An Investigation Into The Failure Rate In Mathematics And Science At Grade Twelve (12) Examinations And Its Impact To The School Of Engineering: A Case Studyof Kitwe District Of Zambia.

Francis Kafata, Dr. Serah K. Mbetwa

ABSTRACT: The study assessed the Performance of the grade 12 students in Kitwe district of Zambia with respect to O-Level examinations in Mathematics and Science subjects in selected secondary schools of Kitwe District in the Copperbelt province of Zambia and its impact to the school of Engineering. Currently most of the colleges that offer engineering programs require that the applicant should have a minimum of credit grade in mathematics and science subjects while Universities such as Copperbelt University (CBU) has been enrolling applicants in the school of engineering with points from 6 to 8 which shows that the applicants should have very good grades (distinction) in mathematics and science subjects at O-Level examinations. In view of the aforementioned, the objective of the study was to investigate the failure rate in mathematics and science subjects at grade 12 O-Level examinations and its impact to the school of Engineering. A survey design which used both quantitative and qualitative aspects of research was used in the study. Questionnaires and interview schedules were used to collect data. The sample included One hundred and one (101) respondents from 9 Secondary Schools of Kitwe Districts. Three categories of respondents were identified: (i) Sixteen (16) Heads of Departments; (ii) Twenty five (25) Teachers of Mathematics and Science and (iii) Sixty (60) Grade 12 pupils. The methods used included three sets of structured questionnaires and personal interviews. The data was analysed using statistical software called STATA. Data was checked for validity, reliability, identification outliners and normality. The findings of the study revealed that there was a high failure rate in mathematics than in science hence it negatively affected the admissions to the school of engineering. Study also demonstrated that mathematics and science skills and theories should actually be taught with due attention that they deserve for the school of engineering to adequately tap talent from the grade 12 school leavers perhaps this could be the reason why the school of engineering has not grown in Zambia. This calls for the teachers and the pupils to change their negative attitudes towards mathematics and start looking at it as an important learning area that ought to be learnt with pleasure. The significant factors leading to poor performance included high teacher to pupil ratio due to overcrowded classes, negative attitude by pupils towards mathematics, lack of laboratory apparatus and chemicals, lack of laboratory space and lack of teaching and learning materials. The also study reviewed that the performance of mathematics as the major subject to the school of engineering was very poor and hence negatively impacted to the school of engineering as a student who fails mathematics at grade 12 O-Level examination cannot gain entry to school of engineering. This calls for the teachers of mathematics, school administrators, parents and all the stakeholders to get involved in the education of mathematics to pupils at secondary level of education.

Key Words: Engineering, Failure rate,grade 12, impact, mathematics, science, school.

Background to the Study

1.0 Introduction

Education is a process, which does all round harmonious development of the individual to modify his behaviour, attitude and thinking it also means training for the country and love for the nation. Engineering programmes are considered cognitively demanding and require at least very good mathematics and science background at grade 12 O-Level examination results. Entry into these engineering programmes is based on one's marks achieved in mathematics and science in the final school leaving examinations certificate.The profile of engineering students differs stronglyfrom that of students in other disciplines. An engineering student mustbe able to:

Apply knowledge of mathematics, physics, and life sciences in order to understand, formulate, and solve engineering problems; design andconduct experiments; analyze and interpret data;develop designs that meet specified requirements; design solutions to new problems and so on. Enrolling students with good academic performance in mathematics and science subjects isimportant as it allows higher learning institutions to identify those studentswho are most likely to complete their engineering studies successfully and on time. Enrolling under-qualifiedstudents in a university constitutes a misuse ofresources, share waste of time and above underachievement of the education goals. Therefore high scores in mathematics and science subjects at grade 12 O-Level examinations would be thestrongest predictors of academic performance inengineering. One of the perennial problems of the education system in Zambia is high failure rate of students at grade 12 examinations in sciences and mathematics subjects. This problem is as old as the education system in the country dating back to independence. Improving access to education has been also accorded a high priority in Zambia's education policies. Studies have shown that lack of education leads to high fertility rates, low life expectancy and high illiteracy rates which in all affects national development (Wasanga, 1997). Performance in mathematics and science subjects at O-Level certificate in many countries has been poor and Zambia inclusive. The

- *Francis Kafata, Email: franciskafata@gmail.com, +260 955540043*
- *Dr. Serah K. Mbetwa, Email: serah.mbetwa@yahoo.com; business@icuzambia.net, +260 955757331*

importance of having a solid background in mathematics is well recognized as it serves as a gateway to future professions in a variety of fields (Tella 2008; Pandor 2006; De Klerk Wolters cited by Kurt et al. 2002). Mathematics is very important in our daily lives since it deals with real life situation in our daily activities (Ojose 2011). A thorough understanding of mathematics is an asset, if not essential, for applicants interested to enrol in the school of Engineering. In other words, mathematical competence is an essential component in preparing numerate citizens for employment and it is needed to ensure the continued production of highly-skilled persons required by industry, science and technology (Mikulski 2001; Steen 2001; House 2006). According to Steen (2001), mathematics does not only empower people with the capacity to control their lives but also provides science a firm foundation for effective theories; it also guarantees society a vigorous economy. Zambian curriculum dating as back as early 1960s had incorporated sciences in the education system. These sciences comprised of general science at junior secondary and physics, biology, chemistry at senior level. "Mathematics, science and technology are strongly influenced by the global context and in that proficiency in these disciplines is a pre-requisite to economic success." (MaguswiBuumba Victoria 2011).

1.1 Background

Education was defined by Osokoya (2003) as a continuous process which the society establishes to assist its members to understand the heritage of the past and to participate productively in the future. It is the leading out of the in-born powers and potentialities of the individuals in the society and the acquisition of skills, aptitudes, and competencies necessary for self-realisation and for coping with life's problem. Afe (2000), Considered Education as a tool to be used for the integration of the individual into the society to achieve self-realisation, develop national consciousness, promote unity, and strive for social, economic, political, scientific, cultural and technological progress. Therefore all the above to be achieve two very important subjects of study should be the prime mover, and these are mathematics and science subjects.

1.1.1 Mathematics and science

Therefore Education in science and mathematics becomes bedrock and indispensable tools for scientific, technological and economic advancement in any nation. It gives the nation the capacity to apply technology for the exploitation of the resources of nature. Such exploitation will depend greatly on mathematics and science for laying the foundation for political, governmental, military, civil, scientific, technological advancement, economic development, socio-cultural and environmental peace. Performance in Mathematics and Science subjects by students has persistently been poor. This study sought to investigate the poor performance and to establish the strategies that can be adopted to improve performance in Mathematics and Science subjects bystudents in secondary schools in Kitwe District of Zambia. The study will determine among others the performance of pupils from 2010 to 2014, challenges to the teaching and learning of mathematics and science and the impact of the failure rate to the school of engineeringin terms of entry qualifications required. There is no school system in the world which is not in one way or another concerned about a proportion of pupils who fail. Such failure is costly in terms of the efficiency of the school system. This is not to say that all failure is to be avoided. We need to know to what extent the problem might be in any school system and also be in a position to go some way towards controlling it. Despite this perceived role the failure rate in O- Level science examination in Zambian high schools has been high. From 1966 to 1971 the percentage of pass rate in science subject at school certificate level in Zambia declined from 72% to 45% (Mathew, 1973:3).However the enrolment requirements to the school of engineering demand that the applicant should have a very good background performance in mathematics and science subjects as these are the key subject in the school.

1.2 Statement of the problem

Mathematics and science subjects play an important role in the School ofEngineering, scientific and technological development of a nation. The fundamental role of mathematics and science lies in its day to day application in most social sciences, business, economics, medicine and management studies. Indeed, mathematics and science are vital as far as development of new techniques and concepts are scientific, economic and sociological in its consequences to the societal development needs. The performance of students in mathematics among secondary schools in Zambia has remained poor for many years. Despite the important role that mathematics and science plays in society and in the field of engineering particularly, there has always been poor performance in the subjects at public examinations. According to a study conducted by the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) aimed at testing mathematics and reading achievements in 15 countries in Eastern and Southern Africa, Zambia was ranked as the worst with a decline in its performance alongside Malawi, Namibia, Lesotho and Uganda with difficulties in mathematics. Zambian pupils were ranked the worst inMathematics and reading skills in Southern and Eastern Africa. According to 2014 Examination Council of Zambia report it was observedthat Mathematics, Science and Biology only 9.98 percent of candidates obtained a credit or better, while 18.59 percent of the candidates obtained passes and 71.72 percent failed the examination. This reported continued poor performance in Mathematics and Science by the candidates required serious attention as the school of engineering depend largely on good performance in these key subjects. Currently most of the colleges that offer engineering programs require that the applicant should have a minimum of credit grade in mathematics and science subjects while Universities such as Copperbelt University (CBU) has been enrolling applicants in the school of engineering with points from 6 to 8 which shows that the applicants should have very good grades in mathematics and science subjects. Despite the fact that mathematics and science are essential for daily life and plays a crucial role in school curriculum, students' performance remains very low. This caused an outcry from mathematics teachers, mathematics educators, parents, and students.It is against this background that this research sought to establish the high failure rate in mathematics and

science subjects in Kitwe district of Zambia. The research will also attempt to establish the challenges of teaching and learning of mathematics and science subjects and impact to the school of Engineering**.** From this analysis one would rightly say that the problem of secondary school students' poor performance in mathematics and science has not been solved.

1.3Significance of the study

This study sought to investigate performance of grade 12 students during examinations in mathematics and science subjects and its impact to the school of Engineering. Also identify factors contributing to student poor performance and challenges in the teaching of mathematics and science at grade 12 examinations in selected secondary schools in Kitwe District of Zambia. Poor performance in schools poses a big challenge to the school authority therefore ways need to be found to improve the performance of students. Considering that the national performance of secondary schools in Zambia which has been poor in mathematics and science subjects at grade 12 examinations, it was reasonable to think that Kitwe District was not an exception. The findings from this study may provide school authorities in secondary schools in Kitwe District with significant factors that are impacting on student's poor performance in mathematics and science subjects. It was also the sincere hope of the researcher that the findings of this study and recommendations would be of a great help to all stakeholders who have anything to do with the success or failure of the child in school and the school of Engineering.

1.4 Research objectives

1.4.1 Main objective

To investigate the failure rate in mathematics and science subjects at grade 12 examinations and its impact to the school of Engineering.

1.4.2 Specific objectives

- To investigate the failure rate of grade 12 students in mathematics and science from 2010 to 2014 in selected secondary schools in Kitwe District.
- To establish the challenges associated to the teaching and learning of mathematics and science subjects.
- To establish the impact of the failure rate to the school of Engineering.

1.5 Research questions

1. What was the failure rate of grade 12 students in mathematics and science subjects in Kitwe District from 2010 to 2014 Examinations?
2. What are the challenges to the teaching and learning of mathematics and science subjects?
3. What is the impact of the failure rate to the school of Engineering?

1.9 Theoretical Framework

According to English (2002), it is argued that the attempt to develop a comprehensive theory that describes how students learn specific mathematics domain was rather rare in the field of mathematics education. This was supported by Wilson (1993), who stated that no one theory of learning completely describes how students acquire mathematical understanding. However, this research was influenced by the theory of Weiner's (1980, 1992) attribution theory.Attribution theory is concerned with how individuals interpret events and how this relates to their thinking and behavior. Heider (1958) was the first to propose a psychological theory of attribution, but Weiner and colleagues (e.g., Jones et al, 1972; Weiner, 1974, 1986) developed a theoretical framework that has become a major research paradigm of social psychology.

1.9.1 Principles

1. Attribution is a three stage process: (1) behavior is observed, (2) behavior is determined to be deliberate, and (3) behavior is attributed to internal or external causes.
2. Achievement can be attributed to (1) effort, (2) ability, (3) level of task difficulty, or (4) luck.
3. Causal dimensions of behavior are (1) locus of control, (2) stability, and (3) controllability.

According to attributiontheory, the explanations that people tend to make, to explain success or failure can be analysed in terms of three sets of characteristics:

- First, the cause of the success or failure may be internal or external. That is, we may succeed or fail because of factors that we believe have their origin within us or because of factors that originate in our environment.
- Second, the cause of the success or failure may be either stable or unstable. If we believe cause is stable, then the outcome is likely to be the same if we perform the same behaviour on another occasion. If it is unstable, the outcome is likely to be different on another occasion.
- Third, the cause of the success or failure may be either controllable or uncontrollable. 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.

Note that this factor is distinct from the previous two categories. An internal factor can be controllable (we can control our effort by trying harder) or uncontrollable (most people cannot easily change their basic intellectual ability or change from being an introvert to being an extrovert). Likewise, an external factor can be controllable (a person failing a difficult course could succeed by taking an easier course) or uncontrollable (if calculus is difficult because it is abstract, it will still be abstract no matter what we do). The concept attribution describes the cognitive process by which a person perceives the cause of what has happened to him/ her either as caused by himself/herself or by others (Asonibare 1986). According to the attribution theory, we tend to explain the causes of success or failure to either internal or external factors. That is, we succeed or fail because of factors that we believe have their origin with us or because of factors that originate in our surroundings. There is an element of whether we control or do not control the success or failure. This is related to Rotter's (1954, 1966) locus of control 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 other peoples (for example, teachers), fate, bad luck or chance primarily determine events (Vijayashree and Jagdischchandra 2011). An important assumption of the attribution theory is that we will interpret our environment in such a way as to maintain a positive self-image. That is, we will attribute our successes or failures to factors that will enable us to feel as good as possible about ourselves. For example, when learners succeed in an academic task, they are likely to attribute the success to their own efforts or abilities and when they fail, they will attribute failure to factors over which they have no control, such as lack of resources, bad teaching methods, lack of experienced teachers and so on. Weiner's attribution theory applies to this study in that learners are most likely to attribute their high failure in mathematics and science to external factors like mathematics and science are difficult subjects, teachers are incompetent, lack of science laboratory for experiments, teachers are not serious and to internal factors like not working hard or having a negative attitude towards mathematics and science (S.A. Tachie and R. Chireshe).

LITERATURE REVIEW

2.1 Introduction

This chapter provides an account of the literature reviewed on failure rate of high school learners in Mathematics and Science subjects at grade 12 examinations. The purpose of the literature review was to outline the factors that contribute towards the poor performance of high school learners as researched internationally and within Zambia. Numerous studies link the poor academic performance of learners to socio-economic problems, poverty, and politics (Engelbrecht et al. 1996). Therefore this chapter discusses previous literature relevant to this study. This study was carried out with the realization that there were inadequate related local studies concerning mathematics and science subjects in Kitwe District of the Copperbelt province. In this research the focuses was on the failure rate by the grade 12 students in Mathematics and Science in grade 12 examinations in Kitwe District of the Copperbelt Province and also its impact to the School of Engineering. Some of the reasons attributed to the poor achievement in mathematics and science by scholars include; shortage of qualified mathematics teachers (Ohuche, 1989), poor facilities, equipment and instructional materials for effective teaching (Odogwu, 1994), use of traditional chalk and talk methods (Edward & Knight, 1994), large pupils to teacher ratio (Alele Williams, 1988) and mathematics phobia and fright (Georgewill, 1990), limited background preparation in mathematics, lack of mathematics teaching equipment and materials, fright and anxiety, low level of interest and some government policy (Abimbade, 1995), lack of problem solving abilities (Abimbade, 1997), self-concept and achievement motivation (Akinsola, 1994).

2.2 Mathematics

Mathematics, is one of the oldest fields of study in the history of mankind, has long been one of the most central components of human thought. It has been believed for centuries that mathematics sharpens the human mind, develops their logical thinking; enhances their reasoning ability and spatial power. It influences an individual's personal development and contributes to the wealth of the country. This is mainly because it is at the heart of many successful careers and successful lives. The field of Engineering is not an exception to this development. One of the chief aims of mathematics has always been to reveal and describe an order in the natural world. If we look back to the early days of mathematics, say four thousand to five thousand years ago, we will see what the Egyptian and Babylonian civilizations offered in mathematics. They offered a very practical approach to mathematics answering questions that rarely extended beyond what was necessary to operate in daily life. During this time, rudimentary arithmetic and algebra were built up to answer questions in commerce and agriculture. The useful purposes for which they employed mathematics dealt with: Money exchange, simple and compound interest, computing wages, expressing weights and lengths, dividing inheritances, and determining volumes of granaries and areas of fields. Their mathematics was also used to study astronomy, making it possible to create calendars to accurately predict natural occurrences such as floods, something necessary for agricultural purposes. Accurate calendars could also be used for purposes of religious ceremony, such as building temples so that the sun would shine on the altar at the appropriate time. These civilizations developed an elementary arithmetic, notation, some early algebra, and basic empirical formulas in geometry. When considering classical mathematics, the Greeks must be a main focus of our attention. In fact, the primary reason for discussing earlier mathematics is to understand what the Greeks inherited and what they left to their posterity. Whereas the Egyptians and Babylonians produced a fairly crude and very practical mathematics based on experience, the Greeks removed mathematics from its practical underpinnings. A major step in the advancement of mathematics was the recognition that mathematics in numbers and geometric figures can be dealt with in the abstract. This was not a small step in human thinking, and this initial step has been attributed to the Pythagorean School of ancient Greece (Thomas Treloar 2012). Cockcroft (1982) states that there can be no doubt that every child should study mathematics at school. He also highlights that most people regard the study of mathematics, together with that of science as being essential. For this reason mathematics is one of the core subjects in all schools worldwide as explained by the amount of time devoted to it in schools. In many countries, it is compulsory from primary to secondary levels of education. Colwell (2000) studied the performance of American students in the international mathematics tests and noted that they were performing poorly. In Kenya, the performance has been below average (K.N.E.C, 2008). Mathematics has been at the centre of all the subjects offered at senior secondary school and tertiary levels. Mathematics is an essential requirement by every field of academic aptitude and human growth to cope with the challenges of life and development. Fajemidagba (1986) and Akpan (1987) assert that, mathematics is the queen and servant of all school subjects, since it cuts across the school curricula. Therefore, mathematics as a school subject affects all aspects of human life at different levels. For instance, mathematics is significant in engineering, accounts, agriculture, science and technology.

Internationally, mathematics is one of the most influential subjects of all curriculum, and mathematical understanding influences decision making in all areas of life, private, social, and civil. Furthermore, mathematics is used in counting, calculation and in measuring of various quantities of interest. Mathematics is applied at national level in the formulation of the national budget. There are countless famous people who have helped shape mathematics. Many of the discoveries of these famous mathematicians have roots in science, medicine, and technology that are now common place. The application of mathematics is so vast that it is used in almost every subject. If we are to say that without mathematics, then science is not possible. In fact, when walking from one place to another place, our mind is also doing mathematics; for instance to know the time at which we will arrive and spend. Almost every aspect of our day to day life involves mathematics too. Mathematics learning is a must element in providing the child with the basic skills to live their life. It is one of the basic pillars for the child on which his/her life is, and would be standing. So the base of this pillar needs to be strong and clear. Therefore, the teaching and learning of mathematics helps the child in developing analytical and reasoning skills with logical and structured thoughts. Mathematics and science are intimately connected to daily life and everybody's life-long planning. Shut out mathematics and science from daily life and civilisation comes to a standstill. It is in the light of this background, that the research seeks to build and elicit among students and teachers the proper appreciation and interest in the value of mathematics to the individual and society. The poor pass rate in mathematics and science subjects is a source of concern to the education system and the government as the economy of the country depend on how the citizen's use the knowledge from these two subjects. Obe (1996) conceptualises mathematics as the master and servant of most disciplines and thus, a source of enlightenment and understanding of the universe. He further **opines** that without it, the understanding of national problems would be superficial. Greaber and Weisman (1995) agree that mathematics helps the individual to understand the environment and to give accurate account of the physical phenomena around every person. Despite the important role that Mathematics plays in society, there has always been poor performance in the subject at national examinations (Aduda, 2003). Mwamwenda (1995) argued that the achievement of students in a subject is determined by their attitudes rather than inability to study. Haimowitz (1989) indicated the cause of most failures in schools might not be due to insufficient or inadequate instruction but by active resistance by the learners. This argument suggests that favourable attitudes towards Mathematics should be developed for achievement in the subject to improve. Setidisho (2001) submits that no other subject forms a strong binding force among various branches of science as mathematics, and without it, knowledge of the sciences often remains superficial. Emphasising the importance of the subject to the society, Robert (1987) stated that in the United States, mathematics has come to play important roles: in the engineering of highways, the search for energy, the designing of television sets, the profitable operation of most business, astronauts flying space-crafts, the study of epidemics, the navigation of ships at sea all depends on the study of mathematics.

2.2.1 Importance of Mathematics

Mathematics is one of the most important subject which acts as a bridge for all knowledge. In the changing world of competition there is a growing demand of the mathematics. There is a definite need of mathematics in any body's lifelong planning and day-to-day planning. A mathematical approach is essential for any progress. Any approach devoid of mathematical considerations is likely to lead to failure. If anyone wants to make a success of his life, he must have resource of mathematics. Mathematics is a tool of many other subjects and we can find another extension of the utilitarian aspect of the subject. The vital of all utilitarian mathematics lies in the using of mathematics. Mathematics is intimately involved in every movement of every life. Right from human existence on this earth, it has been a faithful companion. One of the aims and objectives of the Ministry of Education (MoE) on high school education according to Educating our Future (MoE, 1996), is to promote the extensive knowledge and accurate understanding of chosen areas in Mathematics. The MoE expresses concerns over the poor performance in Mathematics as seen in Grade Twelve examination results at the end of every year. For instance, one-third (⅓) of boys and two-thirds (2/3) of girls, registered total failure in 'O' level Mathematics in the years since 1987 (MoE 1996).

2.2.2 Artistic Aspects of Mathematics

Beauty of a piece of art depends on the manner in which it expresses truth mathematics in knowledge of truth and realities. It is in itself a piece of fine art. It is a thing of beauty and for many it is a joy forever especially when they do not study it for examination purposes. In the artistic view by Helmholtz "The manipulations of artistic' genius are but the unconscious expression of a mysteriously acting rationally". According to Bertland Russell "mathematics, rightly viewed, possesses not only truth, but supreme beauty a beauty, cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimate pure and capable of a stren perfection such as only the greatest art can show." Hence mathematics provides a basis and background for aesthetic appreciation. Appreciation of rhythm, proportion, balance and symmetry postulates a mathematical mind. But the systematic study of these designs and orders of rhythms is fully the knowledge aspects of mathematics. We cannot separate mathematics from our daily life for every person. All the effects of nature are the mathematical results of unmovable or unchangeable laws of a small numbers.

2.3 Science

Science is the field of study concerned with discovering and describing the world around us by observing and experimenting. Biology, chemistry, and physics are all branches of science. Science is an "empirical" field, that is, it develops a body of knowledge by observing things and performing experiments. The meticulous process of gathering and analysing data is called the "scientific method," and we sometimes use science to describe the knowledge we already have. Science is also what's involved in the performance of something complicated: "the science of making a perfect soufflé." (vocabulary.Com.) Body of knowledge comprising of measurable or verifiable facts acquired through application of the scientific method,

and generalized into scientific laws or principles. While all sciences are founded on valid reasoning and conform to the principles of logic, they are not concerned with the definitiveness of their assertions or findings. In the words of the US paleontologist Stephen Jay Gould (1941), "Science is all those things which are confirmed to such a degree that it would be unreasonable to withhold one's provisionalconsent."(http://www.businessdictionary.com/definition/science.). Science has been regarded as the bedrock of modern day technological breakthrough is built. Nowadays, countries all over the world, especially the developing ones like Zambia, are striving hard to develop technologically and scientifically, since the world is turning Scientific as all proper functioning of lives depend greatly on Science. According to Ogunleye (2002), Science is a dynamic human activity concerned with understanding the workings of our world. This understanding helps man to know more about the universe. Without the applications of science, it would have been difficult for man to explore the other planets of the universe and world around him. Science comprises the basic disciplines such a Physics, Chemistry, Mathematics and Biology. Many investigations have shown that secondary school students are exhibiting dwindling interest in Science (Esiobu, 2005). Science occupies an important place in the Zambian school curriculum. Knowledge of this subject is very vital for engineers, scientists, designers, Doctors pilots and many others (Kostyuk 1998:1). Kostyuk (2004) postulates that for sustainable socio-economic development in Zambia to occur, its school system should produce more learners who are scientifically literate, who could be successfully trained as scientists and engineers. Ogunbanjo (1998) **opines** that all over the world, sciences has been accepted as a vehicle of technology, social and economic development. Mathematics is not only basic to these but is the language of science. In another related study, Igbokwe (2003) highlights the intricate link of mathematics to science and technology, and contends that without mathematics there will be no science and without science there will be no technology, and without technology there will be no modern society.

2.3.1 Importance of Science

According to Till (1971) reliance on science and technology is immeasurable. 'Literacy in science is essentially for every man and woman who hopes to function efficiently in our twentieth century society. It will enable the individual in a rapidly changing environment to make intelligent choices about his/her personal well-being. It will provide him/her with a basis for judging and taking action on issues related to science that affects every citizen" In this vein science is very crucial in understanding the world around us, the world in us and world beyond us. It challenges our imaginations with concepts that lead to great discoveries that change one's life. With regards to science education the Ministry of Education (MoE 1977:29) stated that "today we live in a scientific and technological era; more and more importance should be attached to apply the achievements of science and technology to one's work in confronting developmental problems of the country.'' Thus the problems the country faced in matters of providing a balanced diet, development of mineral resources, water supply, health and sanitation, modern scientific farming and combatting livestock diseases, cannot be solved without calling on scientific and technological dexterity. Therefore Mathematics, Science and Technology had to play a vital role in the new curricula so that education can increasingly and more effectively be responsive to some of the major needs of the country. Despite the policy declaration of 1977 the standards of science education had been deteriorating. A study conducted in Zambian secondary schools by Mathews (1973:2) observed that from 1966 to 1971the pass rate in all science subjects at certificate level in Zambia declined from 72% to 45%. The MoE (1996:59) in acknowledgement of the falling standards in science education mentioned that one further aspect of the current high school performance was far from satisfactory, especially in the key areas of mathematics and science. The purpose of teaching and learning Science and Mathematics subjects is specifically to produce two kinds of intellectual capital: Scientists and engineers who will continue the research and development that is central to the economic growth of our country. Therefore good performance in these two subjects will automatically act as a gateway to the admission to the school of engineering.

2.4 Global perspective

Poor performance in secondary schools in mathematics and science subjects is a worldwide problem. Here are some of the studies that have been conducted globally.

2.4.1 American

A primary concern of the American educational system today is that of raising the mathematics levels of its students. However, cross-national studies demonstrate the pervasiveness of poor mathematics performance among American school children relative to that of Chinese, Japanese, and Korean children (Hess, Chang, & McDevitt, 1987; Stevenson, et al., 1990; Stevenson, Lee, Chen, Stigler, Hsu, & Kitamura, 1990). Because these differences were evident as early as kindergarten, it appears that cultural and family factors contributed significantly to the difference. Again, parenting and family factors were implicated. Researchers have indicated several reasons why American students cannot perform as well as Asian students, such as motivation style, curriculum differences, parental involvement, time use, and adolescents' attitudes about how well they were doing in mathematics and how easy mathematics was for them (Chao, 1994). Particularly, traditional Chinese views of teaching and parenting contribute to students' academic success (Ho, 1994).

2.4.2 Sri Lanka

In Sri Lanka a pass in mathematics at the GCE O/L examination is compulsory to qualify for the GCE A/L. The data given in Table 2.1 show the performance of students in mathematics at the GCE O/L examination held in 2007, 2008 and 2009 (DOE, 2008 - 2010).

Table2.1: *Performance in mathematics at the GCE O/L examination*

Class Interval	Percentage 2007	Percentage 2008	Percentage 2009
90-100	0.29	1.68	0.77
80-89	2.22	4.17	2.67
70-79	5.70	5.75	4.25
60-69	5.36	6.84	5.14
50-59	5.37	10.91	6.98
40-49	10.75	7.64	8.08
30-39	21.30	13.84	13.15
20-29	10.83	12.80	16.08
10-19	16.12	17.48	19.12
0-9	22.05	18.90	23.02

Source: *Control Chief Examiners Meeting Reports, Department of Examinations, 2008-2010*

The pass mark at the GCE O/L examination is 35 percent. During the years 2007 to 2009, approximately 60 percent, 55 percent and 65 percent respectively of students obtained a mark below 35 percent in mathematics. In 2008, the initial mathematics paper was cancelled and a repeat paper, similar to the cancelled paper was given. This may be the reason why the number of those who scored less than 35 percent is significantly less in 2008, than in 2007 and 2009. However the performance was still below average. In Sri Lanka, mathematics education is compulsory up to secondary level and is commonly termed “mathematics for all”. Mathematics education up to grade 9 focuses on developing the basic skills required to function effectively in daily life, as well as on enhancing the analytical abilities of students. Also, students in the secondary level are expected to be led away from primary level methodologies where mathematical concepts are introduced with concrete examples and pictures, to a logical understanding of abstract mathematical concepts. The assessment of achievement at this stage is school based. This approach agrees and supports the `mathematics for all’ concept up to grade 9. However, in grades 10 and 11, more emphasis is given to the basics of higher mathematics including algebra and geometry; i.e., all students in this age group are compelled to learn mathematics as a ‘subject’ distorting the concept of ‘mathematics for all’ to a concept of ‘same mathematics for all’ (NIE, 2006). This is also a major contributing factor for the high failure rate in mathematics at the GCE O/L examination.

2.4.3 India

The importance of quality education in nation building has also been realized by several nations including developed countries. Several developed nations including USA realized that their role as leaders in the world’s economy and their capacity to produce wealth and quality jobs depend directly on the ability of education system to produce students who can compete in mathematics and science dominated industries of the future. Thus, improving mathematics and science education has been the priority of the policy making agenda (Anon, 2005). Students’ performance in mathematics subject has been investigated through bilateral surveys in two European countries (Robertson, 2000). Requirements of changes in national policies suiting their respective culture are emphasized in order to minimize the differences in performances amongst the countries. The interactions of a large number of socio-economic as well as academic environmental factors influence the student’s performance in school. Poor school performance not only results in the child having a low self-esteem, but also causes significant stress to the parents (Karande and Kulkarni, 2005). Identification of causes of poor performance and execution of corrective action plan so that the students can perform up to their full potential is required. A psychological aspect of female students with special reference to mathematics and subjects has been matter of investigation in past reporting that high mathematics anxiety is associated with low mathematics achievement (Yee, 1987). Another interesting finding of such study was that for the most capable students, test anxiety seems to act as a facilitator in their mathematics performance. The role of teachers has also been pointed out by the study stating that students' scores on the perception of their mathematics teachers have the strongest correlation with their mathematics anxiety scores. Teacher’s quality supported by training and experiences has influencing role in effective teaching-learning. Teaching experience plays important role in success of education (Tui, 1987).

2.4.4 Portugal

Failure rates are high and deficient learning in science is common place at both the middle and the secondary school levels in Portugal (Fonseca, 2003; GAVE, 2000, 2001; OECD, 2004). Among the 40 countries involved in the 2000 and 2003 PISA studies, Portuguese students were ranked among the lowest in science performance (GAVE, 2001; OECD, 2004). These shortcomings in science achievement are evident in spite of successive reforms in science education-a frequent phenomenon consistent with what has been observed in other international studies (Davies, 2003; Kozoll& Osborne, 2004; National Center for Educational Statistics, 2003). The poor results in science achievement reflect a general panorama of poor academic performance. In southern Portugal, science performance of 15-year-olds is among the lowest in the country (GAVE, 2001) and the failure rate for all secondary students in the region is most prominent at the tenth grade level (Carreira& André, 2000). The Portuguese educational system includes area-specific tracking after the ninth grade. Upon entering tenth grade, students must choose which major subject area they will pursue, for instance sciences, humanities, social sciences, or technology. Students who select the science track are required to enrol in eight disciplines, five of which are in the sciences: Physics/Chemistry, Biology/Geology, Mathematics, and two disciplines in Laboratory Techniques (in Physics/Chemistry and Biology/Geology). The study included 214 girls and 132 boys with a median age of 16. Of all the students, 11.3% had previously failed the tenth grade at least once. Mean tenth-grade science and mathematics classifications for the sample were typical for the Algarve. On a scale that varies from 0 to 20, with 10 representing a passing grade, mean scores were 12.5 in Physics and Chemistry (PC), 11.5 in Mathematics (Math), and 13.4 in Biology and Geology (BG). About 25% of students reported failing grades in PC; about 34% in Math and 9% in BG.

2.5 Regional

2.5.1 Somalia

In Somalia, the problem of secondary school students' poor performance in mathematics has persisted for a long time. Available records show that performance in mathematics among secondary school students in Somalia is as poor as in other countries. One secondary school mathematics teacher recalls that in the school year 1982-1983, out of 270 students (in one school) 19 of them passed in mathematics. This gives a failure rate of almost 93%. Similarly, the mean score was very low. According to statistics from the examination board of Imam Shafi'i Foundation, an educational institution in Mogadishu, out of 232 students who sat for the secondary school leaving examination in the school year 2005-2006, 113 students failed. This accounts for 48.7%. In Somalia a student is considered to be a failure in a subject if he/she scores below 50% in that subject. Here the summative type of evaluation is used (Mohamed AbdulkadirNur 2006).

2.5.2 Kenya

Long before the coming of Arabs and Europeans to Africa, the African people had developed their own systems of education; although the systems varied from one community to the other, their goals were often strikingly similar (Sifuna&Otiende, 1980). At independence in 1963, Kenyan education was viewed as the means to eradicating poverty, ignorance and disease. Mathematics was seen by society as the foundation of scientific and technological knowledge that was vital in social- economic development of the nation. Because of this Mathematics is a compulsory subject at both primary and secondary levels in Kenya. Mathematics is also used as a basic entry requirement into any of the prestigious courses such as medicine, architecture and engineering among other degree programmes. Despite the important role that Mathematics plays in society, there has always been poor performance in the subject at national examinations (Aduda, 2003), this is demonstrated by Table 2.2 in Kenya Certificate of Secondary Education (KCSE).

Table 2.2: *KCSE Performance in Mathematics*

Year	2006	2007	2008
Mean Score	12.24	16.26	18.73

Performance in Mathematics as reflected by the KCSE results has remained poor over the years. Hence, there was need to investigate factors contributing to poor performance in Mathematics at KCSE examinations by students in Koibatek District so that poor performance in mathematics can be reversed. The student factors, social cultural factors and school based factors were investigated as independent variables, and achievement in Mathematics as the dependent variable. According to Benson (1999), school achievement in mathematics in Kenya has been poor as can be seen in students' performance in KCSE. In KCSE examinations, the mean score marks of the candidates has been consistently below 18%. In 1985 alone, about 47.24% of the KCSE candidates got grade E, 22.03% got grade D- while another 11.17% got grade D. The implication is that, in 1995, about 80% of the candidates scored the lowest grades D' plain and E' on a 12 points score marks, where A' is the highest grade and E' is the lowest. Miheso (2002) notes that the failure rate in mathematics at Kenya Certificate of Secondary Education (KCSE) in 1999 was reported as 79.2% by the Kenya National Examinations Council (KNEC) report 2000. Similarly, the report revealed some of the lowest mean grades for 1994, 1996 and 1999 as 9.3, 18.12 and 13.23 respectively (Mohamed AbdulkadirNur 2006).

2.5.3 South Africa

In contextualising identified problems with mathematics and physical science, the 1999 matric results for schools in District 3 of Tshwane North were analysed. District 3 comprised 20 high schools with approximately 100 Grade 12 learners in each school. Included in this analysis were four top-performing, as well as eleven low-performing schools. Grade 12 District D3 results of 1999. Table 3 shows average passes for both mathematics and physical science that each of the different District D3 schools obtained in 1999 (Gauteng Department of Education (GDE), 1999). It was observed from the table that of the 15 schools, the low performing 11 schools (73.7%) had an average of 35% or less in mathematics. It was also seen that the mathematics pass rate ranged between 10.3% and 59.5% among the schools. In physical science the same 11 schools had an average of 43% or less. Here, the pass rate ranged between 20.9% and 63.5% (Andile Mji and Moses Makgato 2006)

Table 2.3: *Average pass (%) of selected schools in Tshwane North District D3 in 1999*

High schools	% Average pass	% Average pass
	Mathematics	Physical Science
A	59.5	63.5
B	50.3	51.7
C	48.3	47.0
D	47.4	47.8
E	34.9	43.4
F	25.3	36.5
G	19.6	32.2
H	18.0	39.6
I	17.5	31.4
J	15.7	34.6
K	15.0	34.1
L	13.0	36.3
M	11.9	29.9
N	10.4	24.7
O	10.3	20.9

* Adapted from GDE, 1999, analysis of results

For the past number of years South Africa has seen a gradual decrease in the National Senior Certificate results for the subject Physical Sciences. South Africa's poor performance in Physical Sciences was seen both nationally and internationally. In 2001 and 2003 the Trends in Mathematics and Science Study (TIMSS) was conducted globally and South Africa was part of this study (Howie 2003). In 2001, 38 countries participated in the study with a view to determining learner performance in the sciences; in

2003, 58 countries participated and in both instances South African learners were placed last (Makgato & Mji 2006:253). From 2005 to 2007, the number of learners who passed Physical Sciences at the higher grade level steadily decreased and this affected their entry into science based programmes at universities (Kriek & Grayson 2009:185). According to Kriek and Grayson (2009: 185-186), in 2005 a total of 29 965 learners passed Physical Sciences, in 2006 this figure dropped to 29 781 and in 2007 it dropped to an alarming 27 122 learners who passed Physical Sciences. Clearly South African learners were not performing in the science field. In the 2009 Senior Certificate results, the national pass rate for Physical Sciences dropped from 55% to 37%. In 2009 all nine provinces across South Africa recorded a decline in Physical Sciences. The most alarming decline was in KwaZulu-Natal where the pass rate in Physical Sciences halved compared to the previous year (Keeton 2010). The poor performance of learners in Physical Sciences was a serious cause for concern, considering the fact that KwaZulu-Natal traditionally provides a high number of successful maths and science students (ThasmaiDhurumraj 2013). Similarly, Mkgato and Mji (2006) cite several studies pointing to high failure rate in mathematics in South Africa in comparison with other countries. Examples of such studies include: Beaton et al. (1996), Howie (2001, 2003), Centre for Development in Education (2004), Naidoo (2004), Reddy (2004) and UNESCO/ UNICEF: Monitoring Learning Achievement Project (2005). While South African learners are generally not performing well in mathematics, the situation is even worse among Black South African learners (Brodie 2004). Kahn (2001) presents the failure rate for Black Grade 12 learners in mathematics in 1999, 2000, 2001 and 2002 as 88.3%, 84.5%, 80% and 76.8% respectively. An analysis of mathematics results over a five year period, 2004 to 2008 in Mthatha district, Eastern Cape in some selected schools is shown in Table 2.5 which also shows an alarming rate of failure in the subject.

Table 2.4: *Record of results for mathematics for selected Mthatha secondary schools from 2004 to 2008*

Schools	Year	Pass Rate
School A	2004	14.5%
School B	2005	17%
School C	2006	21.4%
School D	2007	28%
School E	2008	23.6%

Source: *Mthatha Department of Education Results 2004, 2005, 2006, 2007 and 2008.*

The performance of the learners in these selected schools above clearly indicates that the pass rate was low and that was not impressing to the country's education sector (S.A. Tachie and R. Chireshe).

2.6 Local

The performance of grade 12 pupils in O-Level examinations in mathematics and science subjects in Zambia has been poor and efforts have to be made to improve the pass rate for the school of engineering to develop. Performance by Subject was conducted in 2014 and thirty three (33) subjects were examinable at this level. Percent scores were used to analyze performance and the range was between 15.55 and 64.87 percent. The highest mean percentage was recorded in Luvale with a mean score of 64.73 percent, followed by Art and design (62%), Computer Science (56.6%) and Silozi (54%). The lowest mean percentage was recorded in Commerce (15.66%) followed by Mathematics (17.39%), Science (17.79%) and Agricultural Science (19.58%). The average performance in English, Mathematics, Biology and Science fell below the pass mark of 40 percent (2014 Examinations Performance Report). Performance by grade distribution in mathematics and science subjects was also conducted and the subjects the results are shown in figure 2.5. Mathematics recorded the highest proportion of candidates who failed the examination (51.68%) followed by Science at 46.64% (2014 Examinations Performance Report).

Table 2.5: *Grade Distribution in Mathematics and Science subjects*

GRADE	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	EIGHT	NINE
MATHS	3.97	2.58	6.79	3.27	4.12	11.75	6.23	9.01	51.68
SCIENCE	2.21	1.69	4.69	2.10	3.38	8.76	12.14	18.25	46.64

SOURCE: ECZ 2014 Examinations Performance Report

2.6.1 A case study of Saint Therese Girls Secondary School of Kasama District in Zambia.

The main aim was to improve pupil's academic performance at grade twelve O-level examinations. The school is located in Northern part of Zambia in Kasama district and it is a mission school. At the time of study it had 420 pupils with 24 teachers. The school was opened in 1966. Among the problems that the school had, was the reduction in academic pass-rate from 100% to 93.6% which was noticed in the year 2010 with 2009 grade twelve academic results. The researcher noticed the low academic pass-rate. In the school mission there was need to maintain high pass-rate for the school. Secondly, during monitoring the school was tasked to improve the pass-rate by the Ministry of Education in 2010 through the Director of the standards and curriculum who came to school that year. The study reviewed that, the pass-rate with the use of mathematics clinics for mathematics subject and debate for English subject contributed to the change of the pass-rate from 93.6% to 95.7% at the case study school. However, the challenges were that, the use of trained teacher without a degree to teach science subjects proved to be a failure because the results dropped from 93.6% to 80% in science subject. Low percentages were noticed in pure science which was chemistry which had 72.7% and 81.8% for physics. This was due to the fact that the school had no science teacher with a degree but depended on asking for a teacher with a degree from Mungwi Technical high school a neighboring school.

2.6.2 A case study of Senior Secondary Schools in Solwezi District of Zambia.

The case study was conducted to investigate the teaching and learning of mathematics at Senior Secondary School level in Solwezi District. The investigation reviewed that the general performance of the grade 12 examination results at

provincial level had improved steadily as shown in the table below.

Table 2.1: *General grade 12 ECZ school certificate results for North-Western province (2007-2012)*

GRADE	2007	2008	2009	2010	2011	2012
12	33.5%	40.4%	40.5%	48.5%	51.35%	55.4%

Source: *Researchjournali's Journal of Mathematics Vol. 1 | No. 6 November | 2014*

The picture for mathematics was different as the performance was poor compared to other subjects as shown in the table below.

Table 2.2: *English, RE, History and Mathematics grade 12 ECZ school certificate results for North-Western province (2009-2012)*

Subject	2009	2010	2011	2012
Mathematics	27.6%	34.6%	35.7%	31.3%
English	70.2%	86%	88%	84.4%
History	51.4%	67%	72%	74.2%
RE	60.5%	88%	75%	66.3%

Source: *Researchjournali's Journal of Mathematics Vol. 1 | No. 6 November | 2014*

As can be seen from the table above, while there was a steady increase in the pass percentages for English, RE and History, there was stagnation in the pass percentage for Mathematics. There had been poor performance in mathematics at senior Secondary School level in Solwezi District.

Table 2.8: *Mathematics grade 12 ECZ school certificate results for Solwezi Secondary schools (2009-2012)*

Year	Mathematics Grade 12 ECZ School Certificate Results for Solwezi Secondary Schools. Overall Pass in Percentage.
2009	29.1%
2010	33.2%
2011	38.2%
2012	48.5%

Source: *Researchjournali's Journal of Mathematics Vol. 1 | No. 6 November | 2014.*

From the three tables (2.6, 2.7 and 2.8) above it is clear that there is a problem with the performance of grade 12 students in mathematics during the Examinations. It is against this back ground that this research was undertaken. Looking at the data available it also showed that there has been no solution to the poor performance of students in Mathematics and Science subjects at grade 12 O- Level examinations. The poor performance in these two subjects has greatly impacted on the development of the nation as the science based careers are not undertaken in the higher learning institutions. From the researchers' point of view, not much research focusing on mathematics and science poor performance have been conducted in the Kitwe district yet the examination results continue to be unsatisfactory in these subjects (mathematics and science) which are key subjects for the country's development. It is against this background of poor performance in mathematics and science that the present study would want to establish learners' attributions on poor performance in mathematics and science in Kitwe district.

2.6.3 A case study of selected high schools in Central Province of Zambia.

It was noted that female students in Zambia and worldwide perform badly in O-Level Physics both in class exercises and at national examinations. This scenario is observed in the findings where teachers still follow traditional scope of sequence approach to curriculum (Haambokoma, 2002) that has failed to produce learners that purport to be high Order thinkers and maintain problem solving abilities. The study also revealed that all stakeholders contributes greatly to the under achievements in the female learners despite them having positive perception of physics. Female learners with the right foundation of science at primary and basic level they would develop positive perception and attitude in physics, this in turn would make them perform well in the subject. The government failure to avail schools with well qualified physics teachers, well stocked and working laboratories, instructional materials and adequate funding to institutions made administering of physics courses and examination very difficult. With lack of good funding Head teachers found administrative work very difficult as resource allocated to the Natural Science department would not be sufficient for the experiments or hands-on activities during lessons. In cases where most of the requirements for the department were not available internal monitoring from school administration was almost inexistence. The head of department (HOD's) supervision was minimal making the teacher lazy to prepare adequately for their lessons. With introduction of education for all those who have made a full certificate be in grade 10. The classes have swelled up to 60 to 70 per class. Rally classes are not easy to handle in physics with very limited equipment and apparatus. Such classes are demotivating to female learners that need much attention. Teachers fail to offer remedial work to slow learners due to the big size of the class. Lack of time in most cases made the teachers fail to innovate experiments that would substitute those that have no apparatus or equipment.

2.6.4 Summary

The chapter reviewed the literature of different researchers on the high failure rate in mathematics and science subjects at grade 12 examinations. Further, the chapter established the impact of the research as it has been done globally but very little has been conducted in Zambia particularly Kitwe district. The chapter also reviewed how wide the problem is hence the importance of undertaking the research.

3.0 RESEARCH METHODOLOGY

3.1 The Research Design

A descriptive cross-sectional survey was utilised because it provides an accurate portrayal or account of the characteristics, for example, behaviour, opinions, abilities, beliefs, and knowledge of a particular individual, situation or

group. The research used a cross-sectional survey design adopting qualitative methodology to a smaller extent and quantitative method to obtain evidence to answer research questions. According to McMillan and Schumacher (1997:162), the design describes the procedures for conducting the study, including when, from whom, and under what conditions the data will be obtained. In other words, the design indicated how the research was set up, what happened to the subjects and what methods of data collection were used.

3.2 The Sampling Design and Sample Size

3.2.1 The Research Population

The target population comprised of Heads of Departments for both Mathematics and Science, Teachers of both Mathematics and Science and Grade twelve (12) learners from nine secondary schools of Kitwe District in Copperbelt Province and other Institutions such as the Copperbelt University (CBU) and the Engineering Institution of Zambia (EIZ).

3.2.2 Sample population

The sample comprised of eighteen (18) heads of departments [nine (9) from mathematics and nine (9) from science], twenty (25) teachers [eleven (11) from mathematics and fourteen (14) from science] and sixty (60) grade twelve (12) learners. The entire respondents were from 9 secondary schools of Kitwe District in the Copperbelt Province, CBU and EIZ.

3.2.3 Sample strategies

The probability sampling called Simple Random Sampling (SRS) was used in the study, so that the selection of elementary units depended purely on chance and no personal bias was involved, (Sharma, 1983). White (2005) also stated that the probability random sampling technique ensures that every element in the sampling frame has an equal chance of being included in the sample. The sample of nine (9) secondary schools (7 Government and 2 private) was drawn from a total of fourteen (14) Government secondary schools and eight (8) private Secondary Schools in Kitwe District. The names of the Government secondary schools were assigned a three digit number from 001 to 014 on the cards and these were mixed thoroughly, and then nine (7) cards were drawn one after the other which constituted the sample and also the names of private Secondary Schools were assigned a three digit number from 001 to 008 on the cards and these cards were mixed thoroughly from which two (2) cards were drawn one after the other which constituted the sample. The eighteen heads of departments were all given the questionnaires without assigning them with numbers. Heads of departments were targeted in order to determine the accuracy of results. A range of five to twelve learners depending on the number of classes were selected per school using the simply random sampling procedure where each pupil was assigned a number and these numbers were drawn one after the other. Also a sample of four teachers was selected from each school. These were teachers of Mathematics and Science who had at least taught a grade twelve class. The selection was based on simple random sampling but in some schools teachers were automatically given the questionnaire due to the small number of teachers under the department.

3.3 Data Collection

3.3.1 Secondary data collection

Secondary data for the research was obtained through the use of sources such as; the researcher analysed public documents, such as ECZ Examiners' reports, journals, past researches and the internet. This collection method has been used mostly in the Literature Review.

3.3.2 Primary data collection

Primary data was collected from the field using three sets of survey questionnaires. The three sets of questionnaires were administered to three categories of respondents in secondary schools of Kitwe District: the heads of departments for both mathematics and science subjects, teachers of both mathematics and science subjects and the grade twelve learners. The questionnaire for the heads of department was used to collect information on the performance of pupils in the grade twelve examinations from 2010 to 2014 and the impact of the performances to the field of Engineering. Heads of departments' findings were used to determine the accuracy of results from teachers and learners. The questionnaire for teachers was used to collect information on whether they had learnt mathematics or science at the institutions they had attended and also to find out the difficulties they experience together with the challenges they face in teaching mathematics or science. The data collected was both qualitative and quantitative. The questionnaires for learners collected data on their performance in mathematics and science and challenges encountered in learning mathematics and science. The data collected was both quantitative and qualitative. Advantages of primary data are that: the data collection methods are flexible and specific, first-hand information was collected from respondents, response rate is quicker and it expresses the true emotions of a respondent. The basis for using structured questionnaires was that many respondents can be reached with little time and less cost (Bless et al., 2006). Structured questionnaires are an efficient way of collecting data because they typically contain fixed responses and can be administered to a large number of people simultaneously (Cummings and Worley, 2001). Some questions may require reflection or consultation before answering, for which structured questionnaires might be appropriate as used in this research. The reflection and consultation might not be possible if there is an interviewer waiting for a response, often resulting in hasty responses. Personal interviews were used as follow ups to the questionnaires. Observation was also used to verify the data collected through questionnaires and the interviews.

3.4 Research Instruments

3.4.1 Data gathering

The data collection instruments used in this phase of the study was a set of three (3) survey questionnaires for the respondents (Heads of departments, Teachers and grade twelve pupils) developed by the researcher.

3.4.2 Personal Interviews

The research also carried out personal interviews informally as a way of collecting information for the research. Personal interviews provided the most direct evidence of how performance of the pupils is and has been. This involved collection of data through oral questioning of respondents. Structured questions were used as a guide aimed at soliciting useful data. Five (5) career masters, twenty (20) teachers of both mathematics and science and sixty seven (67) pupils and CBU staff and EIZ S staff were interviewed. The respondents' emotions and feelings were regarded relatively easy to capture through face to face personal contact.

3.5 Data Analysis

The qualitative information that was obtained from the questionnaires, interviews and documents was analysed and was put into themes. On the other hand, quantitative data was analysed through the use of statistical software called STATA and tools such as frequency tables, pie charts and bar charts used (Huberman, 1994). The open-ended questions were analysed through quantitative content analysis by the researcher with the aim of quantifying emerging characteristics and concepts. Concept analysis is the process of analysing verbal or written communications in a systematic way to measure variables quantitatively (Polit and Hungler, 1995). The researcher made an interpretation of data analysis which included description, analysing data and drawing conclusions about its meaning personally and theoretically.

4.0 FINDINGS AND DISCUSSION

4.1 Performance in Mathematics examinations from 2010 to 2014.

The grade 12 percentage performances for the period 2010 to 2014 were collected per school and are shown in table 4.1 below. The names of the secondary schools were withheld in order to protect the identity of these Secondary Schools, instead the letters were used. However from table 4.1 below it can be seen that the performance of grade 12 pupils in Mathematics examinations has been poor. These percentage pass rates were general, which included those with Distinctions, Merits, Credits and passes, therefore from these statistics andthe requirement that any student who would like to pursue Engineering related programmes must have a good background in mathematics as a subject. We may conclude by saying that these pass rates negatively affect the development of the field of engineering. Engineering is the backbone of development because everything is centred on how good the engineering skills are taped from the secondary education, as everything that is used may have an origin of engineering for instance; the medical equipment which our medical personnel use to diagnose patients are products of engineering, communication equipment, etc.

Table 4.1: *Grade 12 Mathematics examination percentage (%) pass rate*

Name of Secondary School	2010 pass rate (%)	2011 pass rate (%)	2012 pass rate (%)	2013 pass rate (%)	2014 pass rate (%)
A	42	40	22	37	25
B	54	50	42	39	48
C	60.8	61.7	55.3	67.2	27.3
D	50.3	43.1	37.6	61.5	----------
E	92	93	87	92	89
F	57	63	54	58	----------
G	42.2	49.2	49.8	52.1	40
H	90	75	80	92	----------

Source: *Field data 2016*

Table 4.2 below shows the failure rate in mathematics and the table clearly interpret how big the problem is. Poor performance in mathematics has a negative affected to the school of Engineering as mathematics is a key subject to gain entry to the school. If the country is to register positive developments it has to start by developing the field of Engineering but this cannot be possible if we record poor performance in mathematics. Hence the first problem we have at hand is poor performance in mathematics at grade 12 examinations then we can move forward to develop the field of Engineering.

Table 4.2: *Grade 12 Mathematics percentage (%) failure rate*

Name of Secondary School	2010 Failure rate (%)	2011 Failure rate (%)	2012 Failure rate (%)	2013 Failure rate (%)	2014 Failure rate (%)
A	58	60	78	63	75
B	46	50	58	61	52
C	39.2	38.3	44.7	32.8	72.7
D	49.7	56.9	62.4	38.5	----------
E	08	07	13	08	11
F	43	37	46	42	----------
G	57.8	50.8	50.2	47.9	60
H	10	25	20	08	----------

Source: *Field data 2016*

4.2 Performance in Science examinations from 2010 to 2014.

The grade 12 percentage performances for the period 2010 to 2014 were collected per school and results are shown in table 4.3 below.

Table 4.3: *Grade 12 Science percentage pass rate*

Name of Secondary School	2010 pass rate (%)	2011pass rate (%)	2012 pass rate (%)	2013 pass rate (%)	2014 pass rate (%)
A	67.7	69.7	69.8	45.9	50.2
B	81	50			28
C	64.03	81.41	53.02	56.13	78.534
D	76	60	68	70	78
E	80	84.5	91	89	78
F	94.16	63.2	79.8	85.4	
G	88	92	79	87	87
H	68	65	62	60	67

Source: *Field data 2016*

4.3 Views held by Heads of Departments and teachers on Challenges to the teaching of Mathematics and Sciences

Both teachers of Mathematics and Science subjects including their Heads of departments expressed their views on the subject matter through the questionnaire and also some interviews and their responses were as follows;

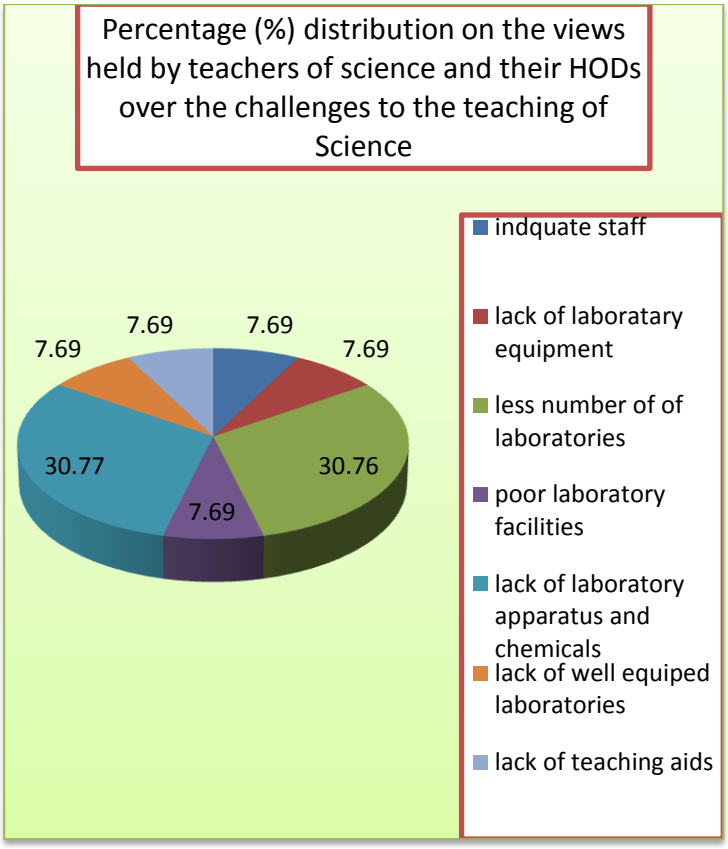
4.3.1 Views held by teachers of mathematics and their Heads of department on Challenges to the teaching of Mathematics

Most of the respondents attributed the challenges to the teaching of mathematics to the negative attitudes of the pupils as they perceive that mathematics is a difficult subject to pass. However some challenges included the lack of learning and teaching aids, high pupil to teacher ratio due to over enrolment (a class ranges to about 60 to 70 pupils), poor background in mathematics from junior levels, lack of interest by pupils towards mathematics, too much dependence on exam leakages, lack of text books, lack of commitment by learners who just think that mathematics is difficult and lack of degree holders to teach mathematics. However each respondent had his or her own views.

4.3.2 Views held by teachers of science and their Heads of department on Challenges to the teaching of science

Both the teachers of science and their Heads of departments attributed the challenges to the teachings of science to lack of laboratory equipment, lack of laboratory chemicals and apparatus to carry out experiments and lack of laboratory space as most of the laboratories were small compared to the number of pupils and in some cases poor laboratory facilities, lack of teaching aids and shortage of science text books to cater for each pupil in class, over enrolment resulting in high teacher to pupil ratio, hence pupils receive less attention from teachers. The summarised views of teachers of science and their heads of departments are shown in figure 4.1 below.

Figure 4.1: *Views held by teachers of Science and their Heads of departments over the challenges to the teaching of Science*



Source: *Field data 2016*

4.4 Views held by the pupils concerning their learning Challenges

4.4.1 Mathematics

Pupils attributed their poor performance as a result of lack of study materials such as Mathematics text books and in some schools lack of experienced teachers, and also lack of teachers' commitment to the teaching of the subject. However most of the pupils acknowledged that some of the challenges they face, where as a result of lack of their commitment and negative attitude towards the subject hence resulted in lack of study groups and lack of study time table to plan their studying. Some of the challenges include poor teaching methods by some teachers, lack of guidance concerning the importance of the subject in their higher education as they only study mathematics just because it is a compulsory subject and lack of study materials. Note that each respondent had his or her own views but the ones above come out strongly

4.4.2 Science

Pupils blamed their poor performance in science to lack of laboratory apparatus and chemicals for them to carry out experiments as the subject is a practical one, they also said lack of laboratory space was another problem as most of the existing laboratories could not cope with the large numbers of pupils in school. Other changes include lack of commitment from some teachers, lack of study and learning

materials. However some pupils blamed themselves due to lack of commitment and time management as the subject involves some calculations which they perceive to be difficult. The percentage distributions of the views held by the pupils on the learning challenges is shown in table 4.4 below. Note that others represent other challenges as each respondent had his or her own view

Table 4.4: *Percentage (%) distribution of the views held by pupils on the learning challenges in science*

lack of laboratory space to meet the large pupil population	**30.9%**
lack of laboratory apparatus and chemicals	41.7%
lack of teachers' commitment to the teaching of the subject	9.1%
lack of by pupils commitment and time management to the subject	9.3%
Lack of study and learning materials	6.5%
Others	3.5%

Source: *Field data 2016*

4.5: The views held by the EIZ and CBU on the failure rate in Mathematics and Science subjects at 12 O-level examinations.

Currently the Copperbelt University (CBU) has been admitting students to the school of engineering with points ranging from 6 to 8 points, hence mathematics and science subjects as being the key subjects in the school should have should have very good grade points such as a distinction. Therefore comparing the grade 12 performance and admission requirements the University is not able to choose from a pull of applicants but limited to the few that apply. However currently in Zambia things seems to ok because the low number of Universities offering engineering related programs which only admit a small number of applicants but this is not very good to the country as it enough manpower which can drive the development of the nation. On the other hand the EIZ noted that its mandatory is to regulate the professionals in the field of engineering however it holds career talks to pupils in secondary and also support the projects by pupils.

4.6 Discussion of Results (Answering Research Questions)

The study sought to establish views held by the Heads of departments, teachers of both mathematics and science, grade 12 pupils EIZ and CBU concerning poor performance in mathematics and science subjects at O-Level examinations and its impact to the schoolof engineering also the challenges to the teaching and learning of mathematics and science and finally possible measure which could be employed to improve the performance of pupils.

The research questions to be answered are:

1. What was the failure rate of grade 12 students in mathematics and science subjects in Kitwe District from 2010 to 2014 Examinations?
2. What are the challenges to the teaching and learning of mathematics and science subjects?
3. What is the impact of the failure rate to the school of Engineering?

From the findings, there is a significant role played by the performance of grade 12 pupils to the development of the field of engineering through the school of engineering as engineering is dependent on good performance in mathematics and science subjects.Probably it can be argued that it would be difficult, or perhaps impossible, to live a normal life in many parts of the world, including Zambia, without making use of Mathematics and Science. Mathematics and Science, however offers a different but complementary perspective in terms of how learners make sense of the world around them. It is against this background that the field of engineering develops its importance to the human life.

4.6.1 Research Question 1

The study involved nine (9) secondary schools of Kitwe district from which researcher collected data on the performance of grade 12 pupils with the main focus on the failure rate. The data collected showed that the performance in mathematics was very poor. These findings are in line with those that were done to the secondary schools in Solwezi district where the mathematics performance was very poor (Researchjournali's Journal of Mathematics Vol. 1 | No. 6 November | 2014). Also consistent with Miheso (2002) who noted that the failure rate in mathematics at Kenya Certificate of Secondary Education (KCSE) in 1999 was reported as 79.2% by the Kenya National Examinations Council (KNEC) report 2000. The findings were also consistent with The Ministry of Education (MoE, 1996) concerns about the poor performances in Mathematics that was overwhelmingly evident in Grade Twelve final examination results year in year out. The MoE (1996) stated that one worrying aspect about the current high poor school performance which required comment was the achievement level that was far from satisfactory, especially in the area of Mathematics. It was further pointed out that the overall unsatisfactory performance in school certificate was attributed to a large extent to poor performance in Mathematics. However this research has gone further to relate the performance in mathematics and science and its impact to the field of engineering. The percentage failure rate has reached alarming levels in mathematics than in science because the failure rate was higher than the pass rate (table 4.2 and table 4.3). The researcher collected this data so that he can use it to check on the information from the teachers and pupils and see if at all it has an impact to the field of engineering through the school of engineering. From table 4.3 it can be concluded that these results negatively impacted on the school of engineering as it depends largely on very good performance in mathematics. It further shows that the relationship between the grade 12 mathematics performance and the entry qualifications in the school of engineering was very poor as most of the pupils could not gain entry to the School of Engineering. The contribution of mathematics subject to the engineering related programs cannot be over emphasised, as its value is the most important means to achieve the fundamental engineering principles. Also Willombe (2011) urged scientists and researchers not only to present hard-core Mathematics but

also to share opportunities and knowledge to transform mathematics education in Zambia Mathematics cannot be separated or replace by any subject in the school of engineering but it remains the pillar to the field. Engineering plays a significant role in the modern world since it is always presented in day to day activities concerning construction, computers, technology, energy, electronic devices, and manufacturing process. Therefore Engineering courses require the awareness of mathematical concepts. During the course, students learn and consolidate basic mathematical principles in order to solve practical problems. Hence poor performance in mathematics at grade 12 examination will not assure admission to the school of engineering and this will at the end deprive the individuals and the nation with a very important skill that is required for personal and national development. Engineering is a science that has different applications and its use is dependent on the nature of the application. The engineering applications find its use in fields like medical, chemical engineering, civil engineering, mechanical engineering, electrical engineering just to mention a few, in short it is found in all our daily life. Therefore the performance in science cannot be ignored to the contribution of the school of engineering. This was the reason why the performance in science was not left out of this research and from table 4.4 it can be seen that science performance was far much better than mathematics performance to benefit the school of engineering but according to the respondent believed that the grades obtained were not very good to assure entry to the School of Engineering. However table 4.4 could not high light the actual grades obtain but it was through an interview with the heads of departments and the career masters acknowledged that most of the grades were passes.(Haambokoma, 2002) proposed that secondary school science has failed to produce learners that purport to be High Order thinkers and maintain problem solving abilities. The quality of pupils that was required for the school of engineering needed to be as proposed by Haambokoma (2002). Therefore the performance of grade 12 pupils in science should be very good to enhance great thinking and problem solving as the field of engineering may demand.

4.6.2 Research Question 2

The challenges that were associated with the teaching and learning of mathematics and science subjects from the viewed held by the teachers and grade 12 pupils were: Most of the respondents attributed the challenges to the teaching and learning of mathematics to the negative attitudes held by the pupils towards the subject as they perceive that mathematics was a difficult subject to pass. However most of the pupils acknowledged that one of the challenges they face was as a result of lack of their commitment and negative attitude towards the subject. This concurred with responses of pupils which was 61.2% (figure 4.13) attributed their poor performance in mathematics to negative impression towards the subject. Due to negativity towards the subject the pupils do not pay particular attention to most of the work in mathematics.This concurswith the views by Githua (2002) who mentioned that the quality of textbooks, students' negative attitude towards mathematics and unsuitable teaching methods as responsible factors for dismal performance in Nairobi and Rift Valley provinces.Pupils attributed their poor performance as a result of lack of study materials such as Mathematics text books and in some schools lack of experienced teachers,including poor teaching methods by some teachers. The research on effective scholarly in the Third World indicated that the availability of textbooks and other print materials in schools influenced achievement in examinations (Fuller, 1985; 1987, Keyneman&Loxey, 1983; Kool & Stool, 1993). Some heads of departments and teachers complained of high pupil to teacher ratio due to over enrolment (a class ranges from about 60 to 70 pupils). When the class size is too large, learners tend to lose focus on the task because instruction is focused on the class as a whole rather than on individual learners (Blachford et al 2011). This is in line with what some pupils complained of lack of individual attention from their teachers. Smaller class sizes benefit learners once they enter high school especially in areas of reading and science (Konstantopoulos& Chung 2009). Ogunniyi, 1986: Macfarlane el al, 1990; and Kool and Stool, 1993 concluded by observing that one of the factors attributing to poor achievement in school science education in Africa is overcrowding. Teachers also complained of poor background in mathematics from junior levels and lack of interest by pupils towards mathematics.On the other hand Pupils complained of lack of guidance concerning the importance of the subject in their higher education, due to this the pupils believe that they only study mathematics just because it is a compulsory subject and passing it is as well compulsory.Science is a practical subject that requires pupils to enhance their understanding of the theory work through practical activities. The data collected from respondents reviewed that science had challenges such as lack of laboratory equipment as viewed by (30.77% respondents) who believed that carrying out of practical activities in the laboratory was not possible and others had a view that inadequate members of staff (30.77% respondents) was a big challenge to the smooth operation of the science department. The number of staff to attend to pupils more especially the laboratory technicians plays a vital role in the teaching of science. However this cannot go alone without enough laboratory equipment. Grade 12 pupils also complained of lack of laboratory chemicals and apparatus (41.7% respondents) to carry out experiments and lack of laboratory space as most of the laboratories were small compared to the number of pupils (30.9% respondents). Practical and theory lessons in large classes, together with limited resources, become very difficult. Smaller classes benefit all learners; however, learners who perform poorly in various subjects would benefit the most as they will receive good attention. The study also collected data on theviews of teachers of mathematics on the number of periods they teach per week and the collected data reviewed that 36.36% teach below 21 periods per week while 27.27% teach between 21 to 25 periods per week while 36.36% teach between 26 to 30 periods per week. For science the data collected reviewed that 46.15% teach below 21 periods per week, while 30.77% teach between 21 to 25 periods per week and 23.08% teach between 26 to 30 periods per week. However the researcher wanted to know the recommended number of periods to teach per week in both mathematics and science subjects, but the

data collected from teachers reviewed that 63.63% had a view that the recommended number of periods in mathematics was below 21 periods, while 27.27% had a view that it was between 21 to 25 periods per week and 9.09% had a views that it was between 26 to 30 periods per week. While for science 15.38% had a view that it was between 26 to 30 periods per week, while 38.46% had a view that it was between 21 to 25 periods per week and 46.15% had a view that it was below 21 periods per week. This data shows that teachers of both subjects were not well informed by their supervisors on the recommended number of periods to teach per week hence a teacher will not know when he/she is overloaded and over-working. Nevertheless over-working a teacher causes fatigue which contributes to poor performance by pupils. Kostyuk (2006) believed that the maximum acceptable periods to teach per week were 24 periods. However the findings in this research also reviewed that three quarters of the teachers were not over loaded but they suffered on high number of pupils per class (high teacher to pupil ratio).

4.6.3 Research Question 3

Under this research question the researcher wanted to know the views held by Heads of departments in both mathematics and science subjects on the impact of the grade 12 performance to the school of Engineering. The data collected on the performance reviewed that 62.5% agreed that the performance of grade 12 pupils in mathematics was poor hence it could not contribute to the admissions to the school of engineering, however 25% agreed that the performance of grade 12 pupils in mathematics was good and would contribute to the admissions to the school of engineering as the number of pupils who got distinctions was reasonable to make an impact and 12.5% strongly agreed that the performance would contribute to the school of engineering. As observed by the respondent the school of engineering is a highly competitive school that require quality of pupils who are great thinker and with problem solving abilities, therefore pupils should be trained to have these qualities as it may be very difficult to develop these qualities at University or College. In general the data collected reviewed that the performance of grade 12 pupils was very poor in mathematics and hence the impact on the school of engineering was very minimal and cold not secure good admissions for the training in the field of engineering. Science is not an exception to the development of engineering as every program offered under School of engineering will have a background of science; therefore good science back ground at secondary is very important to the field. It was against this background that the research included the science component. The data collected reviewed that 62.5% agreed that the performance in science could contribute to the admissions to the school of engineering and 25% strongly agreed that the performance of grade 12 pupils in science would largely contribute to the admissions to the school of engineering, while 12.5% disagreed and said that, the performance of grade 12 pupils would not contribute to the admissions to the of engineering. They argued that the pass grades were note very good to be admitted in the school of engineering. However from table 4.4 the pass rate in science was much better than in mathematics therefore to some extent it could contribute to the admissions to the school of engineering but the actual grades scored were not known and what was known was that recommended grades were distinctions but merits and credits more especially for colleges and vocational training schools were admissible. For instance, the advert by Mopani Copper Mines Pic which implemented a competence-based engineering apprenticeship programme with special emphasis to the training and development of apprentices to artisan levels that will be compatible with international artisans standards in power electrical, auto-electrical, instrumentation, diesel fitting, plating/welding, fitting and machining, and rigger/ropeman trades. The training was to be conducted at Mopani Central Training Centre situated at Mufulira Mine Site and Apprentices who successfully complete the apprenticeship programme for two years would be certified as Crafts tradesmen by TEVETA. In which the minimum required qualifications were grade 12 level of education with credit in Mathematics, any Science and English subjects (recruitment@mopani.com.zm). The researcher also collected data from the teachers of mathematics on current performance (2016) which reviewed that 45.45% said that the performance was good and 18.18% had the view that the performance was very good, while 36.36% had a view that the performance was poor. Despite these responses most teachers interviewed complained of poor performance in mathematics as pupils could not pass the class tests and these responses were not consistent with those of the heads of departments as the pass rate were not seen to improve in most of the secondary schools year in and year out. However when asked to whether the performance would contribute to the school of engineering the data collected reviewed that 45.45% disagreed that the performance of grade 12 pupils would not contribute to the field of engineering, while 45.45% agreed that it would contribute to the school of engineering and 3.09% strongly agreed that the performance would contribute to the school of engineering and 6% strongly disagreed that the performance would not contribute to the school of engineering as they observed that that the current (2016) performance of the pupils could not produce a high number of pupils scoring Distinctions or merits. With regards to science performance the teachers held the views that the current (2016) performance was good as 50% agreed to the view and 25% had the view that the performance was very good, while 25% had the view that the performance was poor. However the respondent believed that the overall examination result would be very good to contribute to the school of engineering. The researcher also collected data from grade 12 pupils on their self-evaluation in mathematics performance which reviewed that 40% (N=24) evaluated themselves to be very good in mathematics, 45% (N=27) evaluated themselves to be good in mathematics and 15% (N=9) evaluated themselves to be average in mathematics. However the researcher observed that the responses were not consistent with those of their teachers and results from the heads of departments. The responses from the pupils made the researcher to agree with pupils on their earlier view on why they fail mathematics which they attributed to lack of academic guidance on the importance of mathematics after their secondary education hence they view mathematics as subject that they have to pass

regardless of the grade scored. The researcher further collected the views of pupils on the programs (courses) they would like to pursue after their secondary education and data collected reviewed that 25.39% would like to pursue Engineering related programs, 40.66% would like to pursue programs related to the field of Medical, 6.76% would like to pursue Education related programs, 5.07% would like to pursue programs related to Law and 6.78% would like to pursue programs in Business. Each Pupil had his/her own career choice but the major ones were those mentioned above. Teachers were asked on their views to whether mathematics was naturally difficult subject to pass and the data collected reviewed that those who **strongly agreed** that mathematics was naturally a difficult subject to pass was 18.18%, those who **agreed** that mathematics was naturally a difficult subject to pass was also 18.18%, while 36.36% was for those who **disagreed** that mathematics was a difficult subject to pass and 27.27% **strongly disagreed** that mathematics was a naturally difficult subject to pass.Mathematics teachers'beliefs and attitudes towards mathematics play a major role in influencing their pupils' attitudes and achievements in mathematics (Nicolaidou, &Philippou, 2003). Thepupils were as well interviewed to whether mathematics was naturally a difficult subject to pass, the data collected reviewed that 53.33% disagreed and their view was that it was notbut that the negative attitude towards mathematics was the major reason why the performance was poor as they could not even make study groups, According to Begerson et al. (2000) students working in small groups significantly outscored students working individually. 26.67% strongly disagreed to mathematics being a difficult subject to pass but acknowledged that it requires hard work to pass and viewed that hard work is a natural call for any task to be achieved, 11.67% agreed that mathematics was a difficult subject to pass and 8.33% strongly agreed that mathematics was difficult subject to pass. As they believed that their effort was not good enough to produce positive results. However this data has reviewed that there is positive thinking about mathematics which make me believe that there is some potential in the pupils and the challenge is left to teachers and the administrators to tap this talent.

RECOMMENDATIONS AND CONCLUSSION

5.1Conclusion

This study draws the conclusion that significant factors contributing to students' poor performance in mathematics and science include: student's negative attitude towards the subjects more especially in mathematics, high teacher to pupil ratios due to over enrolment, lack of laboratory equipment, lack of teaching and learning materials, lack of laboratory apparatus and chemicals and lack of guidance to the pupils on the importance of these subjects to their higher learning. These factors also contribute to the dismal performance in mathematics and science in secondary schools ofKitwe District. Remedies to improve performance of students in mathematics and science as mentioned in the findings of the study include: proper guidance to change the students' negative attitude towards mathematics, improving the supply or stocking of the laboratories, taking pupils on field tours to industries, giving pupils projects related to the subjects, inviting engineers for career talk to motivate pupils and reduce overcrowding of pupils by controlling the enrolments. The formation of mathematics and JETS clubs in the schools would be a great booster to the achievement of students in the subject and also encouraging pupils to join these clubs. As reviewed from data collected over pupils who were members of science club from figure 4.16 where 53.33% were not members of the science club, that simply tells a story that something was wrong somewhere because science is a compulsory subject (covering Integrated Science, Biology, Physics, Chemistry and even Agriculture Science) which should have a large number of pupils in the club. The reviewingon the utilization of the available resources is another strategy which if adopted would make the mathematics and science teaching and learning simplified. Maqutu (2003) pointed out that availability of resources in schools does not necessarily translate into their use. The finding also agreed with that of Kayungwa (2002) who observed that crucial is utility rather than availability, that the teacher can perform poorly "if he/she is not committed or interested to find the correct materials and use the materials to the right learners". Engineering is the key to the development of any nation more especially this time when Zambia is facing energy challenges which are far from being solved, it requires more investment in the engineering field but the goal cannot be realised with poor performance in mathematics and science. This is a challenge to policy makers to shift their thinking towards improving the performance of pupils in mathematics and science by making sure that more resources are available to enhance the teaching and learning of the subjects.

5.2 Recommendations

The following recommendations were made: The secondary schools should partner with engineering organisations (e.g. The Engineering Institution of Zambia) and industries in the teaching of mathematics and science so that it can be made more practical to everyday life and relate to the field of engineer. Students may see a lot of meaning if they are able to relate the connections of mathematics and science to the school of engineering through these partnerships with the engineering organisations and industries. This is in line with MoE (1996) which proposed that partnership between schools and other sectors of the economy must be encouraged. This study reviewed that mathematics is the key subject to the development of the field of engineering through the admissions to the school of engineering but currently the research has reviewed that the performance is very poor hence making it difficult to tap talent. Perhaps this may be the reason why they very few universities offering engineering related programs compared with other schools which are expanding at a rapid rate such as the school of Education. Therefore school administrators have to rise to the challenge by putting measures to improve the performance in mathematics if the school of engineering is to grow.I call upon the government and the private sector and other well-wishers to come together and help improve the school infrastructure so as to reduce on overcrowding in classes and hence teacher to pupil ratio as reviewed by this study. The teaching of science should not be in abstract; therefore enough resources should be channelled towards improving laboratory facilities to meet the learning standards. One challenge that has come out strongly is the

negative attitude of pupils towards mathematics. **Attitude** is an important predictor of achievement as students who have more positive attitudes toward school engage more in learning activities and persist longer in their effort to complete difficult tasks (Reyes, 1984; Wilkins, 2002).The sequence and level of mathematics courses taken in secondary school are critical factors that influence access to higher education particularly the school of engineering.In order for students to graduate from high school ready for success in college and career, they need information and planning tools to allow them to explore long-term college and career goals, identify what is needed to meet those goals, and measure their progress throughout high school. In turn, teachers and counsellors at the school level, along with parents, institutions and administrators, all have roles and responsibilities in supporting students in meeting their goals and this will help students develop positive attitude towards mathematics. There is need to develop love for mathematics through the setting up of "Mathematics Club" in every secondary school. Its aims should be as follows;

I. to initiate and develop love for mathematics
II. to help students develop positive attitude towards mathematics
III. to learn the "History of Mathematics" by sharing its slow and painful development from ancient time to the present and associate it to the field of engineering.

School administrators and Heads of departments have a role to encourage their members of staff to work hard and to develop positive attitude towards the subjects they teach, unlike in this research which reviewed that 36.36% teachers had a view that mathematics was naturally a difficult subject to pass. To improve on poor background in mathematics and science Basic and Primary schools should enhance the teaching of these subjects so that pupils are well natured at lower level. I call upon the Ministry of Education to start considering having teachers specialised in mathematics and science subjects to be teaching these subjects at primary because some primary teachers may have a poor background in mathematics especially and that on its self is a drawback to pupils.

5.3 Future Research

Further research needs to be carried out on a larger population and sample size to increase the generalizability of the findings. More especially that there are a few number of studies on the impact of failure rate of grade 12 pupils in mathematics and science subjects in O-Level examinations to the school of engineering.I also propose that a pilot project be carried out in one secondary school of improving the pass rate in mathematics. A research should be carried out in other secondary schools in the Copperbelt province and also to roll out the research throughout the country. Since the present study was limited to senior secondary schools, similar studies could be carried out to cove the junior secondary schools as well as to ascertain the views that pupils fail mathematics at grade 12 because of poor background in mathematics from Junior Secondary school.

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