

Trends Analysis Of Grade 12 Learners' Academic Performance In Mathematics In Schools Of Kabwe District From 2014 To 2018 School Certificate Examinations: A Projection For 2019 To 2023.

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ABSTRACT

Mathematical thought and concepts have become the primary navigational tools in this data driven world. A strong foundation in secondary school mathematics is essential. Despite the importance of mathematics in life and in the study of other science subjects, there has been a decline in performance of mathematics for grade 12 learners. It was noted that performance in mathematics had been poor in the past six (6) years. When capable students avoid the study of mathematics, it reduces their career options and thereby limiting the nation's resource base in science and technology. Despite the critical role mathematics plays in almost all aspects of human endeavors, performance has continued to decline in the national school certificate examinations among grade 12 learners. The impact that mathematics has on national development cannot be overemphasized. This study, aimed at developing a mathematical model that was used to predict performance at grade 12 in mathematics, in the school certificate examination. Trends were analyzed from 2014 to 2018 and from this, a prediction was determined and later, a projection was conducted for 2019 to 2023. The study was conducted in Kabwe district. There are 24 secondary schools in this district and 9 schools were picked for the sample. Data was drawn from the 9 schools in the sample of Kabwe district schools of central province of Zambia, using mixed method of quantitative and qualitative approaches. The study used simple linear regression model. The findings

revealed that, three (3) schools in the sample had revealed nose diving trends, whereas six (6) of them had upward trends. Data was analyzed using excel, with its in-built analysis tools. Furthermore, findings of the study revealed that from 2019 to 2023 a steady rise in performance will be seen. This predicted Trend is in effect a decline in performance compared to the actual performance of that which was recorded in 2018. In the three schools with downward trends, it showed that these schools were going to continue nose diving throughout the projected 5-year period. Additionally, it was observed that even within those schools that had upward trends, the goodness of fit measures was still showing very low measures of goodness of fit values. It should furthermore, be noted that in some schools that had upward trends, the gradient also was approaching zero, this too was not a good indicator. The recommendations were that projections should be encouraged in schools and monitoring should be strengthened and should be based on the projections. Trends analysis will help to put in mitigation measures with a view to improving learner performance in Mathematics.

Keywords— *Projection, Trend Analysis, Prediction, Performance.*

1. INTRODUCTION

Zambia will uphold the principle of equal opportunity in relation to the education system adopted by the Zambian government for its citizens. But it must be accepted that equal opportunity means more than just opportunity to develop mediocre competence in the area of someone else's strength. Equal opportunity means being provided with the tools to develop one's own special talents to the point of excellence (Moe, 1992). Mathematics has been at the centre of all the subjects offered at senior secondary school level. It is against this background that mathematics is a compulsory subject. Mathematics is an essential requirement in every field of academic aptitude and human growth to cope with the challenges of life. Fajemidagba and Akpan (2006) asserted 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 economics, politics, geography, science and technology. Mathematics is centered on the use of numbers which is an integral component of every aspect of knowledge. Mathematics is actually viewed as a language that is utilized to describe the problem arising in most branches of science and technology. In another study conducted in Ekiti Nigeria by Oluwatusin and Dele-Botimi (2017) findings in this study revealed that there was significant difference between further mathematics and non-further mathematics students' achievement in mathematics, Biology, Chemistry, and Physics, there was also a significant difference between further mathematics and non-further mathematics students' overall achievement in mathematics, Biology, Chemistry and Physics and there was positive significant relationship between each of the subjects (Mathematics, Biology, Chemistry and Physics) and other science subjects. Mathematics is truly the foundation of all subjects. For learners to

perform well in all subjects, they need mathematics and truly mathematics is for all.

As a result of the technological advancement in today's societies, mathematical knowledge has become essential for the success of individuals and for the progress and security of nations (Chaman, 2014). For success in tertiary education and beyond, a strong foundation in secondary school mathematics is essential (Cappellari, Lucifora, & Pozzoli, 2008; Steinberg, Varua, & Yong, 2010). Despite the importance of mathematics in life and in the study of other science subjects, there has been a decline in the number of students enrolled in the tertiary mathematics courses in India as well as in western countries (Mishra, 2011; Smith, 2011). When capable students avoid the study of mathematics, it reduces their career options and thereby limits the nation's resource base in science and technology. In the vision 2030, Zambians, aspire to live in a strong and dynamic middle-income industrial nation that provides opportunities for improving the well-being of all, embodying values of socio-economic justice, underpinned by the seven principles, one of which is, gender responsive sustainable development (GRZ, 2006). For this vision to be realized it will require a lot of man power that is well versed in mathematics. It is from mathematics that you can manage to groom economists, engineers, doctors, agriculturists and so on and so forth. The vision 2030 is well define and for it to be realized we need a lot of mathematics. Citizens need to be abreast with knowledge in mathematics. Internationally, mathematics is one of the most influential subjects of all curricular, and mathematical understanding influences decision making in all areas of life, private, social, and civil. Mathematics is applied internationally by the use of abstraction and logic. 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 also other viable options where mathematics is

used. To add on, 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. For example, we can say that without mathematics, science is not possible, whenever we need to calculate something, we need mathematics. In fact, while crossing the road, our mind is also doing mathematics; for instance, to know the speed at which the car is coming, and also judging the time to cross the road or not to. Almost every sport involves mathematics too. So, mathematics is almost everywhere and is a very important element of our day-to-day life. 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 founded. 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. In the Sub-Sahara region, associations of mathematics have come up with a plan aimed at encouraging the mathematics community to speak with one voice in addressing both the content and context of mathematics teaching at all levels (UNESCO, 2000).

Mathematics Associations, have also been identified

as channels where, teachers meet to share ideas on current trends in the teaching and learning of mathematics in secondary schools. MoE (1977) argued that, there are a number of areas for which special practical application of knowledge and skills gained in school can give rise to activities in the form of associations catering for interest groups of the young and up-coming students of mathematics.

In Zambia, teachers of mathematics have a teacher association where teachers are supposed to affiliate

as members. The affiliation is done at institutional level or individual level or both and the charges are done annually. In regards to the performance there is some improvement in the achievement levels but practical subjects, mathematics and sciences continue to record unsatisfactory results in all kinds of assessments. Cumulatively, one – third of boys, and two thirds of girls, have registered complete fail in mathematics since 2005, while only half of the boys and one fifth of the girls have managed to obtain a pass or better (MESVTEE, 2012).

Policy makers and educators are always concerned about improving the teaching and learning of Mathematics. The United Nations Educational, Scientific and Cultural Organization (UNESCO), under the World Survey of Education, stated that; although educators and other specialists have continued to evaluate the teaching of particular subjects, special attention has been focused on improving the teaching of Mathematics. However, the performance in mathematics has continued to be bad in Central province and Kabwe in particular. Kabwe is of particular interest because that is where the Provincial Education Office is situated. Central province has twelve (12) districts. “The overall unsatisfactory performance in School Certificate is attributable in large measure to poor performance in mathematics and science” (MoE, 1996:53).

Performance of the pupils in Mathematics has been very unsatisfactory as reported by the 1996 Educating Our Future education policy document, and later reiterated by the 2012 Education Curriculum Framework (MESVTEE, 2012).

The poor learner performance in Zambian Secondary Schools, particularly in Mathematics has for a long time continued to be a major concern to Mathematics specialists, teachers, parents and other stakeholders. The 2012 Examinations Council of Zambia (ECZ) report on the 2011 Mathematics Examinations results indicated that a total of 55.2% failed Mathematics at grade 9 level. The report furthermore, reported 60.1% and 51.2% failure

rates for girls and boys respectively. The report further shows that 60.2% of girls and 46.7% of boys failed at grade 12 in ordinary level Mathematics in the same year giving an average total of 52.5% failure rate in Zambia. The 2012 ECZ report on performance in 2011 Examination indicates that only a total of 19% obtained grades 1 to 4, whereas a total of 28.5% managed to obtain weak grades in the range of 5 to 9. In addition, according to 2014 Examination Council of Zambia report it was observed that in 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. ECZ (2017) observed that mathematics is still posing a challenge to candidates even under the revised curriculum and had the highest proportion of candidate's failure at 41.33%.

Table 1: Examination Results for The Past Six Years in Mathematics in the National Examination.

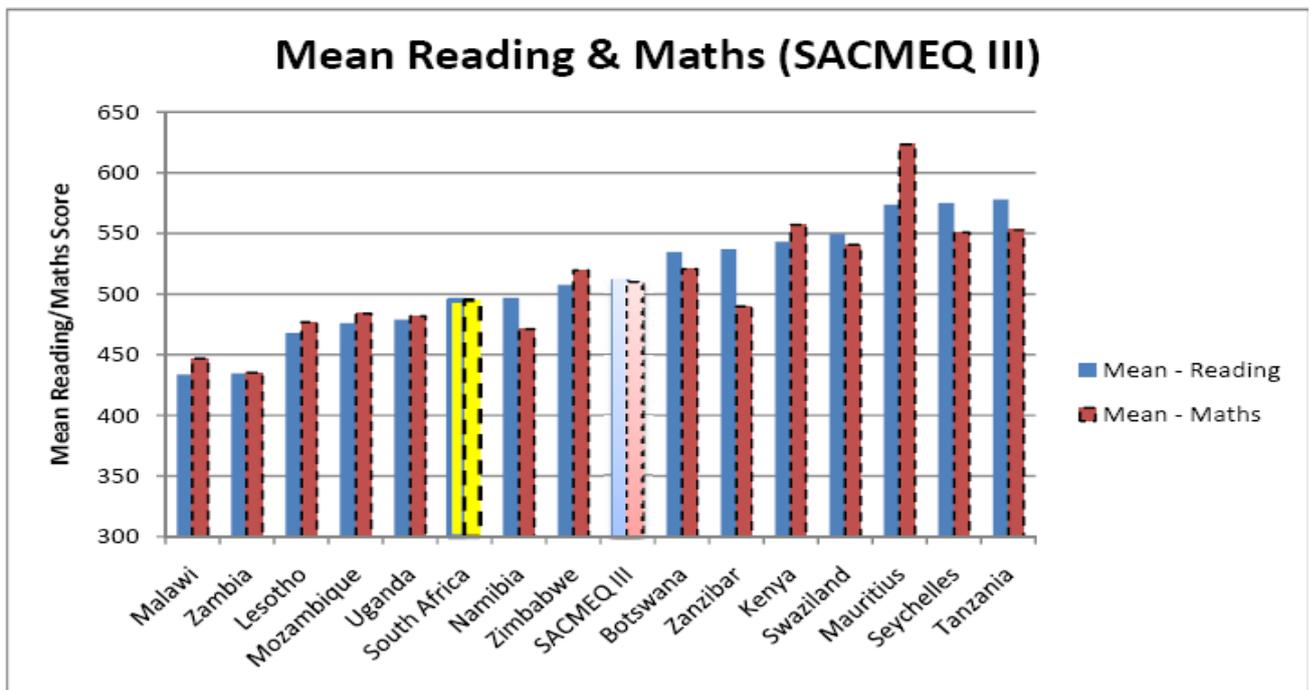
Year	2013	2014	2015	2016	2017	2018
Mean Pass %	26.5	17.4	17.4	24.39	28.29	25.46

Source: ECZ Examination Performance Reports

In a 2017 Grade 12 Ministerial Statement it was brought to light that performance in the four (4) common subjects of English, Mathematics, Science and Biology showed improvements when compared to 2016. The lowest performance in this category was in Mathematics and Agricultural Science. These subjects have proved to be a challenge to our learners under the Revised Curriculum (GRZ, 2017).

This poor performance is also depicted in the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ III) results published in 2011 where Zambia is ranked the lowest in the mean performance in Mathematics among a group of 15 countries (Spaul, 2011).

Figure 1: Mean Reading And Mathematics (SACMEQ III)



Source: 2011 SACMEQ III report

1.2 Statement of the problem

There has been low performance in mathematics at senior Secondary School level in Kabwe District. Unfortunately, there have been mixed feelings regarding causes of poor performance in mathematics in Secondary Schools of Kabwe District at senior level. There are speculations as to what could be the problem leading to such poor performance. A number of factors such as bulky syllabus, poor background of learning Mathematics, inadequate resources (human and material) and teaching methodologies used, teacher qualifications, lack of books and equipment, school infrastructure, teacher incentives or ill staffed Mathematics department in schools. The performance in mathematics had been poor for the past 6 years where the failure mark, always has the highest percentage. This is so, despite measures put in place to improve academic performance of learners in mathematics. There are CPDs, competitions conducted in and among schools, quizzes, jets innovations and so on and so forth. All these are done with a view to improving results and academic performance among learners in schools. A lot of emphasis is placed on analysis of results, at school, provincial as well as National level to see trends in performance of mathematics. It is against this background that the researcher sought to verify whether the interventions put in place by various

schools would yield the desired positive results, hence embarked on a Trends Analysis of grade 12 learners' academic performance in mathematics in selected schools of Kabwe district from 2014 to 2018 school certificate examinations and thereafter, conduct a projection for five years.

1.3 General Objective of the study

The general objective of the study was to conduct a Trends Analysis of Grade 12 Learners' Academic Performance in Mathematics in schools of Kabwe district and a projection for five years.

1.4 Specific Objectives.

- i. To develop a mathematical model to be applied in the Trends Analysis.
- ii. To determine Trends in grade 12 mathematics performance in school certificate examination for 2014 – 2018 in Kabwe District.
- iii. To predict grade 12 mathematics performance in school certificate examinations for 2014 – 2018 in Kabwe District.
- iv. To project grade 12 mathematics performance in school certificate examinations for 2019 – 2023 in Kabwe District.
- v. To highlight the benefit of trends analysis on performance of grade 12 Learners in school certificate examinations in Kabwe District.

1.5 Conceptual Framework of the Study

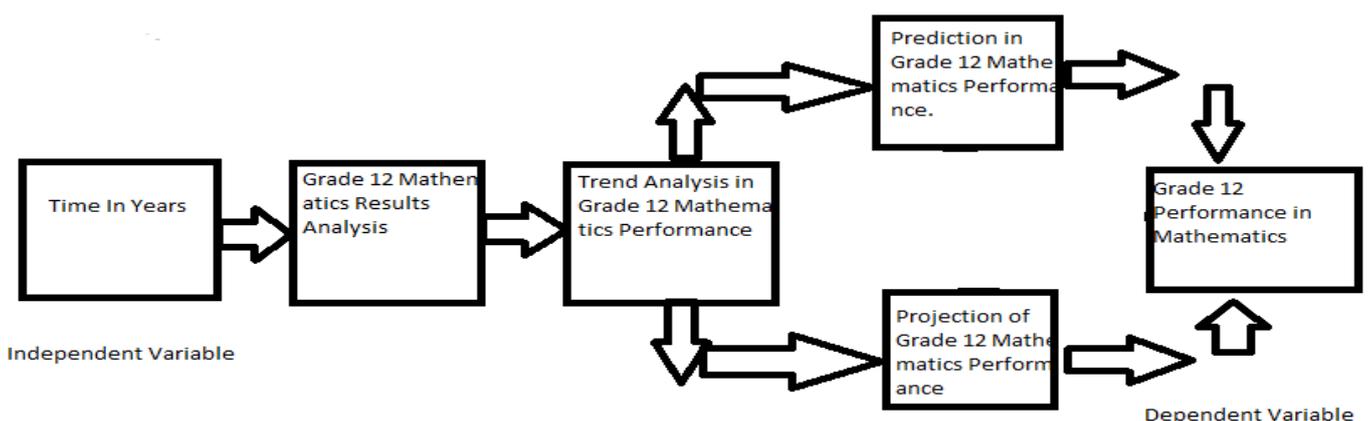


Figure 2: Conceptual Framework

2. REVIEW OF LITERATURE

In the last decade issues in performance in mathematics and achievement had moved to the center of policy-makers' agenda and academic debate. A lot has been said, debates have been and still are going on in this regard. Underachievement in mathematics is particularly recognized as a major problem in schools in most parts of the world. Although many would argue that all subjects are of great importance, evidence has it that Mathematics is a pillar of almost all the streams in academic sectors. Given the important role mathematics plays in tertiary education and most careers, it is not only beneficial but also essential to establish some of the factors that facilitate achievement in mathematics. For instance, in a study conducted in The United Kingdom (UK), results suggest major factors linking deprivation to underachievement which was thematically categorized into a lack of positive environment and support (Banerjee, 2016).

The environment plays a major role in a child's life with regard to performance in school and particularly in line with mathematics. This is furthermore backed by Vygotsky (1978) who argued that the Zonal of Proximal Development (ZPD) needs to be identified and quickly filled up. It is that space that lies just beyond a learner's present understanding. It is that space where a learner cannot quite understand something on his/her own, but has the potential to do so through interaction with a more advanced partner such as a teacher or a peer. The child needs to interact with the environment in order to get maximum benefits from the learning of Mathematics. It is further, postulated that the zonal of proximal development is the distance between what children can do by themselves and the next learning that they can be helped to achieve with competent assistance. He furthermore, advanced to say the scaffolding teaching strategy provides individualized support based on the learners' ZPD. The teacher should provide a scaffold for the child. From the forgoing

it is worth noting that Vygotsky places emphasis on how the child's mind grows through interaction with the social environment (Vygotsky, 1978). Environment plays a major role in a child's learning. A child needs the environment and support. Without this support the child may lose his self-esteem, focus and finally, interest in learning in its totality. If the child tries to persevere, these are the ones who land into underachievement, in this particular case, in Mathematics.

In a study conducted in Secondary schools among students of mathematics in Kerara, India, findings revealed that parental involvement was significantly and positively associated with attitude towards mathematics but had no significant association with mathematics anxiety. Mathematics anxiety and attitude towards mathematics were significantly and positively related. The relationship between parental involvement and mathematics achievement was non-significant. Student attitude towards mathematics, and mathematics anxiety were also not significantly related to mathematics achievement. Gender was found not to have any influence on the variables. Interview data revealed that all of the parents had high expectations for their children's mathematics achievement that they had communicated through consistent reinforcement (Chaman, 2014). This study clearly brought out the fact that mathematics anxiety and attitude towards mathematics were significantly and positively related. Some learners just have the notion that mathematics is tough, difficulty and not easily understood, it is true that anxiety will be heightened. There is a direct relation between these variables. On the other hand, those learners who perform well also the anxiety will be heightened too, they need to maintain that name. There is pressure also from parents, parents want their children to perform well in Mathematics because they want their child to be an engineer, a doctor, an economist and so on and so forth. There is a clear relationship between these variables. On the other hand, the findings indicate that there is no

significance between parental involvement and mathematics achievement. Furthermore, gender was found not to have any influence on the variables.

It is of note that successive governments across several countries have underscored the significance of increasing and widening participation in science, technology, engineering and mathematics (STEM) subjects and careers. This is because the STEM skills are considered of prime importance in most of the careers. It is certainly unfair if children are held back from achieving what they could, due to circumstances beyond their control, such as gender, ethnicity, poverty or neighborhood. One of the first steps to help children from deprived backgrounds is to understand what reasons are cited in evidence-based research reports to be linked to their poor educational attainment. Several factors come out as contributing factors to poor performance in mathematics. For instance, in a study conducted in Kitwe district in Zambia, 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. The 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.

According to the researcher, 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. This study further 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 (Kafata, 2016).

In a study conducted in Madison, the use of meta-analysis to analyze gender differences in recent studies of mathematics performance was employed. First, they meta-analyzed data from 242 studies published between 1990 and 2007, representing the testing of 1,286,350 people. Overall, $d = .05$, indicated no gender difference, and $VR = 1.08$, indicated nearly equal male and female variances. Second, they did analyze data from large data sets based on probability sampling of U.S. adolescents over the past 20 years: the NLSY, NELS88, LSAY, and NAEP. Effect sizes for the gender difference ranged between -0.15 and $+0.22$. Variance ratios ranged from 0.88 to 1.34. Taken together these findings support the view that males and females perform similarly in mathematics (Lindberg, 2010). In this study it was furthermore, shown that in Policy decisions, such as funding for same-sex education, as well as the continuing stereotype that girls and women lack mathematical ability, call for up-to-date information about gender differences in mathematical performance. Such stereotypes normally discourage women from entering or persisting in careers in science, technology, engineering, and mathematics (STEM). Today women earn 45% of the undergraduate degrees in mathematics (NSF, 2008a), but women make up only 17% of university faculty in mathematics (NSF, 2008b). On the other hand, in a study conducted in Accra Ghana, a convenient sample of 182 students, 109 boys and 72 girls in three high schools in Ghana was used. Mathematics performance was assessed using their classroom marks in the first and third year. The results revealed that there was a significant difference between mathematics performance between boys and girls (Oppong, 2010). This is contrary to the findings in Wisconsin in which it was revealed that there was no difference in performance between males and females instead they performed similarly.

Similarly, the percentage of 12th-grade students who performed at the Advanced level in 2015 (3 percent) was not measurably different from the percentages in 2013 and 2005 (Progress, 2017)

It is generally argued that poor performance in mathematics only occurs at lower levels, like basic schools, secondary schools etc, yet according to the study conducted in Ghana the findings of the result revealed that there was poor performance in mathematics at college level too. There might be many factors surrounding the performance of the students but three (3) factors were proven to be the cause of about 41% failure record among level 100 students in mathematics end of first semester examination in the 2014/2015 academic year and it is worthy-noting that these factors are laziness, indiscipline and poor mathematics background. What this means is that the majority of our students cultivate the habit of laziness coupled with the act of indiscipline, and in the meantime these learners have a very poor mathematics background, these three factors are strong enemies to academic excellence, hence any student who happened to find herself in these acts is likely to perform weakly or poorly at the end of the course (Kumah, 2016).

In a study conducted in Nzhelele East Circuit in Limpopo Province, South Africa, the findings revealed that Mathematics was understood to be a crucial school subject in most regions of the world generally, and Sub-Saharan Africa in particular. It was argued that in all engineering, economics, business and even social courses, Mathematics is needed. For any technological advancement, mathematics is a must. It was furthermore, noted that an overabundance of governments – particularly those in developing economies where governments are pursuing industrialization and technological advancement, it is strongly argued that mathematics is critical for facilitating development and advancement of the general populace of their regions. The study highlighted socio-cultural and psychological factors that are

seen to be barriers in mathematics performance (Sinyosi, 2015).

It must clearly be pointed out that Mathematics is a compulsory subject in most education systems around the world. This is so for obvious reasons; Mathematics is the hub for national development. All nations that have made strides have their economies anchored on mathematics. Of course, there are a variety of other complexities and constraints affecting the teaching and learning of mathematics in most regions of the world. It has been consistently found that there is poor learner performance in mathematics. This is indicated by high failure rate in mathematics during end-of-year learner assessments. From the study above, the researchers found a variety of reasons for the poor performance of learners in mathematics in the selected schools. In their findings, the researchers found that reasons that were found for poor performance in mathematics were vast and intertwined. Efforts have been made at international level to intervene with regard to finding solutions to complexities and constraints affecting teaching-learning environment in mathematics.

In a study conducted in Nasarawa state Secondary Schools in Nigeria, the study revealed that firstly performance pattern was unstable over time, and secondly, the observed and predicted performance rates indicated that less than 50% of the candidates passed at credit level over the reviewed period. The study discovered that mathematics performance in Nasarawa State has been persistently poor over the years reviewed similar to what has been reported for the whole nation and could continue from 2014 to 2020 based on the forecast. It further observed that the Nigeria vision 2020 might not be realized as planned unless urgent steps are taken to improve performance in mathematics. This is because mathematics serves critical role in the development of human capital in Science, Technology, Engineering and other key sectors of the economy (Dauda, 2014).

From these findings it goes to show that there is a lot of attention needed to counter this negative trend. A lot of attention needs to be paid to the improvement of mathematics. It is a critical subject such that if left unchecked, it may lead to negative growth of anyone given economy. According to Dauda and Mamman (2014) argued to say among others, that policy makers should review the existing mathematics curriculum and enforce its implementation.

It goes to show that there is need for close monitoring of teaching and learning, the conduct of the examination and ensuring that assessment is given priority and not just taken as a routine activity just meant to fulfill the book with a view to writing ear tickling reports.

It is further noted that in a study conducted in Solwezi in the north-western province of Zambia, findings were that there was a lack of content and pedagogical knowledge in teachers which drastically affects enormously the performance of pupils in mathematics. It was furthermore observed that the attitude towards the learning of mathematics is very bad, in most cases pupils go to class without instruments (no calculators, mathematics sets and, in some cases, no pens and books). There are either inadequate or no teaching and learning resources. One would argue that according to the United Nations Charter, Article 6, it clearly states that Education is a basic right, everyone has a right to education and in addition the Johmtien Conference spelt out that, education is for all, with the foregoing pronouncements, classes are overcrowded due to over-enrolment (UNDP, 1990). There is dilapidated infrastructure hence no special rooms for mathematics clubs and libraries. If the libraries were there then they had depleted books. No adequate Continuous Professional Development at either school level or outside school. No adequate funding to sponsor teachers to upgrade (Mwape and Musonda, 2014).

In a study conducted in Ondo state in Malete Nigeria findings revealed that 86 out of 100

teachers (86%) and 262 out of 400 students (65.5%) agreed that leakage of examination questions contributed to students failure, 264 out of 400 students (66%) agreed that the bribery and corruption on the part of supervisors also contributed to failing of pupils 84 out 100 teachers (84%) and 296 out of 400 students (74%) also agreed that lack of enough Mathematics teachers at primary school level to build a solid Mathematical foundation in the students served as one of the major causes of students mass failure in Mathematics examinations 94 out of 100 teachers (94%) and 272 (68%) out of 400 students agreed that the practices of not admitting students on merit and what they are mentally capable of studying contributed to their failure 300 out of 400 students (75%) believed that government failure to ensure that the teaching of Mathematics is handled by experts in Mathematics contributed to students mass failure.

Also, 98 out of 100 teachers representing 98% and 284 out 400 students representing 71% submitted that students Laziness served as a major reason for mass failure in NECO/WAEC mathematics examinations (Salman, 2012). From the foregoing, it can be seen also that teachers contribute to passing of learners in mathematics, the study above brought to light also the fact that government needs to employ experts, that is teachers who are trained in that area to teach the learners. These teachers are the ones to contribute to the passing of learners in mathematics. These teachers are supposed to be motivated to teach. If the teachers were not motivated it would impact negatively on the part of the learners, performance will be negatively affected. This is also supported as seen in the study conducted in Makurdi in Nigeria, in this study results revealed that majority of the teachers (61.0%) under study were not satisfied with their condition of service. Three quarter of teachers (75.0%) under study were seen not to be satisfied with the fringe benefits attached to their salaries while majority of the respondents (66.0%) were not

satisfied with the condition of service of teachers. It was observed that the condition of service of teachers, teachers' Fringe benefit payment, and teachers' promotion of in-service training have a direct influence on the student's performance in mathematics (Adeyemo et al., 2013).

Motivation is very important to both teachers and pupils yet it is more on the part of the teachers because these are the ones who guide the learners. Teachers are the ones who should even motivate learners first. It is teachers who are in contact with the learners more than any other person in the Education system. So once the teachers are not motivated the end result is catastrophic. As the study shows in its findings, teachers are not motivated and hence it is clearly shown that the end result is pupil poor performance in mathematics.

In another study conducted in Bohlabela in Limpopo, the findings revealed that while fear is a major determinant of poor performance in mathematics, other factors such as lack of time, material, financial and human resources also play a significant role in the performance of learners. It was concluded that as long as learners continued to study under deficient conditions their performance will continue to slide downwards. (Makofane and Maile, 2019). Many scholars argue that fear normally contribute to poor performance in mathematics among many learners in schools.

On the other hand, in another study conducted in Eastern province of Zambia regarding the nature of factors affecting interest and attitudes of pupils toward learning mathematics, the research findings have indications to show that as pupils come into secondary school, they have a lot of interest and have positive attitude towards mathematics learning. It is observed that they only lose this interest and develop a negative attitude due to the way some teachers of mathematics deliver their lessons; using teacher centered methods (expository methods) and not assisting pupils who lag behind or are faced with challenges. Pupils' nature of interest

and attitudes towards learning mathematics has been stated to be weak (Mtonga, 2016).

Furthermore, the research revealed that rural secondary schools had more pupils who lacked interest and had negative attitudes towards learning Mathematics compared to pupils from urban schools in selected secondary schools in eastern province. It is further reported that pupils lost interest and developed negative attitude towards learning mathematic, mainly because of the mathematics teachers and other factors such as poor pupils' grade 9 mathematics results; lack of text books (Teaching and learning materials); location of the school (rural or urban) (Mtonga, 2016).

It is of note that issues in Mathematics education in Zambia according to Nakawa (2012) indicated that students in Zambia have very low performance due to teachers' low competence and their limited views on Mathematics lessons. This state of affairs has not brought any contentment to the Ministry of Education, Science, Vocational, Training and Early Education. The Ministry through its policy document bearing the title 'Educating our Future (1996, p.25), noted that, 'the overall unsatisfactory performance in the school certificate Examination is ascribed, to the large measure to poor performance in Mathematics....' Although more teachers that are qualified continue to be recruited and deployed in various schools in Eastern province.

It is observed that Zambian Secondary Schools have experienced a low performance in Mathematics at School certificate level in the recent years that have passed.

In a study conducted in Nigeria, Fafasi and Yahya (2004) argued that teacher involvement in marking national exams could help learner performance. This is so critical because as the teacher is involved at all levels of education the teacher will be very familiar with the system which will put them at an advantage to help the learners. A teacher is a learner at all times, the more they learn the better for them and in turn the better for the learner. However, given the number of teachers, it is not possible for all teachers to be involved in marking

hence the need to find other avenues for non-makers of national exams to get exposed to the strengths and weaknesses of learners in various topics in national exams.

The results revealed that the students who took the subjects for the two academic years were not able to meet the required criteria. On the other hand, study techniques were the common factor that affects the performance of the students in Mathematics. The researchers formulated an action plan to enhance the students' performance and for the intervention program. (Patena and Balla, 2013). Results showed that gender difference were significant when impact of motivation on academic achievement was compared in male and female students. Also, other result indicates significant difference when extent of motivation was taken as variable of interest on academic achievement in mathematics based on the degree of their motivation. (Adedeji, 2007)

In this study above the results revealed that majority of the teachers (61.0%) under study are not satisfied with their condition of service. Three quarter of teachers (75.0%) under study are not satisfied with the fringe benefits attached to their salaries while majority of the respondents (66.0%) are not satisfied with the condition of service of teachers. It was observed that the condition of service of teachers, teachers' Fringe benefit payment, and teachers' promotion of in-service training have a direct influence on the student's performance in mathematics. (Adeyemo et al, 2013). In a study conducted in Akuapem North District of Ghana, the findings revealed that students had negative attitude towards mathematics and that assessment tools used by teachers for the purpose of evaluation were inadequate. The study also revealed that most parents did not have the financial means to provide learning materials for their children and were also unable to help them with their school work (Asiedu-Addo et al, 2014). Assessment is very important in a school system because that is what provides direction in the process. Failure to assess normally

brings catastrophic consequences. The researcher brought to the fore the fact that teachers had negative attitude towards mathematics and furthermore assessment tools were inadequate, how can a system be sound without assessment. It is worse off when the researcher further highlighted that parents did not have the financial means to provide learning materials for their children. Learners lacked learning materials, teachers were negative, inadequate assessment tools, these factors may have led to disastrous end, no wonder performance in this district was poor. Assessment is critical in the school system no wonder this study has embarked on Trends analysis, making predictions and Projecting performance.

In a study conducted in Orissa in India, the researcher used multiple regression analysis and the study revealed that Mathematics foundation knowledge as assessed at the entry point to secondary stage of education emerged as the strongest predictor accounting for 46.8 per cent of variance while the rest five predictors explained only 2.1 percent of variance. Since poor Mathematics foundation knowledge substantially increases the risk of failure, it is suggested that early diagnostic assessment and remedial intervention would work out as an effective strategy for reducing the risk of student failure in Mathematics in secondary education (Dibakar, 2012).

In another study conducted in Bylakuppe, New Delhi, in India, findings revealed that the poor performance in mathematics could be explained by correlates like Students' mathematical base, Attitude towards mathematics, Study habits and Parental Involvement (Vijayan, nd).

In another study conducted in rural India, the findings revealed the need for affirmative action policies to both test and monitor these differences and design interventions such as changes in delivery or pedagogy of the subject to understand this gap better. These results assume even greater

significance in the current contestations around the New Education Policy in India (Upasak, 2017). The study indicated that the system needs to be monitored closely and on a regular interval. This also goes for the new Educational policy. It is worthy-noting that monitoring and evaluation are supposed to be on going. At no time should this be given a break.

In a compilation conducted in England it was revealed that in 2017, Attainment 8 scores were calculated using slightly different point score scales in comparison to 2016, in order to minimize change following the introduction of grade 9 to 1 reformed GCSEs. In this release, pupils must achieve grades 5 or above for English and mathematics to achieve these threshold attainment measures (Education, 2018). In this study it is seen that due to changes in teaching approaches there was a rise in performance.

Scores of educators normally blame it on the foundation at basic schools. It is claimed that learners are not well grounded at basic school level, on the other hand the others blamed it on parents, and some parents do not take interest in the learning of their children. On the other hand, it is generally believed that mathematics is tough, which fact put off learners and as such they develop a negative attitude towards the subject (Kariuki, 2018).

On the other hand, another study conducted in Zimbabwe, it was revealed that the type of school leadership by the head, career guidance, teacher-pupil ratio, qualified and dedicated teachers as well as discipline and order are the major internal factors affecting students' academic achievement. The identified external factors are family socioeconomic status, school community relations, distance or proximity to the school and witchcraft practices. Other findings are that boys perform better than girls at ordinary level (Munyaradzi, 2017). From these findings it is imperative that head teachers should provide a conducive environment and additionally guidance should provide sufficient information regarding careers. Learners need a lot

of guidance regarding subjects that go with respective careers. When considering discipline, it also goes with discipline in terms of orderliness. Records should be kept in an orderly manner. For the institution to know the direction well they need to be disciplined, they need to conduct trends analyses, make predictions, they need to make projections, that way the other things will fall in place to help improve learner performance. It is difficult for learners to perform well where the pupil-teacher ratio is too high, it calls for discipline to maintain the numbers.

On the other hand, in a study conducted in Nyeti and Kirinyanga counties findings revealed that 68.5% of teachers and 64.3% of students agreed on expectations, 90.7% of teachers and 84.6% of students agreed that positive teacher-student relationship, 81.5% of the teachers and 86.5% of students agreed that rewards highly motivated students. The research concluded that student motivation by teachers has positive influence on academic performance of these learners.

This is again echoed in a study conducted in Sesheke in western Zambia in which the findings also revealed that teachers attended to boys in mathematics classes than they did to girls and that some teachers discouraged girls in mathematics lessons by not recognizing their efforts in trying to answer questions. Also, girls did not comprehend mathematics easily with teacher centered methods that the teachers used in mathematics lessons. Furthermore, it was discovered that more time was given to boys than to girls to answer questions, a situation which discouraged girls from being active participants in the learning process of mathematics. On the other hand, with regard to parental support to girls 'mathematics education, the study established that many parents believed that girls were poor performers in mathematics and that girls did most household chores. With regard to girls 'attitude towards Mathematics, the study established that most girls at Sesheke secondary

school had negative attitude towards mathematics (Clifford, 2014).

A descriptive survey design was adopted for the study and data collected using three questionnaires. Correlation between syllabus coverage and student performance using Pearson's Product Moment Correlation Coefficient (PPMCC) was 0.8343. Furthermore, a one-way Analysis of Variance (ANOVA) was determined and confirmed that the syllabus coverage has a significant effect on student performance in Mathematics at KCSE level. Also, a number of factors were identified as being responsible for early, late or non-coverage of the syllabus. (Musasia et al, 2012)

It was found that more items on NECO SSCE were at higher level of difficulty and were generally less discriminatory than WASSCE questions. Conversely, more of WASSCE items were at the appropriate level of difficulty and had better discriminatory indices. It was suggested that the two bodies should collaborate more in their item construction activities and that a regulatory body should be established to oversee the papers of the bodies with a view to making them more comparable. (Femi, 2014)

In another study the Pearson's correlation conducted on the data collected from 111 students enrolled on the MTH 111 course at the Campus over the academic years 2010/2011 and 2011/2012 revealed that prior academic achievement, self-efficacy, academic resources, self-regulation and learning styles were positively correlated to MTH 111 performance at the $p < .05$ level. Multiple regression analysis utilizing the stepwise method indicated that the best set of predictors were prior academic achievement, learning styles and academic resources which accounted for 44.1 % of the variation in MTH 111 performance at the $p < .05$ level. (Murray, 2013)

It was revealed that performance pattern was unstable over time, (ii) the observed and predicted performance rates indicated that less than 50% of the candidates passed at credit level over the

reviewed period. The study discovered that mathematics performance in Nasarawa State has been persistently poor over the years reviewed similar to what has been reported for the whole nation and could continue from 2014 to 2020 based on the forecast. It further observed that the Nigeria vision 2020 might not be realized as planned unless urgent steps are taken to improve performance in mathematics. This is because mathematics serves critical role in the development of human capital in Science, Technology, Engineering and other key sectors of the economy. Based on the findings, the study recommended among others, that policy makers should review the existing mathematics curriculum and enforce its implementation. (Musa, 2014)

On another hand in another study conducted in Ghana, it was shown that the qualification possessed by a mathematics teacher has a great positive effect on the learners. However, adequate and availability of facilities such as library, mathematics laboratory is necessary in order to improve on the students' poor performance in mathematics. (Udonsa, 2015).

In a study conducted in Batangas city in Philippine, the results revealed that the students who took the subjects for the two academic years were not able to meet the required criteria.

On the other hand, study techniques were the common factor that affects the performance of the students in Mathematics. The researchers formulated an action plan to enhance the students' performance and for the intervention program. The researchers recommended to organize periodic seminar and workshops for students, teachers and school administrators to promote positive attitude towards mathematics and to conduct tutorials session to improve students' performance (Pattena A, 2013).

The results revealed that, in general, students held positive attitudes towards mathematics and also highlighted the main effects of grade and math achievement on these attitudes. No gender effect

was identified although the girls showed a continuous decline in attitudes the further, they progressed in school. A hierarchical analysis using structural equation modeling showed that motivation-related variables are the main predictors of attitudes towards mathematics and that teachers and the social support of peers are also highly significant in understanding these attitudes (Maria de Lourdes et al., 2012).

In a study conducted in Ago-Iwoye, Ogun State, in Nigeria, findings showed that students performed well in the selected STEM subjects in the years under review. Furthermore, the study revealed that while performance in other subjects will continue to improve steadily, performance in mathematics will dwindle between 2016 and 2018 and then will begin to steadily improve from 2019 to 2020 (Onanugu, 2011). The integration of the STEM subjects has an advantage in that it brings learners' thinking closer to the real world. Learners come to appreciate the integration of these subjects in the real world. As much as this is a good other nation have continued to teach these subjects as distinct subjects.

However, in another study conducted in Bayelsa, the findings revealed that learners' performance in mathematics in junior secondary school examinations were high, favoring male students (Maliki, 2009).

In a study conducted in Limpopo, findings reveal that while fear is a major determinant of poor performance in Mathematics other factors such as lack of time, material, financial and human resources also play a significant role in the performance of learners (Makofane, 2019).

In another study conducted in Azare Metropolis of Bauchi State in Nigeria, findings revealed that there is negative attitude towards mathematics, anxiety and fear of mathematics, inadequate qualified teachers, poor teaching methods, inadequate teaching materials, and overcrowded classes were some of the causes of poor performance in mathematics. Developing positive attitude, motivation and proper guidance towards

mathematics, using proper methods of teaching the subject, provision of relevant teaching materials, additional classrooms and furniture, provision of libraries and mathematical laboratories were some of the ways of improving performance in mathematics (Sa'ad, 2014)

Zambia's vision is to become 'A Prosperous Middle-Income Nation by 2030'. As such, Zambians, aspire to live in a strong and dynamic middle-income industrial nation that provides opportunities for improving the well-being of all its citizens by 2030. It is no wonder therefore, all efforts in all sectors of the Zambian micro and macro-organizations have planned and moved in the direction streamlined by the Vision 2030. Within this vision and its principles culminates the devising of a revised curriculum by the Ministry of Education in which it aims to shape its education system in which it enshrines values of socio-economic development through the provision of knowledge and skills in all subjects with appropriate approaches and strategies of the curriculum. This could foster sustainable development of both the individual learners and the societies that learners emanate from. As opposed to past approaches, greater emphasis has been put on the adequate preparation of learners from Early Childhood level as well as in strengthening the linkages between different levels of education to achieve effective learning. In this system Mathematics is very critical. With poor mathematics performance, the realization of the vision 2030 may not be feasible in reality.

To this effect, the Zambian society has unanimously acknowledged that numeracy play a pivotal role in economic development especially when learners competently reach desirable levels. To ensure effective teaching and learning of Numeracy, adequate illustrations of the perceived effective approaches and strategies have been elaborately outlined. However, poor performance in mathematics persists. In a baseline study conducted by a joint team of MOE and JICA the findings

revealed that majority of mathematics teachers were male, young professionally as well as by age, it was further found that three quarters were trained to teach mathematics, though over half were teaching grades not trained for (grades 10 - 12). There was low level paid/active membership in ZAME. With regard to teaching trends, teachers used teacher-centred approach, reasons given were that the classes were too large, there was lack of teaching/learning materials, heavy teaching loads and pressure of examinations.

Coming to CPDs, teachers had a sound sense of duty, however, their professional aptitude was weak exemplified by low/none participation in professional activities such as JETS, ZAME or other CPD programmes and it was the general feeling that these CPDs should go with certification. Additionally, it was a general feeling that CPD programmes should be conducted during holidays and facilitated by fellow teachers and though they would welcome College/university lecturers from time to time (Haambokoma, 2002). With the factors highlighted above, it becomes difficulty to mark pupils given work, because of large numbers coupled with heavy teaching loads and furthermore, individualized attention for learners is almost unattainable. With these factors in mind, it brings into question, preparation time for the heavy loads too. The question of motivation also comes into play on the part of both the teacher and the learner. Learning is said generally to be difficulty, so where it calls for a lot of thinking and concentration, whenever a frustration crops up, it is easy for the learner to simply give up. The teachers highlighted heavy loads, pressure for the examination, numerous other demands like CPDs, ZAME affiliations to be paid, and it is indeed kind of irksome. There is need for some kind of motivation that may be introduced to attract more to come on board to teach mathematics and also attract many more others to come on board to join the world of mathematics. It has been a trend in the recent past to date for teachers to change their career as they go

to grade upwards, to change from teaching mathematics to say civic education RE and so on and so forth. It may be highly recommended that there be an introduction of some kind of incentive to be given to those enduring in teaching Mathematics and science.

And in fact, the education Act outlines that the Minister may, for purposes of enhancing the effectiveness and quality of school education, ensure that the curriculum is comprehensive, balanced, integrated, diversified and relevant and prepares learners for opportunities, responsibilities and experiences of adult life and should include foundation subjects and specify then in relation to the assessment arrangements at foundation and at each key stage (GRZ, 2011). The Education Act spells out that there are core subjects that prepares one for adult life and other education opportunities say at university level, Mathematics happens to be one of these core subjects. A learner who does not have a strong foundation in mathematics at ordinary level, finds difficulties coping up with work at a higher level. It is imperative that mathematics as a subject be monitored and evaluated at regular intervals with a view to continuous improvement. It must be emphasized at this point in time that for the nation to realize the vision 2030, mathematics should be given priority among the many things that should be improved.

Performance of learners should be monitored and evaluated at a regular interval at school level, district, provincial and national levels. This points to the fact that subject associations should be supported and backed in their activities and the further meaning is that the activities for such associations should not just come once as the tradition is, it should be continuous operations with the realization of the vision 2030 in mind. It must be brought to the fore that performance of learners is not just centered on the learner, it is a collective responsibility meaning the parents should be brought in the picture, the teacher, administrators and learners too. The report from the markers

outlined issues targeting teachers and learners to say that performance of the candidates was generally fair although the work presentation of most candidates left much to be desired. Some of the candidates either did not number the questions or wrongly numbered the questions thereby creating confusion for the examiners. Some other candidates scattered the answers for one question on several pages mixing them with answers for other question, making it difficult for the examiners to find the question totals accurately.

Furthermore, it was highlighted that the paper was of good standard and covered the revised syllabus adequately. The questions were also clear on knowledge and skills they were demanding from the candidates thereby giving them a fair chance to attempt the paper (ECZ, 2016). The report confirms that teachers and learners need to work together. Teachers should guide learners in a proper way as not to leave them half prepared for the national examination. All the techniques of answering questions should be highlighted and brought to the fore. Learners should be drilled and given the skills they need for answering questions. Learners should do a lot of practicing before they write the national examinations. As much as it is appreciated that the same teachers are commended for having prepared the paper well covering the revised curriculum thoroughly well, they left out the aspect of preparing the learners, as reported by examiners. This also go to show that teachers should be involved at all levels especially at monitoring and evaluation levels, they are the experts, the observation has been that teachers are invited mainly at the point where things are wrong and they need to exculpate themselves. It is true everyone must be made accountable for their work in a professional manner however, consideration of other factors involved, factors like motivation, honor and recognition as players, should come into play. It must be noted that to influence learners positively, the teacher should be determined to be a good planner, a good organizer, a good coordinator

and a good evaluator of his/her work and that of the learners. This can be attained by a well-equipped teacher who is one of the supreme factors in the education system and indeed the other consideration is the strengthening of teacher's skills in assessing mathematics. All these skills mentioned here must be possessed by a teacher as they contemplating on the preparing of learners for the examination with a view to having improved performance.

3. METHODOLOGY

3.1. Research Design

This study adopted the exposé facto research design in which efforts were made to investigate the relationship of time in years with the performance in mathematics for learners of mathematics for a given period 2014 to 2018 and thereafter, predicted performance in mathematics for a period 2019 to 2023. In this study there was no manipulation of results, all the results were presented as they were given to the researcher and reflected results as published by The ECZ for respective years, and as such, were assumed to be valid and reliable.

3.2 Approach /type

This study adopted a mixed method of quantitative and qualitative approach. There were 26 secondary schools in Kabwe district and from these 9 schools were selected as a sample. The quantitative data in the study was collected from the District Education Office of Kabwe for the 9 schools in the study. Grade 12 results were collected for the period 2014 to 2018 for each of the nine (9) schools in the study.

Three (3) schools out of the nine (9) had their first grade twelve (12) in 2015 and hence for these three schools the trend analysis was for the period 2015 to 2018 and for the other six (6) the period was 2014 to 2018. The quantitative data could safely be said to have come from a cross sectional Time Series.

3.3.1 Sample size

The sample size was 9 out of 24 secondary schools in Kabwe district. It is acceptable practice to pick 10% sample from the population, so given 24 secondary school the 10% was approximately 3 schools. The researcher opted to go over the 10% from 3 to 9 so that the results could easily be generalized for the district.

3.3.2 Procedure

The Researcher obtained an introductory letter from the Information and Communications University (ICU). On arrival at the District Education Office, the DEBS also prepared an introductory letter which served as authority to go ahead and conduct a research in the district. The researcher moved on to the schools and collected the results for grade 12 mathematics for the period of five years, from 2014 to 2018. The researcher visited the nine (9) secondary schools in the study and upon presentation of the Letter of Authority from the

DEBS arrangements were made to have the results collected for the study.

3.4 Data Sample source

The source of the data was the district education board office's planning section.

3.4.1 Model Specification

The Mathematical Model to be used is the Simple Linear Regression Model shown below;

$$Y_i = \beta_0 + \beta_1 X + \varepsilon,$$

$$\beta_1 = \frac{\sum (X_1 - \bar{X})(Y_1 - \bar{Y})}{\sum (X_1 - \bar{X})^2} = \frac{\sum x_1 y_1}{\sum x_1^2}, \beta_0 = \bar{Y} - \beta_1 \bar{X}$$

3.4.2 Estimation Procedure

An Example of Mine secondary School was used;

Table 2: Showing Deviations from the Actual Values

	Y	X	y	x	x ²	Xy	X ²
	41	1	-3.8	-1.5	2.25	5.7	1
	32	2	-12.8	-0.5	0.25	6.4	4
	57	3	12.2	0.5	0.25	6.1	9
	49.2	4	4.4	1.5	2.25	6.6	16
Sum (∑)	179.2	10	0	0	5	24.8	30
Mean	44.8	2.5					

$$\beta_1 = \frac{\sum (X_1 - \bar{X})(Y_1 - \bar{Y})}{\sum (X_1 - \bar{X})^2} = \frac{\sum x_1 y_1}{\sum x_1^2} = \frac{24.8}{5} = 4.96,$$

$$\beta_0 = \bar{Y} - \beta_1 \bar{X} = 44.8 - (4.96)(2.5) = 32.4$$

$$Y_i = \beta_0 + \beta_1 X + \varepsilon,$$

$Y_i = 32.4 + 4.96x + \varepsilon$, The Mathematical Model to be used is estimated.

Table 3: Coefficients of the Model

<i>Coefficients</i>	
Intercept	32.4
Year	4.96

3.4.1.1 The Error Term (ε) (Stochastic error)

Y is the random variable composed of two parts.

3.4.1.1.1 Systematic Component - $E(Y) = \beta_0 + \beta_1 X$ this is the mean of Y.

3.4.1.1.2 Random component $\varepsilon = Y - E(Y)$, this is called the **Stochastic error**

Together $E(Y)$ and the ε form the Mathematical Model.

$$Y_i = \beta_0 + \beta_1 X + \varepsilon$$

The Simple Linear Regression Model.

For example, given that we have the Model as given $Y_i = 32.4 + 4.96x + \varepsilon$, we estimated the Performance for year 7.

$$Y_7 = 32.4 + (4.96)(7) + \varepsilon = 67.12\% + \varepsilon$$

It was noted that the model gave a Linear equation in which β_0 was the Y Intercept and β_1 was the gradient.

Using excel the results were given as seen below;

Table 4: Residual output

Observation	Predicted Performance (\hat{Y})	Residuals (ε)
1	37.36	3.64
2	42.32	-10.32
3	47.28	9.72
4	52.24	-3.04

Source: Excel analysis 2019

ε Was the error term which was coming as the residue in the table, this is also called the Stochastic Error term.

$$Y_i = \beta_0 + \beta_1 X + \varepsilon$$

Taking say observation 4 the predicted value was given as 47.28, but what was the actual value? It was 57. Applying the model, we show as follows to find the error term (ε);

$$Y_i = \beta_0 + \beta_1 X + \varepsilon \quad \text{Actual} = Y_i = \beta_0 + \beta_1 X + \varepsilon \quad 57$$

$$= 32.4 + 4.96(3) + \varepsilon \quad \text{making } \varepsilon \text{ subject we have}$$

$$\varepsilon = 57 - 47.28$$

= 9.72 Instead of the actual 57 the value has moved to a prediction of 47.28 giving an error of 9.72 see table 4 above. Error + Predicted = Actual performance.

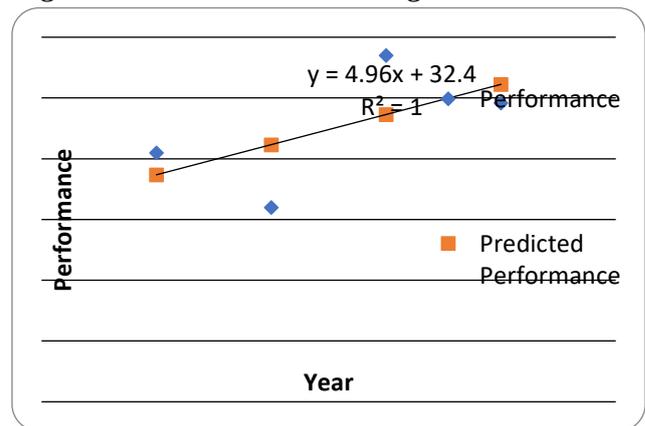
Table 5: Showing Relationship of Observation, Actual, Predicted and Error

Observation	Actual (Y)	Predicted (\hat{Y})	Error
1	41	37.36	3.64
2	32	42.32	-10.32
3	57	47.28	9.72
4	49.2	52.24	-3.04

Source: Excel analysis 2019

The scatter plot showed the performance implying that we had to draw a best fit line.

Figure 3: Scatter Plot Showing Best Fit Line.



The Best fit Line shows us that we are moving away from the original pass mark which is in blue, moving from blue to orange that shows an error, because the actual is in blue, but the blues are scattered, so we bring in the best fit which will have all the marks aligned in a straight line. That drift from the actual in blue to the orange that is what is called the residue, which is the error term (ε).

3.4.1.2 The R² value.

Table 6: Summary of Regression Statistics

Regression Statistics	
Multiple R	0.595837171
R Square	0.355021935
Adjusted R Square	0.032532902
Standard Error	10.57052506
Observations	4

Source: Excel Analysis 2019

R² measures goodness of fit.

$$\text{Defined } R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS} = 1 - \frac{\sum \hat{\epsilon}^2}{\sum (Y_i - \bar{Y})^2}, \quad 1 \leq R^2 \leq 0$$

4. FINDINGS

The study captured 9 secondary schools out of the 24 secondary schools in Kabwe district. This representation is 38% of the schools in Kabwe district that were covered by the study.

Table 7: Mathematics Performance in Schools of Kabwe District 2014 - 2018

	Year	2014	2015	2016	2017	2018
1.	Mine Secondary School	No G12	41%	32%	57%	49.2%
2.	Broadway Secondary School	No G12	40%	41%	29%	60%
3.	Chindwin A' Secondary School	No G12	56%	58%	58%	54%
4.	Chindwin Secondary School	52%	41%	43%	52%	45%
5.	Kalanga Secondary School	60%	63%	64%	66%	52%
6.	Kabwe Secondary school	51%	53%	50%	63%	69%
7.	Bwacha Secondary School	69%	66%	68%	63%	73%
8.	Mukobeko Secondary school	41%	39%	48%	43%	45%
9.	Highridge Secondary school	22%	31%	19%	38%	47%

Source: Schools' Statistics Office.

Table 8: Summary of Projected Performance for Kabwe District 2019 - 2023

S/n	School	Year				
		2019	2020	2021	2022	2023
1.	Mine Secondary School	57.2	62.16	67.12	72.08	77.04
2.	Broadway Secondary School	54.5	59.5	67.12	68.9	73.7
3.	Chindwini 'A' Secondary School	55.00	54.40	53.80	53.20	52.6
4.	Chindwini Secondary School	45.7	45.4	45.1	44.8	44.5
5.	Kalanga Secondary School	57.1	55.8	54.5	53.2	51.9
6.	Kabwe Secondary School	71.0	75.6	80.2	84.8	89.4
7.	Bwacha Secondary School	69.3	69.8	70.3	70.8	71.3
8.	Mukobeko Secondary School	46.8	48.0	49.2	50.4	51.6
9.	Highridge Secondary School	48.5	54.2	59.9	65.6	71.3

Figure 4: Showing individual schools with their predictions for 2019 – 2023.

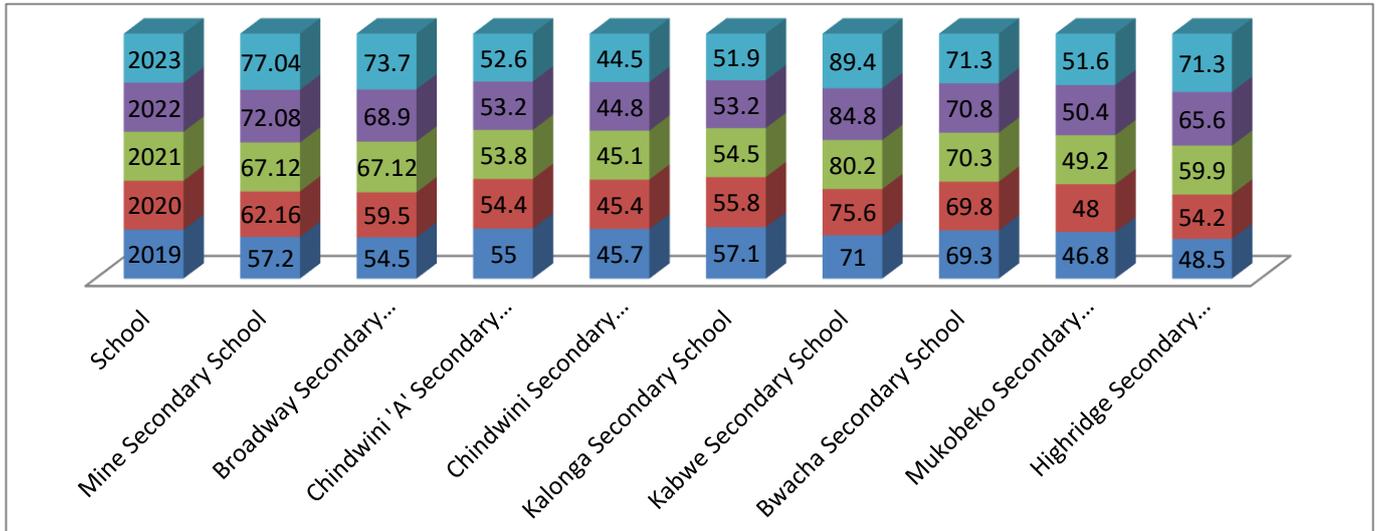
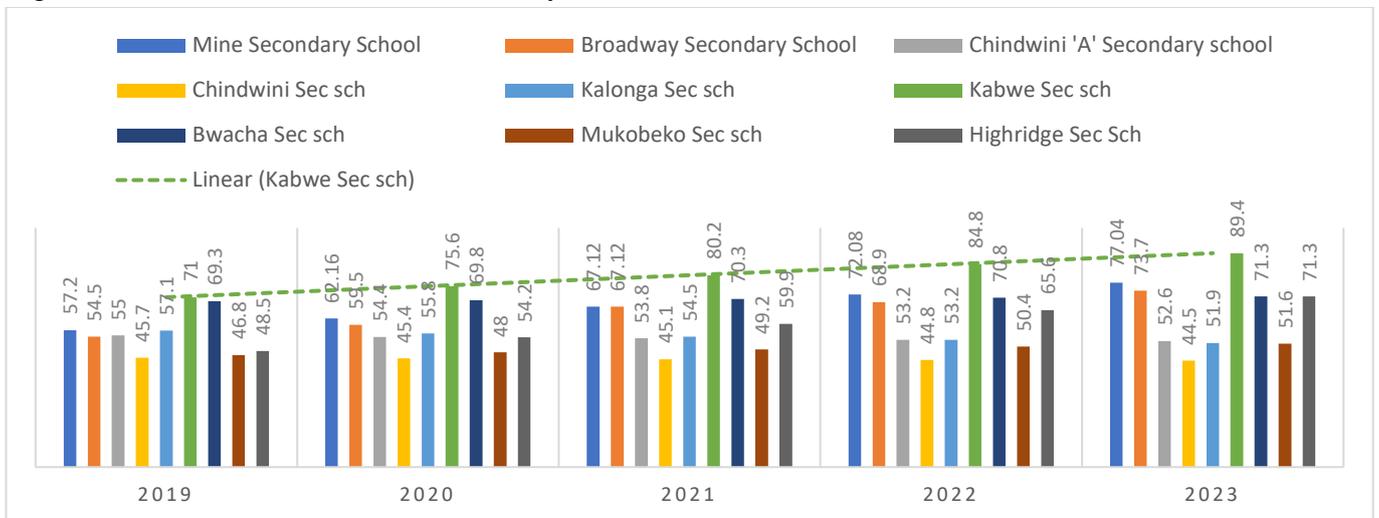
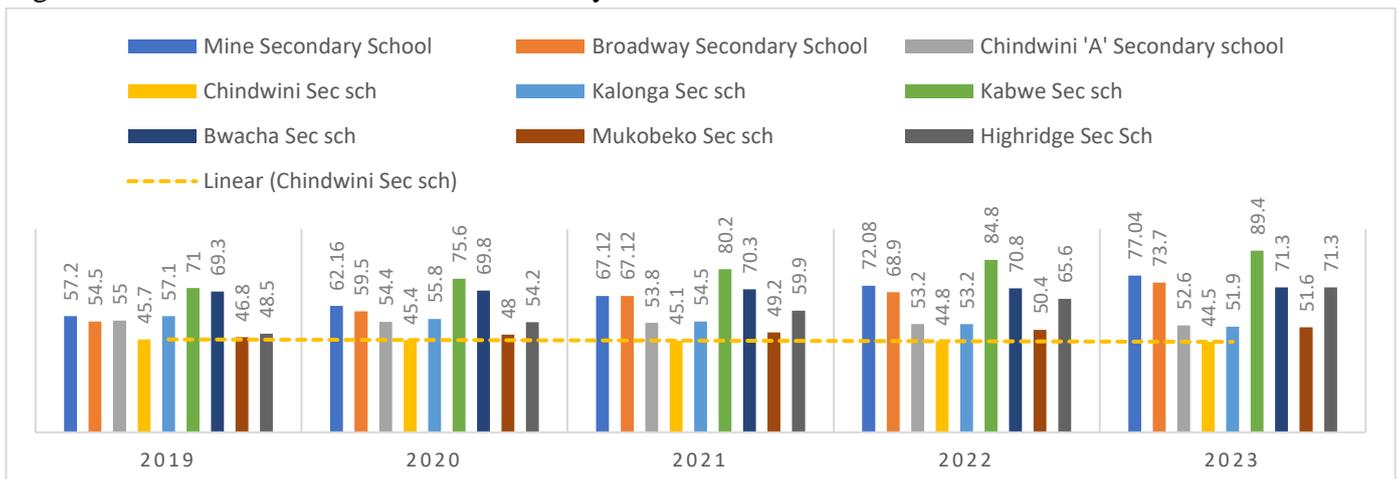


Figure 5: Trend Line for Kabwe Secondary School which had R^2 at 75%.



The R^2 for Kabwe Secondary school was at 75%, and it clearly shows an upward Trend and it is showing a steady rise.

Figure 6: Trend Line for Chindwini Secondary School R^2 at 0.86%.



Trend line for Chindwini with R^2 at 0.86%. We know that a straight line that is parallel to the X- axis has slope zero. Chindwin will experience a decline in performance, it is the least among the nine (9) sampled schools in Kabwe District.

Figure 6: Showing R^2 For Schools in Kabwe District.

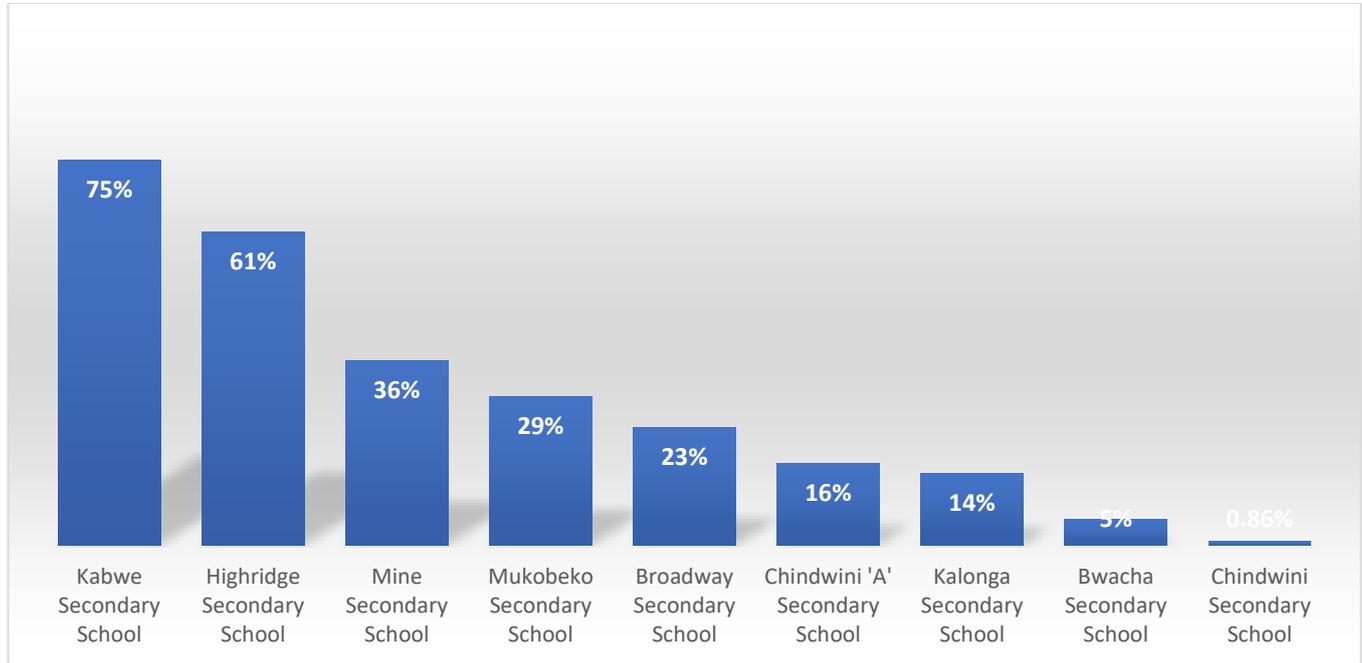


Table 9: Models and R^2 Values for Schools in Kabwe District.

S/n	School	Model	R^2	R^2 in %
1	Mine Secondary School	$Y_i = 4.96x + 32.4 + \epsilon$,	0.355021935	35.50%
2	Broadway Secondary School	$Y_i = 4.8x + 30.5 + \epsilon$	0.2318	23.18%
3	Chindwini 'A' Secondary School	$Y_i = -0.6x + 58 + \epsilon$	0.1636	16.36%
4	Chindwini Secondary School	$Y_i = -0.3x + 47.5 + \epsilon$	0.00855	00.86%
5	Kalonga Secondary School	$\hat{Y}_i = -1.3x + 64.9 + \epsilon$	0.140	14.00%
6	Kabwe Secondary School	$\hat{Y}_i = 4.6x + 43.4 + \epsilon$	0.7535	75.35%
7	Bwacha Secondary School	$\hat{Y}_i = 0.5x + 66.3 + \epsilon$	0.0456	04.56%
8	Mukobeko Secondary School	$\hat{Y}_i = 1.2x + 39.6 + \epsilon$	0.2950	29.50%
9	Highridge Secondary School	$Y = 5.7t + 14.3 + \epsilon$	0.6139	61.39%

Source: Microsoft Excel

5.1 Discussion

It must be noted that the R^2 value measures goodness of fit. And it is Defined as;

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS}$$

$$= 1 - \frac{\sum \hat{\epsilon}^2}{\sum (Y_i - \bar{Y})^2}, \quad 1 \leq R^2 \leq 0$$

The findings indicated that in the year 2014, the lowest performing secondary school was Highridge secondary school at 22% followed by Mukobeko Secondary School at position 5 at 41%. Position 4 was Kabwe Secondary School at 51%. Position 3 was Chindwini Secondary school at 52%. Position 2 was Kalonga secondary school at 60% and topping in this year was Bwacha Secondary School at 69%.

In 2015, the findings indicated that Highridge secondary school was still the least, though it had some improvement of 17.98% from the previous 22%. The school was at 31%. Position 7 was Mukobeko secondary school at 39%, this school had declined from 41% to 39%. Position 6 was Broadway secondary school at 40% and position 5 there were two schools, Mine and Chindwini Secondary Schools. Position 4 was Kabwe Secondary school. Position 3 was Chindwini 'A' secondary school at 56%. Position 2 was Kalonga secondary school, this school had an improvement from 60% in 2014 to 63% in 2015. The leading school was Bwacha secondary school at 66%, however, this school had declined in its performance in mathematics by 3%, from 69% to 66%.

In 2016, Highridge continued to be the lowest at 19% and position 8 was filled up by Mine secondary school at 32%, this school had its performance dropping from 41% to 32%. Position 7 was Broadway secondary school at 41% and position 6 was taken by Chindwini secondary school at 43%. Position 5 was Mukobeko secondary school at 48%, this school showed an improvement from 39% to 48%. Position 4 was taken by Kabwe secondary school at 50%. Position 3 was Chindwini 'A' secondary school at 58%. Position 2 was Kalonga secondary school and position 1 was Bwacha secondary school at 68%.

In 2017, Broadway was the lowest at 29%, position 7 was Highridge secondary school at 38%, this school had an improvement from 19% to 38%, and this was commendable improvement. Position 6

was Mukobeko at 43%, the school had dropped by 5% from 48% to 43%. Position 5 was Chindwini secondary school at 52%. Position 4 was Mine secondary school at 57%, this school improved by 25%, this was commendable. Position 3 was Chindwini 'A' secondary school at 58%. Position 2 were two schools Bwacha and Kabwe secondary schools at 63%. Position 1 was filled by Kalonga secondary school, this school showed a steady improvement.

In 2018, all schools showed some improvement, the lowest at position 8 were Chindwini and Mukobeko secondary schools at 45%, at position 7 was Highridge secondary school at 47%. Position 6 was Mine secondary school which dropped by 8%. Position 5 was Kalonga at 52%, this was a drop by 14%, which is not a good indicator. Position 4 was Chindwini 'A' secondary school which also dropped by 4%. Position 4 was taken up by Broadway secondary school at 60%. Broadway did a commendable job by improving by 31% from 29% to 60%. Position 2 was Kabwe secondary school at 69%. Position 1 was taken up by Bwacha secondary school.

The table 9 outlines respective Models and R^2 values for respective schools captured in this study. The study shows that Kabwe secondary school has the best goodness of fit measure which is at 75%. Going by this measure the school is likely going to steadily improve from 69% in 2018 to 71% in 2019, then progress to 75.6% in 2020, and steadily to 80.2% in 2021. In 2022 performance is likely going to move to 84.8% and in 2023 it is likely going to 89.4%.

The model was $\hat{Y}_i = 4.6x + 43.4 + \varepsilon$, showing that the gradient is positive signifying an upward trend, no wonder we see steady progress upwards.

Figure 5 clearly shows the upward trend for Kabwe Secondary School and it clearly shows that it has the best goodness of fit measure and it shows consistency in performance. It is again shown in table 9 that it has its R^2 value at 75% which is the

best of all the nine (9) schools sampled. The second best was Highridge secondary School R^2 value at 61% and the third is Mine secondary school with R^2 value at 35%. This is third best position but the goodness of fit is very far away from 1. Figure 5, on the other hand shows Chindwini Secondary School as the least of all the sampled schools with its slope almost parallel to the horizontal axis, the inclination is shown that it is negative sloping with gradient

Conducting Trend analysis shows numbers that can be seen and interpreted by anyone. It is a tool that can be used for monitoring and self - evaluation for individual teachers, at departmental level and also at school level. It is a tool that should be used for decision making with a view to setting targets.

Table 9 shows listing of schools' performance with Kabwe Secondary School at 75% with respect to its R^2 , in position 1, Highridge Secondary School at 61% in position 2, Mine secondary school at position 3 with 36%, position 4 was Mukobeko Secondary school at 29%, position 5 was Broadway Secondary school 23%, position 6 was Chindwini 'A' Secondary school, position 7 was Kalonga secondary school at 14%, position 8 was Bwacha secondary school at 5% and the least of all at position 9 was Chindwini secondary school at 0.86%. The listing of schools is seen in Figure 38 with Kabwe Secondary having the best goodness of fit measure and the least being Chindwini secondary school.

Table 9 indicates that Chindwini, Chindwini 'A' and Kalonga Secondary Schools had downward Trends, their respective slopes were -0.6 for Chindwini, -0.3 for Chindwini 'A' and -1.3 for Kalonga Secondary School. Their respective R^2 values were 0.86% for Chindwini, 14% for Kalonga and 16.36% for Chindwini 'A' Secondary School. The Trends were nose diving, implying that there are measures that need to be put in place to correct these trends. On the other hand, positive trends were seen with Kabwe Secondary School being the best with its slope at 4.6 and R^2 at 75%, followed by

shown as -0.3 the rise is in the negative. Table 9 shows the R^2 for Chindwini at 0.86% which is very poor. Chindwini is the least of all schools in the sample. There are three schools with a negative trend in the sample, these Chindwini Secondary School indicating the downward trend with slope -0.3, followed by Chindwini 'A' Secondary School with slope -0.6 and its R^2 being 16% and the third being Kalonga -1.3 slope and the R^2 being 14%.

Highridge Secondary school with slope of 5.7 and R^2 of 61%, the third being, Mine secondary school with a slope of 4.96 and R^2 value of 36%, the fourth was Mukobeko Secondary school with slope of 1.2 and R^2 value being 29.5%, the fifth being Broadway secondary with slope of 4.8 and the sixth was Bwacha secondary school with its slope being 0.5 and R^2 at 4.5%.

Bwacha Secondary School recorded performance of 69% in 2014 But when the stochastic error was brought into play, it showed that the predicted performance was actually was seen dropping from 69% to 66.8% and then later on there was going to be a rise in 2015 from 66% to 67.3%. In 2016 instead of 68%, the predicted shows a decline of 67.8%, considering the stochastic error. In 2017, instead of 63% the predicted showed a rise to 68.3%. In 2018, instead of 73% the predicted showed a decline to 68.8%. The findings of the study, revealed that from 2019 to 2023 a steady rise in performance will be seen from the predicted 68.8% to 69.3% in 2019, 69.8% in 2020, 70.3% in 2021, 70.8% in 2022 and 71.3% in 2023. This predicted Trend is in effect a decline in performance compared to the actual performance of 73% in 2018. This predicted decline is due to its low R^2 value which was at 4.5%, \approx 5% and a slope of 0.5. This signifies that there are several factors that should be considered in analysis and improvement of performance in Mathematics in schools in Kabwe district. It must clearly be pointed out that this study used Simple Linear Regression as a Mathematical Model, implying that we only had a consideration

of only two variables in the study, these were time in years and performance.

It must be brought to the fore, once again that R^2 value is the measure of goodness of fit.

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{RSS}{TSS}$$
$$= 1 - \frac{\sum \hat{\varepsilon}_i^2}{\sum (Y_i - \bar{Y})^2}$$

This can also be expressed as;

$$R^2 = \frac{\sum (\hat{Y}_i - \bar{Y})^2}{\sum (Y_i - \bar{Y})^2}, \quad 1 \geq R^2 \geq 0$$

It must be noted that the ratio ESS and TSS is very low and as such the trend in performance is seen to show some decline from 2018 at 73% going to 68.8% rising to 71.3% in 2023. When Highridge is compared to Bwacha, it shows a better R^2 value which is at 61.39%. Highridge was the lowest in performance in 2014 at 22% when Bwacha was in first position at 69%, 2015, Highridge was at 31% as the least in the sample and yet Bwacha was the first at 66%, 2016 Highridge was at 19%, Bwacha at 68%, 2017, Highridge was at 38% and Bwacha at 63% and 2018, Highridge was at 47% and yet Bwacha was at 73%. In the prediction for 2019 to 2023 it was brought to the fore that the two schools are seen to be at 71.3% by 2023. This is due to the fact that Highridge secondary school has a better R^2 value of 61.39% compared to that of Bwacha at 4.5%.

5.2.1 How to Develop a Mathematical model to be applied in Trends Analysis?

A Mathematical Model was developed in this study and applied in the trend's analysis for the sampled schools in Kabwe district.

5.2.2 What are the Trends in grade 12 mathematics performance in school certificate examinations for 2014 – 2018 in Kabwe District?

The trends indicated three (3) secondary schools in the study had downward trends and six (6) had upward trends in Kabwe district.

5.2.3 What are the predictions in grade 12 mathematics performance in school certificate examinations for 2014 – 2018 in Kabwe district?

The prediction was that three schools predicted a decline in performance in mathematics in the school certificate national examinations whereas six (6) other schools predicted a rise in performance, however among these one of them despite having an upward trend showed a decline in performance, from 73% in 2018 to 71.3% in 2023.

5.2.4 Project grade 12 mathematics performance in school certificate examinations for 2019 – 2023 in Kabwe District.

A projection was done for the period 2019 to 2023 in the school certificate examinations for 2019 – 2023 in Kabwe district.

5.2.5 What are the benefits of trends analysis on performance of grade 12 learners in school certificate examination in Kabwe district?

Benefits of Trends analysis are great, the school is able to conduct an in-depth analysis of performance. The school is able to project and use the project as an instrument of as a measure in monitoring. The projected performance will act as a standard in monitoring. Not only schools but also the DEBS

Will have something to be used as a standard measure in monitoring. This can also be used by the provincial education office in their monitoring of schools in the province.

5. CONCLUSION

Three schools in this study indicated downward trends in the analysis. The implication of the downward trend in predicted rates of performance in the three schools in relation to economic growth is that more and more youths will find it difficult to gain admission into higher learning institutions where the youths are offered a variety of opportunity for skills acquisition and professional training in different fields of human endeavor. As a result of which the country might have a growing population of youths without the requisite capacity for global economic competitiveness, particularly in Kabwe district.

Unless urgent steps are taken to reverse the trend in a desired direction, Zambia may not realize the vision 2030, in which it is aimed to be a middle-income nation by 2030.

This realization cannot leave mathematics out of the picture, it means mathematics performance must seriously be monitored so that it can take an upward trend.

Given the present pattern of students' performance in Kabwe district in three (03) schools in the national school certificate examinations in mathematics, the vision of the government may not be realized in the nearest future. On the other hand, the six (06) schools that had an upward trend have learners' performance with an upward trend which is very good indicator, however, there is need for some schools to improve on the performance which was seen to be very low, yet having a good R^2 , positive action need to be taken to remedy the situation. The 'it is business as usual trend', should not be entertained but there should be immediate introductive of corrective measures to help improve performance in mathematics. Six (6) schools showed an upward trend but performance was predicted to decline, it calls for urgent measures to be implemented to help improve performance in mathematics in Kabwe district.

The benefits of conducting trends analysis are many. Schools as well as the district can easily

monitor performance of learners throughout the learning period up to the time learners come to write examinations. It is easy to see downward trends and once this is observed, intervention measures can be introduced to remedy the situation.

5.3 Recommendations

Based on the findings of the study, the following recommendations are provided:

5.3.1 Schools should conduct trends analyses for their respective schools and closely monitor mathematics performance on a regular interval starting with monthly tests, to mid-term test and through to the end of term tests, with a view to helping teachers have a self-analysis of their performance through these graphical presentations of pupil performance. These analyses, if nose diving, will help the teachers to find ways of mitigating this negative trend and will probably help the teacher to find better ways to make delivery of materials to the learners. In an event that the trends are positive then teachers will have to share the best practices that help them to have such positive results with fellow teachers in the district and teachers in other districts in the province at large.

5.3.2 Schools should make Predictions of learner performance in mathematics for specified periods of time and closely monitor these activities. This will help schools in setting up targets and work towards achieving such targets. Such making of predictions calls for good quality assurance which in turn will help to improve quality control in schools.

5.3.3 District Education Board office should monitor the trends analyses of Individual schools and evaluate them on a regular basis. The DEBS will need to have good quality assurance which will in turn help to provide good quality control in school

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