highest pass rate. A comparison on the coverage of prerequisite knowledge can be made based on the contents of the syllabi. Both grade eight and nine and grade 10 – 12 syllabi have five same parts. According to MOGE (2012, p.7), "the Junior Secondary School English Language Syllabus is divided into five parts:

Part 1: Listening and Speaking
Part 2: Reading
Part 3: Composition
Part 4: Structure
Part 5: Summary"

At senior level (grade 10 - 12) the coverage of topics is as shown in Table 26.

Table 26: Coverage of topics in English grade 10 - 12

Grade 10	**Grade 11**	**Grade 12**
Components	**Components**	**Components**
Part 1: Listening and peaking Part 2: Reading and comprehension Part 3: Composition Part 4: Structure Part 5: Summary	Part 1: Listening and peaking Part 2: Reading and comprehension Part 3: Composition Part 4: Structure Part 5: Summary	Part 1: Listening and peaking Part 2: Reading and comprehension Part 3: Composition Part 4: Structure Part 5: Summary

Source: (CDC, 2013, p. iv)

From Table 26 it can be seen that all the major components in the grade 10 – 12 English syllabus have prerequisite coverage. This indication could be attributed to the high pass rate as compared to physics and science in the results analysis.

CHAPTER 5

DISCUSSION

This study principally sought to find a way of improving pupils' performance in physics. This was done by considering three aspects which where the research questions to be answered. The discussion was addressed by investigating the perceptions of the Science scholars (Specialists, Educators and Learners) in Lusaka District on possibility of rearranging some physics topics at senior and junior level of education in Zambian schools, assessing the general performance of pupils in physics and identifying topics which can enhance the performance at senior secondary level and proposing a strategy for rearrangement of some physics topics. This chapter discusses the extent to which the research questions were answered and the implications that were brought forth.

5.1 Research Question 1

Under this research question the researcher wanted to ascertain the views held by the science scholars on the rearrangement of some physics topics. The question was composed of six statements to which the respondents specified their extent of agreement or disagreement.

Statement 1:

Pupils perform generally well in physics at senior level of education.

The researcher wanted to ascertain the views of respondents based on their general observation and experience. The views were different per category of respondents and the aggregate shows that there were slightly more respondents who disagreed (45.7%) than those who agreed (44.0%). The rest were undecided.

Statement 2:

The physics topics in grade eight and nine Integrated Science are enough for preparation for physics in grade 10-12.

This statement dwells much on the prerequisite aspect of physics. The topics in integrated science are intended to prepare the pupils for grade 10 to 12 physics and science, as one would confidently assume. The results indicate that the percentage of respondents who disagreed (47.9 %) was slightly higher than for those who agreed (45.0 %). The rest of them were undecided. In order to draw a more substantial conclusion on this statement, a more representative sample from a wider population would be of great importance. Going by the percentage of those who agreed and those who disagreed, it would be difficult to ascertain whether or not the physics topics in integrated science are adequate as prerequisites for physics in grade 10 to 12.

Statement 3:

Physics is better understood than most other subjects in grade 10 - 12.

The results show that there were more respondents who disagreed (58.0%) than those who agreed (22.1%) and the rest were undecided. This implies that the majority of respondents found physics more difficult to understand than most other subjects. This concurs with the results in the performance analysis which show that the performance in physics has been relatively lower than in other subjects. In 2003, according to the selected schools, the performance in physics and science was the least ($p = 0.000$) and the rejection of the null hypothesis was justified. A further Pots Hoc analysis confirmed that the average performance in physics differed significantly from the other averages in other subjects. In 2009, the performance in physics and science in the selected schools was lower than in other subjects. This justified the rejection of the null hypothesis ($p = 0.00145$). The confirmation using the post-hoc analysis showed that the average performance in science and physics differed significantly from the other subjects. Similarly, in 2014, the average performance in science was the least among others and it differed significantly. The null hypothesis was rejected at $p = 0.000$. From these responses, it appears that there are concepts in physics which are difficulty for pupils to understand or for teachers to teach. From the teachers' perspective it implies that difficult concepts are concepts that are difficult to teach. In the same vein, difficult concepts are those concepts that are difficult to learn and comprehend, from the pupils' perspective.

> Accordingly, lack of proper understanding of concepts in physics, among other factors, has been reported to account for students' low performance in the subject.

> In the same vein, 2008 West African Senior Secondary Certificate Examination Chief Examiner's report showed that lack of understanding of the fundamental concepts of physics contributed to the abysmal performance of students in physics examinations (Obafemi & Onwioduokit, 20013, p. 317).

In the same way, Nkwo, Akinbobola and Edinyang (2008) stated that most physics concepts are perceived difficult as students and teachers are unable to construct understanding of the concepts. If physics was better understood than most other subjects, at least, the performance would not have been as low as shown in the results analysis for the selected years.

Statement 4:

Some topics in grade 10 - 12 physics can be done at earlier stages.

According to the results, it was revealed that the majority of respondents (76.7 %) were for the idea of doing some grade 10 – 12 physics topics at earlier stages while others (17.9 %) disagreed and the rest were undecided.

Statement 5:

It is easier to understand physics in grade 10-12 if some topics are covered at earlier stages or in grade eight and nine

This statement borders on the need for prerequisite knowledge and general preparation. The results from the analysis show that there were more respondents (78.8 %) who agreed than those who disagreed (15.0 %) and the rest were undecided. From their perspective it implies that pupils would find it easier to understand physics in grade 10 – 12 if some topics are covered in grade eight and nine. Some topics that are done in grade eight and nine strengthen the background and prepare the pupils more advanced topics later in the education process.

Statement 6:

If some physics topics are taught at earlier stages or in grade eight and nine, pupils can perform better in grade 10-12 physics.

This statement is suggestive in nature and purports an endeavor to improve the performance in physics. According to the results in the analysis there were more respondents (80.65 %) who agreed than those who disagreed (12.88 %) and the rest were not decided. From the results, it implies that if some physics topics are taught at junior level (grade eight and nine), pupils can perform better at senior level of education (grade 10 - 12). With this insight from the respondents, one would argue that the performance may or may not significantly improve. The uncertainty in the extent to which the performance in physics can improve is left as a recommendation for future studies.

5.2 Research Question 2

The study involved the ECZ and the MOGE from which the researcher collected data on the performance of grade 12 pupils in physics and selected core subjects from the schools which have grade 12 examination centers. The analysis done showed that the performance in physics was generally poor. The results on the performance of pupils in 2003 involved 20 schools that were randomly selected from within Lusaka province. The average performance for 2003 was lowest in physics. The results analysis for 2009 showed that the average performance was lowest in science and physics. Other results for pupils' performance in 2014 involved all the schools in Lusaka province. The average performance for all the schools was lowest in science. When compared with other subjects it was revealed that the performance in physics and science was lower and differed significantly. The performance of pupils in physics and science as the results show, are in agreement with the research publication done by Maguswi (2011). Her research encompassed the assessment of the performance of female and male candidates in O' Level physics in central province for 2006, 2007 and 2007. She established the following:

> In 2006, out of 38 females candidates who sat for the examination only 89% (N=34) passed. Out of 34 candidates 65% (N=22) obtained grades 7 and 8 leaving only 35% (N=12) with quality grades. At the same time, out of 44 males who sat for the examination, 93% (N=41) passed. Out of 41 candidates 44% (N=18) obtained 7 and 8 leaving 56% (N=23) with quality grades.

> In 2007 out of 31 females candidates who sat for the examination only 97% (N=30) passed. Out of 30 candidates 63% (N=20) obtained grades 7 and 8 leaving only 32% (N=12) with quality grades. At the same time out of 96 males who sat for the examination, 93% (N=89) passed. Out of 89 candidates 66% (N=59) obtained 7 and 8 leaving 42% (N=37) with quality grades.
>
> In 2008 out of 35 females candidates who sat for the examination only 91% (N=32) passed. Out of 32 candidates 72% (N=23) obtained grades 7 and 8 leaving only 28% (N=9) with quality grades. At the same time out of 67 male who sat for the examination 90% (N=60) passed. Out of 60 candidates 43% (N=26) obtained 7 and 8 leaving 57% (N=34) with quality grades (p. 33 - 35).

With these statements it can be seen that the majority of candidates (both male and female) scored grades seven, eight and nine and it shows a similar trend for the years which were considered.

Moreover, the ECZ (2015) compiled reports showing the performance of candidates in physics and science nationwide. According to the report as illustrated in Figure 7, the 2014 School Certificate (SC) and General Certificate of Education (GCE) results show that grades seven, eight and nine were scored by the majority of candidates.

However, this study went further to determine the significance in the performance average differences. In each case of the results analysis for the years 2003, 2009 and 2014, the effect size and the post-hoc comparison tests were conducted. The effect size was considerably significant and the post-hoc tests that were carried out showed that the average performance in physics and science was lower and differed significantly from the other core subjects which were selected for comparison.

The researcher collected these sets of data in order to provide empirical evidence of how the performance in physics had been. All the results analyses show a similar trend in the way the candidates were performing in physics and science. One would argue that over a wide range of years (2003 to 2015) the general performance of grade 12 candidates in physics and science had been poor. This is food for thought for researchers especially when it concerns physics and science education. Going by the results it can arguably be said that the physics education system has not been producing adequate competent scientists or physicists. Haambokoma et al (2002) argued that secondary school science has failed to produce learners that purport to be High Order thinkers and maintain problem solving abilities. He argued as such owing to the low performance that candidates exhibited in the national science and physics examinations.

5.3 Research Question 3

The identification of topics that can enhance the performance in physics mainly involved reference to the integrated science, physics, science and English syllabi. The research question 2 was answered by a review and comparison on the coverage of some topics from grade eight to 12 in the integrated science, physics, science and English syllabus. The results show that some topics had prerequisite coverage while others did not have. In most of the topics that had prerequisite coverage, pupils' performance was fair and good. The performance was average and poor in some of the topics which were without prerequisite coverage. Some topics such as mass, weight and density at junior secondary were repeated at senior secondary level. On the other hand, some topics are covered only once. The results further show that the pupils' performance was good and fair in those topics that were repeated at both levels. However, in some of the topics that were covered once and later at senior secondary level, the performance was reported to be average and poor. English had the highest pass rate in the results analysis. A check on the syllabus revealed that the major components covered in grade 10 – 12 where also covered in grade eight and nine. This shows that the prerequisites were adequately covered and could be the main reason why the pass rate was high.

From another perspective, a peculiar observation was made that in spite of some topics not having some prerequisite coverage at earlier stages, the candidates' performance in those topics was fairly good. Table shows that topics such as linear motion, Force and moments and work, energy and power did not have prerequisite coverage. However, it is shown that the candidates' performance in linear motion was good, in force and moments it was average and in work, energy and power it was good. One would pose an argument that the nature of the topics might have influenced the candidates' performance to some extent. Some topics in the physics syllabus are perceived to difficulty and some as easy to understand. According to a study done by Kiptum (2015), 68% of respondents perceived linear motion as easy (see Table 3). Force and moments was perceived as easy by 77% (see Table 2) and 72% (see Table 3) of the respondents while work, energy and power was perceived as easy by 59% of the respondents (see Table 3). In this context, the nature of the topic in terms of the level of difficulty and easiness may be attributed to the level of performance of the candidates which is exhibited at final examinations.

Subsequently, it can follow that, according to Gagne's model of instructional design, all topics regardless of whether they are easy or difficulty, require a well prepared sequence of instructions. This in turn may bring about the strengthening of prerequisite knowledge. Ultimately, the theoretical framework has shown that instructional designs that take into consideration the necessary prior knowledge can enhance learners' performance. The topics where candidates' performance was poor are the ones that can enhance the performance when the background knowledge and prerequisites are reconsidered.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

In this chapter a conclusion is drawn based on the results of the research presented in chapter 4. It looks at what can be concluded about the performance analysis in physics, the identification of topics that can enhance the performance in physics and the science scholars' perceptions on the rearrangement and introduction of some topics at junior secondary level of education. All the conclusions made are within the confines of the study results. Furthermore in this chapter, some recommendations are given to the Science Specialists, Educators, Learners, The Ministry of Education and science support groups and finally suggestions for future studies are highlighted.

6.1 Study Conclusions

According to the perceptions of the teachers, pupils, students and science specialists who participated in the research, the study concludes that:

- Pupils do not performed generally well in physics. The analysis of final examination results confirmed this notion.
- The physics topics in grade eight and nine Integrated Science were not enough for preparation for physics in grade 10 to 12. If the preparation in integrated science was adequate, the pupils' performance in physics would have been better than what was exhibited.
- Physics in grade 10 to 12 is more difficult to understand than most other subjects. This notion shows that some phobia had been created owing to difficulty in understanding the concepts in the subject and continued general poor performance.
- Some topics in grade 10 to 12 physics can be done at earlier stages or in grade eight and nine.
- It is easier to understand physics in grade 10 to 12 if some topics are covered at earlier stages or in grade eight and nine. Some of these topics are the ones in which the candidates exhibited lack of in-depth understanding, as reported by the ECZ (2015). These topics include radioactivity, electromagnetism, and introduction to electronics.

- If some physics topics are taught at earlier stages or at junior level (grade eight and nine), pupils can perform better at senior level of education (grade 10 - 12). Prerequisites to topics such as introduction to electronics can be covered at earlier stages. This approach is a possibility and attainable because some topics such as light have adequate prerequisite coverage at earlier stages and the candidates have exhibited good performance in them.

The perceptions expressed would suggest a need to rearrange some physics topics so that they can be covered at earlier stages of junior secondary or in grade 10. This approach reaffirms the essentiality of upholding Gagne's model of instructional design. The respondents' perceptions show that the information processing model of the mental events, as outlined in Gagne's model of instructional design, is vital if desirable learning outcomes are to be achieved. However, a more thorough study with a representative national sample is needed. In this vein, the results of the study are not representative of the views of all the science scholars and they may not be extrapolated to the entire population, notwithstanding the fact that they signal hope for curbing the scourge of poor performance.

In light of the empirical data on the general performance of pupils in physics and the analysis carried out, the study draws a conclusion that the performance is generally below the expected standards. This can be seen in the recurrent low performance in the selected years. With the exception of few schools that performed well in some years, most schools performed consistently lower than expected standards. The one-way ANOVA tests, the post-hoc analyses and effect size verified and confirmed that the performance in other selected subjects was significantly better than in physics and science, and it was recurring at least for the years which were selected. This kind of performance could be attributed to lack of adequate preparation at earlier stages of the integrated science and physics courses.

Topics that can enhance the performance in physics are those in which candidates faired poorly. In these topics the candidates demonstrated a lack of in-depth understanding. The analysis in the ECZ report (2014) confirmed thus;

> In science, the performance in the physics components was very poor. The sampled scripts show that most candidates have challenges that are related to the

> mastery of the concepts, mathematical manipulation and the interpretation of practical observation and skills in drawing graphs. Some topics like electronics, nuclear atoms in physics and mole concept and organic chemistry are either scantly covered or are not covered at all. These tend to give challenges to most candidates (p. 56).

In light of this, the study floats a suggestion that, these topics in which candidates tend to fair poorly can be covered earlier, partly or fully, in place of those that are repeated at junior and senior secondary levels. This approach may strengthen the prerequisite knowledge and in turn reduce the novelty which these topics pose to the candidates during examinations. The strengthening of prerequisite knowledge and erasure of novelty in the topics may enhance the performance in physics to some measurable extent.

6.2 Recommendations

The recommendations outlined below are intended to suggest necessary actions to be taken by the MOGE, the CDC and other stake holders in the assurance of good quality physics education in response to the research findings.

The government through the MOGE should continue to probe more possible ways to improve the performance of pupils in physics and science at secondary school level of education. More research should also be encouraged by the government. This would open more doors for further and similar research from a perspective of those that are not in favor of rearranging and introducing some physics topics at junior secondary. Good results in physics and science are important to pupils because they are a gateway to further studies at university level of education can influence public perceptions on the effectiveness of physics education system.

The CDC should consider the possibilities of restructuring the school curriculum so that some physics topics could be taught at earlier stages. The CDC has done its best in ensuring the provision of a good standard school curriculum on several occasions. However, it appears that much more has to be done for the performance in physics to improve. Even if it takes long, it is worth the try for the betterment of Zambia's educational system particularly in physics and science.

More research needs to be done on how to harmonize the junior and senior secondary school physics curriculum.

School administrators and Heads of departments have a role to encourage their members of staff to work extra hard and to develop positive attitude towards the subjects they teach. This is in response to the 58% of scholars who perceived that physics is more difficult to understand than most other subjects in grade 10 - 12.

6.3 Suggestion for future studies

This study may not have exhausted all the possible ways of suggesting the reduction in poor performance in physics and science due to time and resource constraints. However, more of such studies may significantly assist in finding ways of improving the performance of pupils in physics and science. The following are some of the suggestions for future studies:

Further research needs to be carried out on a larger population and sample size to increase the generalizability of the findings. A similar study should be carried out in other provinces of Zambia, more schools and concerned institutions should be sampled and a wider range of years should be considered for performance analysis.

Similar studies can be carried out with much focus on chemistry and biology. Such studies may broaden the knowledge on how the problems of poor performance in science can be solved.

An experimental study can be carried out in which

a. An experimental group of pupils is subjected to rearranged topics in physics to take a complete course in grade 10, 11 and 12.
b. A control group is subjected to the physics topics as currently arranged in the syllabus to take a complete course as usual.

In this study, assessment strategies can be designed as diagnostic, formative or summative to be administered to the two groups. The performance of pupils in these assessments can then be checked and comparisons made.

REFERENCES

Adeyemo, S. A. (2010). Teaching/learning of Physics in Nigerian Schools: The Curriculum Transsformation Issues, Problems and Prospects. *International Journal of Educational Research and Technology*.

Ahmed, K., & Haseeb, M. (2005). *Use of Basic Physics - Commision on E-science and Technology for Sustainable Development in the south.* islamabad, Pakistan: COMSATS.

Akhter, J., & Malik, K. A. (2005). *Use of Physics in Agriculture: Improving Relationship between Soil, Water and Plants under stress-environment.* Faisalabad, Pakistan: Nuclear Institute for Agriculture and Biology.

Akhter, J., Waheed, R. A., Aslam, Z., & Malik, K. A. (1987). *A Rapid Method of Appraising Soil Salinity* (Vol. 24). Pak. J. Agric. Sci.

Akhter, J., Waheed, R. A., Haq, M. I., Malik, K. A., & Naqvi, S. H. (1986). *Subsurface Hydrology of North-west Faisalabad using Isotope Technology* (Vol. 1). Pak. J. Soil Sci.

Akpan, B. B. (1994). *Implementing Science and Technology Education for All: Guide to better Policy and Practice for Teachers.* London, England: Commonwealth Secretariat.

Ambrose, A. (2010). *How Learning Works: Seven Research-based Principles for Smart Teaching.* John Wiley & Sons.

Andreas, R., Hansson, L., Hansson, O., & Juter, K. (n.d.). *The Role of Mathematics in the Teaching and Learning of Physics.* Kristiastad, Sweden: Kristiastad University.

Ango, M. (1990). *Basic Science Laboratory with Practical Suggestions and Procedures.* Lagos: Hinders.

Askhia, O. A. (2010). Students and Teachers' Perception of the cause of Poor Perfformance in Ogun State Secondary Schools. *European Journal of Science, 13*, 229 - 242.

Assessing Women in Engineering (AWE) Project 200. (n.d.). *Attribution Theory AWE Research Overview*.

Bassey, M. (1995). *Creating Education Through Research: A Global Perspective of Educational Research for the 21st century*. Kirklington Moor Press, Newark in association with the British.

Biemans, H. J., & Simons, P. R. (1996). CONTACT-2: A Computer-assisted Instructional Strategy for Promoting Conceptual Change. *Instructional Science, 24*, 157 - 176.

Brown, J. D. (2008, April). Questions and Answers about Language Testing Statistics: Effect Size and Eta Squared. *JALT Testing & Evaluation SIG Newsletter, 12*(2), pp. 38 - 43.

Burns, N., & Grove, S. (2001). *The Practice of Nursing Research: Conduct, Critic and Utilization* (4 ed.). Philadelphia, Pennsylvania, USA: W.B.Saunders.

Butler, A. C. (2010). Repeated Testing Produces Superior Transfers of Learning Relative to Repeated Studying. *Journal of Experimental Psychology: Learning, Memory and Cognition, 36*(5).

Chilufya, T. (2014). *Integrating Environmental Sustainability Issues in Zambian 2013 Revised Science Curriculum at Junior Secondary School Level.* The University of Zambia.

Colins, A., Brown, J. S., & Holum, A. (1991). *Cognitive Apprenticeship: Making Thinking Visible.* American Educator.

Connor, A. (2013). *The Importance of Physics to Economic Growth.* UK: Institute Of Physics IOP.

Emanuel, E. J., Crouch, R. A., Arras, J. D., Moreno, J. D., & Grady, C. (Eds.). (2003). *Ethical and Regulatory Aspects of Clinical Research.* Baltimore: The Johns Hopkins University Press.

Erinosho, S. Y. (2013). How do students perceive the difficulty of physics in secondary school? An exploratory study in. *International Journal of Cross-disciplinary Subjects in Education (IJCDSE) Special Issue, 3*(3), 1510-1515.

Examination Council of Zambia (ECZ). (2001). *School Certificate and GCE Examiners' Report. Physical Science 2000 Examination.* Lusaka: ECZ.

Examination Council of Zambia (ECZ). (2015). *2014 Examination Performance Report - General Performance Analysis.* Lusaka: ECZ.

Examination Council of Zambia. (2008). *2003 Grade 12 Grade Distribution by Location.* Lusaka: ECZ.

Examination Council of Zambia. (2010). *2009 Grade 12 Grade Distribution by Location.* Lusaka: ECZ.

Gagne, R. (1977). *The Condition of Lerning.* Michigan, USA: Halt, Rinehart and Winston.

Gagne, R. (1985). *The Condition of Learning and the Theory of Instruction* (4th ed.). New York, USA: Holt, Rinehart and Winston.

Gagne, R., Briggs, L., & Wager, W. (Eds.). (1998). *Principles of Instructional Design* (3rd ed.). New York, USA: Holt, Rinehart and Winston.

Gal, I., & Piaget, A. (2004). Health Education Research. *Academic.oup.com*.

Grissom, R. J., & Kim, J. J. (2012). *Effect Sizes for Research: Univariate and Multivariate Applications* (2nd ed.). New York: Routledge.

Haambokoma, C., Nkhata, B., Kostyuk, V. S., Chabalengula, V., Mbewe, S., Tabakamulamu, M., et al. (2002). *Strengthening of Mathematics and Science Education in Zambian Secondary Schools. A Baseline Study Report.* Lusaka: JICA/MOE.

Hameed, A. K. (2005). *Evolutiopn and Impact of Physics on Our Lives. Commision on E-science and Technology for Sustainable Development in the South.* Islamabad, Pakistan: COMSATS.

Hart, C. (1998). *Doing a Literature Review.* London, UK: Sage Publications.

International Institute for Land and Improvement. (1989). *Effectiveness and Social/Environmental Impacts of Irrigation Projects: A Review.* Wiganigan, The Netherlands: ILRI.

Jenaro, G. A. (2005). *The Implications of Physics Education Research on the Teaching at High School and University.* wupguarj@sp.ehu.es.

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

Karpicke, J. D., & Janell, R. (2011). *Retrieval Practice Produces more learning than Elaborative Studying with Concept Mapping* (Vol. 331). Science.

Kaulu, G. (2008). *Effectiveness of the Physicsclassroom Computer Software in the Learning of Kinematics at Munali High School in Lusaka.* Lusaka: The University of Zambia.

Khadjooi, K., Rostami, K., & Ishaq, S. (2011). How to use Gagne's Model of Instructional Design in Teaching Psychomotor Skills. *4*(3), 116 - 119.

Kiptum, G. M. (2015). *Difficulty Physics Topics in Kenyan Secondary Schools: A Case Study of Uasin Gushu County.* Nyahururu, Kenya.

Kiwala, F., Nachibinga, M., & Macwani, S. (2015). *2015 Examinations Performance Report for Natural Sciences.* Lusaka: Examination Council of Zambia.

Klymkowsky, M., & Cooper, M. (2012, December). Now for the Hard Part: The Path to Coherent Curricular Design, Biochem. *Journal of Reading, 40*, 271 - 272.

Maguswi, B. V. (2011). *Factors Contributing to Under-achievement of Zambian Female Students in O-Level Physics Examinations. A Case of Selected High Schools in Central Province.* Lusaka: The University of Zambia.

MESVTEE. (2014). *Lusaka Province Performance Analysis: Credit or better.* Lusaka: MESVTEE.

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

MOESVTEE. (2013). *Science Syllabus - Grade 10 - 12.* Lusaka, Zambia: Curriculum Development Center (CDC).

Murray, C. (2009). A Year in the APS and the Importance of Physics in the 21st Century. *American Physics Society April Meeting.* Washington DC.

Nadeem, K. (2005). The Role of Biophysics in Medicine. In A. Hameed, M. M. Qurashi, T. Hussain, & I. Hayee, *Physics In Our Lives* (pp. 133 - 140). Faisalabad, Pakistan: N.I.B.G.E.

Nkwo, N. I., Akimbobola, A. O., & Edinyang, S. D. (2008). Effect of Prior Kmowledge of Institutional Objectives on Students in Selcted Difficult Concepts in Senior Secondary School Physics. *Journal of Science Teachers' Association of Nigeria, 43*(1&2), 62 - 71.

Obafemi, T. D., & Onwioduokit, F. A. (2013). *Identification of Difficult Concepts in Senior Secondary School Two (SS2). Physics Curriculm in River State.* Nigeria.

Owolabi, O. T., & Adedayo, J. O. (2012). *Effect of Teacher's Qualification on the Performance of Senior Secondary School Physics Students: Implication on Technology in Nigeria.*

Piskurich, G. (2006). *What is this Instructional Design Stuff Anyway?* John.

Pradhan, H. C., & Mody, A. K. (n.d.). *Constructivism Applied to Physics Teaching for Capacity Building of Undergraduate Students.* Mumbai: Sindhi Society Chembur.

Ratner, C. (2002). *Subjectivity and Objectivity in Qualitative Methodology.* CA, USA.

Rief, F. (1985). *Acquiring an Effective understanding of Scientific Concepts.* (L. West, & A. Pines, Eds.) Orlando: Cognitive F.L Academic Press.

Rotter, J. B. (1966). *Generalized Expectancies for Internal versus External Control of Reinforcement. Psychological Monographs.*

Rugg, G., & Petre, M. (2007). *A Gentle guide to Research Methods.* New York: Open University Press, McGraw-Hill Education.

Salant, P. A., & Dillman, D. A. (1994). *How To Conduct Your Own Survey*. New York: John Wiley & Sons, Inc.

Steven, J. P. (1999). *Intermediate Statistics: A Modern Approach* (2nd ed.). Mahwan, NJ: Lawrence Erlbaum Associates.

Trostli, R. (1995). *Physics is Fun.* Octavo Editions.

Weiner, B. (1972). *Theories of Motivation: From Mechanism to Cognition.* Chicago.

Weiner, B. (2000). Intrapersonal and Interpersonal Theories of Motivation from an Attributional Perspective. *Educational Psychology Review*, *12*(1), pp. 1 - 14.

APPENDICES

Appendix I: Physics topics covered in grade 8 to 9 (2013)

Physics topics covered in grade eight and nine (Source: Integrated Science syllabus grade eight and nine)

Topic	**Sub topic**
Materials and energy	Heat transfer
	Heat and expansion of substances
	Mass and weight
	Density
	Light and its nature
	Electric current and voltage in circuits
	Pressure
	Energy and its conservation
	Communication
	Digital and analogue transmission
	Satellite communication

Appendix II: Physics topics covered in grade 10 – 12 (2013)

Physics topics covered in grade 10 to 12 (source: Science Syllabus grade 10 to 12; 2013)

Topic	**Grade 10**		**Grade 11**		**Grade 12**
Unit 1 Measurements	Sub topic	Unit 3 Thermal Physics	Sub topic	Static electricity	Sub topic
	International system of units (SI)		Simple kinetic theory of matter		Static electricity
	Length and time		Measurement of temperature	Current electricity	Electrical charge, current and potential difference
	Mass and weight		Expansion of solid, liquid and gas		Electric cells
	Density		Heat transfer by conduction, convection and radiation		Electrical resistance
Unit 2 Mechanics	Scalars and vectors		Measurement of heat		Heating effect of an electric current
	Linear motion				Magnetic effects of an electric current
	Forces	Unit 4	Simple ideas of wave motion theory	Electromagnetic induction	The phenomenon of electromagnetic induction
	Moment of forces	Wave motion	Propagation of waves		The simple a.c and d.c generators
	Work energy and power		Electromagnetic spectrum		Transformers
	Simple machines	Sound	Properties of sound	Basic electronics	Thermionic emission and electrons
	pressure	Unit 6 Light	Rectilinear propagation of light		Circuit components
			Refraction of light		Simple electronic

					systems
			Thin converging and diverging lenses		Impact of electronics on society and industry
		Magnetism	Simple phenomenon of magnetism	Atomic Physics	Nuclear atom Radioactivity

Appendix III: List of sampled institutions

1. Curriculum Development Centre
2. Evelyn Hone College
3. Examinations Council of Zambia
4. Kamulanga Secondary School
5. Kamwala Secondary School
6. Lusaka High School (GRZ)
7. Makeni College of Education
8. Makeni Ecumenical Centre
9. National Technology and Science Council
10. Zambia Bureau of Standards
11. Libala Secondary School
12. Lilayi Secondary School

Appendix IV: Sample questionnaire used in pilot survey

.No. ....

The University of Zambia

School of Education

Department of Mathematics and Science Education

(Physics Education Research)

The possibility of rearranging some physics topics to enhance performance

Dear Respondent,

This questionnaire is asking for your opinion on a possibility of rearranging some physics topics as a way of enhancing the performance. Therefore, your honesty and truthful perception is very important and will be highly appreciated. Your answers will be used for academic purposes and will only be seen by the researcher and the supervisors of this study.

Please assist by responding to the following:

[Tick (√) and write where appropriate]

---

1. Age range in years:
   Below 20 [ ]   20-30 [ ]   31-40 [ ]   41-50 [ ]   51-60 [ ]   Above 60 [ ]
2. Sex: Male [ ]   Female [ ]   Intersex [ ]   Other specify: ……………………
3. Education status:

   Grade 1-12 [ ]   Primary Teacher's Certificate [ ]   Ordinary Diploma [ ]

   Advanced Diploma [ ]   Bachelor's Degree [ ]   Masters Degree [ ]

   Other specify…………………………………
4. Are you a teacher? Yes [ ]   No [ ]   If not specify: ………………………………

5. At which institution are you based? ....

6. Have you ever taught sciences at any level? Yes [ ]   No [ ]   If yes specify what level (s): ………………………………………………………..

7. How would you rate the general performance of pupils in physics at senior level (grade 10 – 12)?

   Good [ ]   Fair [ ]   Poor [ ]   Not sure [ ]

8. If some physics topics were rearranged and taught at earlier stages, how would you predict the general performance of pupils at senior level?

   Good [ ]   Fair [ ]   Poor [ ]   Not sure [ ]

9. Should some physics topics be rearranged and be taught at earlier stages?

Code		Tick(√)
1	No opinion	
2	Strongly disagree	
3	Disagree	
4	Agree	
5	Strongly agree	

Any comment:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………..…………………………………………………….

Thank you for your co-operation!

Appendix V: Sample questionnaire used in the main research

The University of Zambia
School of Education
Department of Mathematics and Science Education
(Physics Education Research)

The possible rearrangement of some physics topics to enhance performance

Dear Respondent,

This questionnaire is asking for your opinion on a possibility of rearranging some Physics topics as a way of enhancing the performance. Therefore, your honesty and truthful perception is very important and will be highly appreciated. Your answers will be used for academic purposes and will only be seen by the researcher and the supervisors of this study.

Please assist by responding to the following:

Part A: Socio-Demographic Information

[Tick (√) and write where appropriate]

1. Age range in years:
   Below 20 [ ] 20-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] Above 60 [ ]
2. Sex: Male [ ] Female [ ]
3. Education status :
   Grade 1-12 [ ] Primary Teacher's Certificate [ ] Ordinary Diploma [ ]
   Advanced Diploma [ ] Bachelor's Degree [ ] Masters Degree [ ]
   Other specify…………………………………
4. Are you a teacher? Yes [ ] No [ ]
5. If not specify: …………………………………
6. At which institution are you based? ....
7. At what level have you taught science? Grade 1-9 [ ] Grade 10-12 [ ]
   College level [ ] University level [ ] Not any [ ]
   Other specify: ………………………………………………….

Part B

#	Please circle the extent of your agreement. Key: SD-strongly disagree D-disagree U-undecided A-agree SA-strongly agree					
1	Pupils perform generally well in physics at senior level of education.	SD	D	U	A	SA
2	The physics topics in grade eight and nine Integrated Science are enough for preparation for physics in grade 10-12.	SD	D	U	A	SA
3	Physics is better understood than most other subjects in grade 10 - 12.	SD	D	U	A	SA
4	Some topics in grade 10 - 12 physics can be done at earlier stages.	SD	D	U	A	SA
5	It is easier to understand physics in grade 10-12 if some topics are covered at earlier stages or in grade eight and nine.	SD	D	U	A	SA
6	If some physics topics are taught at earlier stages or in grade eight and nine, pupils can perform better in grade 10-12 physics.	SD	D	U	A	SA

Any comments:

....

....

....

Thank you for your co-operation!

Appendix VI: Proposed work plan

Serial	Activity	Time in months
1	Proposal stage	2 months
2	Preparation of research materials	3 months
3	Data collection stage	6 months
4	Data analysis stage	2 months
5	Draft report writing stage	3 months
6	Editing and finalizing the report	3 months
7	Submission	1 month