UTILIZATION OF FORMATIVE ASSESSMENT STRATEGIES IN MATHEMATICS INSTRUCTION AND THEIR IMPACT ON LEARNER ACHIEVEMENT IN SECONDARY SCHOOLS IN KENYA

BY

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DECLARATION

Declaration by the Candidate

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To my family, my Husband Dr. Mathew Kosgei and my children: Maxine, Crispin, Griffins and Marlene whose love, understanding, prayers and wholehearted support made me what I am today.

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ABSTRACT

Formative assessment is Key in Mathematics instruction and thus requires attention for optimization of learners' achievement. There is need for effective utilization of the five formative assessment strategies(FAS) including; clarifying and sharing learning intentions and criteria for success, engineering effective classroom discussions questions and learning tasks, feedback that moves learners forward, self assessment and peer assessment. The study sought to investigate the utilization of formative assessment strategies in Mathematics instruction and their impact on learners' achievement in secondary schools in Nandi County, Kenya. Specifically the study investigated the level of use of the five effective formative assessment strategies in Mathematics instruction, determine the impact of the five effective formative assessment strategies on learners' achievement in Mathematics, ascertain learners' and teachers' perceptions on the use of the five effective formative assessment strategies in Mathematics instruction, fitted a structural association model for learners achievement in mathematics instruction and investigated teachers' support on effective implementation of the five formative assessment strategies in mathematics instruction. The study was guided by Wiliam and Thompson framework of formative assessment, grounded in Vygotskys' Socio-constructivist theory of learning and Heritage's model of formative assessment. Pre-Posttest control Quasi-experimental mixed method intervention design was employed. Both quantitative and qualitative data were collected. The study involved form three students, their mathematics teachers and head teachers. Proportionate stratified random sampling was used to select twelve schools while simple random sampling was used to select classes and subjects; 534 students, 33 teachers and 12 head teachers. Data was collected using questionnaires, mathematics achievement tests, interviews and observation schedule. Piloting was done using test retest method, data was subjected to Cronbach alpha and reliability obtained was 0.914 and 0.907 for teachers' and students' questionnaires respectively. Validity of instruments was determined using expert help. Quantitative data were analyzed using frequencies, percentages, means, correlation analysis, independent sample t-test and structural equation modeling (SEM) whereas qualitative data were analyzed thematically and presented in form of excerpts and qualitative descriptions. The results indicated that there was: low utilization of FAS in Nandi County due to lack of understanding and awareness of FAS, a positive impact on learners' achievement ($p= 0.00, <0.05$ with $F=11.23$, $t=14.82$), a positive influence on the teachers' and learners' perceptions ($F=15$, $t=4.4$, $p=0.00< 0.05$ for teachers and $F=1.7$, $t=17.2$, $p=0.00$ for students) in mathematics instruction, Structural association model fits well the data ($X^2=49.14$, $p=0.508$, CFI=1, GFI=0.97, RMSEA=0.026) and there was inadequate teachers' support on the implementation of the five FAS (majority were on the affirmative) .It was concluded that teachers do not understand formative assessment strategies, effective utilization of FAS has a positive impact on learners' achievement and a positive influence on the teachers' and learners' perceptions in Mathematics instruction, All the five FAS can be used to predict learners' achievement and there is need for adequate support for effective implementation of FAS in Nandi County. The study recommends that Ministry of Education should create more awareness and understanding of FAS through more in-service training and Professional Learning Communities, institutions of teacher training and Curriculum reviewers to rethink FAS and more support to be offered to teachers for effective and successful implementation of FAS in Mathematics instruction towards achievement of sustainable development goals.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CATs	Continuous Assessment Tests
CERMESA	East South African German Exchange Services
CFI	Comparative Fit Index
DAAD	Deutscher Akademischer Austauschdienst (German Academic Exchange Service)
FAS	Formative Assessment Strategies
GFI	Goodness of Fit Index
JICA	Japan International Cooperation Agency
K.C.S.E	Kenya Certificate of Secondary Education
K.I.E	Kenya Institute of Education
K.N.E.C	Kenya National Examination Council
KIE	Kenya Institute of Education
KLT	Keeping Learning on Track
KNBS	Kenya National Bureau of Statistics
NACOSTI	National Commission for Science, Technology and Innovation
OECD	Organization for Economic Cooperation and Development
PISA	Program for International Student Assessment
RMSEA	Standard Root Mean Square Residual
SDG	Sustainable Development Goals
SEM	Structural Equation Modeling
SMASSE	Strengthening Mathematics and Science subjects in Secondary Education
SPSS	Statistical Package for the Social Sciences

TIMSS	Third International Mathematics and Science Study

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction

The quality of an education system is a very crucial determinant of economic development and social stability of the nation (Maithya, 2012). Kenya's economy requires a steady supply of scientifically and technologically knowledgeable human resource (Mutahi, 2009). This underscores the immense role science and technology play in the development of a country. Hence, students should be well-equipped with the necessary knowledge and skills in science and technology to perform in the modern economy. Mathematics is a fundamental subject in every educational system that prepares the citizens to take up essential skills in the 21st century. The development of highly-skilled and well educated manpower is critical to support an innovative technology- driven economy especially in Kenya as spelt in Kenya Vision 2030. Furthermore, a strong grounding in Mathematics and talent pool is necessary to support the wide range of value-added economic activities and innovations to achieve Sustainable Development Goals in Education.

Mathematics Education aims at preparing Mathematics instructors for quality education. Many Countries are paying attention to the quality of their Mathematics education as shown by the growing interest in Third International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) which speaks of the global interest and importance placed on Mathematics education (Ministry of Education, Singapore, 2013).

Research shows that the use of formative assessment has a positive effect on student achievement (Lee, Harrison & Black 2004; Popham, 2008). However, much of the

available evidence concerning the effectiveness of formative assessment instructional practices for improving student achievement remains inconclusive and one of the reasons is that the uncertainty in judging the impact of formative assessment may be due to inconsistency in how formative assessment practices are implemented in the published studies (Thum, 2015). This study filled the gap by looking at the effective utilization of formative assessment strategies in Mathematics instruction and their impact on learner achievement in secondary schools in Kenya.

This chapter presents the background information of the study, the statement of the problem and the purpose of the study. It also focuses on the research objectives, research questions, the hypotheses, justification and the significance of the study. Finally, the assumptions of the study, scope, limitations of the study, conceptual and the theoretical frame-work that was employed in the study are discussed.

1.2 Background of the Study

Mathematics is a fundamental subject in the development of science and technology. Citizens of any country should attain a reasonable level of mathematical literacy if adequate levels of scientific and technological developments are to be achieved (Owiti, 2001; Chemeli, 2013).

Mathematics is the cradle of all creations, without which the world cannot move an inch. Mathematics makes our life orderly and prevents chaos. Certain qualities that are nurtured by Mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability and even effective communication skills. Be it a cook or a farmer, a carpenter or a mechanic, a shopkeeper or a doctor, an engineer or a scientist, a musician or a magician, everyone needs Mathematics in their day-to-day life (Web, 2007).

Mathematics is also a very important subject in the school curriculum and a strategic subject in the learning of other subjects and development of science and technology. Hence any citizen of any country should attain a reasonable level of mathematical literacy if adequate levels of scientific and technological development are to be achieved. Ekwueme and Ali (2003) assert that despite the important position Mathematics occupies, it still remains one of the subjects that students persistently perform poorly in.

Mathematical functions such as addition, subtraction, division and multiplication are used in always activities by people of various ages, status and backgrounds. The present technological society requires use of such skills as estimating, problem solving, interpreting data, measuring, predicting and applying Mathematics to everyday situation. In secondary education, Mathematics is a fundamental subject to the learners in career choices, it is used in Medicine, Engineering of all type, physical Sciences, Economics, Industrial works, Business and Management (Owiti, 2001; Mwei, 2015). These researchers further noted that 'Mathematics plays an important part in character building, building of self-esteem and providing opportunities for developing curiosity and creativity in the learners.

Mathematics is a compulsory subject both at primary and secondary school levels in Kenya and despite the importance attached to Mathematics, the performance of Kenyan students in Mathematics in the national examinations has been very poor and more than 50% of the students fail Mathematics in the National examinations (Kivuti, 2015).This is evident in the Table 1.

Table 1: Candidates performance in KCSE Mathematics for the year 2013- 2017

Year	Candidature	Mean score
2013	304,863	42.59
2014	335,489	42.26
2015	356,107	46.07
2016	378,349	47.03
2017	393,286	47.98

Source: KNEC, Report, 2013 – 2017

Table 1 shows that the Mean score of Mathematics in KCSE for the five consecutive years was below average Nationwide (KNEC, 2017).

The analysis of KCSE for Nandi District for 2008 report stated that:

> *"Mathematics, Kiswahili and Science had dropped in performance. It is hoped that when the primary schools SMASE program is rolled out performance in Mathematics & sciences will improve"*.

Despite the SMASSE program rolled out in Nandi County in 2006, performance is still below average. This is evident in the following Table 2.

Table 2: Nandi County KCSE Mathematics mean score for 2013 -2017

Year	Mean score
2013	42.780
2014	43.772
2015	43.758
2016	44.014
2017	44.589

Nandi County KCSE Analysis Report, 2013 – 2017

Table 2 shows that the Mean score of Mathematics in K.C.S.E Nandi County for the five consecutive years was below average.

Although Mathematics is an important subject in the school curriculum, the performance of students in the subject worldwide and at KCSE level is deplorable and alarming (Mwei, 2009; Kitten 2007; Chemeli, 2013). In USA, performance in Mathematics is not satisfying as Kitten (2007) recalled, "as far as I can tell, Mathematics Education has always sucked in the US". The Third International Mathematics and Science Study (TIMSS) results were published in 1996/7 Macnab (2000) indicated that the US students performed poorly although better than UK.

Chemeli (2013) asserts that before the program of Strengthening of Mathematics and Science in Secondary Education (SMASSE), intervention, a survey conducted to establish the cause of the persistent poor performance of Mathematics and the Science subject in Secondary Education in Kenya showed that the dominant classroom practices were ineffective. SMASSE (2002) found it necessary to focus on the classroom, where the battle against poor performance must be waged and won (Kenya Education Insight, 2006).

Low achievement in Mathematics is attributed to poor interpretation of questions, poor grasping of concepts and failure to relate Mathematics knowledge to real life situation (KNEC, 2014). Research findings have also cited other factors as students' negative attitudes towards the learning of Mathematics (Badmus, 2002; Obodo, 2004), parents/guardians educational level (Bii, 2006), insufficient learning materials (Muraya & Kimamo , 2011), gender difference (Agwagah, 2000) and teachers' use of inappropriate teaching methods which make students become passive and have less interaction with each other in doing task (Zakaria, Solfitri, Daud & Abidin, 2012;

Muraya & Kimamo, 2011; Harbour-Peters, 2001; Gambari, 2010). Poor teaching method is cited as one of the major factors influencing poor achievement and retention (Osemwinyen, 2009). Assessment is an indispensable component of the teaching and learning process and thus teachers need to understand how to effectively assess student's learning as this also informs their choices of instructional methods and media based on the points of strengths and weaknesses of the students.

Classroom assessment has been referred to as the continual evaluation of the students conducted with the main intention of enhancing both teaching and learning (Stiggins, Chappuis & Arter, 2014). It is an indispensable component of the teaching and learning process and its' main purpose is to enable the teacher to realize areas that students demonstrate mastery and those that they experience difficulties. Teachers use a wide range of assessment methods ranging from recording anecdotal notes while observing a student to administering standardized tests (Earl, 2012; Stiggins et al., 2014).

Classroom assessments can either be summative or formative. Summative assessments are used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period typically at the end of a project, unit, course, semester, program, or school year (Stiggins & chappuis, 2014). Some of the most well-known and widely discussed examples of summative assessments are the standardized tests administered by governments and testing organizations, usually in Mathematics, reading, writing, and science. Summative assessments are mainly used to measure what students have learnt at the end of a unit, to promote students, to ensure they have met required standards on the way to earning certification for school completion or to enter certain occupations, or as a method for

selecting students for entry into further education (Taras, 2005). While most summative assessments are given at the conclusion of an instructional period, some summative assessments can still be used diagnostically (Knight, 2002).

On the other hand, classroom assessment may also serve a formative function. In classrooms, formative assessment refers to frequent, interactive assessments of student progress and understanding to identify learning needs and adjust teaching appropriately (Clark, 2008). It typically involves qualitative feedback rather than scores for both student and teacher that focus on the details of content and performance. Teachers using formative assessment approaches and techniques are better prepared to meet diverse students' needs through differentiation and adaptation of teaching to raise levels of student achievement and to achieve a greater equity of student outcomes (Nicol & Macfarlane-Dick, 2006). Through formative assessments, teachers monitor student progress, provide students feedback, and adjust instructional approaches toward improved teaching and learning, (Earl, 2012).

While both forms of assessment serve specific and separate functions, summative and formative assessments are not mutually exclusive in practice. This infers that it is the purpose of the assessment, rather than the task, that delineates the form of the assessment, (Earl& Katz, 2006). The key difference is that unlike summative assessment, formative assessment helps the students identify their strengths and weaknesses and the target areas that need to be worked on. Additionally, it helps the teacher recognize where students are struggling and address problems immediately. Summative assessments on the other hand often have high face-value in that they evaluate student learning at the end of an instructional unit by comparing it against some standard or benchmark. Traditionally, teachers have had a difficult time

incorporating various types of assessment in a multi-synergistic and purposeful fashion (Earl & Katz, 2006; Volante & Beckett, 2011). Consequently, most teachers use a single form of assessment in classroom instruction.

According to Aboulsoud (2011), Stiggins, (2014) and Burke, (2014), formative assessment is more effective compared to summative assessment approach. When incorporated into classroom practice, formative assessment provides the information needed to appropriately adjust both the teaching and learning processes while they are happening. In this sense, formative assessment informs both the teacher and the student about the learners' understanding so that opportune adjustments can be effected. These adjustments help to ensure students achieve the targeted standards-based learning goals within a set time frame. Although formative assessment strategies appear in a variety of formats, there are some distinct ways to distinguish them from summative assessments. Previous researches have also shown that specific formative assessment practices have a direct positive impact on student learning and achievement. In particular, four large reviews on the impact of formative assessment (Yin, 2008; López-Pastor , 2013; McMillan, Venable & Varier, 2013; Keeley, 2015) have supported the claim that the use of formative strategies such as questioning techniques, feedback without grades, self-assessment, peer assessment, and formative use of summative assessments can double the speed of student learning. Even more outstandingly, formative assessment reduces the achievement gap by helping low achievers the most (Black, 2012).

Traditionally, classroom assessment has been used by individual teachers to monitor student's learning and to provide a basis for assigning grades (Stiggins, Chappuis & Arter, 2014). Over the years, however, the character of educational assessment has

changed. Shepard (2000) noted that in the 1980s, concerns about reading and computational literacy led many states to implement minimum competency programs as a requirement for high school graduation. The role of assessment continued to evolve, as policy makers turned to assessment as a way to improve education. Standards-based reforms of the 1990s gave assessment increasing visibility, sending signals about the successes and failures of schools and school districts, as well as of individual students (Shepard, 2000).

Today, educational systems across the globe are undergoing efforts to move beyond the ways they operated at the beginning of the 20th century. Reforms currently underway reframe what is taught, how it is learned, and how it is being evaluated in innovative ways that help personalize learning. The realization by different state-run education systems that formative assessment approaches possess the aptitude to meet the scholastic needs of the 21st century students began with the "quiet revolution" (Griffin, McGaw & Care, 2012). This revolution began in the early 2000s and it involved the K-12 policy frameworks of a number of nations such as the USA, Britain, Canada, Philippines and Australia among others (Hayward & Hedge, 2005; Bennett & Gitomer, 2009).

The prevalence of K12 formative assessment frameworks in the developed countries in the late 1990s and early 2000s were promoted by its aptitude to align learning goals with accountability in the educational systems. This alignment efficiently motivates classroom instruction to focus on the educational outcomes (Kane & Bejar, 2014). While, many of these teacher-designed assessment strategies (summative assessments) are increasingly common in the classrooms of developing countries, they are hardly used in developed countries. Formative assessment frameworks have

been successfully integrated in the educational systems of most developed countries. To truly improve student learning in developing countries, it is imperative to transform how teachers assess their students learning in the classroom.

According to Perry (2013) in the study formative assessment use and training in Africa, 1 out of 2 children in Africa will reach adolescence without basic skills in reading and Mathematics (Brookings institution, 2012). They found out that focus is shifting from access to quality (UNESCO, 2004; World bank2004; World bank 2011).Also, it was noted that one activity strongly promoted by international agencies to improve educational quality is student assessment (USAID, 2011; World Bank 2011). Furthermore, in 2011, 18 out of 41 World Bank projects that promoted student assessment included formative assessment component (Clarke, 2011). On the rise of formative assessment projects and policies in Africa, there was increase in government policies supporting formative assessment and continuous assessment.

The current research is motivated by the United Nations SDG number 4 and according to Annah (2017), United Nations Educational Scientific Cultural and Organisation (UNESCO) (2017) documented the SDGs 2016-2030, and its overarching goal No. 4 that requires nations to provide equitable and inclusive quality education and promote life-long learning opportunities for all by 2030. The SDGs also requires that every human being acquire twenty first century skills, knowledge, attitudes and values to deal with world challenges and realize sustainable future and according to OECD (2012) lifelong skills development will effectively address inequality, access to quality education, acquisition of essential skills for social development, labour market integration and youth unemployment challenge.

World Bank (2017) has documented existence of learning crisis in the low and middle-income countries and the findings revealed that schools put a lot of emphasis on schooling without focusing on students learning and the Africa-America Institute (2015) echoes the findings that while there are many students gaining access to education in secondary schools, they are not gaining basic skills. In addition, Africa faces severe shortage of highly skilled African talent, the skills that will confront today's world challenges will depend on the improvement of students' performance with the teacher being part of the process or the pathway to learning (Annah, 2017).

According to Global Monitoring Report (2016), the Sub Saharan Africa investment in education has not fully translated to development of functional skills and knowledge that could transform economies of which they live in general and individuals in particular. The report of Africa Progress Panel (2012) established that African children transiting to secondary schools from primary school lack basic literacy and numeracy skills, implying that children experiences deficits in basic learning competencies. Formative assessment is a learner centered approach which is bound up with students becoming autonomous lifelong learners who are active participants in the classroom and beyond (Cowie, 2013) and as Ayers (2014) posits that teachers' use of formative assessment to inform instruction is an essential piece of effective pedagogy.

Thum (2015) asserts that much of the available evidence concerning the effectiveness of formative assessment instructional practices for improving student achievement remains inconclusive and the use of teacher-centered summative assessment methods is pre-dominant in Mathematics instruction in schools in most developing countries. Research carried out by the Kenyan National Examination Council (2014) revealed

that teachers hardly use formative assessment in classroom instruction and in essence, summative assessments are dominant in Kenyan education system whose focus is exam oriented curriculum. Harlen (2006) notes that high –stake testing creates anxiety and dis-affection among students.

Abrams (2007) posit that the intense focus on testing de-skills, de-motivates and de-professionalizes teachers and Noddings (2004) contends that standardized tests "are loaded with trivia" and students are "being fed intellectual junck food"(p.494) to succeed on these tests (Spring, 2011). According to Policy view (2008), the over-emphasis on examinations has limited schemes for making learning and training programs practical oriented. The learners are taught content that is predicted to be examined while sometimes the same content is repeated several times for the students to memorize (Kemboi, 2015).

From the foregoing background, there was therefore need for this study to attempt to fill the gap by investigating the utilization of formative assessment strategies in a Mathematics instruction and their impact on learners' achievement of form three students in Nandi County, Kenya. This research figured out whether the integration of the five effective formative assessment strategies in classroom instruction in developing countries can positively transform the quality and the output of classroom instruction as discussed in the next sections.

1.3 Statement of the Problem

Poor performance in Mathematics has continued to cause great concern to educators, teachers, stakeholders, parents in Kenya. Despite numerous efforts to reverse the trend, less has been achieved (Too, 2004; Mwei, 2009; Chemeli, 2013). As a nation,

the development of highly- skilled and well educated manpower is critical to support an innovative technology- driven economy. Furthermore, a strong grounding in Mathematics and talent- pool is essential to support the wide range of value- added economic activities and innovations to attain vision 2030 and sustainable development goals in education (Ministry of Education, Singapore 2015).

For Kenya to realize her goal of being an industrialized nation by 2030, current schooling and training program should be geared towards producing qualified technicians, engineers and scientists who are well-versed with modern and relevant scientific skills. To pursue science related courses at tertiary and University level one must do well in Mathematics and Sciences at KCSE level. However, there has been continued dismal Mathematics performance of students at KSCE level over the years in Nandi county for instance the mean score for Mathematics in the year 2013 to 2017 were 42.6%, 42.3%, 46.0%, 47.0% and 48.0% respectively.

Quality assessment is a key component to effective teaching and learning. It is the heart of effective teaching and learning. Regular, reliable and timely assessment is key to improving learning and enhancing quality education (UNESCO, 2005). Formative classroom assessment approaches have been shown to be very efficient in improving content mastery in the classroom and academic performance generally. Past research have shown that teachers who use formative assessments to provide specific and timely feedback to their students have had a greater impact on their students' academic achievement (Aboulsoud, 2011; Bennett, 2011; Black, 2012; Bordoh *et al.*, 2013; Brookhart & Nitko, 2013; Confrey, 2015; Earl, 2012; Kilpatrick, 2014; Pinto & Santos, 2012).

Though formative assessment frameworks have been successfully integrated in the educational systems of most developed countries, most developing countries are still using teacher-designed summative classroom assessment approaches. Research carried out by the Kenya National Examinations Council (2014) revealed that teachers hardly used formative assessment instruments in classroom instruction. In essence, summative assessments are dominant in Kenyan education system. Despite the continued use of summative assessment approaches in schools in Kenya, little has changed in how students perform on national examinations. This is largely attributed to the fact that the current classroom instruction has not led to large gains in learning as measured by these forms of assessment.

Studies show the relationship between the performance of the student and the frequency of the formative assessment strategies as directly proportional (Stiggins & Chappuis, 2012).Formative assessment strategies have not been utilized to the fullest extent possible (Lyon, 2005) and there is paucity of literature in Kenya on the effective utilization of formative assessment strategies given Kenya's strong focus on formal national examinations and therefore this study sought to determine the effective utilization of formative assessment strategies in Mathematics instruction and their impact on learners' achievement in secondary schools in Kenya.

Several researchers (Leahy, Lyon,Thomson and Wiliam, (2005) Thomson and Wiliam (2008), Bennet, (2011), Oswalt, (2013), Michael& Susan Dell Foundation, (2016) have identified five key formative assessment strategies which are said to be effective in improving learners' achievement in mathematics instruction. These strategies are; clarifying and sharing learning intentions and criteria for success, engineering effective classroom discussions(questions and learning tasks), providing feedback

that moves learners forward, activating students as the owners of their own learning(self-assessment) and activating students as instructional resources for one another(peer assessment). No single study in Kenya on formative assessment had focused on the five key strategies of formative assessment which were the focus of this study. The researcher picked the strategies which have been folded in a formative assessment framework of William and Thompson (2007) to test whether they were really effective in the study context and in most parts of this Thesis, these strategies were generally referred to as the five effective formative assessment strategies.

1.4 Purpose of the Study

The purpose of this study was to investigate the utilization of formative assessment strategies in Mathematics instruction and their impact on learners' achievement in secondary schools in Nandi County, Kenya.

1.5 Objectives of the Study

The study objectives were centered on the five effective formative assessment strategies that include; clarifying and sharing learning intentions and criteria for success, engineering effective classroom discussions (questions and learning tasks), feedback that moves learners forward, self assessment and peer assessment. Therefore the research objectives were;

i. To investigate the level of use of the five Effective Formative Assessment strategies in Mathematics instruction.
ii. To determine the impact of the five Effective Formative Assessment strategies on learner's achievement in Mathematics.

iii. To ascertain the teachers and learner's perception of the five Effective Formative Assessment strategies in Mathematics instruction.

iv. To fit a structural association model for the learners' achievement in Mathematics instruction.

v. To investigate the teachers' support on effective implementation of the five Formative Assessment strategies in Mathematics instruction.

1.6 Research Questions

Just like the objectives, the research questions were centered on the five effective formative assessment strategies;

i. What is the level of use of the five Effective Formative Assessment strategies in Mathematics instruction?

ii. What is the impact of the five Effective Formative Assessment strategies on learner's achievement in Mathematics?

iii. What are the teachers' and learners' perceptions of the five Effective Formative Assessment strategies in Mathematics instruction?

iv. How is the structural association model for learners' achievement in Mathematics instruction?

v. How is the teachers' support on effective implementation of the five Formative Assessment strategies in Mathematics instruction?

1.7 Research Hypotheses

The following three null hypotheses were tested at significance level of 0.05.

i. $H0_1$: There is no significant difference in learner's achievement between the experimental and control groups when subjected to the five effective formative assessment strategies in Mathematics instruction.

ii. $H0_2$: There is no significant difference in teachers' and learners' perceptions of the five effective formative assessment strategies between the experimental and control groups in Mathematics instruction.

iii. $H0_3$: The structural association model fits well the data for learners' achievement in Mathematics instruction.

1.8 Justification of the Study

In order to increase student achievement, teachers must pay greater attention to improving the nature of classroom assessment (Stiggins, 2005). Formative classroom assessment approaches have been shown by various researches all over the world to be very efficient in improving content mastery in the classroom and academic performance generally. Though formative assessment frameworks have been successfully integrated in the educational systems of most developed countries, research has shown that most developing countries are still using teacher-designed summative classroom assessment approaches with exam oriented curriculum where main focus is on high stake-tests and grading of learners. Despite the summative use, learners' performance and acquisition of problem solving skills continues to cause great concern in Kenya and around the world. There is need to utilize effectively the five FAS in Mathematics instruction in order to optimize learners' learning.

Additionally, the few schools using formative assessment strategies might be using them incorrectly and thus not achieving the objectives or the benefits presented by the use of formative assessments. The above gaps can be filled through a research on utilization of formative assessment strategies in Mathematics instruction and their impact on learner achievement in secondary schools in Kenya.

1.9 Significance of the Study

The findings of this study will be important in assisting secondary school teachers, curriculum developers in Kenya, Education stakeholders and policy makers in understanding the need for effective utilization of formative assessment strategies in improving learners' learning, the need for systemic support in terms of time, resources, curriculum modification, technology integration, professional and administrative support for effective and successful implementation of formative assessment strategies in Mathematics instruction. Also, the need to create awareness and understanding of the relationships between the five formative assessment strategies and learners' achievement in Mathematics instruction and the importance of learning contexts in order to optimize learners' learning. Secondary schools may also use the results and recommendations of this study to develop effective formative assessment professional development guidelines for their respective schools. The findings of the study will also inform stakeholders in the Education sector on the most appropriate classroom assessment tenets which promote efficient learning of the Mathematics towards achievement of sustainable development goals of education.

1.10 Assumption of the Study

The study was based on the following assumptions.

i. Learners from the participating schools had similar learner characteristics.
ii. Form three students have enough experience in school and could make appropriate evaluation about utilization of formative assessment strategies in Mathematics classroom instruction.
iii. Behaviors of both the teacher and students were not affected by the researcher's presence in the school.

iv. Teachers/instructors in the experimental group employed the five FAS as per the expectation of the researcher so as to test the effects of the strategies on learners' achievement. These strategies are; Clarifying and sharing learning intentions and criteria for success, engineering effective classroom discussions, questions, and learning tasks, providing feedback that moves learners forward, activating students as the owners of their own learning and activating students as instructional resources for one another.

v. Normality of data

vi. Structural Equation modeling assumes linear relationship among the indicators of measured variables.

vii. There is a stochastic relationship between exogenous and endogenous latent variables

viii. Study sample was representative of the population under study and adequate for analysis and interpretation.

1.11 Scope of the Study

The study was conducted in selected public secondary schools in Nandi County, Kenya. The respondents of the study were Form three students, their Mathematics teachers and school principals of the selected schools. Among the numerous classroom activities, the research was based on the formative classroom assessment strategies, the change in classroom environment and how it affects teachers' and learners' perceptions hence learners' performance in Mathematics. This is because many researchers have dealt with the different factors leading to poor performance in

Mathematics but there is paucity in literature in Kenya on the effective utilization of formative assessment strategies.

1.12 Limitations of the study

The following were the limitations of the study;

(i) Not much research on formative assessment had been conducted in Kenya hence there was paucity in literature. The closely related data was from other countries/contexts which are not likely to be very relevant to the situation in Kenyan education system.

(ii) The study was limited to the sampled public secondary schools in Nandi County and therefore the study findings may not be generalizeable to other secondary schools in other parts of the country.

(iii) The time allocated for the study was limited since it was an intervention study.

(iv) The training and support given to the experimental group teachers was not sufficient.

1.13: Delimitations of the study

i. The study delimited itself to Public Sub- County schools in Nandi County where majority of the students are low achievers and as …… asserts that formative assessment strategies works well with low achievers.

The study delimited itself to only those schools which were covering the same Mathematics content /topic during the intervention period to avoid any changes with teachers planning of their work.

1.14 Theoretical Framework

This study was based on the Framework of Formative assessment by William and Thomson (2007) supported by socio-constructivist theory of learning by Vygotsky (1978), and Heritage (2010) model of formative Assessment. According to Cambridge Education Brief 2 (2012), assessment for learning (formative assessment) is closely associated with socio- constructivist theories of learning where mental models and assumptions that the learner uses to understand a subject are complex and constructed from previous experiences and interaction with people, hence these need to be understood by teachers and learners and refined and developed in the process of education therefore assessment for learning helps in this process by making learning visible and it helps learners understand more accurately on the nature of the material they are learning (what constitutes 'excellence') and themselves as learners. However, this contrasts with the discredited notion that teachers can simply transmit knowledge and understanding directly to students, hence the quality of interactions and feedback between teachers and learners become critical in learning process on assessment for learning.

Vygotsky (1978) in his theory emphasizes the importance of assessing learners' ZPD to improve learning and Heritage (2007) on the identification of the gap in learning asserts that gap has been conceived of by educational psychologists as Zone of proximal development (Vygotsky, 1978; 1986). The zone of proximal development is the area where Vygotsky hypothesizes learning and development take place. Sadler

(1989) emphasizes the importance of identifying the 'gap' between what a learner knows currently and the desired goal for him or her to reach. William and Thompson (2007) drawing from Sadler's (1989) work noted three key processes in teaching and learning: establishing where the learners are in their learning, establishing where they are going and what needs to be done to get them there which is in line with Furtak, William (2010); Ramaprasad (1983) indicating three keys to the instructional process based on the systems approach to formative assessment. From the three key processes, three agents of classroom instruction were identified (teacher, learner, and the peer) and the five effective formative assessment strategies also identified all these were put together in a matrix table to form a framework of formative assessment by Wiliam and Thompson (2007).

Vygotsky (1978) also in his socio- constructivist theory has emphasized the use of the right scaffolding offered in the ZPD by the more knowledgeable others (MKO) which include the teacher, peer, experts and the technologies used. Wood, Bruner, and Ross (1976) devised the term "Scaffolding" to characterize the support that adults (teachers) give to learners in the zone of proximal development to move them from what they already know to what they can do next. Building on this, some scholars point out that formative assessment should identify what students might achieve in the ZPD (Shavelson, 2006). In other words "formative assessment gathers and use information about students' knowledge and performance to close the gap between students' current learning state and the desired state by pedagogical actions" (Shavelson,2006, p.3). Thus, according to Shepard and team (2005), Scaffolding and formative assessment are complementary concepts.

Margaret Heritage (2007) model focuses the work on the following four elements of formative assessment: Learning progressions, including learning goals and success criteria, identifying the gap, eliciting evidence of learning, teacher assessment, teacher feedback, and student involvement to close the gap. The five effective formative assessment strategies in the framework of Dylan William are incorporated in Heritages' (2007) model of formative assessment. Vygotsky (1978) in his theory emphasized the importance of culture and context in knowledge construction of learners and went further to emphasize on collaborative learning as a way of improving learning which have been presented by Dylan and Thompson (2007) as peer assessment and the collaborations by the three agents of instruction in class: teacher, learner and peer.

Shepard (2000) asserts that a learning climate more reflective of a collaborative partnership among teachers, students and parents opens the door for all to view assessment as a source of insight rather than a form or meting out rewards and punishments. The above discussion has displayed the need in this research to use the theory of socio constructivism of Vygotsky (1978) and Margarete, Heritages' (2007) model to support the framework of William and Thompson (2007) in the study.

1.14.1 Formative assessment framework by William and Thompson (2007)

The study is guided by a framework for assessment for learning by William and Thomson (2007)

Table 3: A framework for formative assessment by William and Thompson (2007)

<table>
<tr><th></th><th>Where the learner is going</th><th>Where the learner is now</th><th>How to get there</th></tr>
<tr><td>Teacher</td><td rowspan="3">Clarifying, sharing and understanding learning intentions and success criteria</td><td>Engineering effective discussions, tasks and activities that elicit evidence of learning</td><td>Providing feedback that moves learning forward</td></tr>
<tr><td>Peer</td><td colspan="2">Activating students as learning resources for one another</td></tr>
<tr><td>Learner</td><td colspan="2">Activating students as owners of their own learning</td></tr>
</table>

Source: William and Thomson (2007)

The framework highlights the five effective formative assessment practices, three agents of instruction in the classroom; Teacher; Learner and Peer. The framework also indicates three questions to be answered by the three agents in a Mathematics instruction namely: Where the learner is going? Where the learner is now? and how to get there? as represented by the following model.

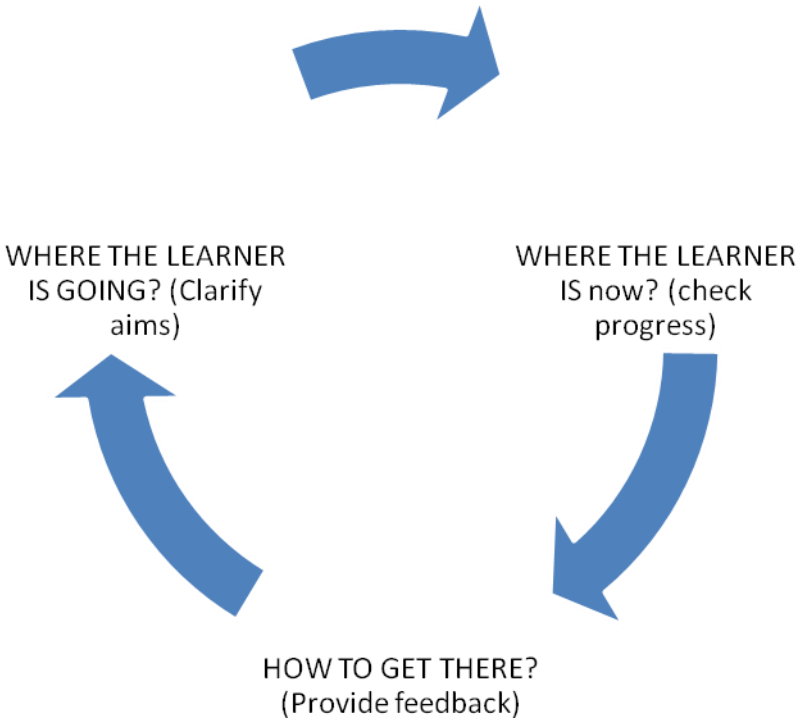

Figure 1: Three questions in assessment for learning framework

William and Thompson (2007) framework of formative assessment emphasizes that formative assessment should: make clear what students had to do in order to succeed, encourage productive classroom discussion, involve teacher feedback that helped the students to move in their learning, provide opportunities for students to be learning resources for each other and devise strategies that encouraged students to take ownership of their own learning (William, and Thompson, 2007). This study was carried out to test whether the formative assessment strategies in the framework of William and Thompson (2007) ~ the independent variables relate to the achievement of learners in Mathematics~ the dependent variable.

1.14.2 Socio-Constructivist Theory of learning (Vygotsky, 1978)

The principles of constructivism are grounded in the established work of Vygotsky (Vygotsky, 1978).Vygotsky valued the role of social process and interactions as

essential components to shape learning. Constructivism is a philosophical theory of how individuals learn and make sense of their world (Yuliani & Saragih, 2015). Vygotsky's (1978) theory emphasizes on culture and context in understanding what occurs in society and constructing knowledge based on this understanding. According to Vygotsky culture gives the child the cognitive tools needed for development and the adults such as parents and teachers are conduits for the tools of the culture including cultural history, social context and language. Today these tools also include electronic forms of information access example is the computer. Vygotsky's theory asserts three major themes regarding social construction; social interaction, the More Knowledgeable Others and the Zone of Proximal Development where more scaffolding is encouraged.

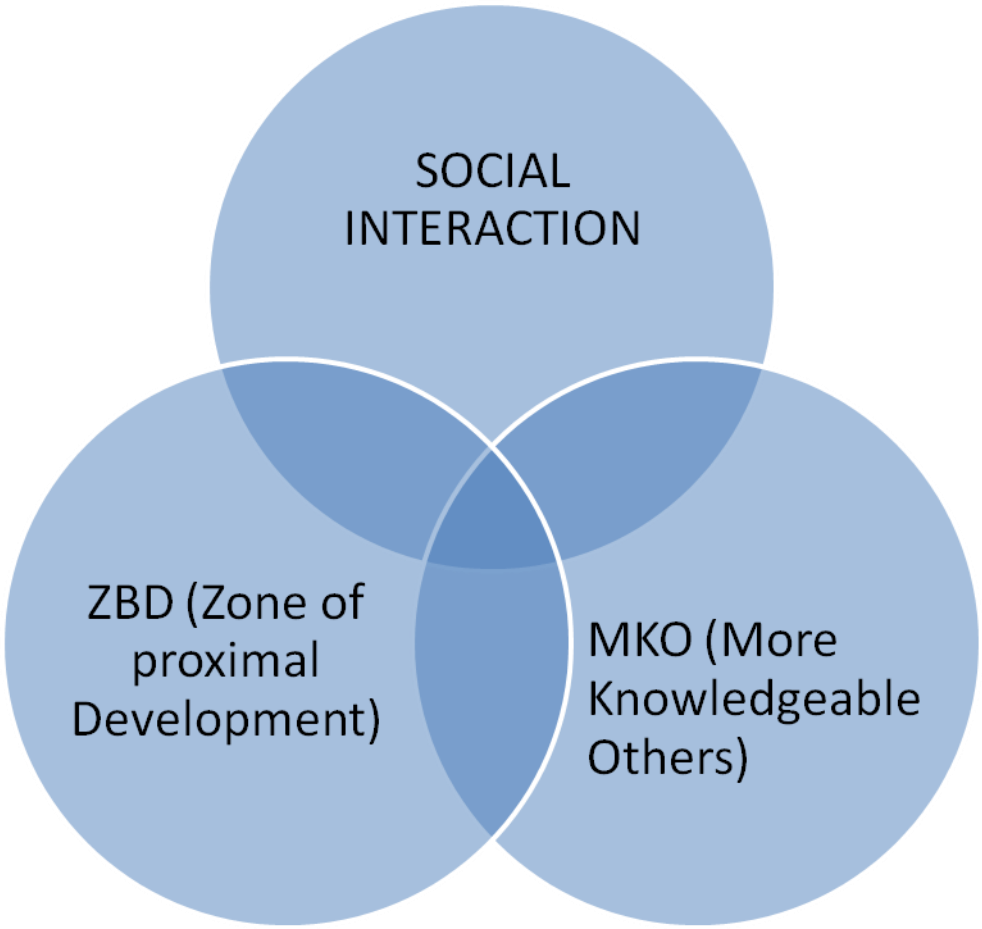

Figure 2: Vygotskys' (1978) three themes of social construction

Social interaction plays an important role in the process of cognitive development. Social development theory argues that social interaction precedes development; consciousness and cognition are the end product of socialization and social behavior. More Knowledgeable Others (MKO) refers to anyone who has better understanding or a higher ability level than the learner with respect to a particular task, process or concept. The MKO is normally thought of as being a teacher, coach or older adult but the MKO could also be peers, younger person or computers.

Zone of Proximal Development (ZBD) is the distance between student's ability to perform a task under adult guidance or with peer collaboration and the student's ability solving the problem independently. According to Vygotsky learning occurred in this zone with the help of the more knowledgeable others.

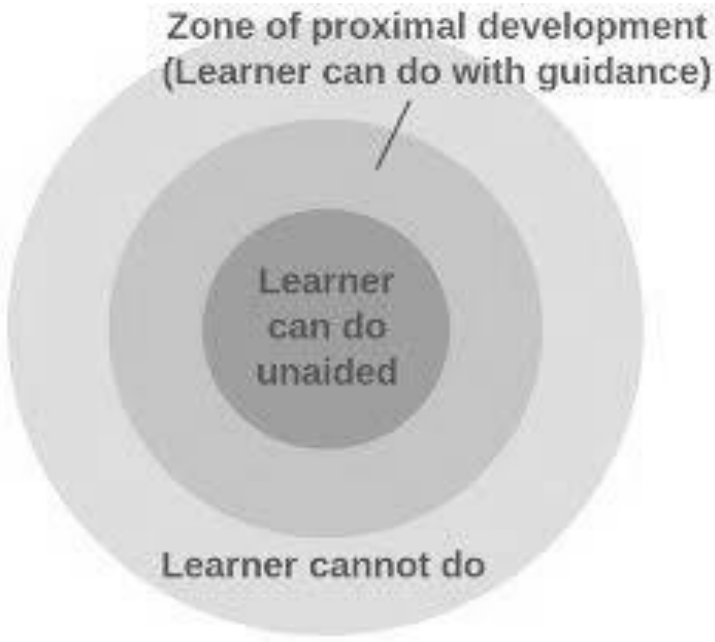

Figure 3: Zone of Proximal Development (ZBD)

Source: Adam (2017)

Learning from a Vygotskian perspective involves the process of internalization, within the zone of proximal development (ZPD). In an educational context, Vygotsky believed in the important role of the learning environment, whereby a student interacts with the teacher and their peers, thus, the experiences and processes become internalised as their own belief and understanding (Tandiseru, 2015).

The main reason to the introduction of the notion of the ZPD by Vygotsky was due to his dissatisfaction with two practical issues in educational psychology (Adam, 2017; Turuk, 2008). The first issue is assessing child on intellectual abilities and the second is the evaluation of the instructional practices. He believes that testing should not be based only on the current level of a child's achievements but it is more important to include the child's potential development as well (Adam, 2017; Verenikina, 2010).

Adam (2017) pointed out the key points in Vygotsky's theory; Social interactions are critical; knowledge is co-constructed between two or more people, Self-regulation is developed through internalization (developing an internal representation) of actions and mental operations that occur in social interactions, Human development occurs through the cultural transmission of tools (language, symbols), Language is the most critical tool: Language develops from social speech, to private speech, to covert (inner) speech and the zone of proximal development (ZPD) is the difference between what children can do on their own and what they can do with assistance from others: Interactions with adults and peers in the ZPD promote cognitive development.

1.14.3 Heritage (2010) Formative assessment model

It is also based on unified theoretical platform for formative assessment advanced by Margaret Heritage (2007) of the National Center for Research on Evaluation,

Standards, and Student Testing (CRESST). This theory folds the attributes of formative assessment into a model process. The process focuses the work on the following four elements of formative assessment: learning progressions (learning goals and success criteria, identifying the gap, eliciting evidence of learning) teacher assessment, teacher feedback and student involvement. Figure 1.1 shows the model as proposed by Heritage (2007).

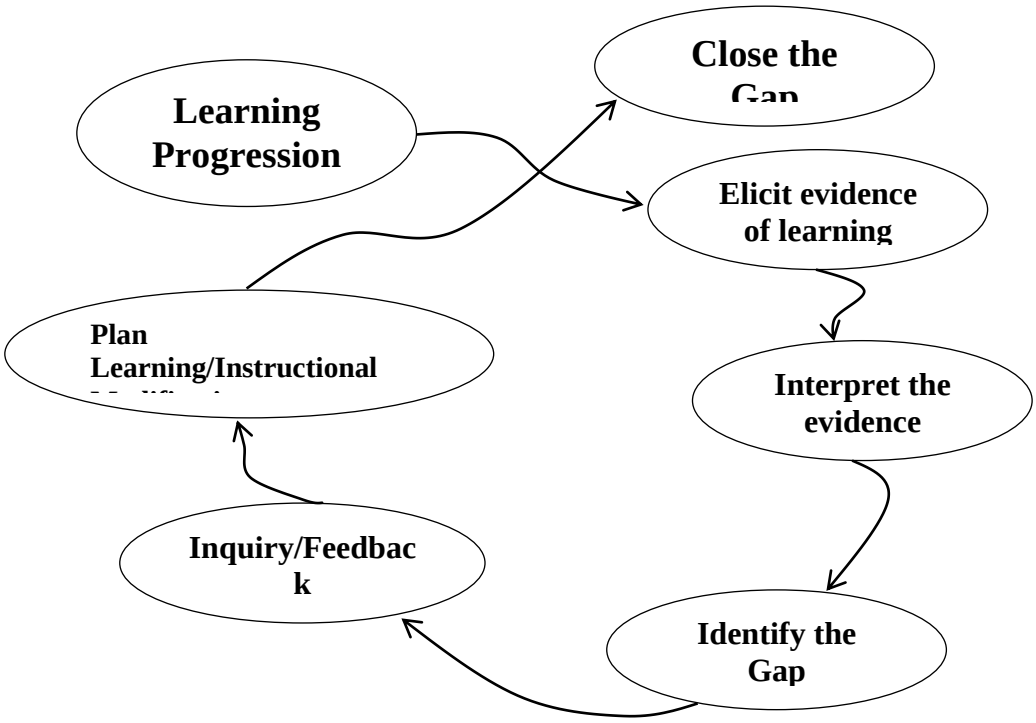

Figure 4: Heritage (2007) Formative Assessment Model

Teachers need to understand the pathways along which students are expected to progress. Learning progression define the pathway along which students are expected to progress in a domain. According to Heritage (2008), the key purpose of formative assessment is to provide feedback to teachers and students during the course of learning about the gap between students' current and desired performance so that

action can be taken to close the gap. To do this effectively, teachers need to have in mind a continuum (progression) of how learning develops in any particular knowledge domain so that they are able to locate students' current learning status and decide on pedagogical action to move students' learning forward. Learning progressions that clearly articulate a progression of learning in a domain can provide the big picture of what is to be learned, support instructional planning and act as a touchstone for formative assessment (Heritage *et al.,* 2009).

The rate of individual student's progress may vary along the learning progressions, but progressions should ultimately connect the knowledge, concepts, and skills students develop as they evolve from novice to more expert performances (Heritage, 2008). In this way, teachers and students should be able to see and understand the scaffolding they will be climbing as they approach learning goals (Stiggins, 2005). In addition, if learning is derailed at any point, a teacher can identify this and adjust accordingly.

Teachers need to plan questions in advance of the lesson to elicit student thinking during the course of instruction, or they need to structure student discussions so that they will gain insights to student thinking through the course of the classroom discussion. This will elicit evidence of students' learning in Mathematics classroom. The elaborate component of feedback should be detailed and specific to how the learner can improve or advance the learning but not too complex (Shute, 2008). In addition, feedback should be goal-directed, providing learners with information about their advancement toward specific goals in Mathematics instruction.

Students need to monitor and evaluate their own learning process to determine what they know and understand, and to develop a variety of learning strategies so that they

can adapt their learning to the task at hand. Sharing the criteria for success with the students at the outset of the instructional segment not only provides transparency on the learning process, it also meant that the students can monitor their learning while engaged in the learning task through both self and peer assessment processes. Ultimately, the teachers and the students will likely want to evaluate how well they have met the longer-term goal of "using conditionals in past and future to speculate about possible causes (past) and review a range of options (future)," which could involve evaluating with a rubric a piece of writing intended to display this competence.

The theory looks at learning progression, identifying the gap, eliciting evidence of learning, teacher assessments, teacher's feedback and student involvement to determine where the students are going, where they are now and how to close the gap. Specifically the current study investigated the effective utilization of the five formative assessment strategies applied through lesson observations, focus group discussions, teachers' interviews, teachers' and learners' questionnaires. These strategies are; Clarifying and sharing learning intentions and criteria for success; Engineering effective classroom discussions, questions, and learning tasks; Feedback that moves learners forward; Self-assessment (activating students as the owners of their own learning) and Peer assessment (activating students as instructional resources for one another).

From the relationships between theoretical framework of formative assessment of Wiliam and Thompson (2007), Socio constructivist theory of Vygotsky (1978) and Heritage (2010) model of formative assessment discussed above, it is clear that the trio support each other and hence there was need for the researcher to come up with

an overall theoretical framework which indicated the components from each one that informed the study as depicted in figure 5 in the next section.

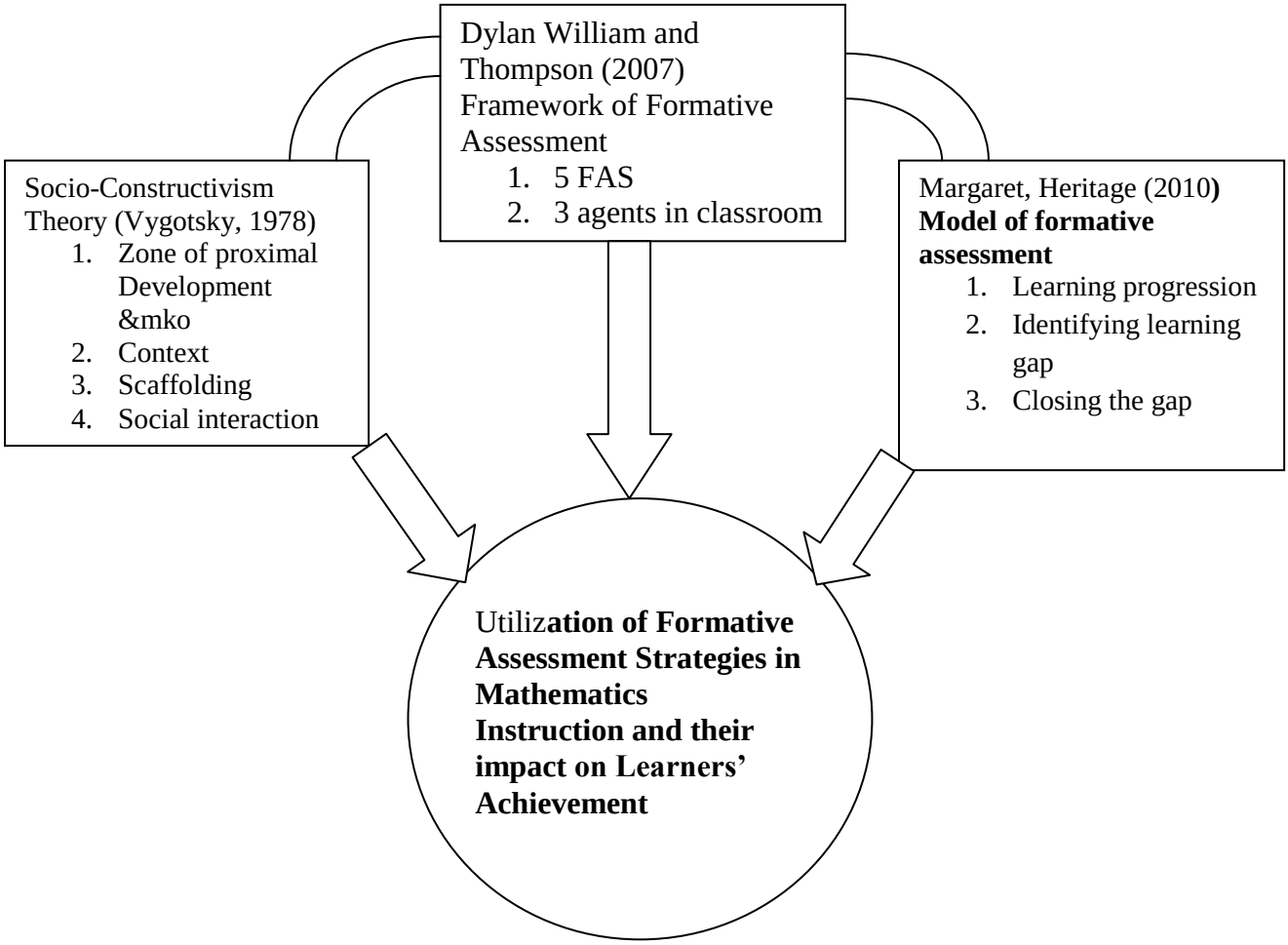

Figure 5: An overall theoretical framework of the study. Source: by the researcher

The above framework shows the components from the supporting theory and model that the researcher picked in order to support the framework of formative assessment of Dylan William and Thompson (2007). From the theory of Vygotsky (1978) the following were picked: Zone of Proximal Development (ZPD), context, scaffolding, social interaction and collaborative learning. From Margaret, Heritages' model, the researcher picked the following: Learning progression, Identifying the gap, Teacher feedback and closing of the gap.

Formative assessment strategies framework can be effectively implemented if the teacher understand the environment/the context of the learner. In Nandi County, learners are in different contexts (socio cultural, school) despite being in the same stratum for example Sub- County schools who were the sample for the study hence Socio-Cultural theory says that acquisition of knowledge is influenced by environment (in this study the context). The relationship between FAS and achievement is also influenced by context or environment as explained by Vigotsky (2008), and the level of use is directly proportional to the context support. If the context support's implementation, then the level of use is increased and vice versa.

1.15 Conceptual Framework

The different formative assessment strategies used by teachers in teaching Mathematics (independent variables) may influence learners achievement in Mathematics instruction in general (dependent variables) in terms of performance, mastery of content, Critical thinking and creativity, problem solving skills and self-questioning, communication and collaboration, manipulative skills and learners' interest which are all the skills for 21st Century. The intervening variables in this study were societal expectation, school policies and classroom environment. The conceptual framework is shown in Figure 2.

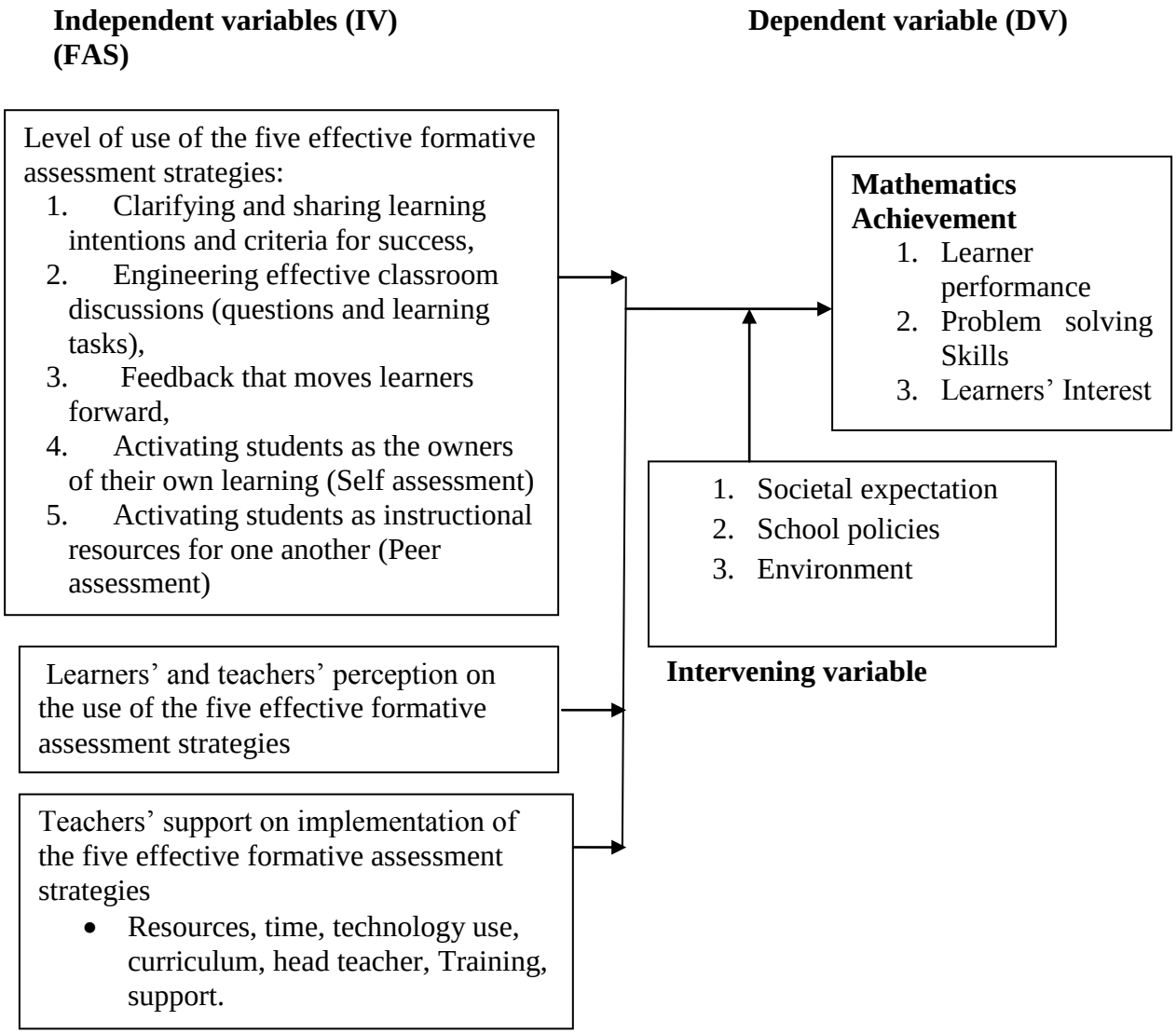

Figure 6: Conceptual Framework

1.16 Definitions of Key Terms

Assessment Environment: Classroom context experienced by students as the teacher determines assessment purposes, develops assessment tasks, defines assessment criteria and standards, provides feedback, and monitors outcomes

Assessment task: Activities which learners undertake to confirm whether or not the outcome has been achieved during and at the end of learning process.

Assessment: Is the process of gathering evidence of what a student knows, understands, and is able to do. It can also help to identify students' learning needs. Teachers set specific criteria based on learning outcomes and expected levels of performance to evaluate students' learning.

Classroom Instruction: Refers to "the purposeful direction of the learning process" and is one of the major teacher class activities (along with planning and management).

Effectiveness: Degree to which the use of formative assessment strategies are successful in producing a desired result, success i.e achievement of desired set goals by students in Mathematics after use of formative instructional approaches by teachers.

Evaluation: Judging the quality or goodness of a performance. In this study it refers to assessment of performance of students in Mathematics as a result of instructional methods used by Mathematics teachers in secondary schools.

Formative assessment strategies: These are the strategies used always during Mathematics lesson where evidence of learning is elicited, interpreted and used to change instruction and improve learning. In this study five effective formative assessment strategies which have been identified in research are the focus of this study. These are; clarifying and sharing learning intentions and criteria for success; Engineering effective classroom discussions (questions and learning tasks); Feedback that moves learners forward; Activating students as the owners of their own learning (Self assessment) and Activating students as instructional resources for one another (Peer assessment).

Formative Assessment: is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended outcomes.

Impact: Refers to a marked effect or influence. In the study the influence of the formative assessment strategies subjected to learners is assessed.

Implementation: Refers to the process of putting a decision or plan into effect or execution or carrying on with the formative assessment practices.

Knowledge and Skills: Refers to the competencies needed in choosing appropriate assessment strategies in relation to the learner's needs and the course objectives.

Learner achievement: Refers to a result from learning activity of a learner or a change in an individual learner as a result of a learning activity. In this study it is indicated in performance scores and problem solving skills acquired when FAS is used.

Learning intentions: Refers to the objectives of a Mathematics lesson.

Mathematics instruction: Refers to the teaching and learning of Mathematics.

Perceptions: Refers to the way teachers and learners belief or feel about the use of formative assessment strategies.

Scaffolding: Refers to the support structures given to the learner at the zone of proximal development. It involves the clues given to the learner by the teacher on how to solve a problem.

Strategy: A plan of action designed by Mathematics teachers to improve students' performance in Mathematics.

Support: Giving necessary assistance in order to ensure implementation of FAS, which can either be material, financial, technological, time and incentives to the teachers.

Utilization: Refers to the action of making practical and effective use of something. In the study it is the practical use of the formative assessment strategies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter deals with the review of related literature and the gaps there in. The related literature is discussed under these sub-headings; an empirical overview of classroom assessment, forms of formative classroom assessment tasks, teacher's skills in choosing appropriate formative assessment strategies, aligning formative assessment to learning goals, effectiveness of formative assessment in aiding student's mastery of content and the effectiveness of formative assessment in meeting student's needs. Finally, a summary of the reviewed literature is presented and the emerging gaps discussed.

2.2 Empirical Review

Classroom assessment is an indispensable component of the teaching and learning process. It has been defined variously in the literature by various different researchers. Davidson *et al.* (2005) define classroom assessment of students as a systematic process of collecting information about student progress towards the learning goals. Similarly, Dhindsa *et al.* (2007) characterize assessment as a key component of teaching and learning, "a systematic process of data gathering" about students' progress. They maintain that students' performance can be measured in various ways, including "traditional paper and pencil tests, extended responses (essays), performance of authentic task, teacher observation and student self-report".

According to Stiggins *et al.* (2014), classroom assessment refers to formative and continual evaluation of the students conducted with the main intention of enhancing both teaching and learning. In these three definitions, the authors distinguish between

two other terms aligned with assessment: 1) test "an instrument for measuring a sample of behavior" and 2) measurement, "the process of obtaining a numerical description of the degree to which an individual possesses a particular characteristic".

Recent years have seen increased research on classroom assessment as an essential aspect of effective teaching and learning. Indeed, it is becoming more and more evident that classroom assessment is an integral component of the teaching and learning process (Earl, 2012; Vonderwell & Boboc, 2013). The SMASSE Project (2008) regarded classroom assessment as a tool for learning Mathematics. It contended that effective Mathematics teaching requires understanding what students know and what they need to learn. This is mainly because a teacher needs to know what his/her students are able to do or not if he/she is to plan effectively. According to Bordoh, Bassaw & Eshun (2013) assessment informs the teacher about what students think and about how they think.

Most research studies in both education and cognitive psychology have reported weaknesses in the way Mathematics is taught in the secondary schools level. The most serious weakness is the psychological assumption about how Mathematics is learned which is based on the "stimulus-response" theory (Proctor & Vu, 2006). The "stimulus-response" theory states that learning occurs when a "bond" is established between some stimulus and a person's response to it (Cathcart, Pothier, Vance & Bezuk, 2001). Cathcart *et al.* (2001) went further to say that, in the above scenario, drill/assessments becomes a major component in the instructional process because the more often a correct response is made to stimulus, the more established the bond becomes. Under this theory children are given lengthy and often complex problems, particularly computations with the belief that the exercises will strengthen the mind.

On the other hand, the constructivist view is different and calls for different teaching approaches. According to Mintzes, Wandersee & Novak (2005), the constructivist view takes the position that students construct their own understanding of mathematical ideas by means of mental activities or through interaction with the physical world.

The main hypothesis of constructivism is that knowledge is not passively received from an outside source but is actively constructed by the individual learner. Within this hypothesis lies the crucial role of the teacher. The assertion that children should construct their own mathematical knowledge is not to suggest that Mathematics teachers should sit back and wait for this to happen. Rather, teachers must create the learning environment for students and then actively monitor the students through various classroom assessment methods as they engage in an investigation. The other role of the teacher should be to provide the students with experiences that will enable them to establish links and relationships. Teaching Mathematics is providing experiences that will enable children to discover relationships and construct meaning. Students should be assisted to see the importance of Mathematics not by rote learning but by investigating and relating to real-life situations. Giving students dozens and dozens of problems to solve does not help them to understand Mathematics, if anything it frustrates them even more. The more they do things they cannot understand or explain, the more they get frustrated.

2.3 Formative Assessment

According to Cambridge international (2015), Building on the formative assessment work by Michael Scriven and others, work about assessment for learning (formative

assessment) in the UK was undertaken by Paul Black and Dylan Wiliam (1998) their work (inside the Black box) was based on a literature review of research work on classroom assessment practices. Black and William concluded that: Teachers' tests generally encouraged superficial learning, concentrating on recall of isolated details, usually items of knowledge which learners soon forget, teachers did not generally review the assessment questions that they use and did not discuss them critically with peers so there was little reflection on what was being assessed, the grading function was over-emphasized and learning function was under- emphasized and also there was a tendency to use an approach that emphasize d competition between learners rather than personal improvement. Black and Wiliam (1998) proposed a regime of classroom assessment which: made clear what students had to do in order to succeed, encourage productive classroom discussion, involved teacher feedback that helped the students to move on in their learning, provide opportunities for students to be learning resources for each other and devised strategies that encouraged students to take ownership of their own learning.

According to Clark (2012), formative assessment provides feedback and information during the instructional process, while learning is taking place, and while learning is occurring. Formative assessment measures student progress but it can also assess your own progress as an instructor. The primary focus of formative assessment is to identify areas that may need improvement. These assessments typically are not graded and act as a gauge to students' learning progress and to determine teaching effectiveness (implementing appropriate methods and activities). There are various forms of formative thinking including:

Observations during in-class activities, homework exercises as review for exams and class discussions, reflections journals that are reviewed periodically during the semester/term, question and answer sessions, conferences between the instructor and student at various points in the semester, in-class activities where students informally present their results, student feedback collected by periodically answering specific question about the instruction and their self-evaluation of performance and progress among other formative assessment tasks.

Developed by leading formative assessment expert Dylan Wiliam and his colleagues at ETS, Keeping Learning on Track (Educational Testing Service [ETS], 2009, 2010) is a sustained multi-year professional development program designed to support teachers' adoption of five key formative assessment strategies. These strategies include: 1) teachers elicit evidence of student learning minute-to-minute and day-by-day, 2) teachers identify and share learning expectations with their students, 3) teachers structure opportunities for students to take ownership of their own learning, 4) teachers structure opportunities to activate students as instructional resources for one another, 5) teachers provide feedback to move learning forward and create a structure for students to act on it. Through a series of workshops and job-embedded engagement in school-based TLCs, KLT exposes teachers to a wide range of classroom techniques. At the core of the KLT professional development program is a definition of formative assessments as:

> Any curriculum-embedded assessment used by teachers to provide specific feedback to students about their progress and needs. More specifically, it is argued that classroom practice is formative "to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited" (Black & Wiliam, 1998, p. 7).

KLT's theory of action predicts that teachers who receive sustained professional development make changes in their classroom practices (Butler, Novak, Jarvis-Selinger, & Beckingham, 2004). Specifically, successful professional development effects may be recognized by the increased use of five classroom strategies: teachers who elicit evidence of student learning on a always basis can adapt their instruction (Jones & Krouse, 1988; Peterson, Carpenter, & Fennema, 1989; Fuchs, Fuchs, Hamlett, & Stecker, 1991), identify and share learning expectations, structure opportunities for students to take ownership of their own learning, activate students as instructional resources for one another, and provide feedback to move learning forward. These teaching practices should then influence student engagement (Jones & Krouse, 1988) and foster students' self-regulation of their own learning (Fernandes & Fontana, 1996). Finally, as student engagement increases, student learning improves (Finn & Rock, 1997; Skinner, Wellborn, & Connell, 1990).

According to Ayers (2014), Formative assessment is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of the intended instructional outcomes. In addition, formative assessment is much more than repeated assessment measures over time.

According to Mwei and Too (2017) in Core principles in Curriculum, Formative assessment is carried out by the teacher (and the school) or a group of schools in order to make informed judgments of students' progress as they transit the secondary school level (tier). Continuous assessment tests (commonly known as CATS) assignments / homework end of term, end of year, mocks and pre- mocks) or regional (or County) examination are used to obtain data for formative evaluation. Mathematics teachers in

schools (or in participating group of schools) are mandated to set (test design and construction) administer, score and interpret these results. On their explanation about what formative is, it can be concluded that formative assessment is taken to be a test. In addition, the looked at challenges affecting implementation of Mathematics Curriculum in Kenya and some of the challenges are; high stake in examinations forcing teacher and learners to focus on passing examinations which has led to rote learning at the expense of understanding also there is increased teacher workload affecting the use of constructivist student- centered approaches.

2.3.1 Effectiveness of Formative Assessment and Student's Mastery of Content

Formative assessment has been highly touted for its purported positive impact on student learning (Black & Wiliam, 2009; Organization for Economic Co-operation and Development, 2005). Black and Wiliam (2009), reviewing some 681 publications on studies related to formative assessment, concluded that "attention to formative assessment can lead to significant learning gains" (p. 9) and asserted that there is no evidence to suggest that it may have negative effects. However, caution should be exercised in making an uncritical endorsement of formative assessment (Bennett, 2011; Kingston & Nash, 2012). One issue is that the term "formative assessment" itself has been interpreted to mean different things (Bennett, 2011). For example, it may be used to describe commercial assessments that are not truly capable of serving a formative purpose because they are not tied closely enough to the teaching and learning context (Perie, Marion, Gong, & Wurtzel, 2007; Clark, 2012). Another issue is that the body of research on which claims of the positive impact of formative assessment are based is relatively small, and many of the relevant studies do not have

the methodological rigor to support conclusions about the effectiveness of formative assessment.

Most claims about the benefits of formative assessment begin with the Black and Wiliam (2009) review of research on formative assessment. Their review is often referred to as a "meta-analysis," but, as the authors themselves observe, a true meta-analysis was not feasible for them because the studies they used represented such a wide range of practices and research methods. What the studies they reviewed had in common was teachers' use of some of the features of formative assessment (e.g., feedback, teacher questioning, student self-assessment); these features were associated with moderate-to-large effect sizes. Bennett (2011) suggests that the characterization of Black and Wiliam's (2009) review as a meta-analysis is education's equivalent of an urban legend. A recent meta-analysis of studies on the impact of formative assessment on K–12 student achievement concludes that, if only the studies hewing to rigorous methods are examined, the effect sizes of formative assessment are quite modest (a mean of .20); however, the effects are usually positive (of the 42 effect sizes reported, only 7 were negative), and some positive effects are greater than others (Kingston & Nash, 2012a).

This meta-analysis has been criticized for the methods it employed, leading to a debate as to whether the findings were limited by the methodology (Briggs *et al.*, 2012; Kingston & Nash, 2012). In other summaries, implementation of particular formative assessment strategies that teachers had learned in professional development sessions resulted in an average effect size of .30 (Wiliam, Lee, Harrison, & Black, 2010), and use of a computer-based formative assessment system of writing resulted in an effect size of .28 (Rich, Harrington, Kim, & West, 2008).

There is some suggestion in the research literature as to why the effects of formative assessment are not as large as one might expect: Teachers are unsure what to do in response to what they learn about their students from formative assessment. The evidence gathered through formative assessment should be used to determine whether instruction needs to be modified and, if so, how. However, this part of the formative assessment cycle often falters: Teachers may succeed in gathering evidence about student learning and may accurately interpret the evidence to identify what knowledge a student lacks, yet may not be able to identify, target, and carry out specific instructional steps to close the learning gaps (Heritage *et al.,* 2009).

2.3.2 Effectiveness of Formative Assessment and Student's Needs

The students' role in formative assessment begins when they have a clear conception of the learning target (their personalized needs). Just as the teacher is collecting evidence in relation to the goal, so too are the students through self-assessment, a separate, but complementary feedback process (Heritage, 2007). In self-assessment students engage in metacognitive activity, a hallmark of effective personalized learning. Metacognitive activity involves students in thinking about their own learning goals while they are learning. In this process, they are generating internal feedback that tells them when they need to make adjustments to their learning strategies (Bennett, 2011).

These adjustments might include, for example, drawing a diagram to help in the understanding of a mathematical problem, or determining that more research is needed to be able to analyze historical events, or rereading a text to clarify the meaning. The students' role ideally also includes peer-assessment. In peer-

assessment, students give feedback to their classmates that are intended to be constructive and help them make progress toward the lesson goal (Rushton, 2005). Peers assess each other's learning against the same indicators that they use to check on their own learning when they are engaged in self-assessment. Peer feedback has a number of advantages both for those students providing the feedback and for those receiving it. It involves thinking about learning and can deepen students' understanding of their own learning because they have to internalize the learning goal and progress indicators in the context of someone else's work (Torrance & Pryor, 2001).

The final point about the students' role in formative assessment is that they actually use the feedback. It is important that students have to both reflect on their learning and use the feedback to advance learning. Overall, the feedback loop is fueled by three convergent sources of feedback: from teachers, peers, and the students themselves. However, the successful provision and use of this feedback is dependent on the nature of the classroom climate in which the learning is taking place (Stiggins, 2005).

2.3.3 Formative Assessment Strategies for Effective Mathematics Instruction

Formative Assessment for Students and Teachers-State Collaborative on Assessment and Student Standards (FAST SCASS) identified the following five attributes as critical features of formative assessment (McManus, 2008, pg14); Learning Progressions which articulate the sub-goals of the ultimate learning goal, learning Goals and Criteria for Success which should be clearly identified and communicated to students, descriptive Feedback which is linked to the intended instructional

outcomes and criteria for success, Self- and Peer-Assessment which are important for providing students an opportunity to think metacognitively about their learning and Collaboration where teachers and students are partners in learning.

Leahy, Lyon, Thompson, & Wiliam, (2005); Thompson & Wiliam (2008), Bennet, (2011) have identified the same five key formative assessment strategies as follows: Clarifying and sharing learning intentions and criteria for success; Engineering effective classroom discussions, questions, and learning tasks; Providing feedback that moves learners forward, Activating students as the owners of their own learning and Activating students as instructional resources for one another.

These five strategies overlap substantially with the attributes of formative assessment from FAST SCASS, with the primary difference being the inclusion of activities designed to monitor student learning and the exclusion of the attributes of learning progressions and collaboration, elements logically encompassed by the other strategies (Oswalt, 2013). Stiggins, Arter, Chappuis, and Chappuis (2004) and Chappuis (2017) proposed the seven strategies of assessment for learning in table 4.

Table 4: Seven Strategies of Assessment for Learning

Where Am I Going?
Strategy 1: Provide students with a clear and understandable vision of the learning target. Strategy 2: Use examples and models of strong and weak work.
Where Am I Now?
Strategy 3: Offer regular descriptive feedback. Strategy 4: Teach students to self-assess and set goals.
How Can I Close the Gap?
Strategy 5: Design lessons to focus on one learning target or aspect of quality at a time. Strategy 6: Teach students focused revision. Strategy 7: Engage students in self-reflection, and let them keep track of and share their learning

This study examined the utilization of formative assessment strategies in Mathematics instruction and their impact on learners' achievement in secondary schools in Nandi County, Kenya. The five key formative assessment strategies which have been identified by several researchers in the foregoing as effective are a focus of the study. These strategies are; Clarifying and sharing learning intentions and criteria for success, Engineering effective classroom discussions, questions, and learning tasks, Providing feedback that moves learners forward, activating students as the owners of their own learning (Self-assessment) and activating students as instructional resources for one another (Peer assessment) .

2.3.3.1 Clarifying and sharing learning intentions and criteria for success

This is the first strategy of formative assessment and it means that students and teachers both clearly understand how success is defined. This scale of clear, shared understanding of learning targets serves as a foundation for all other scales of formative assessment because if teachers and students do not have this, then there is no basis for evaluating student progress towards them (Oswalt, 2013). The difference between desired results and current status has been described as the learning gap

between what students know and what they need to know (Sadler, 1989). Sadler explained that a learner must: (a) Possess a concept of the standard (or goal, or reference level) being aimed for, (b) Compare the actual (or current) level of performance with the standard, and (c) Engage in appropriate action which leads to some closure of the gap (p. 121).

The clear understanding of learning targets is crucial because it has been suggested that low achievement often comes simply because students do not know what is required of them (Black & Wiliam, 1998). The setting of clear learning targets (be they behavioral objectives or cognitive goals) is a well-established instructional foundation (Wiggins & McTighe, 2005). It is important to note that clarifying and sharing learning intentions does not simply involve posting objectives on a board, but it includes various ways that teachers can make transparent to students the criteria for their success (Leahy et al., 2005). It means coming to deeply understand characteristics of quality work, taking the time to help students see what quality work and performance look like so that the learning targets/standards are not a mystery to them (Pinchok et al., 2009). The following activities was the focus of this study; clarifying of objectives at the start of each topic, sharing of learning goals at the start of each lesson, explaining procedure of success in each topic and giving students time to think through the procedures of success and apply in own work.

2.3.3.2 Engineering Effective Classroom Discussions, Questions, and Learning Tasks

This is the second operational scale of formative assessment. This strategy of engineering effective classroom discussions, questions, and learning tasks focuses on the teacher's ability to diagnose the state of student learning on an ongoing basis.

This scale is interwoven throughout the formative assessment process, but must be separated for study. Bennett (2011) made the point that there are two key mechanisms involved in formative assessment: making inferences about student learning and using those inferences to adapt instruction. He observed "that distinction, between making evidence-based inferences and subsequently adapting instruction is crucial…because a failure in either step can reduce the effectiveness of formative assessment" (Bennett, 2011, p. 14). Thus, it is important that this strategy be separated for examination as one of the operational scales (Oswalt, 2013).

The breadth of techniques that can be used to monitor student learning through engineering effective classroom discussions, questions, and learning tasks is admittedly immense. One technique, however, is worthy of particular attention because of the manner in which it often permeates classroom instruction - questioning. Unfortunately, questioning in the classroom is too often done shallowly, narrowly, or ineffectively (Leahy et al., 2005; Pinchok et al., 2009). When used formatively, however, questioning can be for such purposes as eliciting information, probing thoughts and ideas, tapping into different types of knowledge, and instigating deeper levels of understanding (Ruiz- Primo, 2011). To help teachers improve their questioning skills, Walsh and Sattes (2005) proposed the simple acronym QUILT (Questioning and Understanding to Improve Learning and Thinking) as a starting point (as cited in Fisher & Frey, 2007, p. 37-41).

Step 1 is to prepare the question, particularly in terms of the purpose and type of question to ask. Step 2 is to present the question, making clear how the question is to be answered and who is to answer it. Step 3 is to prompt student responses, providing adequate "wait- time" (3-5 seconds) after asking the question, scaffolding the question

for students who struggle, and pausing after the answer so that students can think about it. Step 4 is to process student responses, providing appropriate feedback while continuing to utilize follow-up probes for elaboration on incorrect answers and expansion on correct answers. Step 5 is to reflect on the questioning process, identifying ways to improve future questioning and encourage the participation of students.

While other areas of effective questioning skills could be considered, such as providing non-verbal support and developing authentic questions (Fisher & Frey, 2007), implementing the skill sets of QUILT would be of great use to teachers in diagnosing the state of their students' Learning (Oswalt, 2013). In this study the researcher included the routine strategies like quizzes, cats, assignment, homeworks, observations and the following activities was the focus of the study; asking students at random questions of a particular topic during the lesson, listening of student responses attentively for what they understand about a particular topic and not for correctness and use of questions that reveal student thinking (filling of gaps questions).

2.3.3.3 Providing Feedback That Moves Learners Forward

The strategy of providing feedback that moves learner's forward focuses on the teacher's response to the monitoring of student learning. Feedback has been defined as "information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, metacognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies" (P. H. Winne & Butler, 1994, p. 5740). Giving students feedback on their written responses to a challenging task may create an additional impetus for

encouraging them to persist with the task. It provides them with an opportunity to use their current knowledge, to engage in productive struggle, and to put in effort knowing that they will receive specific feedback to guide their future learning. To be useful to students, feedback from the teacher needs to: provide meaningful assessment tasks linked to key learning objectives, detect current performance level, communicate the gap between current performance and reference levels and provide follow-up activities that help students monitor their progress in closing the gap (Brookhart, 2007).

Researchers have found that feedback is a key component in improving student achievement (Hattie, 2009); however, there are factors that affect its efficacy. Hattie and Timperley (2007), in examining multiple meta-analyses, including 196 studies and almost 7,000 effect sizes related to providing student feedback, concluded that the efficacy of feedback depended on factors such as the type provided (e.g., positive or negative) and the context in which it was provided (e.g., timing of feedback). Specifically, feedback is found to be most effective when it is specific, descriptive, immediate, and focused on student work rather than personal student characteristics (Chappuis & Stiggins, 2002).

Hattie and Timberley (2007) developed a model for effective feedback that incorporates three elements: learning goals, progress toward those goals, and steps needed to make better progress toward those goals. Interestingly, as seen in that model, the use of feedback is tied strongly to the first formative assessment strategy of delineating clear, mutually understood learning targets. Likewise, in outlining ten principles of learning, McTighe and Seif (2010) included models of excellence (per Strategy 1) and ongoing feedback (per Strategy 3) to enhance student learning, saying

that “learners need to see models of excellent work and be provided with regular, timely, and user-friendly feedback in order to practice, retry, rethink, and revise their work” (p. 153) in Oswalt 2013.

A recent study on examination of 15 classroom-based studies (N =827) regarding the effectiveness of oral corrective feedback (CF) in second language acquisition (SLA) classrooms found that CF had significant and durable effects on target language development (Lyster & Saito, 2010). Types of CF included clarification requests, recasts, repetition, elicitation, metalinguistic clues, and explicit correction. In analyzing the results of that study, Lyster and Saito (2010) found that oral corrective feedback made a significant impact on second language learners (d = 0.74) for posttests in comparison with control group students. Students who received CF displayed large effect sizes (d = 0.91) in comparison with their pretest performance. Students not receiving CF also exhibited improvement (d = 0.39), which may be attributed to test-retest effects or to the fact that these students, by virtue of being in classroom settings, also received instruction, albeit without intentionally designed CF treatments.

While this study only considered the use of CF in second language classrooms, it does support the idea that oral feedback can result in enhanced student learning (Oswalt, 2013). However, the researcher focused on the following activities by teachers; students are encouraged to discover their own errors in Mathematics without giving them scores, Mathematics teacher gives few areas that need to be fixed at ago and give specific advice and more work given to the learner by use of 3 questions technique to address what is next.

2.3.3.4 Self-Assessment

Self-assessment is a valuable tool for learning and measurement. For example, when students are engaged in assessing their own work, they try to learn the criteria for high-quality performance, and they experience a willingness to apply those criteria (Boston, 2002). However, Black and Wiliam (2009) remain concerned about student readiness to self-assess or evaluate peers. They propose that once students acquire a clear picture of the outcome or purpose, "they become more committed and more effective as learners: their own assessment becomes an object discussion with their teachers and with one another".

However, agreements exist among educators, in which they recognize the value of self and peer-assessment which helps students exert control over their learning (Stiggins & Chappuis 2005). Initially, some teachers provide rubrics for student so that they can assess their progress. The rubrics incorporate the criteria that provide the opportunity for students to reflect on the extent to which they have made progress. Coffey *et al.* (2001) illustrate a feature of alternative assessment that asks learners to ask three questions as they assess themselves: "where am I trying to go? Where am I now; and how do I close the gap" (Stiggins *et al.*, 2014). In this study the researcher focused on the following activities; students are encouraged to do self-assessment during the lesson, students are asked to mark their own assignments and engaging students in self-reflection and letting them to keep track of their learning

2.3.3.5 Peer Assessment

Similar to self-assessment, educators consider peer-assessment advantageous, as it furthers opportunities for students to identify targeted learning goals (Nicol & Macfarlane-Dick, 2006). In peer-assessment, students often assess other students'

work compared to the criteria developed by the instructor, or both students and the class instructor. An important aspect of peer assessment is that it engages students in dialogue with their classmates, commenting on each other's work rather than a one-way feedback system from instructor to student.

To enrich peer-assessment and use it productively, Black and Wiliam (2009) propose that students be trained to assess their peers purposefully, with the goal of improving learning. As students comment on their peers' work, they use informal language which is understandable to them. In addition, according to Topping *et al.* (2000), given the concept of peer-assessment, students compare other students' work to the accepted criteria, which "enables them to discern outstanding elements of both their own and their classmate's performances and products".

In this study the researcher focused on the following activities; encouraging learners to seek assistance from their peers before going to the teachers (C_3B_4ME), students are encouraged to assist one another and assess each others' work during the lesson and engaging students in dialogue with their peers commenting on each other's' work. The five key formative assessment strategies identified by several researchers as mentioned earlier as effective in the teaching and learning of mathematics were referred in the whole thesis as effective formative assessment strategies. These strategies were the focus of the study and were centered in the objectives of the study which are discussed in the next sections of literature.

2.4. The level of use of the five effective formative assessment strategies in Mathematics instruction.

A non-experimental, quantitative survey approach was used to test whether the levels of use of formative assessment strategies vary by content area taught (English vs.

Mathematics), teacher's perceptions of their knowledge of these practices, and other teacher demographics (for example gender, years of experience, degrees or qualifications). Survey items on formative assessment strategies included specific items from Classroom Assessment for Student Learning Doing It Right – Using It Well. Feedback survey questions were based on Nyquists' typology of feedback. The findings of the study revealed teachers' self-perception of their knowledge of formative assessment practices and participation in professional development activities had a significant association with their level of use of such strategies. In addition, content area taught (English or Mathematics) did have a significant association with the type of feedback provided to students most often. Overall, teachers are not always using effective formative assessment strategies during instruction (Hauser, 2015).

The value and effectiveness of formative assessment in the classroom has gained an increasing amount of attention. A case study investigated internally constructed and externally imposed contextual elements that constrained or facilitated the use of formative assessment by three high school science teachers in China. The research revealed distinct differences among the three teachers and several different factors that constrained or facilitated the use of formative assessment in their instruction. The forms of teacher knowledge that played a critical role in shaping their assessment practices and had a bearing on their ability to convert espoused theories about assessment into actual classroom practice and other externally imposed barriers that constrained the use of formative assessment included expectations, habits, and dispositions of students; the pressure that teachers felt to "cover" all of the curriculum in order to prepare students for the end-of-year, high-stakes exam: an instructivist rather than constructivist approach to teaching (James, 2015).

The empirical support for accelerative practices, ability grouping, and formative assessment does not always translate into practice. This qualitative study sought to explore how teacher expectations about student ability influenced teacher use of accelerative practices, ability grouping, and formative assessment. The findings indicate that the availability and use of formative assessments, coupled with high teacher expectations about student ability, support teacher use of best practices in pacing and grouping strategies (Misetti, 2016).

A study was conducted to explore the perceptions, attitudes and frequency of use of formative assessment strategies of teachers in the Grenadian lower secondary school (Forms 1, 2 and 3). The study involved 252 lower secondary school teachers. Overall the participants had positive perceptions and attitudes towards formative assessment. Significant differences in the perceptions of formative assessment held by trained and untrained teachers as well as in the attitudes towards formative assessment were found. Trained and untrained teachers were found to have similar frequencies of practice of formative assessment strategies. About half of the teachers reported not allowing students to provide input into test construction and encouraging students to engage in journal writing (Young, 2014).

The implementation of formative assessment strategies is challenging for teachers all over the world. A study to evaluated teachers' implementation fidelity of a curriculum-embedded formative assessment program for primary school science education, investigating both material-supported, direct application and subsequent transfer and furthermore, the relationship between implementation fidelity and teacher variables was explored. German primary school teachers participated in professional development on formative assessment, teachers formed a control group. Teachers'

implementation reliability was evaluated via classroom observations student ratings and an analysis of students' workbooks, focusing on the frequency and quality of intended formative assessment elements (assessments, feedback and instructional adaptations). Regarding direct application, treatment group teachers' implementation fidelity was high, with slight variations in quality. Regarding transfer, implementation fidelity was lower but teachers still implemented more formative assessment elements than the control group. Teachers' pedagogical content knowledge and their evaluation of the formative assessment intervention were associated with implementation success (Handrich, 2016).

A study by Kemboi (2015) on Classroom assessment practices by Mathematics teachers in secondary schools in Kenya found out that the new alternative classroom assessment practices (CAPS) namely self assessment, peer assessment and use of portfolios were least used or not used at all by Mathematics teachers. Also he found out that mathematics teachers had little or no neither experience nor training on the use of these types of CAPS, teacher made tests are widely used in schools and in classroom. In addition, he found that mathematics teachers seldom use the information from CAPS to plan for future lessons and that timely use of assessment helps students foster meta-cognitive skills such as positive attitude towards Mathematics and responsibility towards ones' own learning.

In another study, twenty teachers working in elementary and secondary schools were interviewed from 2 school districts in southern Ontario, Canada about their understanding and use of particular formative assessment strategies. Analysis of the interviews followed a constant comparison method and revealed a variety of emerging themes. Results suggested an imbalance in the use of formative assessment methods

associated with improvements in student learning and achievement. Many teachers noted tensions in utilizing particular formative assessment strategies such as peer assessment and self-assessment. The discussion focuses on the implications for teacher education reform and in-service professional development so that greater synergy between formative assessment research and practice can be obtained in contemporary classrooms (Volante, 2015).

A study that supports the work of Black and Wiliam (1998), who demonstrated that when teachers effectively utilize formative assessment strategies, student learning increases significantly was conducted. But the researchers also found a "poverty of practice" among teachers, in that few fully understood how to implement classroom formative assessment. The study examined a series of voluntary workshops offered at one middle school designed to address this poverty of practice. Results indicated that teacher workshop participants experienced a growth in their capacity to use and teach others various formative assessment strategies, and even non-participating teachers reported greater use of formative assessment in their own instruction. Workshop participants and non-participating teachers perceived little growth in the area of differentiation of instruction, which contradicted some administrator perceptions (Stewart, 2014).

There is an accumulating research base that supports the effectiveness of formative assessment practices in enhancing the quality of educational outcomes, yet research findings seem to indicate sluggish implementation of these formative assessment strategies in the classrooms. Many factors influence teachers' formative assessment practices including the school environment. A school environment can be broadly characterized by its members, facilities and policies. They are external factors that can

affect teachers' practices. In this study, the extent of the influence of a school environment in influencing teachers' formative assessment practices was investigated. Using a qualitative approach, the study examined how two teachers teaching in a similar school environment conducted their formative assessment practices. The findings revealed that the two teachers exhibited very different formative assessment practices. The implication is that perhaps having similar school environment may not be the only factor that influences teachers' formative assessment practices. This study suggests that perhaps the bidirectional relationships between teachers and their environment play a more significant role in determining teachers' practices (Ranuka, 2016).

Among the present-day means of enhancing student learning, formative assessment is perhaps one of the most important and effective. While formative assessment ideas and practices have been shown to have a proven record enhancing student learning, these practices are slow to be fully integrated into teachers' day-to-day classroom practices. This study describes a collaborative effort among university faculty and public school partners to train teachers in the skills and practices of formative assessment. Regarding teachers' involvement in the formative assessment professional development, findings highlight that , teachers' participation in the professional development efforts did strengthen their understanding of both general knowledge of formative assessment and the use of formative assessment practices, teachers' plans to use the strategies in the future were related to their understanding of these strategies, and in-depth and comprehensive understanding of formative assessment practices were critical to concrete applications of such practices in their classrooms.

With respect to the impact on student learning, an overall effect size of 0.41 was found for teachers who utilized a formative assessment strategy compared with district averages for similar learning objectives when the practices were not use (Reed, 2014). The purpose of this research study was to investigate the level of implementation of formative assessment strategies among Rhode Island high school teachers and students in three districts. Furthermore, the research analyzed the relationship of the disciplines taught the amount and kinds of professional development teachers had, and district urbanicity relative to their levels of implementation of formative assessment strategies. Formative assessment is a bidirectional process between teacher and student to enhance, recognize, and respond to the learning.

The results of a "t" test found significant difference between students and teachers regarding teacher modification of instruction when students are struggling. Students reported that implementation occurs sometimes (M = 2.47, SD = 0.92), while teachers reported that they almost always change their instructional practice (M = 3.67) and with strong agreement among themselves (SD = 0.57). A large effect size was calculated (d = 1.57). Correlational analysis results showed a significant positive relationship between teachers use of feedback strategies and the amount of professional development received on this same topic (r = 0.25) (Burns, 2015).

2.5 Impact of the five effective formative assessment strategies used on learners' achievement in Mathematics

Formative assessment represents a set of student-centered practices, the results of which are not always optimal. Furthermore, different technologies are better suited to

certain tasks than to others. The study follows a Design-Based Research approach and was conducted in Chile in two phases. In the first phase of the study, a formative assessment strategy for teaching spelling is developed. In a subsequent phase, the impact of different technologies on this strategy is analyzed. This is achieved by comparing two different technologies: Tablet PCs and the interpersonal computer. The results reveal that a self-paced formative assessment strategy using Tablets is more effective than the same strategy using an interpersonal computer when teaching spelling to primary school students. This therefore highlights the impact of technology on learning when adopting a formative assessment strategy (Vásquez, 2017).

Formative assessment is a process that engages teachers and students in gathering, interpreting, and using evidence about what and how students are learning in order to facilitate further student learning during a short period of time. The process offers the potential to guide educator decisions about midstream adjustments to instruction that address learner needs in a timely manner. Formative assessment can be implemented in classrooms in various ways. For example, formative assessment can be quick and informal, such as giving students "I learned..." prompts to reflect on and discuss their progress toward lesson objectives. Formative assessment can also be more formal and involve multiple components, such as curriculum-based measurement, to frequently track and analyze individual student learning for the purpose of modifying instruction as warranted (Black & Wiliam, 1998).

In view of the above statement by Black and William, Twenty-two of the studies compared academic outcomes for students participating in formative assessment with academic outcomes for students who did not participate in formative assessment In United States of America, and noted that 19 of the 22 studies provided enough

information to calculate an effect size, which describes the magnitude of the effect of the intervention. When examining the results across these 19 studies, the review team concluded that: Overall, formative assessment had a positive effect on student academic achievement. On average across all the studies, students who participated in formative assessment performed better on measures of academic achievement than those who did not; Formative assessment used during math instruction had larger effects, on average, than did formative assessment used during reading and writing instruction; across all subject areas (math, reading, and writing), formative assessment had larger effects on student academic achievement when other agents, such as a teacher or a computer program, directed the formative assessment.

For math, both student-directed formative assessment and formative assessment directed by other agents were effective. For reading, other-directed formative assessment was more effective than student-directed formative assessment; and For writing, the effect of other-directed formative assessment on student academic achievement was small, and not enough evidence was available to determine the effectiveness of student-directed formative assessment (Klute, 2017).

On the other hand, five full-time online Mathematics instructors participated in a study to test the impact of using discussion forums as a space for formative assessments. Mean student posting activity and student quiz scores for sections in which the instructors used formative assessments were compared with previous sections in which formative assessments were not used. The research indicates that online discussion forums can be an important part of the learning process. Specifically, a certain type of formative assessment, known as classroom assessment

techniques (Cross and Angelo 1988), may actually elicit more discussion forum conversation from students and positively impact student quiz scores (Palese, 2015).

Formative assessment should be thought of as a path to evidence the authentic assessment of knowledge, understanding, and skills that students acquire during instruction. How powerful would that assessment be for students receiving constructive feedback regarding their performance from both the teacher and their peers? “When students focus on improvement and progress, they are more likely to adopt mastery goals and develop high self-efficacy and expectations for success”. Therefore, when students receive validation and affirmation of their learning from multiple sources in a variety of ways, they gain confidence and self-efficacy related to their ability to learn and master concepts and teachers gain reflective evidence in regards to effectiveness in the classroom settings (Riddel, 2016).

A different study investigated the continuous influence of applying formative assessment on EFL (English as a foreign language) learners' anxiety and listening efficacy. The participants, divided into an experimental and a control group, were 60 Iranian EFL learners in an English-language institute. The study thus highlights the pedagogical implications of assessment in EFL classrooms. This means that the report investigated the effect of formative testing used by teachers on students' achievement in EFL classes and its effect on reducing anxiety and improvement of listening efficacy. The sample consisted of one experimental and one control group. The data collected were analyzed by using t-test. The results revealed that there was a significant difference in the level of achievement of the treatment group in the intended matters (anxiety and listening efficacy in comparison to the control group in the summative test due to taking advantage of formative assessment (Abas, 2017).

Formative assessment, assessment for learning, involves checking in with students during the learning process to see if they understand concept or standard, before holding them accountable for mastery and moving on to the next concept or standard. This process can be used in the classroom during the lesson or across a subject area as teachers of the same subject create and administer common formative assessments and then use the data to make instructional decisions before moving on. Research has shown increases in student achievement with the use of formative assessment. The problem with formative assessment, however, is that it is defined in different ways. There is not one consistent definition across the educational spectrum. In addition, at the classroom level, teachers tend to be more comfortable with traditional ways of teaching and hesitant to incorporate new strategies that enable them to check in with every student throughout the lesson.

The researcher sought to understand the experiences of classroom teachers as they implement formative assessment in the classroom, use the assessment data to see where the students are in the learning process, and, ultimately, use the data to make decisions about what to do next for the learners. This study involved six middle school teachers at two schools in a rural school district who were identified by their principals, testing coordinators, and instructional coaches as the best in the school for implementation of formative assessment in the classroom. The researcher used observations and interviews to investigate the following research questions: (1) How do teachers implement formative assessment in the classroom?; (2) How do teachers use formative assessment data to make instructional decisions?; and (3) How were the teachers trained in the use of formative assessment? The study revealed the same issues found throughout the literature on formative assessment.

A variety of definitions exists, even among teachers in the same school and district. Some teachers are still tied to tradition in the way they deliver lessons and check for understanding. There is a lack of collaboration among colleagues, which prevents effective use of formative assessment across subject areas. There also exists a lack of training on the use of data to make instructional decisions. There was an association between student's improvement in performance and the utilization of the five formative assessment strategies (Doffermyre, 2017).

Ballan (2012) conducted a mixed method quasi-experimental intervention study on assessment for learning (formative assessment) in Mathematics education with a sample size of 47. The aim of the study was to introduce a formative assessment practice in a mathematics classroom by implementing the five strategies of formative assessment framework proposed by Wiliam and Thompson(2007).The findings revealed that there was an improvement in problem solving performance for students in the intervention group, there was a positive change in students' mathematical beliefs, the components of formative assessment practice were linked in complex ways often supporting and reinforcing each other. Despite the positive findings the study had weaknesses and to begin with, the sample size was small and hence generalization of findings was difficult, the study relied on questionnaires data only and did not complement with interviews in order to gain deeper insight, Different tasks were used for pretest and posttest hence difficult to compare and the main performance targeted in the study is problem solving tasks, hence the intervention did not seem to counteract the learning of other skills. All the gaps in this study were addressed in the current study.

A quantitative study to ascertain the impact on student achievement following professional development on the principles of formative assessment was conducted. The study compared Mathematics and reading performance data from student populations with teachers who received training in formative assessment to performance data from student populations with teachers who have not received training in formative assessment. The performance data included the Virginia Standards of Learning, as well as quarterly benchmarks and diagnostic assessments of students within Loudoun County Public Schools in Northern Virginia.

Consequently, the study found that students who received instruction from teachers with training in formative assessments had higher scores in 3 key areas. The assessment data showed a statistically significant difference in growth in the area of Mathematics on the state and diagnostic assessments. The present study also showed a statically significant difference in growth in the area of reading on the state assessment. The implication of this study serve to validate that the utilization of the principles of formative assessment can help teachers and students reach an optimal level of teaching and learning (DeNome, n.d).

In a study conducted in South Africa, it revealed that there was statistically significant association between achievement and classroom discussion but this association is negative, which could be indicative of a lack of content knowledge, and hence, learners are not able to become involved in discussions. The researcher concluded that the learners in Grade Five who participated in the study seemed not to have the necessary skills to engage in classroom discussion as one of the effective formative assessments strategy (Arends, 2017).

Research on teacher professional learning has shown that formative assessment can improve student learning more than most instructional practices. Empirical evidence indicates that thoughtfully implemented formative assessment practices improve students' learning, increase students' scores, and narrow achievement gaps between low-achieving students and others. Practiced well, formative assessment holds promise for fostering equity.

Given the role that students' achievement in middle school Mathematics classes can play in college-going trajectories, articulating how formative assessment can support equity in Mathematics classrooms is critically important. Doing formative assessment in Mathematics classes depends greatly on teachers' and students' use of language: producing language, taking language in, and sharpening language skills. Some conceptualizations of formative assessment are more explicit than others in their focus on language use. In this article, the authors present their conceptualization of formative assessment; introduce FA moves of priming, posing, pausing, probing, bouncing, tagging, and binning; and illustrate the moves at play in one middle school Mathematics class. Each of these moves lends itself to sustaining a focus on the development of academic language for all students, which is critical to fostering equity in Mathematics learning and teaching (Dockor, 2017).

Context-based science courses stimulate students to reconstruct the information presented by connecting to their prior knowledge and experiences. However, students need support. Formative assessments inform both teacher and students about students' knowledge deficiencies and misconceptions and how students can be supported. Research on formative assessments suggests a positive impact on students' science achievement, although its success depends on how the formative assessment is

implemented in class. The aim of the study was to provide insights into the effects of formative assessments on achievement during a context-based chemistry course on lactic acid. In a classroom action research setting, a pre-test/post-test control group design with switching replications was applied.

Student achievement was measured in two pre-tests, two post-tests and a retention test. Participants were Grade 9 students from one secondary school in the Netherlands. Repeated-measures analysis showed a significant effect of formative assessments on students' achievement. During the implementation of the formative assessments, intriguing discussions emerged between students, between students and teacher, and between teachers. Adding formative assessments to context-based approaches reinforces their strength to meet with the current challenges of chemistry education. Formative assessments affect students' achievement positively and stimulate feedback between students and teacher(s) (Vogelzang, 2017).

A study in Kenya by Kiplagat (2016) on rethinking primary school Mathematics teaching:A formative assessment approach, whose purpose was to determine the effects of formative assessment classroom teaching strategy (FACTS) on mathematics academic achievement among primary school pupils conducted an experimental study with a sample of 140 pupils of class 6. The FACTS was composed of a strategy grounded in instructional cycle of engaging students in interesting learning activities, assessing, analyzing and providing corrective instruction. His findings revealed that there was a significant effect of FACTS on pupils Mathematics academic achievement ($F=131.14$, $p=0.00<0.05$). He concluded that formative assessment classroom teaching strategy improved achievement in primary school Mathematics. The current study will employ the five key strategies of formative assessment as

stated earlier in the experimental group to bring a different classroom environment which are totally different from the type of FACTS used in the above study.

Another study in Kenya, Kivuti (2015) on the influence of formative evaluation on learner performance in Mathematics in secondary schools in Kenya using a descriptive survey research design with a sample of 130 respondents. Questionnaires and tests were used to collect data and the formative evaluation is taken to be the number of examinations done in the class in a given period of time. Findings revealed that frequent assessment of students' performance improved student outcomes. Kivuti (2015) posits that mathematics teachers employ assignments and tests as a formative evaluation approach, the way of measuring students' progress in mathematics performance which formed an integral part of education system and that examinations made teachers to be selective in the content taught. The above study supported the exam oriented curriculum where learners are taught to pass exam which is contrary to what formative assessment is all about.

Ayers (2014) asserts that formative assessment is much more than repeated assessment measures over time instead formative assessment is a process which includes a feedback loop to assist learners in closing the gap between current status and desired outcomes , milestones, or goals. According to Kemboi (2015), the overemphasis on examinations has limited schemes for making learning and training programmes practical oriented, the learners are taught content that is predicted to be examined while sometimes the same content is repeated several times for the students to memorize (policy views,2008). From the foregoing study it was displayed that some researchers themselves do not have the right understanding of FAS and they conduct researches claimed to be formative yet they are not. The current study

addressed this gap by getting the right understanding of formative assessment and introducing a new classroom environment where the five key formative assessment strategies identified in many past researches as effective (stated earlier) were tested in order to find their impact on learners achievement which had been done in other contexts.

Moyosore (2015) in Nigeria, conducted an experimental study on the effect of formative assessment on students achievement in secondary school Mathematics with a sample size of 120 Mathematics students in secondary art classes. Findings revealed a strong significant differences in mean achievement score of Mathematics students exposed to FAS (t= 36.54, p=0.00) also there was no gender difference in achievement scores of mathematics students exposed to formative assessment.

2.6 Teachers' and learners' perceptions in relation to the use of the five effective formative assessment strategies in Mathematics instruction.

One of the key aims of formative assessment in higher education is to enable students to become self-regulated learners. Based on Nicol and Macfarlane-Dick's framework, formative assessment practices proposed by them were used by one college EFL writing teacher to facilitate learner self-regulation in a Confucian Heritage Culture (CHC) setting (i.e. Hong Kong) and student perceptions of these practices in relation to self-regulation. Five formative assessment practices were found to be implemented by the teacher to support learner self-regulation. The students seemed to be more positive about teacher-and-student-directed practices than student-directed ones. Suggestions have been provided to maximize the potential of these practices in facilitating learner self-regulation (Jing, 2017).

The idea of providing students with formative feedback is a crucial part of formative assessment. Teachers need to provide students with feedback that improves their learning. In other words, formative feedback should provide learners with information that help them bridge their learning gap. The study investigated how formative feedback which is the main component of formative assessment is being implemented. To answer this main question, classroom observations were conducted and Focus Group Discussions (FGDs) were carried out with a group of primary school ESL teachers in Malaysia. The results indicated that using feedback systematically to support learning is rare and teachers are not aware of strategies to implement formative feedback to improve students' learning and use the information in their future instruction (Abbasnasab, 2016).

A qualitative study used action research to provide an insight into how pupils experience and perceive assessment in music education. In collaboration with pupils we constructed an assessment for learning model aimed at involving pupils in the co-development of assessment criteria and in the processes of self and peer assessment. In addition we also aimed to develop, with the support of feedback, self-regulatory attitudes to learning in the pupils. An action research model involving two cycles was used for this study, with this paper showing how pupils' perception of assessment changed from seeing it as to do with punishment or reward to how it provided support for learning. This change was brought about by a focus on formative assessment strategies with a strong emphasis on quality descriptive assessment, formative feedback and the teacher's attitude to assessment (Kafol, 2017).

The implementation of formative assessment strategies is challenging for teachers. We evaluated teachers' implementation fidelity of a curriculum-embedded formative

assessment programme for primary school science education, investigating both material-supported, direct application and subsequent transfer. Furthermore, the relationship between implementation fidelity and teacher variables was explored. N = 17 German primary school teachers participated in professional development on formative assessment, N=11 teachers formed a control group. Teachers' implementation fidelity was evaluated via classroom observations student ratings and an analysis of students' workbooks, focusing on the frequency and quality of intended formative assessment elements (assessments, feedback and instructional adaptations).

Regarding direct application, treatment group teachers' implementation fidelity was high, with slight variations in quality. Regarding transfer, implementation fidelity was lower but teachers still implemented more formative assessment elements than the control group. Teachers' pedagogical content knowledge and their evaluation of the formative assessment intervention were associated with implementation success (Handrich, 2016).

2.7 Teachers' support on the implementation of the five effective formative assessment strategies in Mathematics instruction.

The purpose of this mixed-methods study was to gain insights and understandings of high school teachers' perceptions and use of formative assessment to enhance their planning, individualization of instruction, and adjustment of course content to improve student learning. The study was conducted over two years in a mid-western high school of approximately 1,000 students. Crucial to the three project teachers' understanding of formative assessment was developing and using preset curriculum

road maps that tightly aligned course goals, learning objectives, activities, instructional methods, and assessment (Melani, 2017).

The in-depth case studies of the sample's three teachers revealed that, when provided with specific information about formative assessment through staff development, they became more positive toward such assessment, and their implementation skills were greatly improved. The staff development had an especially positive impact on the teachers' understanding and skill sets for individualizing instructional practices. The personalization of the staff development proved to be the most beneficial when it tailored the content to the varying levels of initial proficiency of the three sample teachers. Support for formative assessment by the administrative team members was essential to creating a cultural shift from summative to formative assessment (Melani, 2017).

Formative assessment has been demonstrated to result in increased student achievement across a variety of educational contexts. When using formative assessment strategies, teachers engage students in instructional tasks that allow the teacher to uncover levels of student understanding so that the teacher may change instruction accordingly. Tools that support the implementation of formative assessment strategies are therefore likely to enhance student achievement. Connected classroom technologies (CCTs) include a family of devices that show promise in facilitating formative assessment. By promoting the use of interactive student tasks and providing both teachers and students with rapid and accurate data on student learning, CCT can provide teachers with necessary evidence for making instructional decisions about subsequent lessons.

In this study, the experiences of four middle and high school science teachers in their first year of implementing the TI-Navigator system, a specific type of CCT, are used to characterize the ways in which CCT supports the goals of effective formative assessment. CCT was found to support implementation of a variety of instructional tasks that generate evidence of student learning for the teacher. The rapid aggregation and display of student learning evidence provided teachers with robust data on which to base subsequent instructional decisions (Melissa, 2015).

One method for monitoring student learning is formative assessment. As part of a project funded by a state department of education grant, Mathematics teachers received professional development (PD) in the principles of formative assessment to enhance the learning of all students in their classroom, including those with exceptional learning needs. This study inform the present study that formative assessment methods spotlighted in the project, along with how formative assessment was implemented in two algebra classrooms. Through the formative assessment project, teachers received PD on formative assessment provided by university faculty with expertise in Mathematics education and instructional methods for students with exceptional learning needs. The teachers were supported in implementing formative assessment methods by coaches who observed instruction and provided feedback and suggestions. Specifically, the teachers formed professional learning communities and agreed on the use of specific questions to guide implementation of formative assessment repeatedly in their mathematic classrooms.

Throughout the project, teachers received PD on formative assessment methods, including breaking problems into steps for error analysis; using data collection charts to identify student response patterns; providing multiple probes to assess student

understanding; and embedding one key question into a formative assessment for analysis. There was evidence that teachers after receiving support from the school and the government were able to implement the formative assessment strategies and improvement in students' performance (Accardo, 2017).

Box's (2015) research revealed distinct differences among the three teachers and several different factors that constrained or facilitated the use of formative assessment in their instruction. Most notable of these factors were the forms of teacher knowledge that played a critical role in shaping their assessment practices and had a bearing on their ability to convert espoused theories about assessment into actual classroom practice. Other externally imposed barriers that constrained the use of formative assessment included expectations, habits, and dispositions of students; the pressure that teachers felt to "cover" all of the curriculum in order to prepare students for the end-of-year, high-stakes exam; and an instructivist rather than constructivist approach to teaching and learning. Results from this study add to the growing body of knowledge about the complex terrain teachers negotiate in making teaching and assessment decisions and provides a framework for future studies (Box, 2015).

Ayers (2014) posit that implementation of a formative assessment process is not a one- time event, but rather it is a decision that needs systemic change and requires professional development to train, empower, and support teachers and educational leaders charged with its implementation.

2.8 Summary of Literature and Gap Therein

This chapter has discussed the broad subject of classroom assessment, the formative assessment, the five key formative assessment strategies found to be effective as stated earlier, the literature on the objectives as stated in chapter one and further developed into specific issues pertaining formative assessment including effectiveness of formative assessment in addressing students' needs and in enhancing mastery of content, in meeting course objectives. From the foregoing literature, several researches done in Kenya have not dealt with the five key strategies identified in the past researches from other contexts as very effective formative assessment strategies and thus were the focus in the current study. The formative assessment researches done in Kenya had smaller sample sizes but the current study used a bigger sample size (579) comprising of 534 Form three students, 33 mathematics teachers and 12 head teachers which gave a good representative sample for the study to have generalizeable findings.

Ballan (2012) asserts that the framework by William and Thompson may aid in identifying important dimensions of assessment for learning, which can be used for instance when implementing a formative assessment practice in a classroom, but how these strategies interact by strengthening and interfering with each other in the classroom is still not very well known hence it may be argued that studies investigating how the strategies co-exist as opposed to investigating each of the strategies in isolation from the others are needed. The current study addressed this gap by determining the structural association between the five formative assessment strategies and learners achievement in mathematics instruction.

Research done in Kenya on formative assessment have different understanding of what FAS is; some have taken FAS to be repeated examinations, some have it as homework & assignments, continuous assessment tests which are for grading the learners but in the current study FAS was taken as a process used by teachers and learners during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of the intended instructional outcome. Ayers (2014) posit that teachers' use of formative assessment to inform instruction is an essential piece of effective pedagogy which is supported by many researchers in other contexts including Black and Wiliam (2012) hence there was need to conduct the current study in Kenya.

Again some studies in literature were conducted in primary schools and those in secondary schools were in different contexts therefore there was need to conduct the same in Nandi County. In addition most of the researches on FAS employed mixed methodology but the main use of qualitative data was to compare the results but in the current research both quantitative and qualitative data were collected but the use of the qualitative data was to explain further the quantitative finding to get in-depth understanding, therefore there was urgent need for the current study to be conducted.

Also, from literature few studies dealt with teachers support on the implementation of FAS and structural relationship of the five FAS and learners achievement which the current study addressed. From literature, it is quite clear that there is paucity of literature in Kenya about formative assessment and more so none of the studies had been conducted on how FAS was utilized in Mathematics classrooms and as Wyllie & Lyion (2012) posited that FAS have a positive impact in mathematics however,

teachers are not utilizing to the fullest extent possible hence the need for the current study to address the gap.

However, much of the available evidence concerning the effectiveness of formative assessment instructional practices for improving student achievement remains inconclusive. One reason is that few of the published studies were designed in a way that ruled out competing explanations of intervention effects. Another uncertainty in judging the impact of formative assessment may be due to inconsistency in how formative assessment practices are implemented in these studies. Further complications arise from the wide variety of achievement measures employed (Thum, 2015). The current research thus tries to fill these gaps by investigating the utilization of formative assessment strategies in Mathematics instruction and their impact on learner achievement in secondary schools in Nandi County, Kenya.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter deals with how the researcher obtained the data for the study and how the collected data was analyzed. It consists of paradigms guiding the study, research methodology adopted, research design, study area, target population, study sample, sampling procedure, research instruments, validity & reliability of the study instruments, piloting, data collection procedure, data analysis procedures and the ethical considerations.

3.2 Research Paradigms

Creswell (2018) points out that in planning a study , researchers need to think through the philosophical worldview assumptions that they bring to the study, the research design that is related to this worldview and the specific methods or procedures of research that translate the approach into practice. According to Taylor (2007), philosophical paradigm in a research refers to "a broad view or perspective of the study variables". Additionally, Weaver and Olson's (2006) definition of paradigm reveals how research could be affected and guided by a certain paradigm by stating, "paradigms are patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished".

According to Johnson and Christensen (2008), research paradigm is a perspective that is based on the set of shared assumptions, values, concepts and practices. In other world, paradigm can be defined as a function of how researcher thinks about the development of knowledge. The term paradigm in research can be used in three ways:

it can be used for the institutionalization of intellectual activity, for the broad groupings of certain approaches and perspectives to the study of any subject, and for the description of broad approaches to research. Research paradigm is a combination of two ideas that are related to the nature of world and the function of researcher. It helps researcher to conduct the study in an effective manner. A paradigm consists of the following components: ontology, epistemology, methodology, and, methods (Scotland, 2012).

Ontology is concerned with the nature of reality and what there is to know about the world (Ormston, 2014). It is the study of being (Scotland, 2012). Ontological assumptions are concerned with what constitutes reality, in other words *what is*, hence researchers need to take a position regarding their perceptions of how things really are and how things really work. In very broad terms social science has been shaped by two overarching ontological positions in relation to issues namely realism and idealism. According to Ormston (2014), realism is based on the idea that there is an external reality which exists independently of people's beliefs about or understanding of it, in other words there is a distinction about the way the world is and the meaning and the interpretation of that world held by individuals. On the other hand Idealism asserts that reality is fundamentally mind–dependent; it is only knowable through the human mind and through socially constructed meanings, and no reality exists independently of these.

Epistemology is concerned with the nature and forms of knowledge (Scotland, 2012; Cohen et al., 2007, p. 7), Epistemological assumptions are concerned with how knowledge can be created, acquired and communicated, in other words *what it means to know* in addition, Guba and Lincon (1994, p. 108) explain that epistemology asks

the question, what is the nature of the relationship between the would-be knower and what can be known? Ormston (2014) asserts that the way knowledge is acquired is based on deductive and inductive. While inductive process involves using evidence as the genesis of conclusion- evidence is collected first and knowledge and theories are build from this. The deductive process involves use of evidence in support of a conclusion- a hypothesis is first developed and evidence is then collected to confirm or reject it.

Blaikie (2007) among others argues that there is no such a thing as 'pure' induction and or 'pure' deduction for example when so called inductive researchers generate and interpret their data they cannot approach this with a blank mind even if they are not testing hypothesis, the kind of data they have generated, the questions they have asked and the analytical categories they have employed will have been influenced by assumptions deductively derived from previous work in their fields and similarly deductive researchers setting out to test a hypothesis will have drawn on a body of theory which in turn has been inductively derived from prior observation.

Scotland (2012) explains that "Every paradigm is based upon its own ontological and epistemological assumptions, since all assumptions are conjecture, the philosophical underpinnings of each paradigm can never be empirically proven or disproven and different paradigms inherently contain differing ontological and epistemological views; therefore, they have differing assumptions of reality and knowledge which underpin their particular research approach, this is reflected in their methodology and methods".

Methodology is the strategy or plan of action which lies behind the choice and use of particular methods (Scotland, 2012; Crotty, 1998) and thus, methodology is

concerned with why, what, from where, when and how data is collected and analyzed. Guba and Lincon (1994) explain that methodology asks the question: how can the inquirer go about finding out whatever they believe can be known? Methods are the specific techniques and procedures used to collect and analyze data (Crotty, 1998). The Four major philosophical worldviews used in research are: postpositivism, constructivism, transformative and pragmatism.

3.2.1 Paradigm of the study-Pragmatism

The philosophy that guided the study was pragmatic worldview. According to Creswell (2018), pragmatism derives from the work of Peirce, James, Mead and Dewey (Cherryholmes, 1992) and other writers include Murphy (1990), Patton (1990), and Rorty(1990). However, Pragmatism as a worldview arises out of actions, situations, and consequences rather than antecedent conditions (as in postpositivism) and there is concern with applications –what works- and solutions to problems (Patton, 1990). Moreover, Instead of focusing on methods, researchers emphasis the research problem and question and use all approaches available to understand the problem (Rossman & Wilson, 1985) and as a philosophical underpinning for mixed methods studies.

Morgan (2007), Patton (1990) and Tashakkori and Teddlie (2010) convey its importance for focusing attention on the research problem in social science and then using pluralistic approaches to derive knowledge about the problem. Early pragmatists "rejected the scientific notion that social inquiry was able to access the 'truth' about the real world solely by virtue of a single scientific method" (Mertens, 2005, p. 26) in Amina, Brey (2014). The underlying philosophy of the pragmatic

paradigm is that it provides the theoretical framework for a mixed method research (Mertens, 2005). Pragmatism focuses on the ‘what’ and ‘how’ of the research problem (Creswell, 2003).

According to Creswell (2009) an important believe held by pragmatists is that the methodologies employed by advocates of the positivist/postpositivist and interpretivist paradigms are complementary and that researchers will derive a more complete picture of the research problem when both the qualitative and quantitative methodologies are co-employed. The pragmatic paradigm allows research to decide and draw liberally from both quantitative (positivist/postpositivist) and qualitative (interpretivist/ constructivist) methodologies within same research study rather than subscribing to only one way (Creswell, 2009).The advantage is that it allows for both theories to be tested and developed while undertaking research.

Creswell (2018), Morgan (2007) and Cherryholmes (1992) have identified the philosophical assumptions of pragmatism that pragmatism is not committed to any one system of philosophy and reality in that inquirers draw liberally from both quantitative and qualitative assumptions when engaging in their research, individual researchers have freedom of choice, pragmatist do not see the world as absolute unity (many approaches are used to collect and analyze data, truth is what works at the time, Pragmatist researchers look to the what and how to research based on the intended consequences, Pragmatists agree that research always occurs in social, historical, political and other contexts.

Pragmatists also have a believed in an external world independent of the mind as well as that lodged in the mind and thus for a mixed method researcher pragmatism opens the door to multiple methods, different worldviews, different assumptions as well as

different forms of data collection and analysis. The study collected and analyzed both qualitative and quantitative data therefore the pragmatist paradigm with its philosophical underpinnings guided the study.

3.2.2 Positivism/ Postpositivism

According to Creswell (2018), the postpositivist tradition comes from 19th – century writers, such as Comte, Mill, Durkheim, Newton, and Locke, (Smith, 1983) and more recently from writers such as Phillips and Burbules (2000). This worldview is sometimes called the scientific method or doing science research, it is also called positivist/postpositivist research, empirical science and postpositivism (Creswell, 2018). It is called postpositivism because it represents the thinking after positivism, challenging the traditional notion of the absolute truth of knowledge (Creswell, 2018; Philips & Burbules, 2000) and recognizing that we cannot be absolutely positive about our claims of knowledge when studying the behavior and actions of humans.

Creswell (2018) points out that postpositivism hold a derterministic philosophy whereby the problems studied reflect the need to identify and assess the causes that influence the outcome such as those found in experiments, it is also reductionistic in that the intent is to reduce the ideas into small, discrete set to test, such as the variables that comprise hypotheses and research questions. In addition it is empirical in that the knowledge developed is based on careful observation and measurement of the objective reality that exists “out there” in the world and finally the need to test, verify and refine the theories and laws that exist in order to understand the world. The accepted approach to research by postpositivists is that a researcher begins with a theory, collect data that either supports or refutes the theory, and then makes necessary revisions and conducts additional tests (Creswell, 2018).

Creswell (2018) has highlighted key assumptions of postpositivism in Philips and Burbules (2000) such as the following: Knowledge is conjectural, most of quantitative researches start with a theory, Data evidence and rational consideration shape knowledge, causal relationships among variables of interest are described, objectivity is essential aspect of competent inquiry.

3.2.3 Constructivism/ interpretivist worldview

Constructivism or social constructivism in Creswell (2018) is such a perspective typically seen as an approach for qualitative research and the ideas came from Mannheim and from works such as Berger and Luckmann's (1967) The social construction of Reality and Lincoln and Guba's (1985) Naturalistic inquiry and more recent writers who have summarized this position are Lincoln and colleagues (2011), Mertens (2010), and Crotty (1998), among others. Social constructivism believe that individuals seek understanding of the world in which they live and work in order to develop subjective, varied and multiple meanings of their experiences leading the researchers to look for complexity of views rather than narrowing meanings into a few categories or ideas (Creswell, 2018). In addition, the goal of the research is to rely as much as possible on the participants' views of the situation being studied and the questions become broad and general so that the participants can construct the meaning of a situation, typically forged in discussions and or interactions with other persons hence (social constructivism).

Furthermore, constructivist researchers focus on specific contexts in which people live and work in order to understand the historical and cultural settings of the participants and thus, the researcher's intent is to make sense of (interpret) the meanings others have about the world and hence, rather than starting with a theory (as

in postpositivism), inquirers generate or inductively develop a theory or pattern of meaning (Creswell 2018) and the key assumptions for constructivism are identified in Crotty (1998) as follows: Human beings construct meanings as they engage with the world they are interpreting(use of open ended questions by qualitative researchers), Humans engage with their world and make sense of it based on their historical and social perspectives and the process of qualitative research is largely inductive where the inquirer generates meaning from the data collected in the field.

3.3 Research Methodology

Rajasekar et al. (2013, p. 5) describe research methodology as "…the procedures by which researchers go about their work of describing, explaining and predicting phenomena". This study adopted the use of mixed methodology where both quantitative and qualitative data collection and analysis approaches were used.

3.3.1 Quantitative Approach

Quantitative research is regarded as a deductive approach towards research (Rovai et al., 2014). Quantitative researchers regard the world as being outside of themselves and that there is "… an objective reality independent of any observations" (Rovai et al., 2014). They contend that by subdividing this reality into smaller, manageable pieces, for the purposes of study, that this reality can be understood. It is within these smaller subdivisions that observations can be made and that hypotheses can be tested and reproduced with regard to the relationships among variables. This approach is typified by the researcher putting forward a theory that is exemplified within a specific hypothesis, which is then put to the test; conclusions can then be drawn with

regard to this hypothesis, following a series of observations and an analysis of data (Rovai et al., 2014).

In this study quantitative data were obtained through the use of questionnaires and analyzed by use of frequencies, percentages, means, t-tests and Structural Equation Modelling. The formative assessment strategies in the William and Thompson framework (2007) were tested to find out whether they are effective and a relationship between them and learners' achievement was established.

3.3.2 Qualitative Approach

Qualitative research places emphasis upon exploring and understanding "… the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2014). Denzin and Lincoln (2005) describe this approach as gaining a perspective of issues from investigating them in their own specific context and the meaning that individuals bring to them. It focuses upon drawing meaning from the experiences and opinions of participants—it pinpoints "… meaning, purpose or reality" (Cohen et al., 2011; Merriam, 2009). Qualitative methods are usually described as inductive, with the underlying assumptions being that reality is a social construct, that variables are difficult to measure, complex and interwoven, that there is a primacy of subject matter and that the data collected will consist of an insider's viewpoint (Rovai et al., 2014).

Rovai et al. (2014) make the point that this approach towards research "… values individuality, culture, and social justice" which provides a content and context rich breadth of information which, although subjective in nature, is current (Tracy, 2013). However, the employment of qualitative approach methods does not prevent the administration of a critical, disciplined and balanced study into any educational issue

(Thomas et al., 2011; Silverman, 2009; Bell, 2010). In this study, qualitative data were obtained from interviewing secondary school principals, form three Mathematics teachers and classroom observations and thereafter data were transcribed, thematically classified and arranged before they were reported in descriptions and excerpts. In this study, the qualitative data were used to explain the quantitative finding in- depth. Qualitative data were used to explore and expand on the quantitative finding to get a clear picture.

3.3.3 Mixed Methods Approach

The study adopted mixed methods which involve integration of philosophical assumptions where there is use of both quantitative and qualitative approaches. It is thus more than simply collecting and analyzing both kinds of data; it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either one of the two approaches (Creswell, 2009). According to Creswell and Plano Clark, (2007) the mixing of quantitative and qualitative approaches provides a better understanding of research problems than either approach alone.

Mixed methodology is the corner stone of research within social science that is experienced within everyday life" (Creswell & Plano Clark, 2011; Johnson & Onwuegbuzie, 2004). Mixed methodology is described as being "the third paradigm" (Johnson & Onwuegbuzie, 2004); a "third methodological movement (Teddlie &Tashakkori, 2009) and includes two (or more, or both) quantitative and/or qualitative approaches (Morse & Niehaus, 2016). It no longer restricts the researcher to particular paradigms that have been traditionally the case and is considered a legitimate means of undertaking research in social and human science (Creswell & Plano Clark, 2011).

Using mixed methodology can help blend different approaches allowing the researcher to design research questions within the context and parameters of their study (Johnson & Onwuegbuzie, 2004). Bernard (2014) adds that mixed methodology has led to an explosion of collaborative and creative research across disciplines. It helps to address broader questions providing a more expansive and creative approach to research (Johnson & Onwuegbuzie, 2004). The mixed methods approach includes a multiple level strategy incorporating a two-phase approach where (for example) quantitative research is undertaken first, followed by qualitative research; a systematic and planned approach to research (Flick, 2011).

Each phase can then be triangulated into a third phase where quantitative data can provide general patterns and width and, qualitative data reflects upon experience and depth (Newby, 2014). The findings from the qualitative data can also help contextualizes and enrich findings (Bryman, 2004, Mason 2006), increase validity when interpreting the data (Orgard, 2005), and generate new knowledge (Stange, 2006). Using mixed methodology can help understand the topic area in greater depth (Hoover &Krishnamurti, 2010). It can help increase confidence in findings, providing more evidence while offsetting possible shortcomings from using a single approach (Caruth, 2013; Creswell & Plano Clark, 2011; Tashakkori & Creswell, 2008).

This study adopted an explanatory sequential mixed methodology where quantitative data was collected in phase one followed by qualitative data in phase two. The qualitative data was used to explore in depth the quantitative findings of this research. The explanatory sequential mixed methodology was explained further in the research design and its visual representation was displayed. Mixed methods allow for triangulation within method or between methods.

3.3.3.1 Triangulation

Flick,(2008) asserted that Triangulation should produce knowledge on different levels which means they go beyond the knowledge made possible by one approach and this contribute to promoting quality in research. The study employed a methodological triangulation where more than one option was used to gather data. A within method triangulation was used whereby in gathering quantitative data, students' & teachers' survey and observation schedule were used.

3.4 Research design

Research designs are types of inquiry within qualitative, quantitative and mixed methods approaches that provide specific direction for procedures in a research study (Creswell, 2018). The study adopted the Quasi-experimental mixed method intervention research design. The quasi–experimental research design was chosen which involved the use of pre-test, post-test control group design with no randomness on participants instead intact classes of learners and their Mathematics teachers were used.

The study utilized experimental design where effective formative assessment strategies: level of use of the five formative assessment strategies, impact of strategies on learners achievement in Mathematics, changes in students perception and kind of support needed for effective implementation of formative assessment strategies were the independent variables while learners' achievement in Mathematics in terms of performance, acquisition of problem solving skills and interest were the dependent variables. An experimental design is a strong design for a researcher to test hypothesis

to reach valid conclusions between independent and dependent variables (Best & Kahn, 2003).

The design was mixed methods design because the study collected both quantitative and qualitative data where the explanatory sequential mixed method core design was embedded before and after the intervention. This is a two phase mixed method research design where the researcher first conducts quantitative research, analyzes the results and then builds on the results to explain them in more detail with qualitative research (Creswell, 2018). It is a two phase model that consists of first collecting the quantitative data and then collecting qualitative data to help explain or elaborate on the quantitative results (Creswell & Plano, 2011).

The rationale for this approach is that the quantitative data and results provide a general picture of the research problem; more analysis, specifically through qualitative data collection, is needed to refine, extend or explain the general picture (Creswell, 2014, p. 572). It involves a two-phase data collection project in which the researcher collects quantitative data in the first phase, analyze results and then uses the results to plan (or build on to) the second, qualitative phase (Creswell, 2018). The quantitative results typically inform the types of participants to be purposefully selected for the qualitative phase and the types of questions that will be asked of the participants. The overall intent of this design is to have the qualitative data help explain in more detail the initial quantitative results thus it is important to tie together or to connect the quantitative results to the qualitative data collection. Creswell (2018) explains further that it is considered explanatory because the initial quantitative data results are explained further with the qualitative data and it is considered sequential because the initial quantitative phase is followed by the qualitative phase.

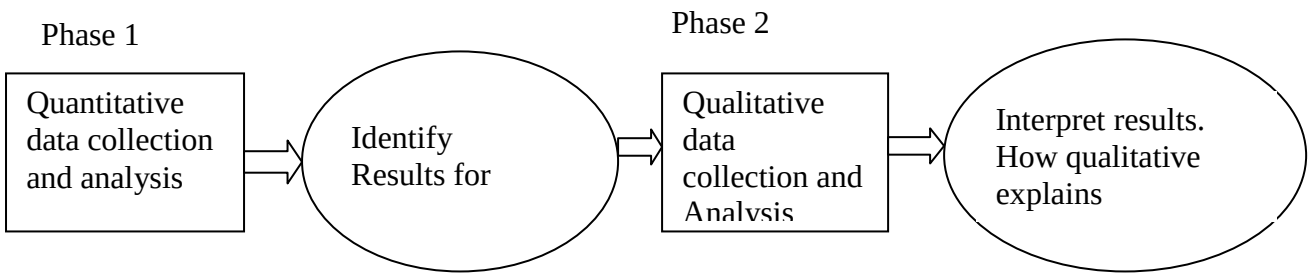

Figure 7: Explanatory Sequential Design (Two Phase Design) – source (Creswell, 2018 p.218)

It is considered intervention because a treatment was given to experimental group where learners were taught using the five effective formative assessment strategies to test their impact on learners' achievement and the control group were taught using the traditional/normal methods.

The researcher adopted the explanation of Robson (2003) which says that an experimental design is employed where participants were exposed to different conditions. To get the true effects of the program or intervention, it is necessary to have both a treatment group and a control group. This experimental design adopted symbols as proposed by De Vaus & de Vaus (2001). Groups E1 and E2 were classes that were randomly assigned to the experimental and control groups. O_1 and O_3 were pre-tests while O_2, O_4 were post-tests. The assessment given to the control and experimental groups for the pre-test and post-test were the Student Mathematic Assessment Test (SMAT).

Test items were from the past standardized KNEC examinations on the topic "Sequence and series" selected by the researcher with the assistants of the participating teachers and examination experts. X represents the treatment variable

which in this study was the use of the five effective formative assessment strategies, while - represents the control condition which in this study is the conventional teaching approach.

Table 5:Pre-test and Post-test Research Design

GROUPS		PRE-TEST		PROCESS		POST TEST
E1	⇨	O_1	⇨	X	⇨	O_2
E2	⇨	O_3	⇨	--	⇨	O4

Source: De Vaus& de Vaus (2001).

The intervention period was six weeks.

Observation

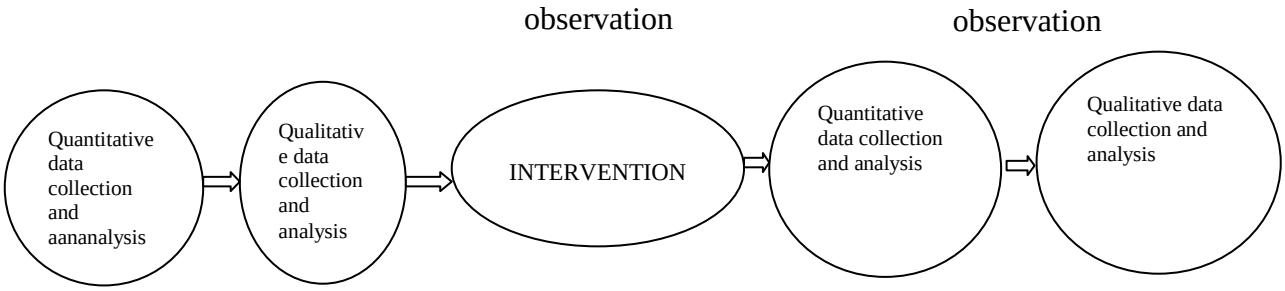

Figure 8: Visual representation of the research design (researcher designed)

In this study both quantitative and qualitative data were collected and analyzed. Qualitative data was obtained through teacher interviews (one to one and focus group interviews), school principals' interviews, researchers' field notes and observations while quantitative data was obtained from pre-test/post-test of student and teacher questionnaires, Mathematics performance test, and observation scores making this study to be mixed methods.

3.5 Study Area

The study was carried out among form three students, their Mathematics teachers and principals of selected secondary schools in Nandi County, Kenya. According to a 2009 census, the county has a population of 752,965 (KNBS, 2013). The county's major area is covered by the Nandi Hills. Nandi is a cosmopolitan area inhabited by members of various communities. The county (2,884.5 km^2 or 1,113.7 sq mi) is further sub-divided into 30 wards.

The county has six sub counties: Mosop Sub-county, Emgwen Sub-county, Aldai Sub-county, Tinderet Sub-county, Nandi Hills Sub-county and Chesumei Sub-county. There are 163 secondary schools in Nandi County. County and sub-county schools perform poorly in Mathematics despite the use of various routine formative assessment strategies. The study looked at the effectiveness of formative assessment strategies used specifically through their quality and the frequencies of their usage and also variety of usage to improve Mathematics performance in secondary schools and attainment of vision 2030 skills. The map of the study area is shown in appendix IV.

3.6 Target Population

Burns and Grove (2003) describe a population as all the elements that meet the criteria for inclusion in a study. The target population for the study was all form 3 students, Mathematics teachers, and their principals of Sub-county schools. The county has 132 public Sub-County secondary schools with 212 teachers of Mathematics and 15,457 students. Therefore, the target population of this study was 5472 form three students and 138 teachers of Mathematics. Form three students participated because they have 3 years' secondary school education learning

experience, form four is a busy class while form one and two may not be experienced enough.

3.7 Sample Size and Sampling Procedure

This section presents the sample size and sampling procedures that were used in the study

3.7.1 Sample size

The current research was grounded on sample size determination formula by Krejcie and Morgan (1970) as quoted by Kasomo (2001). The formula is given as:

$$n = \frac{X^2 * N * P(1-P)}{\left(ME^2 * (N-1)\right) + (X^2 * P * (1-P))}$$

Where

n=Sample size

X^2=Chi Square for the specified confidence level at 1 degree of freedom= (3.841) from tables

N=Population size

P=Population proportion (.50 in the table)

ME=Desired margin of error (expressed as a proportion=0.05).

N=3.841*5472*0.5(1-0.5)÷0.05^2 *(5472-1)+(3.841*0.5(0.5)=358.97 (approximately 359 students). This is the exact sample size of the representative sample of form three students. However the nature of the research was a quasi experimental study (no randomness of the participant, hence intact classes were used. A convenience sample was selected based on the common course content the teachers were covering at the time of research (Hauser, 2015; Creswell, 2014). The researcher selected 12 schools using simple random sampling technique and also to obtained 12 classes because each school had more than one class of form three.

In reference to intact classes the sample was more than the calculated sample (534 students participated in the study) therefore statistic was closer to the parameter.

Using simple random sampling six classes were selected in experimental group and the remaining six were control group. During reconnaissance study it was found that teachers in all the sampled schools used teamwork to teach form three Mathematics hence a class was taught by more than one teachers. In the first phase of this research study, 33 teachers and 534 students participated in filling the survey on the utilization of the formative assessment strategies. The second phase of the study was the qualitative phase of the sequential explanatory design and the participants were purposively selected to be able to explore qualitatively on the quantitative finding before intervention, here only 12 teachers out of the 33 were randomly selected on free will that is one teacher for every selected school and 6 head teachers randomly selected from the twelve selected schools. After intervention 534 students, 33 teachers filled the post test survey and 6 teachers from experimental group were purposively selected for the Focus Group Interview.

3.7.2 Sampling Procedures

The study selected schools first followed by classes and finally selection of students, teachers and head teachers. Proportionate Stratified simple random sampling technique was used to classify schools into three categories namely: National schools, County schools and Sub-County schools. Only public sub-county schools participated in the study whereas simple random sampling was used to select 12 schools. Furthermore, all the Mathematics teachers and all the students in the selected classes

participated in the study. Simple random sampling method was used to group classes into experimental and control group.

The participants in the experimental group were: 15 teachers and 227 students while the control group were:18 teachers and 307 students. Since the study is an intervention study, the explanatory sequential mixed method core design was repeated after the intervention period. Before the intervention the participants for the first phase (the quantitative phase) were 534 students and 33 teachers followed by the second phase (the qualitative phase) of 12 teachers and 6 head teachers. After the intervention the participants for quantitative phase remain the same but those for the qualitative phase changed. Only 6 teachers purposively selected from the experimental group participated in a focus group interview to explore on the quantitative finding and to give their experiences for the intervention.

3.8 Research Instruments

According to Kombo and Tromp (2006), social science commonly uses questionnaires, interview schedules, observational forms and standardized test as research instruments. This study used both quantitative and qualitative data collection techniques. The following instruments were employed during data collection: Teacher and student questionnaires, observation interview guide(face to face and Focus group interview) and Mathematics performance test (pre-test and post-test).

3.8.1 Questionnaire

Questionnaire was the main tool used to collect the quantitative data from the secondary school students and their Mathematics teachers. According to Kothari (2008), questionnaires are usually free from the interview bias as the answers are in

respondents own words. Respondents also have adequate time to give well thought out answers. Questionnaires also save time and information can be collected from a very large sample. The questionnaire choice is therefore based on the fact that questionnaires are free from bias of the interviewer and respondents have adequate time to give well thought out answers, and is appropriate for literate, educated and co-operative respondents where in this case all respondents of the study were considered to meet this requirement. The questionnaire gave quantitative data on the level of use of the five effective formative assessment strategies, learners' and teachers' perceptions in relation to the use of the strategies, the kind of support by the school/ government and challenges on the implementation of the five effective formative assessment strategies.

Teacher and the student questionnaires adopted in the present study is a modified Likert scale by Micheal and Susan Dell foundation (2016) with a scale range of four and five. In a scale of four, the respondents choose from the options such as (1) Strongly Disagree, (2) Disagree, (3) Agree, (4) Strongly Agree while in a scale of five the options were: 1=Never 2=seldom 3 =Sometimes 4= Often 5= Always. The teacher's questionnaire items are: 27 on the level of use of the effective formative assessment strategies, 5 items on perceptions and 8 on teachers' support to give a total of 40 items (Appendix ii). The student questionnaire adopted the same modified likert-scale and the items are: 27 items for the level of use and 7 items on student perceptions giving a total of 34 items (Appendix iii)

3.8.2 Observation Schedule

In observation, information is usually gathered by directly observing people at a research site (Creswell 2002). According to Kombo and Tromp, (2006), observation

provides information about actual behavior of the targeted group. Direct observation technique was suitable for this quasi experimental study because it is objective–based and facilitates derivation of more authentic data. Direct observation was considered useful because some classroom practices involve habitual routines which teachers are hardly aware of. Thus, observation was necessary to verify information collected from questionnaire and interviews.

Therefore, the current study employed direct observation whereby the researcher observed 12 Mathematics lessons directly before the experiment for the twelve selected schools, then during the experiment the researcher made two lesson observations for each school in the experimental group to make follow ups on the use of the strategies by the experimental group teachers. The researcher observed and recorded the level of use of the five effective formative assessment strategies before during and after the intervention. In addition, the researcher observed the acquisition of problem solving skills to assess the impact of the five effective formative assessment strategies on learner's achievement in Mathematics. A data gathering observation schedule which was both quantitative and qualitative guided by the observation protocol (Appendix viii) was adopted from modified Michael and Susan Dell Foundation (2016).

The observation protocol illustrates the teacher ability to use the five effective formative assessment strategies and the teachers were rated beginner, developing and exemplary. The observation schedule helped the researcher to rate the activities in terms of level of use of the five effective formative assessment strategies as (1) None, (2) Poor, (3) Fair (4) Good (5) Excellent. The researcher also observed acquisition of problem solving skills by the students during the lesson and used the same rating. The researcher made notes also during observations made (Appendix iv)

3.8.3 Interviews

Orodho (2009) postulate that many people are willing to communicate orally than in writing and they would provide data more readily and fully than on a questionnaire. An investigator is able to encourage subjects and probe them deeply into a problem. The study is an explanatory sequential mixed method, in this case face to face interviews and focus group interviews were administered to explore the quantitative findings of the study both before and after intervention. An advantage with interviews is that the interviews gave an opportunity to explore affective as well as cognitive aspects of the participants' responses (Balan, 2012).

During the interviews, interview guides were used and the advantage of using such guides is that it gives the interviewer the freedom to follow up and probe deeper into respondents' answers within the areas of inquiry, gives enough structure for not loosing focus leaving out important issues or lack time to cover all areas of interest. In addition the interview guide to some extent guarantee that similar information is obtained from each respondent hence making interviews with multiple subjects become more systematic and comprehensive (Balan, 2012; Flick, 2002)

3.8.3.1: Face to Face interviews

Before intervention, One on one interviews were administered to 12 teachers of the selected schools and 50 % of the principals (6) from selected schools. After the intervention, focus group interview was administered to only 6 teachers who were in the experimental group to explore on the qualitative finding and propping them on their experiences during the intervention with the use of the five effective formative assessment strategies. The interview guide for the one to one interviews for teachers had 13 questions, the head teacher interview guide had 7 questions and the focus

group interviews guide had 8 questions. Video recording of the interviews were done to help gather and record the data and at the same time the field notes were taken by the assistant researcher.

3.8.3.2 Focus Group interview (FGI)

A focus group interview is a technique involving the use of in-depth group interviews in which participants are selected because they are a purposive although not necessarily representative, sampling of a specific population, this group being 'focused' on a given topic (Rabie, 2004; Lederman(see Thomas et. al. 1995). Participants in this type of research are therefore selected on the criteria that they would have something to say on the topic, are within the age range, have similar socio-characteristics and would be comfortable talking to the interviewer and each other(Rabae, 2004; Richardson & Rabae, 2001). According to Rabae (2004), one of the distinct features of focus group interviews is its group dynamics, hence the type and range of data generated through the social interaction of the group are often deeper and richer than those obtained from one- to- one interviews (Thomas et. al. 1995).

The optimum number of participants for a focus group may vary and Krueger & casey (2000) in Rabae (2004) suggest between six and eight participants, as smaller groups show greater potential. However, the number generally suggested as being manageable is between six and ten participants; large enough to give a variety of perspectives and small enough not to become disorderly or fragmented. Based on these suggestions, the study conducted one focus group interview of 6 teachers from the experimental group after the intervention in order to explore on the quantitative

findings of the study on the utilization of the five effective formative assessment strategies in Mathematics instruction.

3.8.4 Students' Mathematical Assessment Test (SMAT)

This constituted a pre-test and posttest. The test consisted of tasks from earlier national tests (standardized test) in Mathematics for reliability purposes. The test items were from the selected form three topic "Sequence and series". The researcher and the participant teachers chose the particular topic and the course book to use among the twelve selected schools (classes) during the intervention period which lasted for four weeks. During intervention, the experimental group was taught using the five effective formative assessment strategies in the framework while the control group continued with their classes as usual (without any treatment).The intention with the test was to analyze the impact of the five effective formative assessment strategies on learners' achievement in Mathematics.

3.9 Validity of the Research Instruments

Validity refers to the accuracy, correctness, meaningfulness of inferences and soundness of results of conclusion, which are based on the research findings (Kothari, 2008; Mugenda & Mugenda, 2003).

3.9.1 Face validity

Basically face validity checks that the questionnaire seems to measure the concept being tested (LoBiondo-Wood & Haber, 2010) and this was assessed by getting colleague D.phil students to test-run the instrument to see if the questions appear to be relevant, clear and unambiguous as outlined by Jones &Rattray (2010).

3.9.2 Content validity

The test checks whether there was enough relevant questions covering all aspects being studied and those irrelevant questions are not asked (Parahoo, 2006). The test is based on judgment as no objective methods exist. A panel of experts is used to evaluate the content validity of the questionnaires (Polit& Beck, 2010). The questionnaire was submitted to departmental specialists to check and examine whether the questions reflect the concepts being studied and that the scope of the questions is adequate, in the manner proposed by LoBiondo-Wood & Haber (2010). It is the most critical criterion that indicates the degree to which an instrument measures what it is supposed to measure (Kothari, 2009).

3.9.3 Construct Validity

A measure is said to possess construct validity to the degree that it conforms to predicted correlations with other theoretical propositions. Construct validity is the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory. For determining construct validity, we associate a set of other propositions with the results received from using our measurement instrument. If measurements on our devised scale correlate in a predicted way with these other propositions, we can conclude that there is some construct validity (Kothari, 2004). Construct validity of the teachers' questionnaire was verified by measuring the internal consistency of the single scales.

In ensuring validity of head-teachers' interview, the researcher assumed that the comments from Mathematics head-teachers are credible due to the fact that they have taught Mathematics for a period of time and therefore understand the formative assessments applied. The research tools were developed and validated before their use

with expert help from supervisors and lecturers from the school of education. The study also used adequate definitions and measures of variables. The researcher used the experts help to verify the content, construct and face validities of the instruments.

3.10 Reliability of the Research Instruments

According to Parahoo (2006) reliability is very crucial in research. Reliability of a questionnaire refers to its ability to yield the same data when it is re-administered under the same conditions but it is difficult to obtain a replication of data when you are dealing with people (Robson, 2007). It refers to the accuracy of the measurement. Reliability for quantitative research focuses mainly on stability and consistency (Polit & Beck, 2010).

The stability of a questionnaire is the degree to which it produces similar results on being administered twice. As recommended by Polit and Beck (2010) the researcher proposes doing a stability test using the test-retest method on a small population. The administration of the tools was carried out on two occasions within duration of two weeks with subjects from different schools that were not used in the actual study. Reliability was determined by correlating two administrations using Pearson's product-moment correlation coefficient (r).

During pilot study, three schools in Uasin Gishu County participated. The questionnaires were administered and the filled questionnaires were coded into SPSS software. After coding, Cronbach alpha reliability coefficient was computed using appropriate statistical software. In each questionnaire, a Cronbach alpha of 0.7 and above was considered reliable according to George and Mallery (2003). A croncbach alpha of 0.914 was obtained on teachers' questionnaire which had 40 items while a

cronbach alpha of 0.907 was obtained on students' questionnaire which had 34 items hence both the teacher and learner questionnaires were found to be reliable.

3.11 Piloting

To obtain high-quality outcomes, a good research study with relevant research design and accurate performance was required in this study. Analyzing its feasibility or pilot study prior to performing the main study was very beneficial for this purpose. A pilot study is the first step of the entire research protocol and is often a smaller-sized study assisting in planning and modification of the main study (Junyong, 2017). Piloting was done to establish whether the instruments could be used to collect relevant data, identify any problems likely to occur at the time of actual data collection process and to also check whether the instructions in the questionnaires are understandable to the respondents. The results were used to test the validity and reliability of the research tools. The study was conducted in neighboring Uasin Gishu County in three schools.

3.12 Data Collection Procedures

Before data collection, the researcher first sought permission from National Commission of Science, Technology and Innovations (NACOSTI). The researcher also further seek for authority to conduct the study from the County commissioner and the County Director of Education, Nandi County further the researcher seek for permission from the sampled secondary schools principals to conduct research in their respective schools.

The data collection instruments were validated, piloted and their reliability determined before actual data collection. Data were collected using questionnaires, interview schedules, Mathematics achievement tests, and observation checklist and

teachers Focus group interview. The researcher booked an appointment with the relevant subjects to be interviewed. For the purpose of this study, the researcher conducted face-to-face, semi-structured interviews and focus group interviews to investigate the participants' perceptions and experiences regarding the study. During the interviews, the researcher asked the interviewees predetermined, open-ended questions, allowing for flexibility in follow-up questions. Data collection involved distribution of research instruments to the selected schools for the research.

Before embarking on data collection, a reconnaissance study was undertaken for the schools selected. The researcher visited the schools to seek permission from the head teachers and to familiarize herself with the teachers who volunteered to participate in the study.

3.13 Data Analysis

3.13.1 Quantitative Data

The quantitative data from Teacher and student questionnaires, observation schedule were first subjected to preliminary processing through validation, coding and tabulation in readiness for analysis with the help of the SPSS software to analyze data related to objectives. Frequencies, percentages, means, t-test, and Structural Equation modeling were used to analyze quantitative data.

3.13.2 Qualitative Data

The qualitative data from teachers' and head teachers' interview guides and observation schedule were transcribed, thematically classified and arranged before they were reported in narrations and excerpts. The transcripts were read a number of times and categorized by the researcher and by using meaning concentration method

(Balan, 2012) a number of subthemes were identified. Constant comparison analyses were used to analyze data from interview guides.

The analyzed data were presented in tables and graphs. In addition, the quantitative analysis was supplemented by qualitative descriptions to explore and expand on the quantitative finding in order to provide in–depth explanations of the findings and validation.

Table 6: Summary of Data Analysis

Objective	IV	DV	Statistical Test
To investigate the level of use of the five effective formative assessment strategies in Mathematics instruction	Level of use of FAS	Mathematics achievement	Frequencies, Percentages Means and SD Qualitative thematic analysis
To analyze the impact of the five effective formative assessment strategies used on learners' achievement in Mathematics	Impact of FAS on learner achievement	Mathematics achievement	Independent sample t test Means SD
To ascertain the learners' and teachers' perceptions in relation to the use of the five effective formative assessment strategies in Mathematics instruction	Teacher' and learner'Perceptions on FAS	Mathematics achievement	Frequencies, Percentages, means and std Independent sample t test Qualitative thematic analysis
To analyze structural association between the five effective formative assessment strategies and learners' achievement in Mathematics.	Structural association of five FAS	Mathematics achievement	Structural Equation Modelling (AMOS package).
To investigate teachers' support on the implementation of the five effective formative assessment strategies in Mathematics instruction	Teachers'support on implementation of FAS	Mathematics performance	Frequencies Percentages Means standard deviation Qualitative thematic analysis

3.14 Ethical Considerations

The study will observe all the rules and regulations in carrying out research in Kenya. Before going out to the field, a research permit was obtained from the National Council of Science and Technology and the same to the County Director of Education. Privacy, confidentiality and openness in data collection were ensured throughout the study. The study took note of ethical issues that were important in research. The major ethical issues of concern are informed consent from the participants so as to remove job insecurity, privacy and confidentiality on information supplied, anonymity to safeguard the identity of the respondents and the researcher's sensitivity to human dignity (Oso & Onen, 2002).The researcher always seek consent from the participants and have the consent forms duly signed before participation by the respondents.

The research confidentiality was assured to all the respondents and all participants were informed to voluntarily participate in the research. On trustworthiness, the respondents were requested to be open and honest when dealing with the questions. The identity of the respondent was kept out of this documentation and data availed were used strictly only for the academic purpose of this study. The study was carried out with the consent of the authorities.

At the end of this chapter the researcher gave a visual representation of the entire research process from conceptualization of research and protocol development, ethical approval, reconnaissance study, quantitative data collection and analysis 1, qualitative data collection and analysis 1, interpretation of the finding 1, training of teachers, intervention period, Quantitative data collection and analysis 2, qualitative data

collection and analysis 2, interpretation of the finding 2 and finally writing of thesis findings.

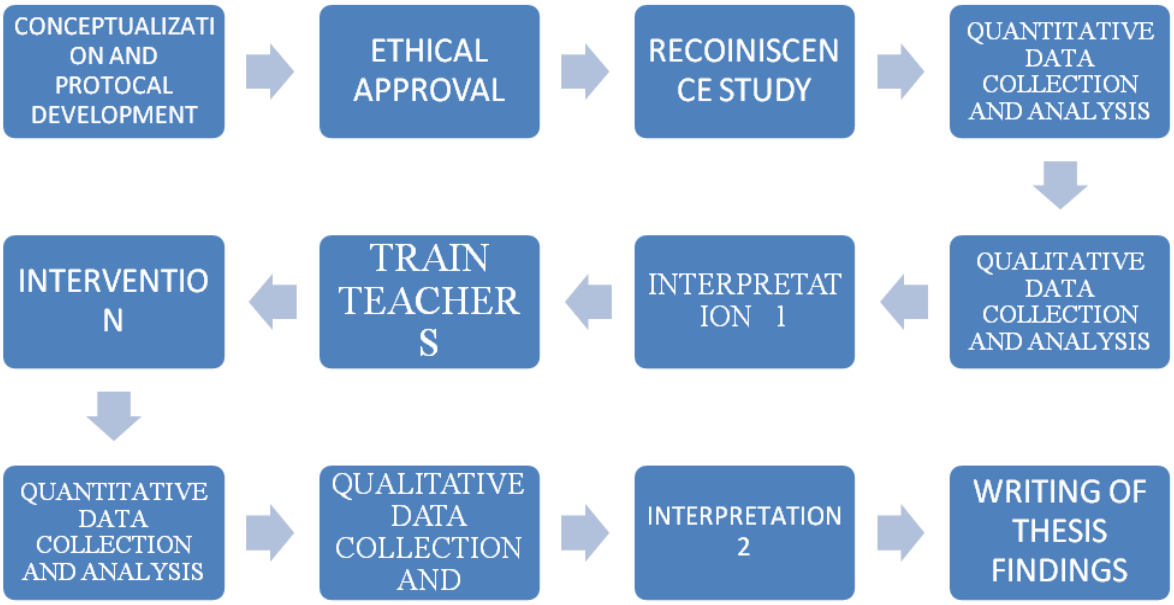

Figure 9: Visual representation of the research process by the researcher.

3.15 Summary of Chapter Three

This chapter has focused on the various details concerning research paradigms, design and methodology the study employed. Details on specific study area, target population sample size and sampling procedures have been given. Details about each research tools and how they were administered to obtain data have been given. Data analysis and ethical considerations were presented and the researcher drew her research cycle with the use of a visual representation showed above. Discussion on data analysis, presentation and interpretation was done in the next chapter.

CHAPTER FOUR

DATA ANALYSIS PRESENTATION, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter presents the data analysis, interpretation and presentation. The analysis of data in this chapter starts with the demographic profile of the respondents and then afterwards follows the research questions of the study. There were a number of data analysis methods employed in this study, among them is descriptive statistics that was used to ascertain the demographic of the respondents in the present study. Descriptive study also was used to compute percentages and means that were obtained out of the research questionnaire. The means obtained in this particular analysis were used to describe the rating of the respondents on every item of the questionnaire on the level of use of the FAS strategies and teachers' support on the implementation of formative assessment strategies.

Independent sample t-test was used to find out if there was any statistically significant difference in performance of students, teachers' and learners' perceptions before and after experiment between control and experimental groups. Structural Equation Modelling was used to analyze the association between the five effective formative assessment strategies and learners' achievement. The critical alpha used in the entire study is 0.05 or confidence interval of 95%. The analyzed data was then presented in form of tables and some pie chart and path diagrams. The study used modified Likert scale questionnaire in which ranges from 1-4 and others 1-5.

4.1 Demographic Profile of the Students and Teachers

The study involved 33 teachers and 534 students who were drawn from Sub- County secondary schools in Nandi County. Their demographic information is as presented in table 7.

Table 7: Demographic Profile of the Students and Teachers

Students Data			
		Frequency	**Percent**
Group of School	Experimental	227	43%
	Control	307	57%
Students' Gender	Male	289	54%
	Female	245	46%
	Boys Only	178	33%
School Type	Girls Only	153	29%
	Mixed	203	38%
	10-14	0	0%
Students Age Group	15-19	501	93%
	20-24	31	7%
Teachers Data			
	Experimental	15	45%
School Group	Control	18	55%
	Male	25	76%
Gender	Female	8	24%
	Bachelors	31	94%
Level of Education	Masters	2	6%
	Below 5 Years	19	58%
Teaching Experience	5-10 Years	8	24%
	11-15 Years	2	6%
	Over 16 Years	4	12%
	Boys Only	7	21%
School Type	Girls Only	9	27%
	Mixed	17	52%

The study involved 534 students from Nandi County who were grouped under the experimental and control groups. This involved 43% of the students who participated in the experiment and 57 % who were in the control group. Among the students who participated in the study, 54% were males and 46% were female. The data acquired during the study show that 33% of the students were from boy's school only, 29% were from girls' schools only, and 38% of the students came from the mixed school as indicated in the following bar graph.

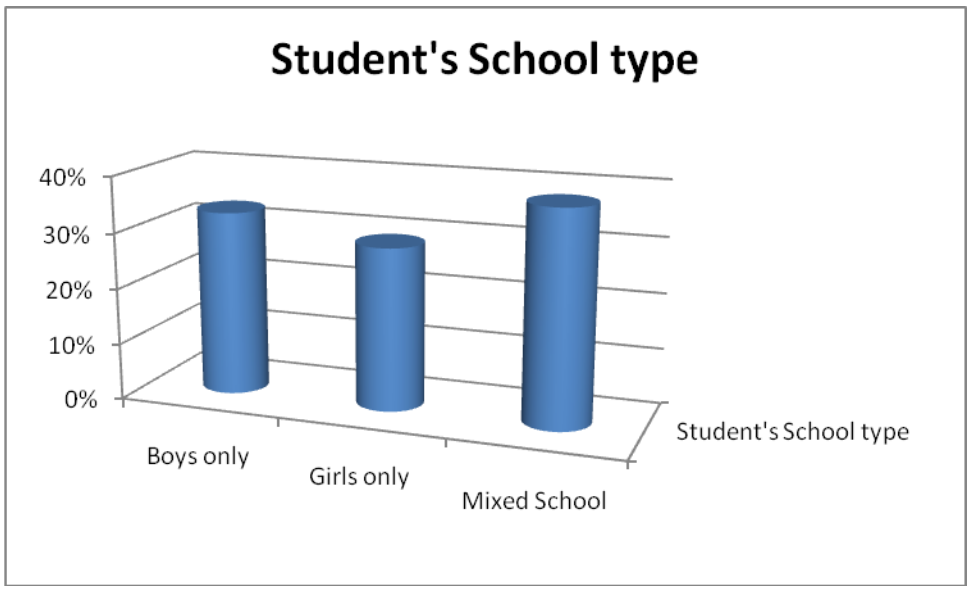

Figure 10: Students' demographic on school type.

The teacher's data reveals that among the 33 teachers who participated in the study, 45% participated were categorized in experimental group while 55% were control schools group. It was noted that 76% of the teachers who participated in the study were male and 24% were female. This shows that majority of the teachers who teach Mathematics in Nandi county are male. It was evident that 94% of the teachers had bachelor's degree as their highest level of education while 6% had a masters as their most level of education as none had diploma as the highest level of education. This

shows that in all the schools in the County, all the teachers had acquired university degrees. As shown in table 7, 58% of the teachers who participated in the study in Nandi County had below five years' experience, 24% had experience of between five to ten years during the time of the study. It was also found out that 6% of the teacher had experience between ten to fifteen years and 12% were over fifteen years in experience.

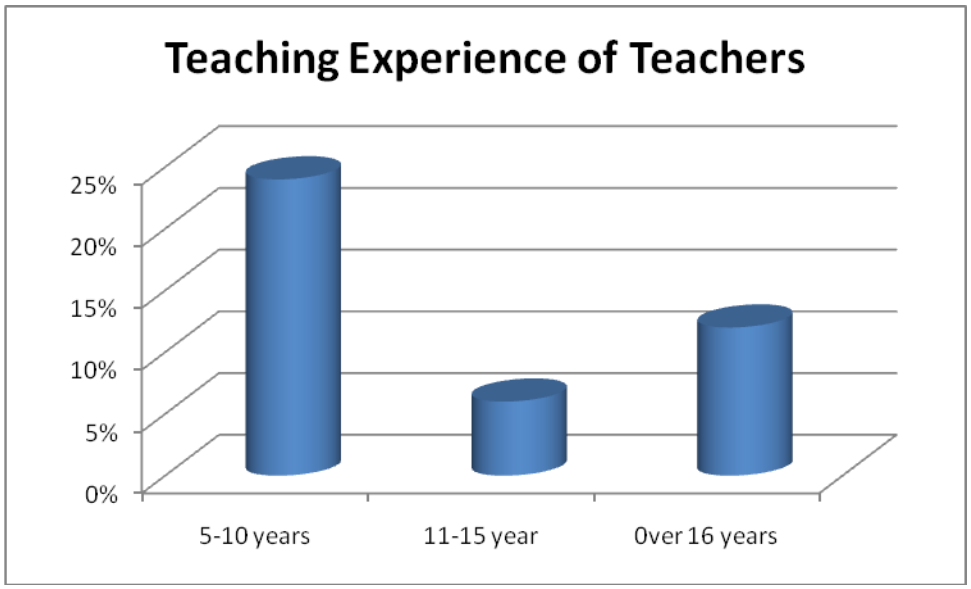

Figure 11: Teachers' demographic on teaching experience

In general, it was evident that majority of the teachers over 80% had experience of less than or equal to ten years in Mathematics instruction. This experience is good enough to show their use of the five formative assessment strategies in Mathematics instruction. The table shows that 21% of the schools were boys, 27% girl's schools, 52% were mixed schools, hence majority of the participating schools were mixed schools.

4.2 Findings According to Study Objectives

The study was centered on the five effective formative assessment strategies as mentioned earlier; clarifying and sharing learning intentions and criteria for success, engineering effective classroom discussions (questions and learning tasks), Feedback that moves learners forward, Activating students as the owners of their own learning (Self assessment) and Activating students as instructional resources for one another (Peer assessment). Therefore, the research objectives were;

i. To investigate the level of use of the five Effective Formative Assessment strategies in Mathematics instruction.
ii. To determine the impact of the five Effective Formative Assessment strategies on learner's achievement in Mathematics.
iii. To ascertain the teachers' and learners' perception of the five Effective Formative Assessment strategies in Mathematics instruction.
iv. To fit a structural association model for the learners' achievement in Mathematics instruction.
v. To investigate teachers' support on the implementation of the five Formative Assessment strategies in Mathematics instruction

The following three null hypotheses were tested at significance level of 0.05

i. $H0_1$: There is no significant difference in learner's achievement between the experimental and control groups when subjected to the five effective formative assessment strategies in Mathematics instruction.
ii. $H0_2$: There is no significant difference in teachers' and learners' perceptions of the five effective formative assessment strategies between the experimental and control groups in Mathematics instruction.

iii. $H0_3$: The structural association model fits well the data for learners' achievement in Mathematics instruction.

4.2.1 Level of use of the Five Effective Formative Assessment Strategies

The objective was to investigate the Level of Use of the Five Effective Formative Assessment strategies in Mathematics Instruction. The strategies include Clarifying and sharing learning intentions and criteria for success; Engineering effective classroom discussions, questions and learning tasks; Providing feedback that moves learners forward; Activating students as the owners of their own learning (Self-Assessment) and as the instructional resources for one another (Peer assessment). Both quantitative and qualitative data were collected sequentially as explained earlier, the quantitative data was used to explore on the quantitative finding where in-depth explanation and expansion were further sought.

4.2.1.1 Quantitative data

Quantitative data were collected before and after the intervention period using students' questionnaire, teachers' questionnaire and researchers' observation schedule. The data from the three were triangulated in order to validate the findings of the study.

4.2.1.1.1 Data from student questionnaire on the five effective formative assessment strategies

The student questionnaire covered six sections (A,B,C,D,E,F) as indicated in appendix (iii) where the first five sections were on the five effective FAS and the sixth section was on learners perceptions. Students rated the level of use of the five

effective formative strategies using a likert scale of five (Never, Seldom, Sometimes, Often and Always). Students' data on each FAS strategy were presented in the next sections.

4.2.1.1.1.1 Clarifying and Sharing Learning Intentions and Criteria for Success

There was need to find out the level of use of clarifying and sharing learning intentions and criteria for success strategy in Mathematics instructions as perceived by the students who participated in the study. The use of this strategy was indicated by their responses on the as shown in table 8.

Table 8: Clarifying and sharing learning intentions and criteria for success

Clarifying and sharing learning intentions and criteria for success		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
My teacher:		E %	C %	E %	C %	E %	C %	E %	C %	E %	C %
1) Provides Mathematics objectives at the beginning of each lesson	A	0	19%	0	1%	0	4%	17%	6%	83%	70%
	B	20%	20%	5%	5%	4%	4%	6%	6%	65%	55%
2) Provide clarification of the listed objectives of the lesson	A	0	16%	0	0	1%	8%	29%	14%	70%	62%
	B	17%	17%	6%	7%	7%	7%	14%	14%	55%	55%
3) State the benefits of each objectives to us	A	0	25%	0	0	0	6%	21%	15%	79%	54%
	B	25%	25%	6%	6%	5%	5%	15%	15%	48%	49%
4) States and explains the procedures of success in each lesson	A	0	15%	0	0	0	7%	26%	18%	74%	60%
	B	15%	15%	9%	9%	6%	6%	17%	17%	52%	53%
5) Gives us enough time to think through the procedures of success and apply in our own work	A	0	27%	0	0	0	5%	26%	24%	74%	44%
	B	26%	26%	7%	7%	6%	5%	24%	24%	38%	38%
6) Explains to us the connections between new, prior, and future learning	A	0	21%	0	7%	0	0	34%	19%	66%	53%
	B	21%	21%	11%	11%	8%	8%	19%	20%	40%	40%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers provide Mathematics objectives at the beginning of each lesson as indicated by the students who participated in the study. The findings show that before the treatment, never was noted by 20% of the students in both groups, seldom by 5% of the students from both groups, sometimes was noted by 4% of the students in both groups; often was noted by 6% of the students in both groups as always was noted by a majority 55% and 65% of the students in the control and experimental groups respectively. After the treatment, the results show that the always use was noted by 83% and 70% of the students from the experimental and control groups respectively. There was a margin of 15% and 18% for the students from the control and experimental groups respectively after the treatment.

The results show that more students from the experimental group acknowledged that objectives were provided at the beginning of each lesson. This resulted from subjecting the learners to the five formative assessment strategies in the experimental group. Hattie, 2009 argued that the effectiveness of an education system is measured by the success of accomplishment of learning objectives and therefore teachers play a key role in shaping effective education by providing students with the learning objectives. The findings further support those of Chappuis (2017) who pointed that teachers need to begin their lessons by giving students a vision of the learning destination where teachers share with their students the learning targets, objectives or goals either at the outset of instruction or before they begin an independent practice activity.

On whether teachers provide clarification of the listed objectives of the lesson, before the experiment, never was indicated by 17% of the students from both the experimental and control groups, seldom was noted by 6% and 7% for the control and

experimental groups respectively, sometimes by 7% of the students from both groups; often by 14% and always by 55% of the students from both the experimental and control groups. However, after the treatment, differences were noted with the experimental group having a higher value of 70% than 62% for the control group. The margin for the experimental group was higher with 15% increase while that of the control group was 7%. This is attributed to the treatment of the experimental group. Anderson and Palm (2017) pointed out that clearer goals facilitated the assessment of the most relevant knowledge and skills, which in turn provided more valid and reliable data about students' learning needs and thus the possibility to make more valid and reliable decisions about how to act to support all students' learning towards the learning goals.

On whether the teacher state the benefits of each objective to the student, before the treatment never was noted by 25% of the students from both the experimental and control groups; seldom by 6% of the students from both groups; sometimes by 5% of the students from both groups; often by 15% of the students from both groups; as always was noted by 48% and 49% of the students from the experimental and control groups respectively. However, after the experiment, never and sometimes was only noted by students from the control groups with values of 25% and 6%, none of the students noted seldom as 21% and 79% a majority of the students from the experimental group noted that their teachers state the benefits of each objective to the students always.

On whether the teachers state and explain the procedures of success in each lesson, pre-test results show that for students from both groups, never was noted by 15%, seldom by 9%, sometimes by 6%, often by 17% and always by 52% and 53% from

the experimental and control groups respectively. However, after the treatment, never and sometimes was noted by 15% and 7% of the students from the control groups only, often was noted by 26% and 18% of the students from the experimental and control groups as always was noted by a majority 74% and 60% of the students from the experimental and control groups respectively. According to Chapius (2017) there are three ways to explain the procedures of success in each lesson; stating the learning target as is, converting the learning target into student friendly language or for learning targets assessed with a rubric and converting the rubric to student-friendly language.

On whether the teachers give students enough time to think through the procedures of success and apply in our own work, pre-test results show that for students from both groups, never was noted by 26%, seldom by 7%, sometimes by 6% and 5% from the experimental and control groups respectively, often and always by 24% and 38% of the students from both groups. The post-test results showed that never and sometimes was noted by 27% and 5% of the students from the control group only, often was noted by 26% and 24% of the students from the experimental and control groups respectively as always was noted by a majority 74% and 44% of the students from the experimental and control groups respectively.

On whether the teachers explain to students the connections between new, prior, and future learning, pre-test results show that for students from both groups, never was noted by 21%, seldom by 11%, sometimes by 8%, often by 19% and 20% for the experimental and control groups respectively as always was noted by 40% for the students from both the experimental and control groups. However, after the treatment, never and seldom were noted by 21% and 7% of the students from the control groups

only, often was noted by 34% and 19% of the students from the experimental and control groups respectively as always was noted by a majority 66% and 53% of the students from the experimental and control groups respectively. From the findings, the use of the strategy; clarifying and sharing learning intentions and criteria for success was rated low before the intervention but the practice improved after subjecting the learners to the five formative assessment strategies. Learners were also asked to respond to the second strategy of the five effective formative assessment strategies that is engineering effective classroom discussions, questions and learning tasks.

4.2.1.1.1.2: Engineering Effective Classroom Discussions, Questions and Learning Tasks

There was need to find out the opinions of students on how their teachers engineered effective classroom discussions, questions and learning tasks. The subjects responded on 6 items in relation to this strategy and their responses are as indicated in table 9.

Table 9: Engineering effective classroom discussions, questions and learning tasks

Engineering effective classroom discussions, questions and learning tasks		Never		Seldom		Sometimes		Often		Always	
		E %	C %	E %	C %	E %	C %	E %	C %	E %	C %
1) My teacher asks questions within the lesson to assess whole group and individual student progress	A	0	10%	0	14%	2%	7%	24%	21%	74	48%
	B	11	11%	3%	2%	6%	6%	12%	12%	69	69%
2) My teacher makes adjustments to instruction within the lesson based upon our responses on the learning tasks	A	1%	20%	0	7%	1%	9%	23%	23%	74%	41%
	B	0	20%	5	5%	6	6%	15	15%	54	54%
3) My teacher gives us adequate wait time to respond to questions	A	1%	18%	0	10%	1%	5%	23%	22%	74%	45%
	B	21	21%	4	4%	4	4%	11	11%	60	60%
4) My teacher uses follow-up questions when engaging us in class discussion	A	4%	16%	1%	9%	2%	10%	26%	25%	67%	40%
	B	17	16%	4	4%	5	5%	20	20%	55	55%
5) The tasks and activities within the lesson are directly tied to learning objectives	A	3%	28%	1%	4%	4%	12%	32%	19%	60%	47%
	B	26	26%	10	10%	13	13%	13	13%	38	38%
6) The tasks and activities within the lesson provide evidence of our progress toward learning objectives	A	3%	19%	0	9%	4%	11%	32%	21%	60%	40%
	B	19	19%	9	9%	9	9%	16	16%	47	47%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

The students asked to respond on whether their teachers ask questions within the lesson to assess whole group and individual student progress. As revealed in the findings, never was noted by 11% of the students from both the experimental and control groups before the experiment, seldom by 3% from the experimental group and 2% from the control group, sometimes and often by 6% and 12% respectively of the students from the experimental and control groups. A majority 69% of the students from both groups noted that it is done always. However, after the treatment, post-test results showed that never and seldom were noted by 10% and 14% students only from the control group. Sometimes was noted by 2% of the students from the experimental group and 7% of the students from the control group; often was noted by 24% of the students from the experimental group and 21% of the students from the control group. A majority, 74% of the students from the experimental group and 48% of the students from the control group noted that teachers ask questions within the lesson to assess whole group and individual student progress always. The results showed that there was a higher margin increase of 5% for the experimental group and a decrease of 21% on the always practice as noted by the students in the control group.

On whether the teacher makes adjustments to instruction within the lesson based upon our responses on the learning tasks, the pre-test results show that never was noted by 20% of the students only from the control group; seldom, sometimes and often was noted by 5%, 6% and 15% respectively for all the students in both the experimental and control groups. A always practice was noted by a majority, 54% of the students from both the experimental and control groups. However, after the experiment, the post-test results showed variations as never 1% and 20% of the students from the experimental and control groups, seldom was noted by 7% of the students only from the control group, sometimes was noted by 1% and 9% of the students from the

experimental and control groups respectively, often by 23% of the students from both the experimental and control groups as the always practice was noted by 74%, a majority from the experimental and 41% for the control groups. The results show that, for the always practice of the strategy, there was a margin of 20% increase for the experimental group while there was a decrease of 14% for the students in the control groups.

On whether the teacher gives students adequate wait time to respond to questions, pre-test data shows that never, seldom, sometimes, often and always was noted by 21%, 4%, 4%, 11% and 60% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 1% and 18% of the students from the experimental and control groups, seldom was only noted by 10% of the students from the control group, sometimes by 1% and 5% of the students from the experimental and control groups, Often by 23% and 22% of students from the experimental and control groups as always practice of the strategy by a majority 74% and 45% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 14% increase for the experimental group while there was a decrease of 15% for the students in the control groups.

On whether the teachers use follow-up questions when engaging students in class discussion sometimes the pre-test data shows that never was noted by 17% and 16% of the students from the experimental and control groups respectively, seldom, sometimes, often and always practice was noted by 4%, 5%, 20% and 55% respectively for all the students in both the experimental and control groups. However after the treatment, the post-test results show that never was noted by 4% and 16% of

the students from the experimental and control groups, seldom was only noted by 1% and 9% of the students from the experimental and control groups respectively, sometimes by 2% and 10% of the students from the experimental and control groups respectively, often by 26% and 25% of the students from the experimental and control groups respectively as always practice of the strategy by a majority 67% and 40% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 12% increase for the experimental group while there was a decrease of 15% for the students in the control groups.

On whether the tasks and activities within the lesson are directly tied to learning objectives, the pre-test results show that that never, seldom, sometimes, often and always was noted by 26%, 10%, 13%, 13% and 38% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 3% and 28% of the students from the experimental and control groups, seldom was only noted by 1% and 4% of the students from the experimental and control groups of the students, sometimes by 4% and 12% of the students from the experimental and control groups, Often by 32% and 19% of students from the experimental and control groups as always practice of the strategy by a majority 60% and 47% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a higher margin of 22% increase for the experimental group as compared to the 9% increase for the students in the control groups.

On whether the tasks and activities within the lesson provide evidence of student's progress toward learning objectives, the pre-test results show that that never, seldom,

sometimes, often and always was noted by 19%, 9%, 9%, 16% and 47% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 3% and 19% of the students from the experimental and control groups, seldom was only noted by 9% of the students only from the control groups, sometimes by 4% and 11% of the students from the experimental and control groups, Often by 32% and 21% of students from the experimental and control groups respectively as always practice of the strategy by a majority 60% and 40% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 13% increase for the experimental group while there was a decrease of 7% for the students in the control groups.

4.2.1.1.1.3: Providing feedback that moves learners forward

The study sought to establish the level of use of the strategy of providing feedback that moves learners forward by teachers. The findings are as presented in table 10.

Table 10: Providing feedback that moves learners forward

Providing feedback that moves learners forward		Never		Seldom		Sometimes		Often		Always	
My teacher:		E %	C %	E %	C %	E %	C %	E %	C %	E %	C %
1) Encourages us to discover our own errors and misconceptions	A	4%	23%	0	0	1%	5%	28%	16%	67%	56%
	B	17%	17%	5%	5%	5%	5%	18%	18%	55%	55%
2)Gives us immediate feedback during the lesson	A	6%	17%	0	6%	1%	10%	32%	13%	61%	54%
	B	17%	17%	4%	4%	8%	8%	16%	16%	55%	55%
3)Gives us corrective measures on our errors and misconceptions immediately	A	2%	16%	0	8%	3%	6%	26%	17%	69%	53%
	B	16%	16%	5%	5%	7%	7%	17%	17%	55%	55%
gives us opportunity to internalize feedback and apply it in a meaningful way	A	4%	19%	0	6%	5%	9%	24%	19%	67%	47%
	B	18%	18%	5%	5%	10%	10%	21%	21%	46%	46%
uses a variety of assignments at the end of every lesson e.g. filling gaps, etc.	A	4%	12%	0	0	3%	7%	21%	15%	72%	66%
	B	13%	13%	5%	6%	7%	7%	15%	15%	59%	49%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

The study sought to establish the level of use of the strategy of providing feedback that moves learners forward as perceived by teachers. Answers were sought as to whether the teachers encourage students to discover our own errors and misconceptions; gives students immediate feedback during the lesson; gives students corrective measures on our errors and misconceptions immediately; give students opportunity to internalize feedback and apply it in a meaningful way and use a variety of assignments at the end of every lesson e.g. filling gaps, etc. The students' responses are as shown in table 4.4 and as presented in the following sections.

The students were asked to respond on whether their teachers encourage them to discover our own errors and misconceptions. As revealed in the findings, before the experiment, never, seldom, sometimes, often and always was noted by 17%, 5%, 5%, 18% and 55% of all the students respectively from both the experimental and control groups. However, after the treatment, post-test result show that never was noted by 4% and 23% of the students from the experimental and control groups. Sometimes was noted by 1% of the students from the experimental group and 5% of the students from the control group; often was noted by 28% of the students from the experimental group and 16% of the students from the control group. A majority, 67% of the students from the experimental group and 56% of the students from the control group noted that teachers encourage them to discover their own errors and misconceptions always. The results show that there was a higher margin increase of 12% for the experimental group as compared to the increase of only 1% on the always practice as noted by the students in the control group.

On whether the teacher gives students immediate feedback during the lesson, the pre-test results show that never, seldom, sometimes, often and always was noted by 17%,

4%, 8%, 16% and 55% respectively for all the students from both the experimental and control groups. However, after the experiment, the post-test results showed variations as never was noted by 6% and 17% of the students from the experimental and control groups, seldom was noted by 6% of the students only from the control group, sometimes was noted by 1% and 10% of the students from the experimental and control groups respectively, often by 32% and 13% of the students from the experimental and control groups respectively as the always practice was noted by 61%, a majority from the experimental and 54% for the control groups. The results show that, for the always practice of the strategy, there was a margin of 6% and 1% increase for the students in the experimental control groups respectively.

On whether the teacher gives students corrective measures on our errors and misconceptions immediately, pre-test data shows that never, seldom, sometimes, often and always was noted by 16%, 5%, 7%, 17% and 55% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 2% and 16% of the students from the experimental and control groups, seldom was only noted by 8% of the students from the control group only, sometimes by 3% and 6% of the students from the experimental and control groups, Often by 26% and 17% of students from the experimental and control groups as always practice of the strategy by a majority 69% and 53% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 14% increase for the experimental group while there was a decrease of 2% for the students in the control groups.

On whether the teachers give students opportunity to internalize feedback and apply it in a meaningful way the pre-test data shows that never, seldom, sometimes, often and always was noted by 18%, 5%, 10%, 21% and 46% of all the students respectively from both the experimental and control groups. However after the treatment, the post-test results show that never was noted by 4% and 19% of the students from the experimental and control groups, seldom was only noted by 6% of the students from the control groups only, sometimes by 5% and 9% of the students from the experimental and control groups respectively, Often by 24% and 19% of the students from the experimental and control groups respectively as always practice of the strategy by a majority 67% and 47% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a higher margin of 21% increase for the experimental group while there was an increase of 1% only for the students in the control groups.

On whether the teachers use a variety of assignments at the end of every lesson e.g. filling gaps among others, the pre-test results show that that never was noted by 13%, of the students from both the experimental and control groups, seldom by 5% and 6% of the students from the experimental and control group, sometimes and often by 7% and 15% of all the students respectively from both the experimental and control groups and always was noted by 59% and 49%, of the students respectively from the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 4% and 12% of the students from the experimental and control groups, sometimes by 3% and 7% of the students from the experimental and control groups respectively, Often by 21% and 15% of the students from the experimental and control groups as always practice of the strategy by a majority 72% and 66% respectively from the experimental and control groups. The results show

that, for the always practice of the strategy, there was a margin of 13% and 17% increase respectively for the students in the experimental and control groups.

4.2.1.1.1.4: Activating Students as Owners of their Own Learning (Self-Assessment)

The study sought to establish the level of use of the strategy of activating students as the owners of their own learning (Self-Assessment). The findings are as presented in table 11.

Table 11: Activating students as the owners of their own learning (Self-Assessment)

Activating students as the owners of their own learning (Self-Assessment)		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
My teacher		E %	C %	E %	C %	E %	C %	E %	C %	E %	C %
1)encourages the learners to do self-assessment during the lesson	A	5%	28%	0	0	1%	5%	27%	16%	65%	51%
	B	26%	26%	6%	6%	5%	5%	16%	16%	46%	47%
2)encourages individual criticisms of tasks and activities During the lesson,	A	6%	30%	0	0	3%	9%	33%	22%	56%	39%
	B	31%	31%	4%	4%	9%	9%	20%	20%	36%	36%
3)engages us in self-reflection and letting us keep track of our learning	A	5%	17%	0	0	3%	9%	29%	20%	63%	54%
	B	17%	17%	8%	8%	9%	9%	19%	17%	47%	47%
4)encourages us to develop self-actualization and self esteem	A	3%	15%	0	0	4%	10%	29%	20%	64%	55%
	B	15%	15%	5%	5%	11%	11%	19%	19%	50%	50%
5)uses evidence generated through our self-assessments to inform future teaching and learning	A	5%	19%	0	0	5%	15%	33%	18%	57%	48%
	B	19%	19%	10%	10%	14%	14%	18%	18%	39%	39%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

The study sought to establish the level of use of the strategy of activating students as the owners of their own learning (Self-Assessment). Answers were sought as to whether the teachers encourage the learners to do self-assessment during the lesson; encourage individual criticisms of tasks and activities during the lesson; engage students in self-reflection and letting them keep track of our learning; encourage students us to develop self-actualization and self-esteem and teacher use of evidence generated through student self-assessments to inform future teaching and learning. The results are as presented in the following sections.

The students were asked to respond on whether their teachers encourage the learners to do self-assessment during the lesson. As revealed in the findings, before the experiment, never seldom, sometimes and often was noted by 26%, 6%, 5% and 16% of the students from both the experimental and control groups respectively. A majority 46% and 47% of the students from the experimental and control groups respectively noted that it is done always. However, after the treatment, post-test result show that never was noted by 5% and 28% of the students from the experimental and control groups respectively. Sometimes was noted by 1% of the students from the experimental group and 5% of the students from the control group; often was noted by 27% of the students from the experimental group and 16% of the students from the control group. A majority, 65% of the students from the experimental group and 51% of the students from the control group noted that teachers encourage the learners to do self-assessment during the lesson always. The results show that there was a higher margin increase of 19% for the experimental group as compared to 4% for the control group on the always practice as noted by the students.

On whether the teacher encourage individual criticisms of tasks and activities during the lesson, the pre-test results show that never, seldom, sometimes, often and always was noted by 31%, 4%, 9%, 20% and 36% respectively for all the students in both the experimental and control groups. However, after the experiment, the post-test results showed variations as never 6% and 30% of the students from the experimental and control groups, sometimes was noted by 3% and 9% of the students from the experimental and control groups respectively, often by 33% and 22% of the students from the experimental and control groups respectively as the always practice was noted by 56%, a majority from the experimental and 39% for the control groups. The results show that, for the always practice of the strategy, there was a margin of 20% increase for the experimental group while there was an increase of 3% only for the students in the control groups.

On whether the teacher engage students in self-reflection and letting them keep track of our learning, pre-test data shows that never, seldom, sometimes and always was noted by 17%, 9%, 9% and 47% of all the students respectively from both the experimental and control groups, often was noted by 19% and 17% of the students from the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 5% and 17% of the students from the experimental and control groups, sometimes was noted by 3% and 9% of the students from the experimental and control groups, Often by 29% and 20% of students from the experimental and control groups as always practice of the strategy by a majority 63% and 54% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 16% and 7% increase for the students in the experimental and control groups respectively.

On whether the teachers encourage students us to develop self-actualization and self-esteem the pre-test data shows that never, seldom, sometimes, often and always practice was noted by 15%, 5%, 11%, 19% and 50% respectively for all the students in both the experimental and control groups. However, after the treatment, the post-test results show that never was noted by 3% and 15% of the students from the experimental and control groups, sometimes by 4% and 10% of the students from the experimental and control groups respectively, Often by 29% and 20% of the students from the experimental and control groups respectively as always practice of the strategy by a majority 64% and 55% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 14% and 5% increase respectively for the students in the experimental and control groups.

On teacher use of evidence generated through student self-assessments to inform future teaching and learning, the pre-test results show that that never, seldom, sometimes, often and always was noted by 19%, 10%, 14%, 18% and 39% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 5% and 19% of the students from the experimental and control groups, sometimes was noted by 5% and 15% of the students from the experimental and control groups, Often by 33% and 18% of students from the experimental and control groups as always practice of the strategy by a majority 57% and 48% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a higher margin of 18% increase for the experimental group as compared to the 9% increase for the students in the control groups.

4.2.1.1.1.5: Activating Students as Instructional Resources for one another (Peer Assessment

The study sought to establish the level of use of the strategy of activating students as the instructional resources for one another (Peer assessment). The findings are as presented in table 12.

Table 12: Activating students as the instructional resources for one another (Peer assessment)

Activating students as the instructional resources for one another (Peer assessment)		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
My teacher:		E %	C %	E %	C %	E %	C %	E %	C %	E %	C %
1)encourages us to assist one another in solving problems during the lesson	A	6%	12%	0	0	1%	4%	20%	8%	73%	76%
	B	12%	12%	5%	5%	4%	4%	8%	8%	71%	71%
2)encourages us to assess each other's work during the lesson	A	11%	40%	0	0	0	6%	35%	19%	54%	35%
	B	40%	40%	4%	4%	6%	6%	18%	17%	32%	33%
3)encourages small group discussions during the lesson	A	12%	33%	0	0	3%	8%	33%	20%	52%	39%
	B	32%	32%	5%	5%	8%	8%	21%	21%	35%	34%
4)encourages us to participate in collaborative tasks, activities and responses	A	8%	25%	0	0	4%	8%	31%	19%	57%	48%
	B	25%	25%	9%	9%	8%	9%	19%	18%	39%	39%
5)engages us in dialogue with our peers comments on each other's' work	A	9%	39%	0	0	7%	14%	29%	18%	55%	29%
	B	40%	40%	7%	7%	14%	14%	17%	17%	21%	22%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

The study sought to establish the level of use of the strategy of Activating students as the instructional resources for one another (Peer assessment). Answers were sought as to whether the teachers encourage students to assist one another in solving problems during the lesson; encourages students to assess each other's work during the lesson; encourage small group discussions during the lesson; encourage students to participate in collaborative tasks, activities and responses and engage students in dialogue with their peers' comments on each other's' work. The results are as presented in the following sections.

The students asked to respond on whether their teachers encourage students to assist one another in solving problems during the lesson. As revealed in the findings, before the experiment, never, seldom, sometimes, often and always was noted by 12%, 5%, 4%, 8 and 71% of the students from both the experimental and control groups respectively. However, after the treatment, post-test result show that never was noted by 6% and 12% of the students from the experimental and control groups respectively. Sometimes was noted by 1% and 4% of the students from the experimental and control groups respectively; often was noted by 20% and 18% of the students from the experimental control groups respectively. A majority, 73% of the students from the experimental group and 76% of the students from the control group noted that teachers encourage students to assist one another in solving problems during the lesson always. The results show that there was a higher margin increase of 5% for the control group as compared to 2% for the experimental group on the always practice as noted by the students.

On whether the teacher encourages students to assess each other's work during the lesson, the pre-test results show that never, seldom and sometimes was noted by 40%,

4% and 6% respectively for all the students in both the experimental and control groups, often was noted by 18% and 17% of the students from the experimental and control groups respectively and always by 32% and 33% of the students from the experimental and control groups. However, after the experiment, the post-test results showed variations as never by 11% and 30% of the students from the experimental and control groups respectively, sometimes was noted by 6% of the students from the control groups only, often by 35% and 19% of the students from the experimental and control groups respectively as the always practice was noted by 54% and 35%, a majority from the experimental and control groups respectively. The results show that, for the always practice of the strategy, there was a margin of 22% increase for the experimental group while there was an increase of 2% only for the students in the control groups.

On whether the teacher encourages small group discussions during the lesson, pre-test data shows that never, seldom, sometimes and often was noted by 32%, 5%, 8% and 21% of all the students respectively from both the experimental and control groups. Always was noted by 35% and 34% of the students from the experimental and control groups respectively. However, after the experiment, the post-test data shows that never was noted by 12% and 33% of the students from the experimental and control groups, sometimes was noted by 3% and 9% of the students from the experimental and control groups, Often by 33% and 20% of students from the experimental and control groups as always practice of the strategy by a majority 52% and 39% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a margin of 17% and 5% increase for the students in the experimental and control groups respectively.

On whether the teachers encourage students to participate in collaborative tasks, activities and responses the pre-test data shows that never, seldom and always practice was noted by 25%, 9% and 39% respectively for all the students in both the experimental and control groups. Sometimes was noted by 4% and 10% of the students from the experimental and control groups respectively However, after the treatment, the post-test results show that never was noted by 3% and 15% of the students from the experimental and control groups, sometimes by 8% and 9% of the students from the experimental and control groups respectively and Often by 19% and 18% of the students from the experimental and control groups respectively. The results show that, for the always practice of the strategy, there was a margin of 18% and 9% increase respectively for the students in the experimental and control groups.

On teacher engages students in dialogue with their peers' comments on each other's' work, the pre-test results show that that never, seldom, sometimes and often was noted by 40%, 7%, 14% and 17% of all the students respectively from both the experimental and control groups. However, after the experiment, the post-test data shows that never was noted by 9% and 39% of the students from the experimental and control groups, sometimes was noted by 7% and 14% of the students from the experimental and control groups, Often by 29% and 18% of students from the experimental and control groups as always practice of the strategy by a majority 55% and 29% respectively from the experimental and control groups. The results show that, for the always practice of the strategy, there was a higher margin of 34% increase for the experimental group as compared to the 7% increase for the students in the control groups.

There was also need to establish the level of use of the five effective formative assessment strategies as perceived by teachers. The five effective formative assessment strategies include Clarifying and sharing learning intentions and criteria for success; Engineering effective classroom discussions, questions and learning tasks; Providing feedback that moves learners forward; Activating students as the owners of their own learning (Self-Assessment) and as the instructional resources for one another (Peer assessment). The teacher's opinions were sought on the same and the results are as presented in the following sections.

4.2.1.1.2: Data from teachers' questionnaire

Teachers' questionnaire consisted of four sections (A, B ,C, D) as indicated in appendix (ii). The five effective FAS were in section B with a total of 27 items and just like the students' questionnaire, the teachers rated the level of use of the strategies with a Likert scale of five (Never, Seldom, Sometimes, Often, and Always) and the data on each strategy were presented in the next sections.

4.2.1.1.2.1: Data on Clarifying and Sharing Learning Intentions and Criteria for Success

Answers were sought from the teachers on whether they provide Mathematics objectives at the beginning of each lesson; provide clarification of the listed objectives of the lesson; state the benefits of each objectives to students; state and explain the procedures of success in each lesson; give students enough time to think through the procedures of success and apply in our own work and explain to students the connections between new, prior, and future learning. The results are as presented in the table 13.

Table 13: Clarifying and sharing learning intentions and criteria for success among students

Clarifying and sharing learning intentions and criteria for success among experimental students	**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
	B %	A %	B %	A %	B %	A %	B %	A %	B %	A %
1)I provide Mathematics objectives at the beginning of each lesson	0	9%	6%	9%	18%	3%	39%	42%	37%	37%
2)I provide clarification of the listed objectives of the lesson	3%	9%	12%	9%	21%	6%	33%	33%	31%	43%
3)I state the benefits of each objectives to students	12%	9%	6%	9%	27%	12%	21%	27%	34%	43%
I state and explain the procedures of success in each lesson	0	3%	0	3%	6%	12%	18%	15%	76%	67%
4)I give students enough time to think through the procedures of success and apply in our own work	0	3%	3%	6%	9%	6%	39%	24%	49%	61%
5)I explain to students the connections between new, prior, and future learning	0	0%	6%	9%	12%	3%	39%	33%	43%	55%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers provide Mathematics objectives at the beginning of each lesson. The findings show that before the treatment, seldom, sometimes, often and always use was noted by 6%, 18%, 39% and 37% of the teachers respectively. After the treatment, never and seldom was noted by 9% of the teachers, sometimes, often and always by 3%, 42% and 37% respectively. On whether the teachers provide clarification of the listed objectives of the lesson, before the treatment, never, seldom, sometimes, often and always were noted by 3%, 12%, 21%, 33% and 31% respectively. After the treatment, never, seldom, sometimes, often and always was noted by 9%, 9%, 6%, 33% and 43% respectively. On whether the teachers state the benefits of each objective to students, before the treatment, never, seldom, sometimes, often and always were noted by 12%, 6%, 27%, 21% and 34% respectively. After the treatment, never, seldom, sometimes, often and always was noted by 9%, 9%, 12%, 27% and 43% respectively.

On whether the teachers state and explain the procedures of success in each lesson, before the treatment, sometimes, often and always was noted by 6%, 18% and 76% respectively. After the treatment, never, seldom, sometimes, often and always was noted by 3%, 3%, 12%, 15% and 67% respectively. On the teachers give students enough time to think through the procedures of success and apply in student's own work, before the treatment, seldom, sometimes, often and always was noted by 3%, 9%, 39%, and 49% respectively. After the treatment, never, seldom, sometimes, often and always was noted by 3%, 6%, 6%, 24% and 61% respectively. On whether the teachers explain to students the connections between new, prior, and future learning, before the treatment, seldom, sometimes, often and always were noted by 6%, 12%, 39% and 43% respectively. After the treatment, seldom, sometimes, often and always was noted by 9%, 3%, 33% and 55% respectively.

4.2.1.1.2.2: Data on Engineering effective classroom discussions, questions and learning tasks by teachers

Answers were sought from the teachers on whether they ask questions within the lesson to assess whole group and individual student progress; make adjustments to instruction within the lesson based upon our responses on the learning tasks; give students adequate wait time to respond to questions; use follow-up questions when engaging us in class discussion; give students tasks and activities that are within the lesson are directly tied to learning objectives and that teachers give tasks and activities within the lesson that are provide evidence of student's progress toward learning objectives. The results are as presented in the table 14.

Table 14: Engineering effective classroom discussions, questions and learning tasks

Engineering effective classroom discussions, questions and learning tasks	**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
	B %	A %	B %	A %	B %	A %	B %	A %	B %	A %
1)I ask questions within the lesson to assess whole group and individual student progress	0	0%	0	0%	6%	9%	27%	24%	67%	67%
2)I make adjustments to instruction within the lesson based upon our responses on the learning tasks	6%	3%	3%	3%	6%	15%	49%	30%	36%	49%
3)I give students adequate wait time to respond to questions	3%	0%	3%	0%	12%	15%	36%	30%	46%	55%
4) I use follow-up questions when engaging us in class discussion.	3%	0	0	0	18%	12%	36%	30%	43%	58%
5) The tasks and activities within the lesson are directly tied to learning objectives.	3%	3%	3%	0	12%	12%	36%	24%	46%	61%
6)The tasks and activities within the lesson provide evidence of our progress toward learning objectives	0	0	0	0	12%	12%	42%	30%	46%	58%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers ask questions within the lesson to assess whole group and individual student progress. The findings show that before the treatment, sometimes, often and always use was noted by 6%, 27%, and 67% of the teachers respectively. After the treatment, sometimes, often and always was noted by 9%, 24% and 67% of the teachers respectively. On whether the teachers make adjustments to instruction within the lesson based upon our responses on the learning tasks, before the treatment, never, seldom, sometimes, often and always was noted by 6%, 3%, 6%, 49% and 36% respectively. After the treatment, never, seldom, sometimes, often and always was noted by 3%, 3%, 15%, 30% and 49% respectively. On whether the teachers give students adequate wait time to respond to questions, before the treatment, never, seldom, sometimes, often and always was noted by 3%, 3%, 12%, 36% and 46% respectively. After the treatment, sometimes, often and always was noted by 15%, 30% and 55% respectively.

On whether the teachers use follow-up questions when engaging us in class discussion, before the treatment, never, sometimes, often and always were noted by 3%, 18%, 36% and 43% respectively. After the treatment, sometimes, often and always was noted by 12%, 30% and 58% respectively. On the teachers give students tasks and activities that are within the lesson are directly tied to learning objectives, before the treatment, never, seldom, sometimes, often and always was noted by 3%, 3%, 12%, 36 and 46% respectively. After the treatment, never, sometimes, often and always was noted by 3%, 12%, 24% and 61% respectively. On whether the teachers give tasks and activities within the lesson that are provide evidence of student's progress toward learning objectives, before the treatment, sometimes, often and always was noted by 12%, 42% and 46% respectively. After the treatment, seldom, sometimes, often and always was noted by 12%, 30% and 58% respectively.

4.2.1.1.2.3: Data on Providing Feedback that Moves Learners Forward by teachers

Answers were sought from the teachers on whether they encourage students to discover our own errors and misconceptions; give students immediate feedback during the lesson; give students corrective measures on our errors and misconceptions immediately; give students an opportunity to internalize feedback and apply it in a meaningful way and use a variety of assignments at the end of every lesson e.g. filling gaps, etc. The results are as presented in the table 15.

Table 15: Providing feedback that moves learners forward

Providing feedback that moves learners forward	**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
	B %	A %	B %	A %	B %	A %	B %	A %	B %	A %
1)I encourage students to discover our own errors and misconceptions	0	0	0	0	30%	21%	40%	30%	30%	49%
2)I give students immediate feedback during the lesson	0	0	0	0	30%	21%	43%	30%	27%	49%
3)I give students corrective measures on our errors and misconceptions immediately	0	0	6%	0	21%	18%	18%	15%	55%	67%
4) I give students an opportunity to internalize feedback and apply it in a meaningful way.	3%	0	3%	0	24%	24%	43%	24%	27%	52%
5) I use a variety of assignments at the end of every lesson e.g. filling gaps, etc.	3%	0	0	0	6%	9%	36%	21%	55%	70%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers encourage students to discover our own errors and misconceptions. The findings show that before the treatment, sometimes, often and always use was noted by 30%, 40% and 30% of the teachers respectively. After the treatment, sometimes, often and always was noted by 21%, 30% and 49% of the teachers respectively. On whether the teachers give students immediate feedback during the lesson, before the treatment; sometimes, often and always was noted by 30%, 43% and 27% of the teachers respectively. After the treatment; sometimes, often and always was noted by 21%, 30% and 49% of the teachers respectively. On whether the teachers give students corrective measures on errors and misconceptions immediately, before the treatment, seldom, sometimes, often and always was noted by 6%, 21%, 18% and 55% of the teachers respectively.

After the treatment, sometimes, often and always was noted by 18%, 15% and 67% of the teachers respectively. On whether the teachers give students an opportunity to internalize feedback and apply it in a meaningful way, before the treatment, never, seldom, sometimes, often and always was noted by 3%, 3%, 24%, 43% and 27% of the teachers respectively. After the treatment, sometimes, often and always was noted by 24%, 24% and 52% of the teachers respectively. On the teachers use a variety of assignments at the end of every lesson e.g. filling gaps, etc., before the treatment, never, sometimes, often and always was noted by 3%, 6%, 36%, and 55% of the teachers respectively. After the treatment, sometimes, often and always was noted by 9%, 21% and 70% respectively.

4.2.1.1.2.4: Data on Activating students as the owners of their own learning (Self-Assessment) by teachers

Answers were sought from the teachers on whether they encourage the learners to do self-assessment during the lesson; encourage learner's individual criticisms of tasks and activities during the lesson; engage students in self-reflection and letting them keep track of our learning; encourage learners to develop self-actualization and self-esteem and use of evidence generated through student's self-assessments to inform future teaching and learning. The results are as presented in the table 16.

Table 16: Activating students as the owners of their own learning (Self-Assessment)

Activating students as the owners of their own learning (Self-Assessment)	**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
	B %	A %	B %	A %	B %	A %	B %	A %	B %	A %
1) I encourage the learners to do self-assessment during the lesson	0	0	3%	0	9%	9%	46%	21%	42%	70%
2) During the lesson, I encourage learners individual criticisms of tasks and activities	3%	3%	6%	6%	12%	15%	39%	21%	40%	55%
3) I engage students in self-reflection and letting us keep track of our learning	0	0	6%	3%	9%	6%	55%	42%	30%	49%
4) I encourage learners to develop self-actualization and self esteem	0	0	3%	0	12%	6%	39%	30%	46%	64%
5) I use evidence generated through our self-assessments to inform future teaching and learning	0	0	3%	0	21%	12%	55%	39%	21%	49%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers encourage the learners to do self-assessment during the lesson. The findings show that before the treatment, seldom, sometimes, often and always use was noted by 3%, 9%, 46% and 42% of the teachers respectively. After the treatment, sometimes, often and always was noted by 9%, 21% and 70% of the teachers respectively. On whether the teachers encourage learner's individual criticisms of tasks and activities during the lesson, before the treatment, never, seldom, sometimes, often and always was noted by 3%, 6%, 12%, 39% and 40% of the teachers respectively. After the treatment, never, seldom, sometimes, often and always was noted by 3%, 6%, 15%, 21% and 55% of the teachers respectively. On whether the teachers engage students in self-reflection and letting them keep track of our learning, before the treatment, seldom, sometimes, often and always was noted by 6%, 9%, 55% and 30% of the teachers respectively.

After the treatment, seldom, sometimes, often and always was noted by 3%, 6%, 42% and 49% of the teachers respectively. On whether the teachers encourage learners to develop self-actualization and self-esteem, before the treatment, seldom, sometimes, often and always was noted by 3%, 12%, 39% and 46% of the teachers respectively. After the treatment, sometimes, often and always was noted by 6%, 30% and 64% of the teachers respectively. On the teachers use of evidence generated through students' self-assessments to inform future teaching and learning, before the treatment, never, sometimes, often and always was noted by 3%, 21%, and 55% and 49% of the teachers respectively. After the treatment, sometimes, often and always was noted by 12%, 39% and 47% of the teachers respectively.

4.2.1.1.2.5: Data on Activating students as the instructional resources for one another (Peer assessment) by the teachers

Answers were sought from the teachers on whether they encourage students to assist one another in solving problems during the lesson; encourage students to assess each other's work during the lesson; encourage small group discussions during the lesson; encourage students to participate in collaborative tasks, activities and responses and engage students in dialogue with our peers' comments on each other's' work. The results are as presented in the table 17.

Table 17: Activating students as the instructional resources for one another (Peer assessment)

Activating students as the instructional resources for one another (Peer assessment)	**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
	B %	A %	B %	A %	B %	A %	B %	A %	B %	A %
1)I encourage students to assist one another in solving problems during the lesson	0	0	0	0	18%	6%	18%	18%	64%	76%
2) I encourage students to assess each other's work during the lesson	6%	0	3%	0	18%	6%	18%	15%	55%	79%
3)I encourage small group discussions during the lesson	0	0	0	0	21%	15%	39%	18%	40%	67%
4)I encourages students to participate in collaborative tasks, activities and responses	0	0	0	0	21%	6%	42%	36%	37%	58%
5)My teacher engages us in dialogue with our peers comments on each other's' work	0	0	3%	3%	21%	9%	46%	36%	30%	52%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

There was need to find out whether teachers encourage students to assist one another in solving problems during the lesson. The findings show that before the treatment, sometimes, often and always use was noted by 18%, 18% and 64% of the teachers respectively. After the treatment, sometimes, often and always was noted by 6%, 18% and 76% of the teachers respectively. On whether the teachers encourage students to assess each other's work during the lesson, before the treatment, never, seldom, sometimes, often and always was noted by 6%, 3%, 18%, 18% and 55% of the teachers respectively. After the treatment, sometimes, often and always was noted by 6%, 15% and 79% of the teachers respectively.

On whether the teachers encourage small group discussions during the lesson, before the treatment, sometimes, often and always was noted by 21%, 31% and 40% of the teachers respectively. After the treatment, sometimes, often and always was noted by 15%, 18% and 67% of the teachers respectively. On whether the teachers encourage students to participate in collaborative tasks, activities and responses, before the treatment, sometimes, often and always was noted by 21%, 42% and 37% of the teachers respectively. After the treatment, sometimes, often and always was noted by 6%, 36% and 57% of the teachers respectively. On the teachers engage students in dialogue with our peers' comments on each other's' work, before the treatment, seldom, sometimes, often and always was noted by 3%, 21%, and 46% and 30% of the teachers respectively. After the treatment, seldom, sometimes, often and always was noted by 3%, 9%, 36% and 52% of the teachers respectively.

From the foregoing descriptive data, it is evident that for both the students' and teachers' data, majority of them rated always after the intervention and often before the intervention as depicted by the frequency tables for each strategy. The overall

finding shows that there was low level of use of the five effective formative assessment strategies before the intervention but after the intervention the level of use increased which is associated with the intervention effects.

There was need to ascertain whether there are differences in the level of use of the five effective formative assessment strategies in Mathematics instruction by the teachers. To establish the differences in the level of use of the 5 strategies, the responses of both the teachers and students who participated in the study were scored and there means computed before and after the treatment. The students in the experimental group were subjected to the five effective formative assessment strategies by their teachers as those in the control group were not. The results of the scores on the question items are as indicated in table 18 below.

Table 18: Means of the Experimental and Control Groups

Strategies	Students Data				Teachers Data			
	Experimental Group		Control Group		Experimental Group		Control Group	
	Means		Means					
	B	A	B	A	B	A	B	A
Clarifying and sharing learning intentions and criteria for success	3.90	4.72	3.67	3.89	4.05	4.6	4.14	3.54
Engineering effective classroom discussions, questions and learning tasks	3.78	4.57	3.79	3.60	4.17	4.8	4.062	4.03
Providing feedback that moves learners forward	3.94	4.50	3.87	3.87	4.159	4.89	4.28	3.9
Activating students as the owners of their own learning (Self-Assessment)	3.75	4.42	3.56	3.74	4.093	4.73	4.05	4.18
Activating students as the instructional resources for one another (Peer assessment)	3.24	4.26	3.30	3.49	4.080	4.84	4.23	4.34
Overall Mean	**3.72**	**4.494**	**3.638**	**3.718**	**4.110**	**4.772**	**4.152**	**4.00**

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

An analysis of the results as shown in table 18 shows that, before the treatment, the means of the experimental and control groups on the use of the strategy of Clarifying and sharing learning intentions and criteria for success were 3.90 and 3.6 for the students and 4.05 and 4.14 for the teachers respectively from the experimental and control groups. After the treatment, the means of the experimental and control groups on the use of the strategy of Clarifying and sharing learning intentions and criteria for success were 4.72 and 3.89 for the students and 4.6 and 3.54 for the teachers respectively from the experimental and control groups. The results show that there

was an increase in the means for the experimental group and a decrease in the means for the control groups. This is attributed to the use of this strategy by teachers on their students.

An analysis of the results as shown in table 18 shows that, before the treatment, the means of the experimental and control groups on the use of the strategy of engineering effective classroom discussions, questions and learning tasks were 3.78 and 3.79 for the students and 4.17 and 4.062 for the teachers respectively from the experimental and control groups. After the treatment, the means of the experimental and control groups on the use of this strategy were 4.57 and 3.60 for the students and 4.8 and 4.03 for the teachers respectively from the experimental and control groups. The results show that there was an increase in the means for the experimental group and a decrease in the means for the control groups. This is attributed to the use of this strategy by teachers on their students.

On the level of use of the strategy of providing feedback that moves learners forward, an analysis of the results as shown in table 18 show that, before the treatment, the means of the experimental and control groups were 3.94 and 3.87 for the students and 4.159 and 4.28 for the teachers respectively from the experimental and control groups. After the treatment, the means of the experimental and control groups on the use of this strategy were 4.50 and 3.87 for the students and 4.89 and 3.9 for the teachers respectively from the experimental and control groups. The results show that there was an increase in the means for the experimental group and a decrease in the means for the control groups. This is attributed to the use of this strategy by teachers on their students.

On the use of the strategy of Activating students as the owners of their own learning (Self-Assessment), an analysis of the results as shown in table 4.12 shows that, before the treatment, the means of the experimental and control groups on the use of the strategy were 3.75 and 3.56 for the students and 4.093 and 4.05 for the teachers respectively from the experimental and control groups. After the treatment, the means were the means of the experimental and control groups on the use of this strategy were 4.42 and 3.74 for the students and 4.73and 4.18 for the teachers respectively from the experimental and control groups. The results show that there was a higher increase in the means for the experimental group and a low increase in the means for the teachers in the control groups and a decrease in the means of the students in the control groups. This is attributed to the use of this strategy by teachers on their students.

On the use of the strategy of activating students as the instructional resources for one another (Peer assessment), an analysis of the results as shown in table 4.12 shows that, before the treatment, the means of the experimental and control groups were 3.24 and 3.30 for the students and 4.080 and 4.23 for the teachers respectively from the experimental and control groups. After the treatment, the means were the means of the experimental and control groups on the use of this strategy were 4.26 and 3.49 for the students and 4.84 and 4.34 for the teachers respectively from the experimental and control groups. The results show that there was an increase in the means for the experimental group and a decrease in the means for the control groups. This is attributed to the use of this strategy by teachers on their students.

From the table above, it’s evident that there is a significant difference in rating by the students on the level of use after intervention between control and experimental

groups. Therefore, students in the experimental group recorded higher rating as compared with control group.

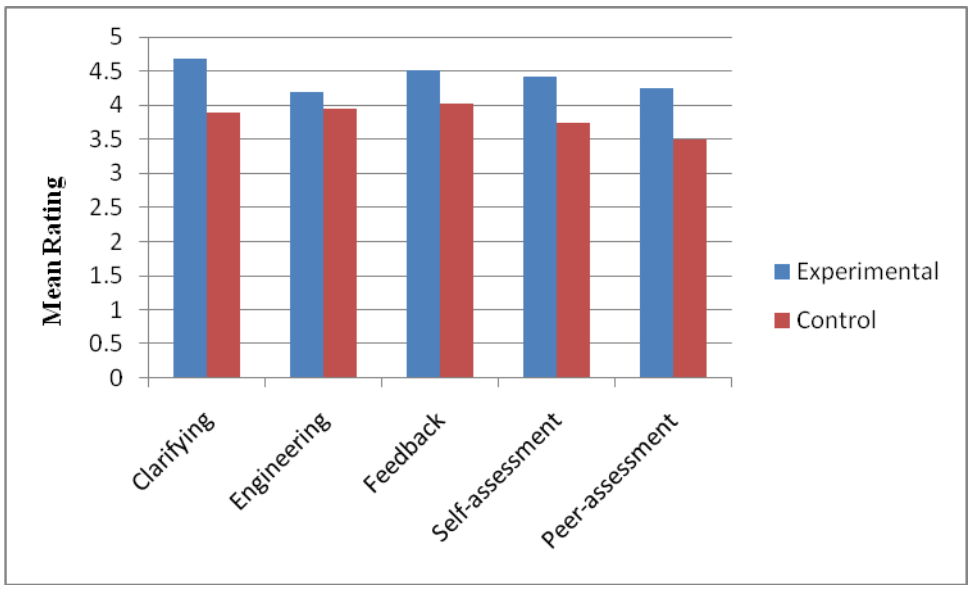

Figure 12: A Bar graph showing the rating of the FAS after intervention

The bar graph shown above depicts that among experimental group students who participated in the study, and after intervention, they rated clarifying FAS as the one most used by the teachers during the study, this is followed by feedback, self-assessment, peer assessment and lastly engineering effective classroom discussion. This reveals that following the researcher's intervention, students rated that their significant improvement in Mathematics performance among experimental group is due to more use of clarifying learning intentions and criteria for success. This means that emphasis on this particular formative assessment strategy could improve more on student's Mathematics performance.

There was need to conduct a 'within' method triangulation in order to get rich information and to achieve a more clear picture on the level of use of the five

effective formative assessment strategies. The researcher therefore conducted lesson observations in all the selected classes before the intervention in order to find what was on the ground, other observation was during the intervention in order to make follow ups with the experimental group teachers to ensure they used the strategies as per the expectation and finally the observations after the intervention to determine the level of use of the formative assessment after subjecting learners to the five effective formative assessment which changed the classroom environment and classroom practices on assessment.

4.2.1.1.3: Data from Researchers' Observation schedule

Researcher's observation schedule was both quantitative and qualitative as indicated in appendix (iv) with five scale Likert (None, Poor, Fair, Good and Excellent).The researcher also wrote notes and categorize the participating teachers as developing, exemplary on every strategy. Mean ratings for the observations were calculated for both the groups before and after the experiment and the findings were presented in table 19.

Table 19: Level of Use of Five Effective Formative Assessment Strategies

		Mean Experimental		Mean Control	
	Strategies	**Before**	**After**	**Before**	**After**
1	Clarifying learning intentions and criteria for success	2.45	4.54	2.21	2.33
2	Engineering effective classroom discussion (questioning**)**	2.5	4.13	1.73	1.53
3	Engineering effective classroom discussion (collaboration)	2.67	4.40	1.60	1.67
4	Engineering (Learning Tasks)	1.93	4.30	1.7	2.67
5	Feedback on instruction	1.61	4.47	1.44	1.47

On the use of the five effective formative assessment strategies, the researcher observed the subjects before, during and after the experiment, scored the results and computed the means. From the findings as indicated in table, clarifying learning intentions and criteria for success strategy, the researcher observed that connection to previous learning, learning objective quality, learning objective implementation and the presentation of criteria for success (Rubrics) were noted with higher ratings for the experimental groups as compared to the control groups.

For engineering effective classroom discussion (questioning**)** strategy, the researcher observed that this strategy was indicated by the questioning pattern (more of probing questions), wait time for responses, eliciting evidence of learning (reveal students' thinking), determining progress of the learners and use of evidence to adjust instruction and which were noted with higher ratings for the experimental groups as compared to the control groups. For engineering effective classroom discussion (collaboration) strategy observed by the researcher was indicated by the classroom climate, use of small group discussion, use of student viewpoints, communicating expectations to the learners and classroom interactions (teacher-student, student-teacher and student-student) and which were rated higher for the experimental groups than for the control groups.

For engineering (learning tasks) strategy, the researcher observed that there were indications of the connection to learning objective (congruence), clarity of tasks (transparency), relevance of tasks to real life problems (authenticity), student autonomy (student consultation on tasks) and individualized tasks (student capabilities) which were noted with higher ratings for the experimental groups than for the control groups. For feedback on instruction as indicated by focused and action

oriented feedback, related to learning goals, self-assessment, individualized feedback, Peer assessment and feedback loops were noted with higher ratings for the experimental groups than for the control groups.

After triangulation within quantitative method, where the teacher, the learner and the researcher gave their voices, the results of their analyses were converged and the overall finding indicated that there was low utilization of formative assessment strategies in Mathematics instruction in the sub-County schools of Nandi County, Kenya which could be a reason why learners Mathematics performance in secondary schools is very low.

This finding was in agreement with the findings of (Hauser (2015) whose overall finding was that teachers are not always using effective formative assessment strategies during instruction. Also the finding on level of use is supported by Kemboi (2015) in his study on classroom assessment practices by mathematics teachers in secondary schools in Kenya, who found out that new alternative classroom assessment practices (CAPS) namely self assessment, peer assessment and use of portfolios were least used or not used at all by mathematics teachers. In addition, the finding was also in agreement with research carried out by the Kenya National Examinations Council (2014) which revealed that teachers hardly used formative assessment instruments in classroom instruction.

There was need to explore further on the quantitative finding in order to go deeper into the factors behind the quantitative finding (low level of utilization of FAS). Qualitative data was collected using teachers' interviews on the selected Mathematics teachers and purposively selected school Principals. The qualitative data was used to

explain and expand on the quantitative finding and the analyses were discussed in the next sub- heading.

4.2.1.2: Qualitative Data on the explorations of the quantitative finding

Qualitative data to explore and explain the quantitative finding on the level of use of the five effective formative assessment strategies were collected using teachers' and school Principals one to one interviews, researchers' observation schedule notes before the intervention and teachers' Focus group interview and also researchers' notes on the observation schedule after the intervention in order to develop and explore on the quantitative results and to expand on the findings by looking at the factors contributing to the level of use of the formative assessment strategies established. Data were coded and analyzed thematically and presented in form of qualitative descriptions and excerpts

4.2.1.2.1: Data from teachers' and school Principals' one to one interviews

Qualitative data from teachers' and school principals' one on one interviews were collected using the respective interview guides as indicated in appendix (vii) and (viii). Data were coded and analyzed thematically and the following themes emerged and were presented in form of excerpts and descriptions: understanding of FAS, Different FAS used in Mathematics instruction in Nandi County, teachers' awareness of the five effective FAS, consistency of using FAS in a Mathematics lesson, Frequency of use of FAS and teachers' knowledge and skills on use of FAS. Each theme is discussed with their excerpts given in the following sections.

4.2.1.2.1.1: Understanding of FAS

The first information that the researcher wanted to know was how the teachers in Nandi County understood the meaning of formative assessment.

Though there were various definitions the researcher noted the following definitions

> **Teacher 1: "**According to my understanding, FAS is regularly administering of tests to assess may be if you finish a topic you give an assignment, you mark. So I think my understand to it a continuous kind of examination where you regularly asses rather than waiting for the whole terms so as to gage understanding of students and may be do necessary adjustments".

> **Teacher 2**: "I think this is an assessment done may be within to test whether the student really understood the concepts, may topical, may be like exams we give out end of term or midterms. Formative assessment is a test".

> **Teachers 3**: "These are strategies geared to improving the teaching of the subjects, it involve resources and how to handle the subject for the betterment of the subject t especially when it comes to the real understanding of the mastery concepts by the students".

The researcher also sought the understanding of formative assessment from the head teachers of the selected schools in order to get more voices to explain the qualitative findings on the level of use of the five effective strategies. The principals had the following to say:

Principal 1: “Haaa, this is what has been agreed on eeh, agreed system of assessing our students in our school of giving two CATs and end term exam for assessing our students. And that is actually what is prescribed by the ministry that we have assessment then we have end of term”.

Principal 2: “Eeeh normally formative assessment is where a student is taken through the curriculum then there are those testing methods then you analyze , and then you see how students are doing or performing in a subject, yeah it’s the whole that whole process you , you test then analyze and then you give the results”.

Principal 3: “Assessment used to test whether the student have understood the topics taught i.e. using exams asking questions in exams often test”.

Principal 4: “Assessment where by teachers give questions to the students based on always activities during lessons and co-curriculum”.

Principal 5: “An agreed system of assessing students in terms of various examinations in their academics regularly”.

The researcher concluded that both the teachers and the administration take formative assessment to be a “test” nothing more than that. In this study formative assessment is a “process” not a test and this process takes place during the Mathematics lessons on a always basis and it involves: eliciting of evidence of learning, interpreting and using it to structure the teaching and learning in order to improve learners achievement. The understanding of formative assessment explained by both teachers and principals is a

clear indicator that assessments are mainly for testing and grading learners and not to 'form' learners. This therefore contributes to low utilization of the five effective formative assessment strategies in Mathematics instruction.

4.2.1.2.1.2: Different FAS used in Mathematics instruction in Nandi County

Teachers were asked to list the formative assessment strategies they use during their Mathematics lessons and they mentioned Oral questions, assignments ,blackboard questions, group work, question and answer, test Observations, marking assignment Objectives listing, free flow of ideas in class, peer assessment, student teacher interaction, assisting one another, demonstration (examples), always exercises, feedback Self-assessment, contest and symposiums and teaching aids.

Based on this list given by the teachers, the researcher observed that the number of the listed FAS is small. Teachers are using different FAS in their respective schools during Mathematics instruction. This could be influenced by their context, though the few listed by each teacher did not cover all the activities used in the five effective formative assessment strategies which are the focus of this study. In reference to this list, teachers are using scanty FAS. And the way they use the scanty FAS is not to the expectations of the study. In summary teachers do not clarify the objectives and learning intentions and also there is no engineering of effective classroom discussion. This indicates that the five effective formative assessment strategies are not utilized to the fullest extend as possible this is in line with (Wyllie & Lyion 2012)

4.2.1.2.1.3 Teachers' awareness of the five effective FAS

The researcher wanted to find out about the awareness of the teachers on the five effective formative assessment strategies and the researcher began by listing them down and explaining what they are to the teachers. This is what they had to say:

> **Teacher 1**: "Generally I do not think I have exhausted all the strategies especially the ones you have mentioned".

> **Teacher 2:** "I have not exhausted much of these strategies, the one I normally use is mainly peer assessment".

> **Teacher 3**: Yes may be the wording or the terms used otherwise we have been using".

In general most teachers are using some formative assessment strategies without their awareness and not in the effective way. Teachers are not aware of the formative assessment strategies based on their responses above when the researcher listed five effective FAS and asked the teachers whether they were aware of them or not. It was clear that there was lack of awareness by the teachers on the use of the strategies which contributes to low utilization.

4.2.1.2.1.4: Consistency of use of FAS during Mathematics instruction

The researcher also wanted to find out when and which parts of the lesson were the strategies incorporated by the teachers during lesson for example the lesson has three parts: the introduction, the development and the conclusion. Teachers' responds were as follows:

> **Teacher 6**: […] **"**During lesson development"

Teacher 9:[….] "At the conclusion and development".

Teacher 3: [….] "All Areas (introduction development and conclusion)".

Teacher7:[….] "Lesson development only".

From the teachers responses it was very clear that majority do not use all the effective formative assessment strategies in all the three parts of the lesson as per the expectation. According to the study the five effective formative assessment strategies should be used intermingably in all parts of the lesson to achieve its fullest use. The responses clearly indicate a inconsistency in the use of the strategies during Mathematics lessons hence contributing to low utilization of FAS.

4.2.1.2.1.5: Frequency of use of FAS

The researcher also wanted to find out from teachers the frequency of use of the five effective formative assessment strategies in Mathematics instruction in order to explore on the level of use quantitative finding. The following were their responses:

Teacher4: "I do not use often may be twice a week".

Teacher 2: "It depends with the topics you are handling, I do not use on a always basis due to time. Covering of syllabus requires time so difficult to use activities of formative assessment".

Teacher 3: "I use strategies on always basis, group work on often basis I can say group is often because you know we do not have actually a lot of time to have them in group work but they can be in specific positions but on often basis so not always".

Teacher 4: "At the end of the week, on Friday's self-assessment, peer assessments in the evenings".

The researcher noticed that there was lack of consistency in the usage of the strategies and the frequency of use of the five effective formative assessment strategies is very low and according to the study, the strategies are used effectively when all of them are consistently used always in the lessons. This therefore has contributed to under-utilization of the five formative assessment strategies in Mathematics instruction in Nandi County.

4.2.1.2.1.6: Teachers' Knowledge and skills on the use of FAS

The researcher went further to ask teachers to explain the procedures or steps they follow on administering their formative assessment strategies in order to explore on the "how" they do it. According to the teachers, the following are the procedures of administering formative assessment during their Mathematics lessons:

Teacher 7: I highlight the objective at the beginning of the topic, start from simple to the complex and then summarize the basic steps.

Teacher 3: I teach and give a quiz at the end of the topic, give feedback after marking and make corrections.

Teacher 10: I give tasks to be done on the board, grouping them and giving assignments then reward the first groups

Teacher 8: I preview during lesson development, create time for Mathematics hour, more time for Mathematics.

The procedures of using FAS by the teachers were not catering for what formative assessment was according to the current study. The steps were inadequate and lacked important details on how the formative assessments strategies were administered hence they did not portray a good picture of effective use as per the expectation of the researcher. From the teachers' responses the oral questioning pattern was not clear though it was the most commonly used, feedback was about giving grades and scores after marking but lacks the descriptive feedback that moves learners forward which includes giving remarks only without grades and working on the comments only to improve learning. All these have contributed to low utilization of the same strategies as indicated quantitatively.

4.2.1.2.1.7:Learning contexts

4.2.1.2.2: Data from teachers' focus group interviews

After the intervention, the level of use of the five effective formative assessment strategies increased in the experimental group as depicted by the increase in percentages and means of strategies as shown earlier in table 18. This was attributed to the intervention effect. The researcher wanted to explore further into the causes of the increased level of utilization of the strategies from the teachers. Focus group interviews were conducted with a group of 6 teachers purposively selected in the

experimental group. Data gathered were analyzed thematically and the same themes came up but teachers were having different narrations.

On the theme understanding of FAS; teachers explained that the understanding was made clear during the training and with clear understanding of what FAS involves, it raised their level of use of the strategies. Also the different FAS used broadened to cover all the five effective FAS while the teachers' awareness was much created, incorporation of FAS during the lesson was improved, Frequency of use also went up as well as the teachers' know how on the use of the five effective formative assessment strategies. The qualitative finding after the intervention was a result of the training offered by the researcher to the experimental group teachers just before the intervention period begun though it was not intensive but brought a significant difference in the level of use of the five effective formative assessment strategies in Mathematics instruction which was witnessed in the impact on learners' achievement. This finding was in line with the finding of Accado (2017) who found that there was evidence that teachers after receiving support from the school and the government were able to implement the formative assessment strategies and improvement in students.

4.2.1.2.3: Data from researchers' observation schedule notes

Qualitative data from researchers' observation schedule were from the researchers' notes against level of use of each strategy where teachers were categorized into; beginning, developing, effective and exemplary as guided by observation protocol of Susan and Dell Foundation (2016). On clarifying learners' intentions and criteria for success before the intervention, the researcher noted that it was fairly done. The

teachers were not stating the objectives frequently, rubrics were not used in order to clarify well the learning intentions hence the researcher rated teachers as beginners. After the intervention, the strategy was improved and the teachers were rated as effective.

On engineering effective classroom discussions, questioning, collaboration and learning tasks, it was noted that; collaboration was not well displayed, classroom climate was fair, questioning pattern was poor for example no propping questions were used, short wait time for students to respond to questions, difficulty for learners to conduct small group discussions hence rarely used, learning tasks during lessons were fairly connected to goals, no transparency in tasks, individualized tasks not used, tasks used were fairly connected to real life situations and there was lack of learners involvement in the tasks. The teachers were rated beginners before intervention and effective after intervention.

On the third strategy; feedback that moves learners forward, most of the teachers concentrated on giving grades and comments like very good, good hence the descriptive feedback was lacking, guiding learners to identify their errors and misconceptions was poorly done, three phases of strong feedback which include feeding up, feeding forward and feeding backwards were not completed hence the teachers were rated by the researcher as beginners before intervention and effective after intervention. On self assessment, the strategy was rarely used in that teachers did not allow learners to reflect on their work, teachers did not provide the standards examples to be used by the learners to gauge their work in order to identify their errors and misconceptions in their learning and teachers rarely encourage learners to

self assess their work. The researcher rated teachers as beginners before intervention and developing after intervention.

Finally on the strategy peer assessment, it was noted that there was some difficulty on the learners to peer assess their work due to poor attitude, teachers fairly encourage learners to peer assess their colleagues work, teachers majorly dwell on frequent exchange of books for marking by learners during the lesson to give wrong or right answers ant it ends there. The researcher therefore rated teachers as beginners before intervention and effective after intervention. From the analysis of the notes, the researcher concluded that teachers were at the beginning stage in most of the five FAS but after intervention they improved and became effective.

The qualitative explorations gave an in depth understanding and a rich data on the root cause of low utilization of formative assessment strategies as well as the factors behind increased utilization of FAS after intervention and therefore the qualitative data explained very well the quantitative finding.

4.2.2: Impact of Formative Assessment Strategies on Learner Achievement in Mathematics instruction

To establish the impact of the five effective formative assessment strategies on learner achievement in Mathematics, the study sought to find out the impact of the use of the strategies on learner acquisition of problems solving skills and performance improvement in Mathematics. Both quantitative and qualitative data were collected.

4.2.2.1: Quantitative data.

Quantitative data were collected using Student Mathematic achievement Test (SMAT) and observation schedule by the researcher. The impact was depicted by performance improvement in the SMAT by comparing the experimental and control groups in their performance at pretest and at post test. Acquisition of problem solving skills were observed by the researcher in terms of learner engagement/motivation, responds to questions, collaboration, attempts to solve problems and reasoning ability of the learners before and after intervention.

4.2.2.1.1: Data on learner performance from Student Mathematics Achievement Tests (SMAT)

To find out the impact of use of the five effective formative assessment strategies on learner performance in Mathematics, the learners were subjected to achievement tests before and after the intervention and the results are as indicated in table 20 below.

Table 20: Means and Standard Deviations (Achievement Scores)

	Pre-Test		Post-Test	
Group	Control	Experimental	Control	Experimental
Mean	40.3160	39.8238	40.0879	48.2026
Std. Deviation	6.20835	5.64862	5.62459	6.98819
N	227	307	227	307

As indicated in table 20, the results on the pre-test were varied as the mean score for the experimental group was 39.8283 and that of the control group was 40.3160. After the treatment, the mean of the test scores for the experimental group was 48.2026 while that for the control group was 40.0879. The results show that the mean score for

the experimental group increased and was higher than the mean score for the control group which decreased and was lower.

To find out whether there were significant differences in the means as a result of the treatment, the following null hypothesis was tested at significance level of 0.05.

> **$H0_1$:** There is no significant difference in learner's achievement between the experimental and control groups when subjected to the five Effective Formative Assessment strategies in Mathematics instruction.

The results were subjected to the t-test and are as shown in table 21 below.

Table 21: Independent Samples t-tests for the pretest

Group Statistics

	group of school	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	experimental	227	39.8238	5.64862	.37491
	Control	307	40.3094	6.20552	.35417

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pre-test	Equal variances assumed	2.030	.155	-.929	532	.354	-.48566	.52305	-1.51316	.54185
	Equal variances not assumed			-.942	509.608	.347	-.48566	.51575	-1.49891	.52759

Independent sample t test was run to ascertain if there is a significant difference between experimental and the control group in the pretest. The output shows that Leaven's test of homogeneity of variance was assumed since p value was 0.2 much greater than 0.05. Analysis further revealed that there was no difference in mean performance before intervention between control group and experimental group of student. Results of posttest were indicated in the table below:

Table 22: Independent Sample t-test after Experiment

Group Statistics

	group of school	N	Mean	Std. Deviation	Std. Error Mean
post-test	Experimental	227	48.2026	6.98819	.46382
	Control	307	40.1010	5.62902	.32127

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
post-test	Equal variances assumed	11.235	.001	14.826	532	.000	8.10167	.54646	7.02818	9.17515
	Equal variances not assumed			14.359	422.967	.000	8.10167	.56422	6.99264	9.21069

After intervention, the findings revealed that there was a significant difference in performance between control and experimental group (t=14.826, p=000) hence the null hypothesis is rejected and that there is a significant difference in learners'

achievement when subjected to the five effective formative assessment strategies in Mathematics instruction. This evidence is also revealed in means. Control group's performance remained the same while experimental group improved in their performance significantly. This improvement in performance is attributed to intervention by using five effective formative assessment strategies by teachers who participated as experimental group. This finding is in agreement with Moyosore (2015) in his experimental research on the effect of formative assessment on students' achievement in secondary school Mathematics who found out that formative assessment has a strong significant difference in the mean achievement score of Mathematics students exposed to it (t=36.54, p=000 while there is no significant difference in the mean achievement score of Mathematics students who are not exposed to the formative assessment (t=2.053, p=0.045). The finding was in agreement with the theory of socio constructivism by Vygotsky (2008) who asserts that learning environment is key in acquisition of knowledge and skills, the framework of formative assessment by William and Thompson (2007) provided the strategies which the learners were subjected to hence changing their learning environment into learner centered one and caused positive variations in the learners' achievement.

4.2.2.1.2: Data on acquisition of problem solving skills from researcher's observation schedule

Acquisition of problem solving skills was observed by the researcher before the intervention and after the intervention and was rated in the observation schedule as displayed by student's participation, engagement, collaboration, response to questions and reasoning ability and quality of interactions during lessons. To determine the learner's acquisition of problem solving skills, the learners were observed in

classroom as they interacted in class during and after the experiment. Their responses were scored and ranked as presented in the table 23.

Table 23: Learner's Acquisition of problem solving skills

Item	Experimental Mean		Control Mean	
	Before	After	Before	After
Student motivation/engagement	1.83	4.67	1.83	1.80
Student participation	2.17	4.68	1.67	1.66
Student collaboration	1.00	4.65	1.62	1.33
Student response to questions	2.00	4.50	1.84	1.83
Student reasoning ability	1.83	4.33	2.13	2.00
Overall Mean	**1.77**	**4.57**	**1.82**	**1.72**

From the findings it was noted that the means for the experimental group were rated at 1.83, 2.17, 1.00, 2.00 and 1.83 for student's engagement/motivation, participation, collaboration, response to questions and reasoning ability respectively before the experiment. For the control groups, the means were 1.83, 1.67, 1.62, 1.84 and 2.13 for the variables respectively before. However afterwards, the results show that there was no significant change in the means of the control group as they remained 1.80, 1.66, 1.33, 1.83 and 2.00 for student's motivation, participation, response to questions and reasoning capacity respectively as the mean for student collaboration reduced to 1.33.

On the other hand, the means for the experimental group after treatment increased to 4.67, 4.68, 4.65, 4.50 and 4.33 respectively for student's motivation/engagement, participation, collaboration, response to questions and reasoning ability. The results show that there was an improvement in learners' acquisition of problem solving skills as displayed by higher mean scores for the experimental group than for the control groups on the variables; student's motivation/engagement, participation,

collaboration, response to questions and reasoning ability as displayed by the overall mean; experimental group M=1.77 and M=4.57 before and after the intervention and for the control group M=1.82 and M=1.72 before and after intervention. There was need to seek teachers' views on the variations of learners' achievement and qualitative data was collected using face to face interviews before intervention and focus group interviews on experimental group teachers after the intervention as discussed in the next section.

4.2.2.2: Qualitative data

There was need to explore further qualitatively to seek reasons behind the quantitative finding on the impact of formative assessment before and after the intervention. Face to face interview and focus group interview were conducted before and after intervention respectively. The teachers were asked to explain how the use of the formative assessment strategies impacted on the learners' learning from their point of view and from the qualitative analysis of teachers' face to face interviews and focus group interviews. Teachers explained that the use of formative assessment strategies have: assisted learners in improving the reasoning ability, employed in specific areas to enable learners to relate with, guide students in problem solving, assist students work sums alone, enable students assess themselves. In addition, formative assessment strategies assist learners in developing confidence, improving their performance and assist teacher to know student's capabilities.

Further it emerged that formative assessment strategies assisted students to acquire skills by embracing group discussion and enable teacher to learn the students. In addition; use of FAS made students active and cooperative, enhance acquisition of knowledge from one another, helps students to acquire reasonable skills, assist

students to pass exams, assist teachers to know the progress of their students and helps the learners to feel free with the teachers thus motivating them.

Before the intervention, the list on the impact was shorter but after the intervention the list on the impact was very long meaning that before intervention, teachers did not see the great impacts of FAS but after creating awareness in them and making use of the strategies they now saw these great impacts. From the teacher's responses it was clear that the few impacts listed by the teachers about formative assessment which relates with low performance in the pretest was due to less attention to the use of formative assessment strategies hence low utilizations. After the intervention the utilization of the strategies went up leading to improvement in learner achievement and the teachers therefore were able to list more great impacts associated with FAS.

4.2.3: Teachers' and learners' Perceptions of the Five Formative Assessment Strategies used in Mathematics instruction.

The study sought to find out the teachers' and learner's perception of five Effective Formative Assessment strategies in Mathematics instruction. Opinions were sought from the teachers and students on how they perceived the strategies and both quantitative and qualitative data were collected.

4.2.3.1: Quantitative data

Quantitative data on teachers' and learners' perceptions of the five effective formative assessment strategies in mathematics instruction were collected using teachers and learners questionnaires (Appendix ii &iii) and researchers observation schedule (Appendix iv) on learning tasks used during the lesson.

4.2.3.1.1: Data from teachers' and learners' questionnaires

Teachers' questionnaire had five items on teachers' perceptions and they were rated by teachers in both experimental and control groups before and after the intervention. Learners' questionnaire had seven items rated by students in both groups before and after the intervention.

4.2.3.1.1.1: Teachers' Perceptions of the Five Effective Formative Strategies

The teachers were asked to respond to questions on a 4-point Likert scale as to how they perceive the five effective formative assessment strategies in Mathematics instruction. The results are as presented in table 24.

Table 24: Teacher's perceptions of the 5 Effective Formative assessment strategies

Perception	G	Strongly Agree		Agree		Disagree		Strongly Disagree	
		A	B	A	B	A	B	A	B
		F %	F %	F %	F %	F %	F %	F %	F %
1) I understand what formative assessment strategies are in Mathematics instruction	E	9(60%)	4(27%)	6(40%)	5(33%)	0 %	5(33%)	0%	1(7%)
	C	4(22%)	5(28%)	4(22%)	5(28%)	6(33%)	6(33%)	4(22)	2(11%
2) I enjoy using formative assessment strategies during Mathematics lessons	E	10(67%	5(33%)	5(33%)	8(53%)	0%	1(7%)	0%	1(7%)
	C	8(44%)	7(39%)	10(55)	10(55)	0%	0%	0%	1(7%)
3)I use formative assessment strategies with ease during Mathematics lessons	E	10(67%	5(33%)	5(33%)	7(47%)	0%	2(13%)	0%	1(7%)
	C	7(39%)	6(33%)	8(44%)	9(50%)	3(17%)	1(6%)	0%	2(12%)
4)Formative assessment is crucial in improving learner's achievement in Mathematics	E	15(100)	5(33%)	0%	7(47%)	0%	2(13%)	0%	1(7%)
	C	7(39%)	5(28%)	6(33%)	6(33%)	2(12%)	4(22%)	3(17)	3(17%
5) I can complete the syllabus on time comfortably when using formative assessment strategies.	E	15(100)	5(33%)	0%	7(47%)	0%	2(13%)	0%	1(7%)
	C	9(50%)	8(44%)	9(50%)	8(44%)	0%	2(12%)	0%	0%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

Answers were sought from the teachers on their understanding of formative assessment strategies, on whether they enjoy using formative assessment strategies during Mathematics lessons, they use formative assessment strategies with ease during Mathematics lessons, whether formative assessment is crucial in improving learner's achievement in Mathematics and as to whether they complete syllabus comfortably when using formative assessment strategies in Mathematics instruction. The findings are as presented in the following sections.

The results as shown in table 18 indicate that on whether the teachers understand what formative assessment strategies are in Mathematics instruction agreement was noted by a majority 60% and 56% for experimental (E) and control groups(C) respectively of the teachers before the experiment and 100% and 44% of the teachers after the experiment, as disagreement was noted by 40% E and 45% C before experiment and 0% E and 55%C after the experiment. This results show that all the teachers in the experimental group displayed an understanding of the formative assessment strategies after the intervention period. On whether the teachers enjoy using formative assessment strategies during Mathematics lessons, agreement was noted by 86%E and 94% before the experiment and 100% and 99% after the experiment as disagreement was noted by 14%E and 7% C before and 0% E, 0% C after the experiment. On whether the teachers use formative assessment strategies with ease during Mathematics lessons, a majority agreed as noted by 80%E and 83%C before and 100%E and 83%C of the teachers after the experiment as compared to only 20%E and18%C of the teachers who disagreed before and 0%E and 17%C after the experiment.

Formative assessment is crucial in improving learner's achievement in Mathematics was agreed by a majority 80%E and 88%C before the experiment and 100%E and 100%C of the teachers after the intervention as compared to only 20% E,11% C before and 0% after the intervention for both E and C of the teachers who disagreed. On whether the teachers complete the syllabus on time comfortably when using FAS, a majority 80%E and 61% before and 100%E , 72%C of the teachers after the intervention agreed as compared to only 20%E, 39%C before and 0%E,29%C of the teachers who disagreed after.

The results show that a majority of the teachers understood, enjoy and use formative assessment strategies with ease during Mathematics lessons, acknowledged that formative assessment is crucial in improving learner's achievement in Mathematics and that they can complete the syllabus on time comfortably when using formative assessment strategies in Mathematics instruction before the intervention but the perceptions were more positive after the intervention in the experimental group. Majority of the teachers (100%) from experimental group were in agreement on the perception items after the intervention as compared to control group. The findings are indicative of a positive change effect on teachers' perceptions as a result of using the five FAS by the experimental group teachers.

4.2.3.1.1.2: Learners' perceptions of the five effective formative assessment strategies.

Learners were asked to rate their perceptions of the five formative assessment strategies in Mathematics instruction on a 4-likert scale and the results were presented in the table 25 below.

Table 25: Learner's perception of 5 Effective Formative assessment strategies

Items		B- Pre-Test				A- Post-Test			
		Strongly Agree		Agree		Disagree		Strongly Disagree	
		E %	C %	E %	C %	E %	C %	E %	C %
I enjoy Mathematics lessons	B	40%	44%	34%	33%	14%	13%	12%	10%
	A	59%	44%	41%	33%	0	13%	0	10%
I can handle Mathematics tasks with an ease during the lesson	B	25%	30%	44%	40%	22%	21%	9%	9%
	A	60%	30%	40%	40%	0	21%	0	9%
I understand the procedures of success in every Mathematics lesson	B	25%	29%	39%	35%	23%	22%	13%	14%
	A	53%	29%	47%	35%	0	22%	0	14%
I enjoy working in small groups during Mathematics lessons	B	41%	42%	32%	37%	14%	12%	13%	9%
	A	63%	42%	37%	37%	0	12%	0	9%
I can assess my work in Mathematics lessons comfortably	B	34%	33%	33%	35%	20%	16%	13%	17%
	A	60%	34%	40%	35%	0	16%	0	17%
I like peer assessment in Mathematics lessons	B	31%	36%	30%	31%	21%	18%	18%	15%
	A	57%	36%	43%	31%	0	18%	0	15%
Teacher's feedback improves my learning during the lesson	B	60%	63%	26%	23%	7%	6%	7%	8%
	A	71%	63%	29%	23%	0	6%	0	8%

(Key: A – After/Posttest; B-Before/Pre-test; E-Experimental Group & C- Control Group)

The students were asked as to whether they enjoy Mathematics lessons before and after the treatment. the results show that agreement was noted by 40% and 34% experimental group (E) and 44% and 33% control group (C) before the intervention and 59% and 41% E and 44% and 33% C of the students after the intervention. On whether the students can handle Mathematics tasks with an ease during the lesson, the results show that agreement was noted by 25% and 30% E and 44% and 40% C before and 60% and 30% E and 40% and 40% C of the students after the intervention. On whether the students understand the procedures of success in every Mathematics lesson, the results show that agreement was noted by 25% and 39% E and 29% and

35% C before and 53% and 47%E and 29% and 35%C of the students after the intervention from the experimental and control groups respectively. On whether the students enjoy working in small groups during Mathematics lessons, the results show that agreement was noted by41% and 32% E and 42% and 37% C before and 63% and 37% E and 42% and 37% C of the students after the intervention.

On whether the students can assess their own work in Mathematics lessons comfortably, the results show that agreement was noted by 34%, 33% and 33%, 35% before and 60%, 40% and 34%, 35% of the students after the intervention from the experimental and control groups respectively. On whether the students like peer assessment in Mathematics lessons, the results show that agreement was noted by 31%, 30% and 36%, 31% before and 57%, 43% and 36%, 31% of the students after the intervention from the experimental and control groups respectively. On whether the teachers' feedback improves students' learning during the lesson, the results showed that agreement was noted by 60%, 26% and 63%, 23% before and 71%, 29% and 63%, 23% of the students after the intervention from the experimental and control groups respectively.

The results indicate that before the intervention, majority of the students from both experimental and control groups were in agreement with the statements on the five FAS hence positive perceptions. After the intervention, majority of the students from experimental group were in agreement with the same statements on the five FAS hence they were more positive than the control group students. The finding thus show that most students from the experimental group after intervention agreed that they enjoy Mathematics lessons; can handle Mathematics tasks with an ease; understand the procedures of success in every Mathematics lesson; enjoy working in small groups

during Mathematics lessons; can assess their own work in Mathematics lessons comfortably; like peer assessment in Mathematics lessons and that the teacher's feedback improves their learning during the lesson. The findings are indicative of a positive change in students' perceptions when subjected to the five FAS in mathematics instruction.

There was need to find the differences in the means of the scores of the students and teachers on the perception scale. The findings are as shown in table 26.

Table 26: Means for Pre-Test and Post-Test Data of Students and teachers Perception of the 5 FAS

	Learners' Perception				**Teachers' Perception**			
Item	Experimental		Control		Experimental		Control	
5 Items	Mean		Mean		Mean		Mean	
	Before	After	Before	After	Before		After	
Overall mean	2.95	3.71	3.53	4.01	3.60	4.3	3.60	3.70

The results show that before the treatment, the means for the students were 2.95 and 3.06 and after the treatment they were 3.71 and 3.01 respectively for the experimental and control groups. The means for the teachers before the treatment were 3.53 and 3. 60 and after the treatment they were 4.01 and 3.60 respectively for the experimental and control groups. The results show that there existed variations in the means of the students and teachers according to the groups with the experimental group exhibiting increased and higher mean scores after the treatment. There was need for the study to find out the differences in teachers' and learner's perception of five Effective

Formative Assessment strategies in Mathematics instruction. The following null hypothesis was tested at significance level of 0.05.

$H0_2$: There is no significant difference in teachers' and learner's perceptions of the five Effective Formative Assessment strategies in Mathematics instruction between control and experimental groups.

Table 27: Pre-Test Results on Student's data

Group Statistics

	Group of school	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	experimental	227	15.3172	3.66831	.24347
	Control	307	15.3062	4.95510	.28280

This table displays the descriptive statistics. The second table contains

Table 28: Independent Samples Test on Student's Data

	Levene's Test for Equality of Variances		**t-test for Equality of Means**						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	16.578	.000	.028	532	.978	.01099	.38990	-.75493	.77692
Equal variances not assumed			.029	531.998	.977	.01099	.37317	-.72208	.74406

Levene's Test for Equality of Variances tests the hypothesis that the variances of the two groups are equal. A small value (<.05) in the column labeled Sig. indicates that this hypothesis is false and that the groups do indeed have unequal variances. In this case, the value <.05 in the sig. column indicates that the variance of the two groups, experimental and control, is equal. In this case in which the hypothesis is that there is no significant difference in learner's perception of five Effective Formative Assessment strategies, the t statistic under the assumption of unequal variances has a value of .029, and the degrees of freedom has a value of 531.998 with an associated significance level of .977. The high significance level tells us that the probability that there is no difference between learners' perception of five Effective Formative Assessment strategies is very high: specifically, less than one time in a thousand would we obtain a mean difference of .01099 or larger between these groups if there were really differences in their perception. The pre-test results show that there were no significant differences in the learner's perception of the five Effective Formative Assessment strategies.

Table 29: Post-Test Results on Student's Data

Group Statistics

	group of school	N	Mean	Std. Deviation	Std. Error Mean
Post-test	experimental	227	22.9427	5.29412	.35138
	Control	307	15.0912	5.15620	.29428

Table 30: Independent Samples Test on Student's Data

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.711	.191	17.199	532	.000	7.85153	.45652	6.95472	8.74833
Equal variances not assumed			17.131	479.860	.000	7.85153	.45833	6.95094	8.75212

In the above case, the value >.05 in that column indicates that the variance of the two groups, experimental and control, is equal. In this case in which the hypothesis is that there is no significant difference in learner's perception of five Effective Formative Assessment strategies, the t statistic under the assumption of equal and unequal variances has values of 17.199 and 17.131 respectively, and the degrees of freedom have values of 532 and 479.860 with an associated significance level of .000. The significance level tells us that the probability that there is no difference between learners' perception of five Effective Formative Assessment strategies is very small: specifically, less than one time in a thousand would we obtain a mean difference of .01099 or larger between these groups if there were really no differences in their perception.

The hypothesis is thus rejected and the results show that there were significant differences in the learner's perception of the five Effective Formative Assessment strategies. This is explained by the teachers' use of the five Effective Formative Assessment strategies in Mathematics instruction on the experimental group of students that impacted positively on their learning of Mathematics. Results on teacher's Perception of Five Effective Formative Assessment Strategies were presented in the next sections.

Table 31: Pre-Test Results on Teacher's Data

Group Statistics					
	group of school	N	Mean	Std. Deviation	Std. Error Mean
Pre-test	experimental	15	14.2667	3.84460	.99267
	Control	18	18.5556	5.66955	1.33633

Table 32: Independent Samples Test on Pre-test Teachers data

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	10.959	.002	-2.489	31	.018	-4.28889	1.72346	-7.80390	-.77387
Equal variances not assumed			-2.576	29.887	.015	-4.28889	1.66468	-7.68916	-.88862

In the above case, the value <.05 in the sig. column indicates that the variance of the two groups, experimental and control, is not equal. In this case, the value <.05 in that column indicates that the variance of the two groups, experimental and controls, is not equal. In this case in which the hypothesis is that there is no significant difference in teacher's perception of five Effective Formative Assessment strategies, the t statistic under the assumption of unequal variances has a value of -2.576, and the degrees of freedom has a value of 29.887 with an associated significance level of .015. The significance level tells us that the probability that there is no difference between teacher's perceptions of the five Effective Formative Assessment strategies is very high: specifically, less than one time in a thousand would we obtain a mean difference of -4.28889 or larger between these groups if there were really no differences in their perception. The pre-test results show that there were no significant differences in the teacher's perceptions of the five Effective Formative Assessment strategies in Mathematics instruction.

Table 33: Post-Test Results on Teachers Data

Group Statistics

	group of school	N	Mean	Std. Deviation	Std. Error Mean
Post-test	experimental	15	25.6000	2.64035	.68173
	Control	18	19.8889	4.68902	1.10521

Table 34: Independent Samples Test on Teachers Data

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	15.021	.001	4.189	31	.000	5.71111	1.36326	2.93072	8.49150
Equal variances not assumed			4.398	27.554	.000	5.71111	1.29856	3.04919	8.37303

In the above case, the value <.05 in the sig. column indicates that the variance of the two groups, experimental and control, is not equal. In this case, the value <.05 in that column indicates that the variance of the two groups, experimental and controls, is not equal. In this case in which the hypothesis is that there is no significant difference in teacher's perception of five Effective Formative Assessment strategies, the t statistic under the assumption of unequal variances has a value of 4.398, and the degrees of freedom has a value of 27.554 with an associated significance level of .000.

The significance level tells us that the probability that there is no difference between teachers' perception of five Effective Formative Assessment strategies is very small: specifically, less than one time in a thousand would we obtain a mean difference of 5.71111 or larger between these groups if there were really no differences in their perception. Hence the hypothesis is rejected and this shows that there were significant differences in the teacher's perception of the five Effective Formative Assessment strategies in Mathematics instruction after the experiment. This could be attributed to the clear understanding of FAS by the experimental group teachers after the training

by the researcher and the improved support these teachers received during intervention period which improved their perceived relevance of the formative assessment strategies in Mathematics instruction.

The pre-test results showed that there was no significant difference in teachers' and learner's perception of five Effective Formative Assessment strategies between experimental and control groups in Mathematics instruction. However, after the intervention, the post test results were indicative of significant differences in the perception of both teachers and students in the experimental and control groups which could be attributed to the use of the five Effective Formative Assessment strategies in Mathematics instruction in the experimental groups.

The finding on perceptions concurs' with the research findings of Hauser (2015) in the study; "Formative assessment strategies: Levels of use by high school English and Mathematics teachers" who found out that there is a statistically significant effect for teachers perceptions of their own knowledge and level of use of formative assessment strategies ($F(4,98) = 5.25$, $p = 0.01$).

There was need to explore further on the quantitative finding on teachers and learners perceptions of the five effective formative assessment strategies, a focus group interview was conducted among the experimental group teachers to collect the qualitative data where teachers gave views on their perceptions as well as views on the way their students perceived the use of the five formative assessment strategies in Mathematics instruction.

4.2.3.2 Qualitative data

Data from the interview schedule and the focus group interviews were analyzed and presented in form of narrations from the participating teachers. On the Teacher's perception on the use of FAS the teachers had the following to say:

> **Teacher 6:** "When madam came to our school and talked about these formative assessment strategies, i looked at it as something complicated, something..mmmh which cannot be implemented but now after induction, I looked at it as something simple which can be used. When I used the strategies, learners found it very simple, interesting and enjoyable, the discussion group makes it easy to manage learners' assessments and give immediate feedback so for me I find it very interesting and can be implemented."
>
> **Teacher 1: "**FAS is very important in the teaching of Mathematics because it make students to regularly do this practice I think Mathematics is not a spectator sport but students have to participate. FAS make students to participate often, I enjoy using them with ease, its' learner centered and engages students the most."
>
> **Teachers 2: "**The FAS are very important although we need enough time, use of FAS depends on the level of understanding of the learners (entry behavior) if you go to some of the schools, that we have around, most of them are below average students so you know although these strategies are very good, the level of understanding of students in very important. If you go to some schools where by students are above average, you will apply this method very fast but now with very weak students you need to go slowly so that you apply very

well. I use with ease and I enjoy using them. Teachers attitude affect learner's attitude towards FAS."

Teachers 3: "FAS should be encouraged. AS will help us to know whether we are doing the right or whether students are going to pass end term exam or not thus for now it will assist us."

Teacher 4: "There is need for FAS it assists teachers to assess students, it boost teamwork among students and reduces teacher work load."

Teacher 5: "FAS is important enjoyable and easy to use, make students more interactive and friendly."

Teacher 6: "Makes teaching enjoyable and self-fulfillments."

Teacher 7: "I enjoy using FAS though they are challenges assessing individual students."

Teachers opinions on Student Perception about Utilization of FAS was also sought and the researcher sought to explore on the perceptions of learners on the use of the strategies from the teachers and from the thematic analyzes of interviews the teachers had the following responses:

Teacher 3: "Some of them do not like, some of them enjoy, when there is a negative reward they do not like, learners request for topical questions and they like discussion, in fact they like discussion most of them when you give a

task you will even before telling them, you will find they have already formed groups."

Teachers 2: "Students are very much interested those who are not using are disadvantaged because they are not seeing the benefit of using but those using actually see the importance because they enjoy and also the teacher."

Teacher 8: "The learners fairly enjoy, FAS encourage learner's participation and improve on learner's interest."

Teacher 10: "They shy off from FAS but for those who have known its importance enjoy the use of FAS."

Teacher 8: "Make students more interactive and friendly, motivates students."

Teacher 3: "Improves participation and student attitude."

From the above responses, it shows that the learners and teachers were having negative perceptions before and after the intervention their perceptions improved greatly meaning that effective use of the strategies improves learners and teacher's perceptions a lot.

There was need to ascertain the causal relationship between the effective five FAS and learner achievement in Mathematics instruction. To accomplish this, the structural model was fitted for the learners' achievement data and the findings were as presented in the next sections.

4.2.6: The Structural association model for the learners' achievement in Mathematics instruction.

There was need for the study to fit a structural association model for learners' achievement in mathematics instruction in order to see how components of the five

FAS combine in order to optimize learners' achievement. A structural equation modeling was used to analyze the causal relationship between the five effective formative assessment strategies (the constructs) and the learners' achievement. A structural equation modeling was used to analyze these relationships and the model was fitted into students' data on utilization of formative assessment strategies in mathematics instruction and their impact on learners' achievement.

The following null hypothesis was tested at a significance level of 0.05.

$H0_3$: The structural association model fits well the data for learners' achievement in Mathematics instruction.

The dataset used contained various measures of assessment strategies in selected schools. Confirmatory factor analysis (CFA) and structural equation modeling (SEM) used to examine the relationship between the observed variables and the un-observed variables (latent variables) as depicted graphically in Fig 13. A CFA model used fourteen (14) observed variables and five (5) correlated latent variables (or factors); Engineering and Clarifying each with six indicators (or manifest variables), whereas Self-assessment, feedback and Peer assessment had five indicators each.SEM analysis focused on the structural part of the model (i.e., the regression among the latent variables). IBM SPSS AMOS version 24was used for the analysis.

The model contains the following variables:

Observed, endogenous variables were; Lesson objectives (gro2),Clarification of objectives (expl2),Time to think before response(time2),Response to questions(ade2),Activities tied to learning objectives (tied2),Assessing each other's work (asse2),Dialogue with peers (dial2),Small group discussion (disc2),Criticism of

tasks (encoura2),Learners' self-assessment(self2),Opportunity to internalize feedback (internali2),Feedback during the lesson (feedback2),Assignments given (assign2),Post examination mark(post).

Unobserved, endogenous variable was Mathematics achievement (achievement).

Unobserved, exogenous variable were the five Formative Assessment Strategies (FAS), namely; Clarification, Engineering, Feedback, Self-Assessment and Peer-Assessment.

From the CFA using the factor loadings, it was found that, clarifying was adequately measured by objectives given during the lesson (gro2) , clarification of the lesson objectives (expl2) and giving the learners enough time to think through the questions. Engineering was measured by adequate time to respond to questions (ade2) and activities being tied to the learning objectives (tied2). Feedback measured adequately by giving learners an opportunity to internalize feedback and apply (internali2), giving feedback during the lesson (feedback2) and the use of a variety of assignments (assign2). Peer-assessment on the other hand was measured appropriately by their response on small group discussion (disc2), encouraging learners to assess each other's work and allowing dialogue among the learners (dial2). Self-assessment's indicators were criticism of tasks given (encoura2), and learner's self-assessment (self2). Mathematics achievement adequately measured by the post-test mark obtained after the experiment by the intervention group.

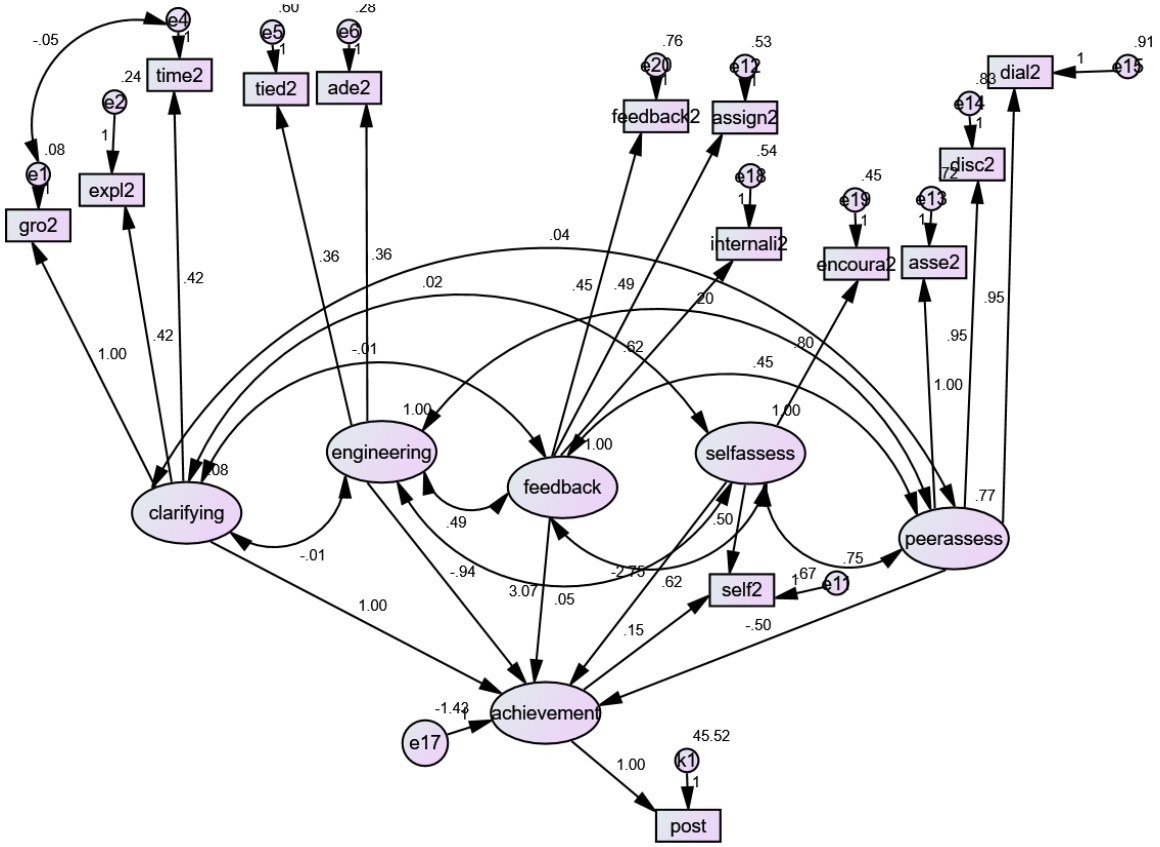

Figure 13: Path diagram of the structural equation model used to fit the student's data.

The SEM fitted and the parameter estimates for feedback and clarifying learners' intentions were found to be statistically significant while the parameter estimates for engineering, self assessment and peer assessment were insignificant at a nominal 5% level of significance. Hence the overall fit of the model was adequate judging from the model fit test statistic(χ^2) of 49.140 with 50 degrees of freedom (P-value=0.508). Other fit indices, similarly indicates a good model fit to the data. The comparative fit index (CFI) is 1.000; Goodness of Fit Index (GFI) is .966 and standardized root mean square residual (RMSEA) is 0.026.

Table 35: Fit indices of the structural model

Fit Statistic	Chi-Square	Degrees of freedom	p-value	GFI	CFI	RMSEA
Value	49.140	50	0.508	0.966	1.000	0.026

The structural model given by;

$$Achievement\ in\ Mathematics = 47.53 + Clarifying - 0.94Engineering + 3.07feedback - 2.75Selfassessment - .5Peerassessment + error\ term$$

Regression coefficients for feedback was significant (p=0.044) at 5% level of significance, whereas for clarification was at the borderline (p=0.056). The regression coefficients for engineering, self-assessment and peer-assessment were however not significant (p>0.05).

From the path diagram, it is clear that there are two sets of measurement models: One measurement model defines the relationship between the 14 observed variables and the five exogenous latent variables. The second measurement model defines the relationship between the post-test mark and the endogenous latent variable (Mathematics achievement) given by;

$$Post - test\ mark = Achievement\ in\ Mathematics$$

Covariance for the five formative assessment strategies: clarification, engineering, feedback, peer-assessment and self-assessment given in table 36 below. Feedback, peer-assessment and self-assessment exhibit significant correlation.

Table 36: Summary of the covariance estimates, standard errors, critical ratio, and the p value for all the FAS.

			Estimate	S.E.	C.R.	P
clarifying	<-->	peerassess	.039	.025	1.534	.125
engineering	<-->	feedback	.045	1.069	.042	.966
engineering	<-->	selfassess	.057	1.346	.042	.966
feedback	<-->	selfassess	.596	.164	3.629	***
Peer assessment	<-->	selfassess	.652	.115	5.648	***
clarifying	<-->	engineering	.015	.367	.042	.966
clarifying	<-->	feedback	.031	.035	.868	.385
clarifying	<-->	selfassess	.018	.032	.555	.579
engineering	<-->	peerassess	.043	1.024	.042	.966
feedback	<-->	peerassess	.458	.127	3.608	***

The finding indicates that the test failed to reject the null hypothesis therefore the structural equation model fits the data for learners' achievement very well and hence there is a relationship between the five FAS and learners' achievement in Mathematics instruction. Although the five FAS are related to learners' achievement, it was found that feedback had a strong positive impact on learners' achievement in Mathematics as indicated in the model.

This finding is in agreement with Hattie and Timperley (2007) who asserted that many studies have suggested that implementing formative assessment specifically feedback has had a significant impact on learning (Black & wiliam 1998). The finding also echoes Hauser (2015) who asserted that review of literature has indicated not only that there is a link between the effective use of assessment for learning(FAS) and improved student achievement, but also that feedback is an integral part of assessment practices and increasing student academic achievement. Clarifying of learning intentions was also found to impact positively on learners' achievement in

Mathematics instruction according to the structural association model, hence Mathematics teachers in the study context need to emphasize the more on feedback and clarifying in order to optimize learners learning.

Self assessment was found to be impacting negatively followed by Engineering and Peer assessment. Negative impact of the three would be due to learners lack of training on the use of the self assessment hence they did not know how to assess their work since they were not offered any training. Negative impact of peer assessment would be due to socio cultural factors where learners see discussion groups as a waste of time and lack of skills by the learners on how to conduct small discussion groups. This finding is in agreement with Arend (2017) who found out that; learners in grade five who participated in the study seemed not to have the necessary skills to engage in classroom discussions as one of the effective formative assessment strategy. On Engineering, the teachers' knowledge on questioning patterns and amount of classroom interactions would be the source of negative impact of engineering. The training given to experimental group teachers was not enough (one day seminar) hence an intensive training would have given better results on improving pedagogical knowledge of teachers.

4.2.7: Teachers' support on the Implementation of Formative Assessment Strategies in Mathematics instruction.

The study sought to investigate the kind of support offered to teachers for effective implementation of the five Formative Assessment strategies in Mathematics instruction. Opinions were sought from the teachers on whether they are accorded support in terms of time, resources, curriculum, head teachers' support, class periods and class sizes and the findings are as indicated in table 37.

Table 37: Support for Implementation of the Five Effective Formative Assessment strategies

	Strongly Agree		Agree		Disagree		Strongly Disagree	
	F	%	F	%	F	%	F	%
1) I have enough time in school to plan for formative assessment.	2	(7%)	7	(21%)	10	(30%)	14	(42%)
2) I have head teacher support in incorporating formative assessment strategies into my teaching practice.	1	(3%)	4	(12%)	17	(52%)	11	(33%)
3) My school provides me with adequate materials/tools to support formative assessment.	1	(3%)	3	(9%)	14	(42%)	15	(46%)
4) My school provides me with adequate training on formative assessment practices.	0	(0%)	5	(16%)	14	(42%)	14	(42%)
5)The curriculum has included very well the use of formative assessment strategies	3	(9%)	5	(16%)	11	(33%)	14	(42%)
6) My school facilitates the use of technology in the implementation of the formative assessment strategies, e.g. computers, internet, and projectors e.tc.	1	(3%)	8	(24%)	11	(33%)	13	(40%)
7) The class sizes allow me to practice formative assessment strategies comfortably during mathematics lessons.	3	(9%)	3	(9%)	10	(30%)	17	(52%)
8)The class periods allow me to practice formative assessment strategies successfully	1	(3%)	9	(27%)	11	(33%)	12	(37%)

Teachers were asked whether they have enough time to plan for formative assessments, and as indicated in table 37, a majority 72% of the teachers disagreed as compared to 28% of the teachers who agreed. On whether the teachers have head teachers' support on the implementation of FAS, a majority 85% disagreed as 15% agreed. On whether the school provide adequate materials to support formative, a majority 88% disagreed as 12% agreed. On whether the school provide them with adequate training on formative assessment practices, a majority 84% disagreed as 16% agreed. On whether the curriculum has included very well the use of formative assessment strategies, a majority 75% disagreed as 25% agreed.

On whether the school facilitates the use of technology e.g. computers, internet, and projectors in the implementation of the formative assessment strategies, a majority 73% of the teachers disagreed as some 27% agreed. On whether the class sizes allow teachers to practice formative assessment strategies comfortably during Mathematics lessons, a majority 82% disagree while 18% agreed and on whether the class periods allow teachers to practice formative assessment strategies successfully, a majority 70% disagreed as 30% agreed. Thus the findings are indicative of an assertion by a majority of the teachers who participated in the study that the class periods provide enough time to use formative assessment strategies. However as indicated in the findings, in most of the schools that participated in the study, the teachers are not provided with adequate training on formative assessment practices. A majority 70% of the teachers disagreed on this statement as only 30% acknowledged.

When teachers were asked whether there is need for reducing class sizes to allow for individualized instruction, a majority 75% agreed as only 25% disagreed. On the need for enough time during class periods to use formative assessment, a majority 70% of the teachers agreed as compared to only 30% who disagreed. The results show that a majority of the teachers disagreed that they were given support in terms of time, curriculum modification, head teachers support materially and professionally, provision of necessary materials/tools, adequate training and facilitation for use of new technology in implementation of the five effective formative assessment strategies in Mathematics instruction. In addition the class sizes and class periods do not support the effective implementation of FAS in their mathematics classrooms.

Based on the finding on support, the implication is clear that there was inadequate support in the implementation of the formative assessment strategies (Majority 88%

disagreed that there was support) and this finding is in line with the finding of Kemboi (2015) in his study on classroom assessment practices by mathematics teachers in secondary schools in Kenya, who found that teachers had little or no neither experience or training on the use of the types of classroom assessment practices used. Also this finding is in agreement with Melani, (2017) who found out that staff development had positive impact on teachers' understanding and skills and he asserts that support for formative assessment by the administrative team members was essential to creating crucial shift from summative to formative assessment.

Accardo, (2017) found out that teachers after receiving support from the school and the government were able to implement the formative assessment strategies and improvement in students and as Ayers (2014) asserts that implementation of a formative assessment process is not a one-time event, but rather it is a decision that needs systemic change and requires professional development to train, empower, and support teachers and educational leaders charged with its implementation.

There was need to collect qualitative data in order to have an in-depth understanding of the factors behind inadequate support and teachers' interviews were conducted. Data from Teachers interviews on support was analyzed and presented in form of descriptions and excerpts discussed in the next sections.

4.2.8: Qualitative data on teachers' support for implementation of the formative assessment strategies

Based on the quantitative finding on teachers' support for the implementation of the five FAS, an exploration using face to face interviews and focus group interviews were carried out on teachers and head teachers to seek in-depth understanding on the

teachers'support for effective implementation of formative assessment and the data were analyzed thematically with the following themes ; training, resources and materials, class sizes, time, curriculum inclusion, head teacher support, class periods and number of trained Mathematics teachers. These themes were discussed in the next sections.

4.2.8.1: Training

Concerning the training**,** teachers were asked whether they have received any kind of training specifically for formative assessment and all of them mention that they have never received any training of that kind in their life and therefore there was lack of teacher preparedness to use formative assessment strategies. A sample of what they said is as follows:

> "I have never gone for seminar or for workshop specifically for formative assessment" **(teacher 8)**
>
> "I have not experienced even in the County, we only have seminars for emerging issues on the subject, particular topics where students perform poorly in KCSE" **(Teacher 6)**
>
> "There is no training specifically for formative assessment**" (teacher 3)**

The teachers also went further during the interview to give their recommendations on the status of the training and they had the following to say:

> "There is need for training of teachers so we should have those workshops or seminars" **(teacher 9)**

> "If you can share the idea to the examiners so that when they are having these seminars they also include this because it is important" **(Teacher 7)**

> "Education stakeholders should come up with ways of training teachers on this kind of formative assessment" **(Teacher 12)**

4.2.8.2: Resources and materials

On the availability of the resources and materials majority of the teachers were of the opinion that they lacked adequate resources and materials to support formative assessment practices in their mathematics lessons. And as one of the head teacher asserted that:

> " Yes the Government support us averagely with resources but not equitably in the schools around, we do not have equal distribution of resources and so low achieving schools are not considered most of the times therefore the performance will continue being poor and even to implement these good strategies of formative assessment may be challenging for us'' (**Principal 4)**

4.2.8.3: Class sizes

The number of students in most of the classes was above the required 45 students per class.

> Formative assessment strategies are good but we have a big challenge with the class size resulting from Free Education. So implementing these strategies will be difficult for us **(Teacher, 1)**

4.2.8.4: Few Mathematics teachers

The number of teachers teaching Mathematics in secondary schools is not proportional to the class sizes hence difficult to implement formative assessment strategies.

> "More teachers to be employed, if we had just enough lessons you will be having enough time to develop or create learner activities so that the lesson becomes learner centered otherwise if you are busy from one class to another you will not have enough time in that case you will start lecture**" (Teacher 3)**

4.2.8.5: Time

Time is a factor which was identified by the teachers as a big challenge in the implementation of formative assessment and they had the following to say

> "The big challenge which have become very striking is time to attend to all those groups due to big number of students**" (Teacher 4)**

> "The callibre of students we have really require time so if we get extra time,it is important**"(Teacher 10)**

> "Sometimes it can be slow in designing the activities you see, those activities to be used well in class sometimes takes a lot of time so comparing these strategies with covering syllabus sometimes they collide**" (Teacher 6)**

> "Designing activities for lesson takes time, we are having so many lessons so we do not have enough time" **(Teacher 7)**

4.2.8.6: Curriculum inclusion

On curriculum issues, the teachers indicated that the current curriculum in Kenya is not working for the effective utilization of formative assessment strategies because assessment used focuses mostly on examination oriented summative assessment hence very difficult to implement formative assessment fully. The teachers had the following to say:

> "Formative assessment strategies have not been included in the curriculum so much" (**Teacher 3**)

> "I do not think they have included so much may be because it is normally CATS we normally do then final exam, I think it is kind of summative that is in place" (**Teacher 9**)

> "I think the curriculum should be designed in a way that students should be assessed formatively, in my opinion formative assessment should be included in the curriculum" **(Teacher 11)**

4.2.8.7: Head teacher support

According to the teachers, support from the head teachers was not adequate and this may have contributed to low utilization of the five effective formative assessment strategies. In their own words they had the following to say:

> "Head teacher support is minimal on formative assessment strategies, the only support we get is during processing of continuous assessment tests

but during teaching and learning may be the support on text books used in class**" (Teacher 5)**

According to the Socio Constructivist theory of learning which grounded the current study, the constructivist teaching aligns particularly well with formative assessment in that it places values on how a teacher views her/ his role and responsibility for students learning via beliefs and practices. Creating a learning environment that is sensitive and responsive to student learning needs and one that allows responsible ownership for their own learning will be a classroom environment where formative assessment is effectively used as an instructional tool to strengthen student critical thinking skills and achievement (Fenstermacher & Richardson (2005). The five effective formative assessment strategies in the framework of William and Thompson (2007) have been verified by this study to be effective but only with the support of a good learning environment proposed by Vygotsky to be constituting social interactions of learners with knowledgeable others (MKO) in the Zone of proximal development with scaffolds.

The context of the learners is found to be very crucial for effective implementation of the five formative assessment strategies therefore teachers need to learn the contexts of their learners first before implementing FAS. This study saw the need of adding the fourth question in the framework of William and Thompson (2007) that is addressing contexts ; "Where am I coming from" or Who am I ? in order to successfully and completely identify and close the learning gaps of learners so as to optimize learners' learning.

4.2.8.8: Understanding Learning Contexts

Understanding learning contexts is also a support to the effective implementation of FAS. Teachers had the following to say:

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the whole study through the discussion of the study findings, the implications of the findings interpreted in the light of the available evidence and conclusions derived from the interpretation and methodological limitations. Furthermore, thesis contribution, some recommendations and areas warranting further investigation are highlighted.

5.2 Summary of the findings

The principal objective of the study in relation to general learning was to investigate the utilization formative assessment strategies in Mathematics instruction and their impact on learners' achievement. The discussion in the section below focuses on the level of use of the five effective formative assessment strategies in Mathematics, the impact of the five Effective Formative Assessment strategies on learner's achievement in Mathematics, the Teachers and learners' perception of the five Effective Formative Assessment strategies in Mathematics instruction, the structural association between the five effective Formative Assessment strategies and the learners achievement in Mathematics instruction and the Teachers' support on the implementation of the five Effective Formative Assessment strategies in Mathematics instruction.

5.2.1: Level of Use of the Five Effective Formative Assessment Strategies in Mathematics

The first objective of the study was to investigate the level of use of the five effective formative assessment strategies in Mathematics instruction. Descriptive and qualitative analyzes were done. Descriptive findings before intervention revealed that majority of the teachers were of the opinion that the five FAS were utilized often and very few teachers were for always. Majority of the learners also rated often, some sometimes and very few always (M=3.7 before &M=4.5 after). From the researchers' observation schedule the finding revealed an average mean scores indicating often was observed before and always after(M=2.5, M=4.5). After the intervention the scores for the teachers, learners and researchers' observation schedule increased and the level of use of the five FAS was rated always. On triangulating the findings from the teachers' ratings, learners' ratings from their respective questionnaires and observation schedule before intervention, the overall finding revealed that there was low utilization of the five FAS in Mathematics instruction in Nandi County.

On the need to get an in-depth explanation of the quantitative finding, qualitative analysis done revealed that teachers lacked understanding and awareness of FAS in Mathematics instruction, there was inconsistency in the use of FAS, lack of knowledge and skills by teachers and learners on the use of FAS, poor attitudes towards FAS and lack of support in terms of head teacher support, lack of time to plan for FAS due to exam oriented curriculum dictating completion of syllabus on time. All these were factors behind the low level of use of the five effective formative assessment strategies. A sample of teachers' and school principals' explanations on their understanding of formative assessment were given:

Teacher 1: "According to my understanding, FAS is regularly administering of tests to assess may be if you finish a topic you give an assignment, you mark. So I think my understand to it a continuous kind of examination where you regularly asses rather than waiting for the whole terms so as to gage understanding of students and may be do necessary adjustments."

Principal 1: "Haaa, this is what has been agreed on eeh, agreed system of assessing our students in our school of giving two CATs and end term exam for assessing our students. And that is actually what is prescribed by the ministry that we have assessment then we have end of term."

The implication of the above finding is that the use of the five effective formative assessment strategies was noted in few schools but they were scantly used. The few noted were not used in the rightful way and to the fullest extent possible. Most of the schools participating were not using all the five effective formative assessment strategies during Mathematics lessons and on exploring using interviews, it was noted that teachers and principals lacked clear understanding of what formative assessment entails, negative perceptions, inadequate support in terms of time, curriculum modification training, and technology use which affected the level of use of the five effective FAS. After the intervention period the experimental group presented higher scores on the level of use of the FAS than the control group which was attributed to the clear understanding of the five effective formative assessment strategies by the teachers as a result of the short training of the experimental group teachers by the researcher on the strategies just before the intervention period.

From the researchers' observation schedule notes analysis, the researcher safely concluded that teachers were still developing in their utilization of the five formative

assessment strategies before intervention but after the intervention, the researcher referred to teachers in the experimental group as effective.

5.2.2 Impact of the Five Effective Formative Assessment Strategies on Learner's Achievement in Mathematics

The second objective of the study sought to determine the impacts of the five formative assessment strategies on learners' achievement in Mathematics. Learners' achievement was in terms of performance scores and acquisition of problem solving skills. Descriptive, Independent t- test and qualitative analyzes were done. Descriptive findings revealed that the mean scores for acquisition of problem solving skills (student engagement/motivation, participation, student collaboration, ,response to questions and reasoning ability) had a significant improvement for the experimental group after the intervention as compared with the control group (M= 1.77and M=4.57 before and after intervention for experimental group and M=1.82, M=1.72 before and after intervention for the control group).

Independent t- test findings revealed that there was no significant difference in learners' achievement between the experimental (E) and control (C) groups in their pretest /before the intervention ($F = 2$, $t = -0.9$, $P = 0.354 > 0.05$). After the intervention, there was a positive significant difference in learners' achievement between the experimental and the control groups in their post test ($F = 11.2$, $t = 14.4$, $P = 0.000 < 0.05$). On the in-depth explanation of the quantitative finding, the qualitative finding revealed that after the intervention the use of FAS increased in the experimental groups and led to: positive change in teachers and learners attitudes towards the use of FAS, improvement of learners' acquisition of problem solving skills, improved communication skills of the learners, improved learners'

participation, engagement/motivation, increased class interactions, improved self esteem, made learners active and cooperative, assist learners in developing confidence hence all great benefits led to increase in performance improvement of the learners.

The first hypothesis of the study was that; **H_{01}**: There is no significant difference in learners' achievement between the experimental and control groups when subjected to the five effective formative assessment strategies. The null hypothesis was rejected and the conclusion was that there was a significant difference in learners' achievement between the experimental and control groups when subjected to the five effective FAS.

The findings of this study showed that the experimental groups obtained significantly higher scores than the control groups after the intervention. More so the higher mean scores of the treatment groups (Experimental) is not coincidental but was probably influenced by the increase use of the five effective formative assessment strategies. On the basis of these findings it was safely concluded that the use of the five Effective Formative Assessment strategies had a positive marked effect on the learners' achievement in Mathematics. The implication from the above interpretation suggests that the five effective formative assessment strategies exerted a more positive influence on the subjects' achievement in Mathematics instruction hence there was an improvement in the experimental group.

5.2.3 Teachers and Learner's Perception of the Five Effective Formative Assessment Strategies in Mathematics Instruction

The third objective sought to ascertain the teachers' and learners' perceptions of the five effective formative assessment strategies in Mathematics instruction. Descriptive, independent t–test and qualitative analyses were done. From the descriptive analysis

the findings revealed that before the intervention, Majority of the teachers disagreed that: they understood FAS, they enjoy using FAS, they use FAS with ease and that they finish syllabus comfortably when using the five FAS. After the intervention, Majority of teachers were in agreement of the above perceptions attributes. The learners also gave their opinions on their perceptions and the finding revealed that before intervention majority of the learners disagreed on; I enjoy Mathematics, I like peer and self assessment, I like small group discussions during lesson and feedback help to improve my learning. After the intervention, majority of the learners were in agreement of the above perception items in their questionnaire.

The independent sample t-test findings revealed that there was no significant difference in the teachers and learners perceptions of the five FAS between experimental and control groups in their pretests/ before the intervention ($F = 16.5$, $t = 0.28$, $P = 0.98 > 0.05$) for learners and ($F= 10.96$, $t = - 2.48$, $P =0.018 > 0.05$) for teachers. After intervention, there was a significant difference in teachers' and learners' perceptions of the five FAS between the experimental and control groups in their posttests ($F = 1.7$, $t = 17.2$, $P = 0.000$) for students' and the teachers ($F = 15.02$, $t = 4.2$, $P =0.000$)

The findings showed that there was a positive change in the teachers' and learners perceptions of the five formative assessment strategies when learners are subjected to the five effective formative assessment strategies. This resulted from good assessment practices in mathematics instruction after using the FAS, improved problem solving skills of the learners and improved students' learning environment. The existence of a significant difference between the experimental groups (E) and the control groups (C) was due to the experimental groups registered significantly higher scores on student'

perception questionnaire (SPQ) and teachers' perception questionnaire (TPQ) after the intervention. The inference made from these findings is that the use of the five Effective Formative Assessment strategies in Mathematics instruction improved the student's and teacher's perceptions and hence had a marked positive influence.

On the basis of these findings it was safely concluded that the use of the five Effective Formative Assessment strategies in Mathematics instruction had a positive marked effect on teachers' and learner's perceptions. The implication from the above interpretation suggests that the teachers' and learner's perception of five Effective Formative Assessment strategies improved positively after the strategies were utilized effectively during instruction meaning that effective utilization of the formative assessment strategies exerted a more positive influence on assessment perceptions of teachers and learners in Mathematics instruction. Qualitative analysis done revealed that before the intervention, teachers and the head teachers lacked understanding and awareness of formative assessment strategies which contributed to poor attitudes hence teachers had difficulties in using the five FAS but after the intervention, teachers' perceptions changed positively hence teachers use the five FAS with ease, enjoyed using them, and they saw the usefulness of five FAS as narrated by one of the experimental group teacher;

> **Teacher 6:** "When madam came to our school and talked about these formative assessment strategies, i looked at it as something complicated, something..mmmh which cannot be implemented but now after induction, I looked at it as something simple which can be used. When I used the strategies, learners found it very simple, interesting and enjoyable, the discussion group makes it easy for me to manage learners' assessments and

give immediate feedback so for me I find it very interesting and can be implemented."

The second hypothesis of the study was that**; H_{02}:** There is no significant difference in teachers' and learners' perceptions of the five effective formative assessment strategies between experimental and control groups when subjected to the five FAS. The null hypothesis was rejected and the conclusion was that there is a significant difference in teachers' and learners' perceptions of the five effective formative assessment strategies between experimental and control groups when subjected to the five effective FAS.

5.2.4: Structural association model for learners' achievement in Mathematics Instruction

The fourth objective of the study was to fit a structural association model for the learners' achievement in Mathematics instruction. Structural equation modeling and correlation analyses were carried out.

From the hypothesis tested ($H0_3$) that the model fits well the data on learners' achievement in Mathematics instruction, the test failed to reject the null hypothesis hence accepted therefore it was found that the structural equation model fits well the data on learners' achievement in Mathematics instruction as indicated by the model fit test statistic(χ^2) of 49.140 with 50 degrees of freedom (P-value=0.508). Other fit indices, similarly indicates a good model fit to the data. The comparative fit index (CFI) is 1.000; Goodness of Fit Index (GFI) is .966 and standardized root mean square residual (RMSEA) is 0.026

The structural model given by;

$$Achievement\ in\ Mathematics = 47.53 + Clarifying - 0.94Engineering + 3.07feedback - 2.75Selfassessment - .5Peerassessment + error\ term$$

From the model, it is indicated that all the five FAS are used to predict learners' achievement in terms of performance and all of them contribute towards learners' achievement. The path diagram presented earlier shows how the five FAS correlate with each other whereby some have strong correlation with others, some weak correlation, the way the five FAS combine to optimize learners learning depends with other factors like learners' contexts, school context cultural factors which were not well considered during this study. From correlation analysis and the model, it was found that feedback had a significant positive impact on learners' achievement in Mathematics followed by clarifying which was also positive while engineering, self assessment and peer assessment had negative impact on learners' achievement.

This finding was not expected in the study and from teachers' perceptions after the intervention period, it led to the understanding that the five FAS predict differently the learners achievement in different contexts. Also the relationships vary with contexts therefore the way components combine to optimize on learners learning vary for different contexts. The implication on the model is that all the five FAS are relevant and it does not mean that the ones with negative significance are not predictors of learners' achievement.

The implication of the finding also is that negative impact of the three would be due to learners lack of training on the use of the self assessment hence they did not know how to assess their work. Negative impact of peer assessment would be due to socio cultural factors where learners saw discussion groups as a waste of time and on engineering the teachers' knowledge on questioning patterns type of learning tasks

used and amount of classroom interactions would be the source of negative impact of engineering. The training given to experimental group teachers was not enough (one day seminar) hence an intensive training would have given better results on improving the pedagogical knowledge of teachers on FAS.

The training of learners on how to use the five formative assessments strategies and what to expect from their Mathematics teachers during lessons was not done hence this might have contributed to negative impacts depicted in the model by both self assessment and peer assessments. There was a possibility that learners were not able to conduct peer assessment, self assessment and even small discussion group for lack of knowledge and skills which were a challenge to effective implementation during intervention period in the experimental group. During the intervention again teachers were not provided with adequate support in terms of time , resources, class sizes, curriculum modifications, technology use but the only little support was from head teacher after the researcher explained the importance of formative assessment in Mathematics instruction and made understanding clear to the head teachers. Due to inadequate support during intervention, it might have contributed to ineffective implementation of FAS by the experimental group.

5.2.5 Teachers' Support on the Implementation of the Five Effective Formative Assessment Strategies in Mathematics Instruction

The fifth objective of the study was to investigate the teachers' support on effective implementation of the five FAS in Mathematics instruction. Descriptive and qualitative analyzes were done. From the descriptive analysis, findings revealed that majority of the teachers disagreed that they were given support in terms of time to

plan for FAS, head teacher support, resources/ materials, training, curriculum inclusion of FAS, technology use, class sizes and class periods hence the inference made was that there was inadequate support on the effective implementation of the five FAS in Mathematics instruction in Nandi County.

An in-depth explanation of the quantitative finding was sought and from qualitative analysis, the findings revealed that inadequate support was due to: lack of training offered to teachers on FAS, lack of adequate resources and materials, big class sizes which did not favor the good use of FAS, lack of time to plan for FAS, FAS not included in curriculum and inadequate head teacher support. Teachers had the following to say:

> "I have never gone for seminar or for workshop specifically for formative assessment" **(teacher 8)**
>
> "I have not experienced even in the County, we only have seminars for emerging issues on the subject, particular topics where students perform poorly in KCSE" **(Teacher 6)**
>
> "Formative assessment strategies have not been included in the curriculum so much" (**Teacher 3**)
>
> Formative assessment strategies are good but we have a big challenge with the class size resulting from Free Education. So implementing these strategies will be difficult for us **(Teacher, 1)**

The implication from the above interpretation suggests that more support is needed in terms of time for planning, resources both materials and human, curriculum modifications, head teacher support, class sizes, technology integration and teacher

motivations through incentives and in-service training in order to have effective and successful implementations of the five FAS.

5.3 Conclusion

From the study findings, it was concluded that:

There is low utilization of formative assessment strategies in mathematics instruction in secondary schools in Nandi County. The main factors behind this are lack of teachers'/ head teachers' understanding and awareness of formative assessment strategies in Mathematics instruction hence low utilization. The results of the study showed that, in most schools the teachers and the administration (head teachers) understood FAS to be continuous assessment tests and not a process used by teachers and learners during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcome. There was no instance where teachers used all the five formative assessment strategies. The few who tried to use, did not use effectively and consistently as rated by the students and the researcher. Majority of the teachers were rated by the researcher as still 'developing' in the utilization of formative assessment strategies in Mathematics instruction.

Use of the five effective formative assessment strategies has a positive impact on learners' achievement in terms of performance scores and acquisition of problem solving skills. There was a significant improvement in Mathematics performance after full utilization of the five effective formative assessment strategies depicted by the experimental group students' data. The implementation of the five FAS in the Mathematics instruction changed the classroom environment into one which is learner centered. This kind of environment improved the learners' motivation/engagement, collaboration, participation, reasoning ability and responds to questions as observed

by the researcher leading to improved acquisition of problem solving skills. The new classroom environment also improved teachers' and learners' assessment perceptions and the kind of tasks used in Mathematics instruction into the ones with no emphasis on grades but comments and learning of skills, no comparison and ranking of learners , the tasks were congruent to learning goals, authentic, individualized, transparent and involved the learner the more. All the above factors contributed immensely to the positive impact on learners' achievement.

Use of the five effective formative assessment strategies has a positive influence on the teachers' and learners' assessment perceptions in Mathematics instruction. Before the intervention, perceptions of teachers and learners on the use of FAS were slightly positive which was attributed to lack of understanding and teachers' knowledge &skills on implementation by teachers. After the intervention, understanding was made clear and awareness was created hence teachers found out to be easy to use FAS and their attitudes towards FAS changed positively hence more positive perceptions led to increase use of the five FAS and hence the learners' perceptions changed positively too.

From the structural association model that fitted well the data on learners' achievement, it was concluded that all the five FAS are related with the learners' achievement and can be used to predict learners' achievement in Mathematics instruction. The significant levels of the five FAS may vary according to different contexts but all are very relevant in the model. The factors which contribute to variations in significant levels which emerged were the contexts including learner contexts, school contexts, societal culture, availability of teacher and learner support and expectations. It is concluded that before implementing the five formative

assessment strategies teachers need to study and understand the various contexts first in order to effectively and successfully implement formative assessment strategies in Mathematics instruction.

There is need for adequate teacher support in order to have effective and successful implementation of the five FAS in Mathematics instruction in Nandi County. The support needed is in terms of time, curriculum modifications, resources/materials, class sizes and periods, technology use and regular teacher trainings and incentives, learner training, head teacher support (administrative) and professional learning developments towards the implementation of effective formative assessment strategies.

On the basis of these findings, it is advanced that there is need for the use of five formative assessment strategies in Mathematics instruction. These findings provide empirical evidence and basis for concluding that the use of strategies such as the five formative assessment strategies in Mathematics instruction facilitates higher level of learning in Mathematics. The implication from the above interpretation, suggests that the level of achievement in learning of mathematical concepts, is marked higher when the students are subjected to the five formative assessment strategies in Mathematics instruction. Therefore, serious considerations should be given to the adoption of the five formative assessment strategies in Mathematics instruction. Achievement in Mathematics can be improved by implementing these formative assessment strategies. This is because the strategies are learner centered and improve students' learning. In general, formative assessment strategies used by teachers to a great extent determine the performance of the learners and acquisition of problem solving skills. Teachers perception is positively changed and that they need to be supported and should make

effort to adopt the five effective formative assessment strategies in their instructional practice.

5.4: Methodological limitations

The study had a number of methodological limitations;

i. Time for training the experimental group teachers was too short (a one day seminar) hence teachers' were not well equipped with knowledge and skills to implement the five FAS effectively as expected. Although the researcher made several lesson observations to make follow ups on how teachers were using the five FAS and correct them, not all the experimental group teachers adhered well to the expectations of the study.

ii. Using teachers to speak for their learners in a qualitative data collection to give qualitative perceptions of their learners was a limitation in this study. Learners' voices if used directly from source would have added originality value to the data.

iii. Training of experimental group learners on how to use the five effective FAS during lessons and guiding them to understand what they expect from their teachers was not done in the study hence intervention results would have been much better.

iv. Hereditary problems of using modified questionnaires whose validity was assumed to be well might have affected the results also.

v. Having the experimental and control groups in different schools of the same stratum might have led to context problems which affected the structural association of the five FAS and learners achievement.

5.5 Thesis Contributions

5.5.1 Empirical contribution

There is empirical contribution to the research bank on the knowledge of the effective utilization and implementation of formative assessment in instruction to educators and curriculum developers in Mathematics instruction. A contribution has been made in the Structural association model fit for the learners' achievement in Mathematics instruction which was validated and can be used in research to predict learners' achievement to improve learners' learning. Also the study has contributed to the need for teachers' support in terms of time, curriculum modification, resources, training of teachers, learners and head teachers also the need to create awareness and understanding of formative assessment and teacher motivation through teacher incentives and seminars.

Contributions have been made also by the study on the rethinking of the context in implementing effective formative assessment strategies in instruction and that prediction of learner performance by the five formative assessment strategies is dependent of the contexts of learning in terms of student level of understanding, teachers' knowledge &skills, school culture, societal expectations and support available. From the findings of this study the researcher developed a model of effective implementation of the five formative assessment strategies in instruction.

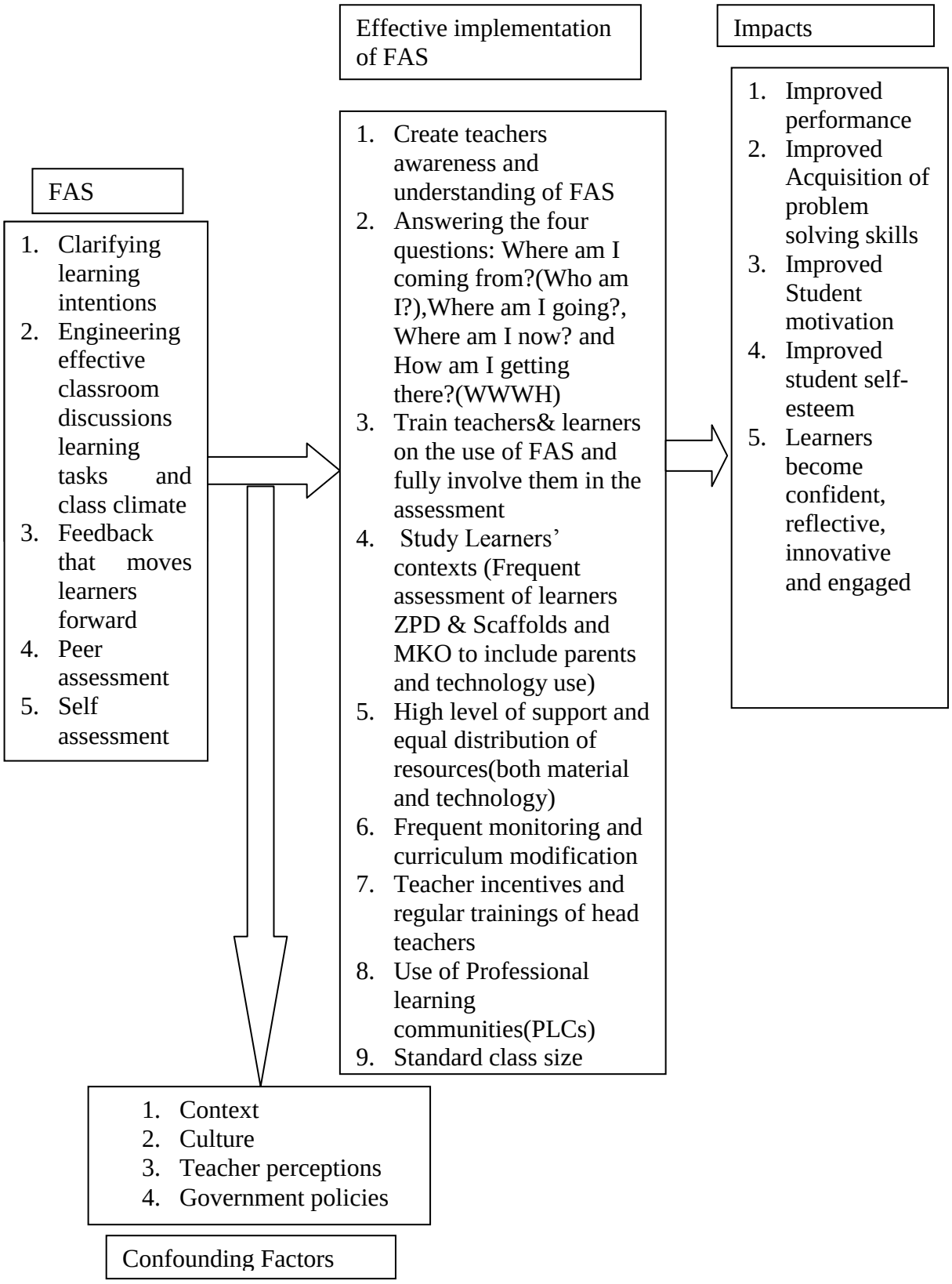

Figure 14 : Conceptual model for effective implementation of the five FAS in Mathematics instruction by the researcher

5.4.2 Theoretical contribution

The research has also provided a theoretical basis upon which a model of the findings is developed based on the theory and the two models of formative assessment informing the study and the development of new concepts as it relates to the effective implementation of formative assessment strategies in Mathematics instruction. A theoretical model with concepts from the findings of this study and those from Vygotsky theory of social constructivism (Vygotsky, 1978), the formative assessment framework of Dylan and Thompson (Dylan William,2007) and Margaret, Heritage ‘s model (Heritage, 2010) which informed the study has been developed and this is a great contribution towards effective implementation of formative assessment strategies in Mathematics instruction.

According to the formative assessment framework by Dylan and Thompson (2007), teachers and students answer three questions when using assessments formatively: Where am I going, Where am I now and how do I get there? (Chappuis, 2015). From the research finding that context affects the level of use of formative assessment strategies, then this study has added the fourth question: WHERE AM I COMING FROM? (WHO AM I?).

This question concerns the need for teachers to know their learners properly which involves knowing their socio cultural contexts, their level of understanding, their school contexts in terms of resources available, and their language proficiency. This will aid in the identification of the learning gap and therefore the four questions will make the process of identifying and closing of the learning gap complete and on this basis a model of the four questions of the formative assessment framework was developed by the researcher.

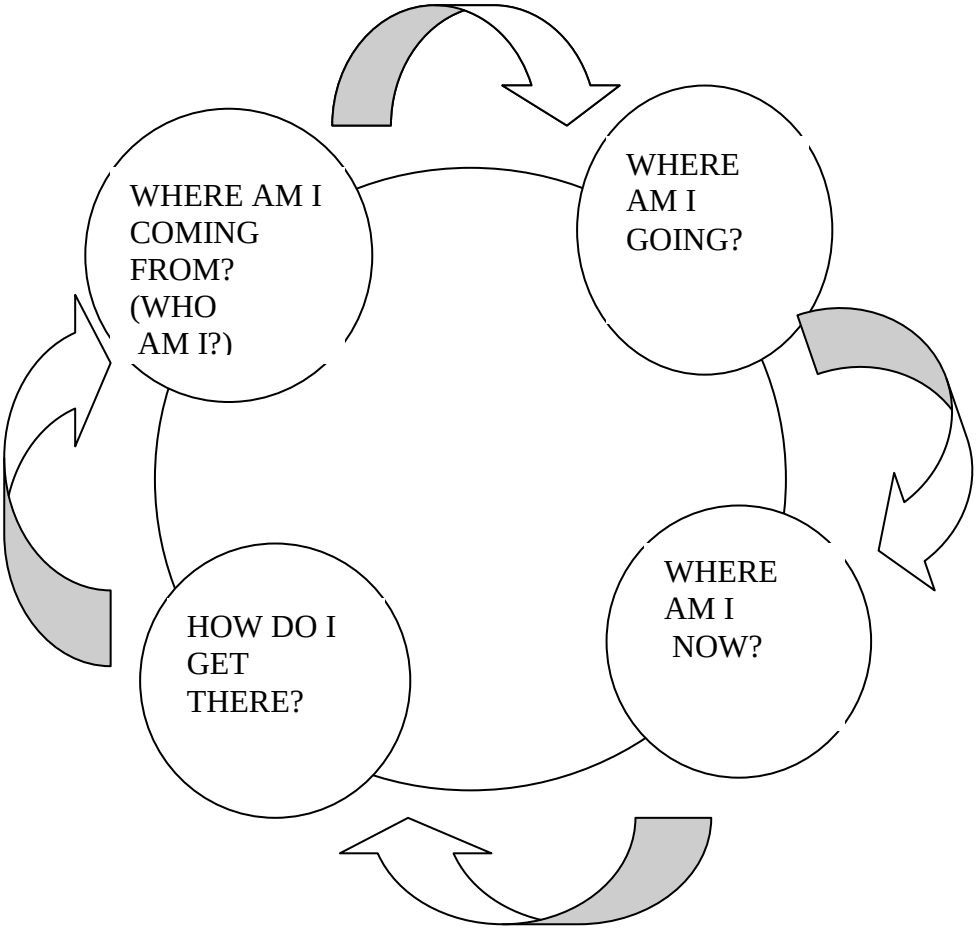

Figure 15: Modified Conceptual Model of Formative assessment

(Source: Researcher)

Another contribution on the framework is that the more knowledgeable others (MKO) in William and Thompson (2007) formative assessment framework is only the teacher and peer but from the findings of this research, Vygotskys'(1978) MKO should be emulated which include parents and the technology use. Involving parents will help to demystify the challenges of culture on the implementation of successful formative assessment strategies. Technology integration will ease the implementation of formative assessment strategies and hence the technology know- how of teachers should be supported well in order to achieve the goal.

The final contribution is that according to this research, formative assessment framework of Dylan and Thompson (2007) will only be successful when the following conditions are met before the implementation of the strategies: Training of the heads of schools on their support roles, training teachers on understanding and use of formative assessment strategies, Training of learners and the peers also on the use of formative assessment strategies , Discuss with parents on their roles in the use of FAS and Teachers to know their learners very well (understanding of learners' contexts) in order to achieve "What works best" to maximize the learning outcomes. Effective Implementation of a successful formative assessment process is not a one-time event, but rather it is a decision that needs systemic change and requires professional development to train, empower and support teachers and educational leaders charged with its implementation.

5.6 Recommendations

i. Create more awareness and understanding of FAS through more training of Mathematics teachers learners and school Principals on what and how to use FAS so as to increase the level of use. Teachers training institutions and universities should review instructional methods and emphasize on teachers' expertise and knowledge of FAS. Teachers Professional Learning Communities should be started in order to train teachers on how to use all the five FAS in mathematics instruction.

ii. For improvement in Mathematics achievement of the learners, Mathematics instructors must increase the use of five FAS during instruction. Encourage frequent assessment of learners' ZBD , use right scaffolds and emphasize on the importance of MKO in Mathematics instruction.

iii. Experts on FAS should conduct regular seminars and training of teachers and learners aimed at improving their perceptions on the use of FAS.

iv. Structural association model for learners achievement provide understanding of the variations in relationships hence allow deeper understanding to be sought in order to optimize learners learning. Study of various learning contexts is crucial before implementing FAS in order to understand what works best to optimize learners learning.

v. Intensive training of head teachers and all stakeholders should be done on the support needed for successful implementation of FAS. In addition, curriculum reviewers must involve stakeholders (Mathematics teachers) so that the reviewed curriculum supports effective implementation of FAS in terms of class sizes, time, learning materials and class periods.

5.7 Suggestions for Further Research

Further research can be undertaken to enrich the present study and also to establish more effects of the formative assessment strategies on achievement in Mathematics.

a) More research on the effects of utilization of the five formative assessment strategies carried out in other areas/subjects

b) There is need to carry out comparative studies on the same in order to explain more about formative assessment and different contexts.

c) More research on impacts of Professional learning Communities on the use of the five Formative assessment strategies to be conducted

d) More studies to be done on structural associations of the five FAS and learners' achievements to come up with variety of effective models on FAS.

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APPENDICES

APPENDIX I: LETTER OF INFORMATION TO THE HEAD TEACHER/PRINCIPAL

Moi University
P. O Box 3900,
Eldoret.

1st April 2016

Dear Sir/Madam

RE: RESEARCH DATA COLLECTION

I am a Doctorate student at Moi University School of Education and will be collecting data on the *utilization of the effective formative assessment strategies in Mathematics instruction and their impact on learner achievement in secondary school in Nandi County, Kenya.* This is an area of great concern to students, teachers, and education stakeholders in the country. Collection of the data will be through questionnaires, interviews focus group discussions and observation. I wish to kindly request you of my visit to your school any time between may to July 2017. Attached are my research abstract and letter of introduction from the University.

Thanking you in advance

Yours faithfully

Janeth Chemeli

STUDENT RESEARCHER

APPENDIX II: TEACHER QUESTIONNAIRES

Kindly respond to the questions below by circling your preferred choice number in the space provided

Section A: Biodata

1. Please indicate your gender

(a) Male ☐

(b) Female ☐

2. What is your highest educational qualification?

(a) Diploma ☐

(b) Bachelors ☐

(c) Masters ☐

(d) PhD ☐

3. What is your teaching experience?

(a) Below 5 years ☐

(b) 5-10 years ☐

(c) 11 -15 years ☐

(d) Over 15 years ☐

4. Indicate your school type

(a) Boys' Only ☐

(b) Girls 'Only ☐

(c) Mixed school ☐

Section B: Level of use of the Five Effective Formative Assessment Strategies

For each of the items below indicate your frequency of use as:

1=Never; 2=seldom; 3 =Sometimes; 4= Often; 5= Always

	Item	Rating				
A:Clarifying and sharing learning intentions and criteria for success						
1	I provide Mathematics objectives at the beginning of each lesson	**1**	**2**	**3**	**4**	**5**
2	I provide clarification of the listed objectives of the lesson	**1**	**2**	**3**	**4**	**5**
3	I state the benefits of each objectives to the learners	**1**	**2**	**3**	**4**	**5**
4	I explain the procedures of success in each lesson	**1**	**2**	**3**	**4**	**5**
5	I give my students enough time to think through the procedures of success and apply in their own work	**1**	**2**	**3**	**4**	**5**
6	I explain to students the connections between new, prior, and future learning	**1**	**2**	**3**	**4**	**5**
B:Engineering effective classroom discussions, questions and learning tasks						
1	I ask questions within the lesson to assess whole group and individual student progress.	**1**	**2**	**3**	**4**	**5**
2	I make adjustments to instruction within the lesson based upon student responses on the learning tasks.	**1**	**2**	**3**	**4**	**5**
3	I ensure the pace of the lesson provides adequate wait time for students to respond to questions.	**1**	**2**	**3**	**4**	**5**
4	I use follow-up questions when engaging students in discourse.	**1**	**2**	**3**	**4**	**5**
5	The tasks and activities within the lesson are directly tied to learning objectives.	**1**	**2**	**3**	**4**	**5**
6	The tasks and activities within the lesson provide evidence of student progress towards learning objectives.	**1**	**2**	**3**	**4**	**5**
C:Providing feedback that moves learners forward						
1	I encouraged students to discover their own errors and misconceptions	**1**	**2**	**3**	**4**	**5**
2	I give students immediate feedback.	**1**	**2**	**3**	**4**	**5**
3	I give learners corrective measures on their errors and misconceptions immediately	**1**	**2**	**3**	**4**	**5**
4	Students have opportunities to internalize feedback and apply it in a meaningful way.	**1**	**2**	**3**	**4**	**5**
5	I use a variety of assignments during and at the end of each lesson e.g filling gaps, etc	**1**	**2**	**3**	**4**	**5**
D: Activating students as the owners of their own learning (Self Assessment)						

1	I encourage the learners to do self-assessment during the lesson	**1**	**2**	**3**	**4**	**5**
2	During the lesson, I encourage learners individual criticisms of tasks and activities	**1**	**2**	**3**	**4**	**5**
3	I engage students in self reflection and letting them keep track of their learning	**1**	**2**	**3**	**4**	**5**
4	I encourage learners to develop self actualization and self esteem	**1**	**2**	**3**	**4**	**5**
5	I use evidence generated through student self-assessments to inform future teaching and learning	**1**	**2**	**3**	**4**	**5**
E: Activating students as instructional resources for one another (Peer assessment)						
1	I encourage students to assist one another in solving problems during the lesson	**1**	**2**	**3**	**4**	**5**
2	I encourage students to assess each other's work during the lesson	**1**	**2**	**3**	**4**	**5**
3	I encourage small group discussions during the lesson	**1**	**2**	**3**	**4**	**5**
4	I encourage learners' collaborative tasks, activities and responses	**1**	**2**	**3**	**4**	**5**
5	I engage students in dialogue with their peers comments on each others' work	**1**	**2**	**3**	**4**	**5**

Section C: Teachers' perceptions in relation to the use of the five effective formative assessment strategies

For each of the statements below indicate your level of agreement as:

(1) Strongly Disagree, (2) Disagree, (3) Agree, (4) Strongly Agree

	Item	**Rating**			
1	I understand what formative assessment strategies are in Mathematics instruction	**1**	**2**	**3**	**4**
2	I enjoy using formative assessment strategies during Mathematics lessons	**1**	**2**	**3**	**4**
3	I use formative assessment strategies with ease during Mathematics lessons	**1**	**2**	**3**	**4**
4	Formative assessment is crucial in improving learner's achievement in Mathematics	**1**	**2**	**3**	**4**

5	I can complete the syllabus on time comfortably when using formative assessment strategies.	**1**	**2**	**3**	**4**

Section D: Teachers' Support for the implementation of the five effective formative assessment strategies

For each of the statements below indicate your level of agreement as:

(1) Strongly Disagree, (2) Disagree, (3) Agree, (4) Strongly Agree

1	I have enough time in school to plan for formative assessments.	**1**	**2**	**3**	**4**
2	I have head teacher's support in incorporating formative assessment strategies in my teaching practice.	**1**	**2**	**3**	**4**
3	My school provides me with adequate materials /tools to support formative assessment.	**1**	**2**	**3**	**4**
4	My school provides me with adequate training on formative assessment strategies.	**1**	**2**	**3**	**4**
5	Our curriculum has included very well the use of formative assessment strategies.	**1**	**2**	**3**	**4**
6	My school should facilitate the use of technology in the implementation of the formative assessment strategies, e.g computers, internet, and projectors e.tc.	**1**	**2**	**3**	**4**
7	The class sizes allow me to practice formative assessment strategies comfortably during Mathematics lessons.	**1**	**2**	**3**	**4**
8	The class periods allow me to practice formative assessment strategies successfully.	**1**	**2**	**3**	**4**

APPENDIX III: STUDENTS' QUESTIONNAIRE

Section A: Biodata

1. Please indicate your gender

(a) Male ☐

(b) Female ☐

2. School type

(a) Boys only ☐

(b) Girls only ☐

(c) Mixed ☐

Section B: Level of use of the formative assessment strategies

For each of the items below indicate your frequency of use as:

1=Never 2=seldom 3 =Sometimes 4= Often 5= Always

	Item	**Rating**				
1a: Clarifying and sharing learning intentions and criteria for success						
1	My teacher provide Mathematics objectives at the beginning of each lesson	**1**	**2**	**3**	**4**	**5**
2	My teacher provide clarification of the listed objectives of the lesson	**1**	**2**	**3**	**4**	**5**
3	My teacher state the benefits of each objectives to us	**1**	**2**	**3**	**4**	**5**
4	My teacher state and explain the procedures of success in each lesson	**1**	**2**	**3**	**4**	**5**
5	My teacher give us enough time to think through the procedures of success and apply in our own work	**1**	**2**	**3**	**4**	**5**
6	My teachers explain to us the connections between new, prior, and future learning	**1**	**2**	**3**	**4**	**5**
1b:Engineering effective classroom discussions, questions and learning tasks						
1	My teacher asks questions within the lesson to assess whole group and individual student progress.	**1**	**2**	**3**	**4**	**5**
2	My teacher makes adjustments to instruction within the lesson	**1**	**2**	**3**	**4**	**5**

	based upon our responses on the learning tasks.					
3	My teacher gives us adequate wait time to respond to questions.	**1**	**2**	**3**	**4**	**5**
4	My teacher use follow-up questions when engaging us in class discussion.	**1**	**2**	**3**	**4**	**5**
5	The tasks and activities within the lesson are directly tied to learning objectives.	**1**	**2**	**3**	**4**	**5**
6	The tasks and activities within the lesson provide evidence of our progress toward learning objectives.	**1**	**2**	**3**	**4**	**5**
1c:Providing feedback that moves learners forward						
1	My teacher encourages us to discover our own errors and misconceptions	**1**	**2**	**3**	**4**	**5**
2	My teacher gives us immediate feedback during the lesson	**1**	**2**	**3**	**4**	**5**
3	My teacher gives us corrective measures on our errors and misconceptions immediately	**1**	**2**	**3**	**4**	**5**
4	My teacher gives us opportunity to internalize feedback and apply it in a meaningful way.	**1**	**2**	**3**	**4**	**5**
5	My teacher uses a variety of assignments at the end of every lesson e.g filling gaps, etc	**1**	**2**	**3**	**4**	**5**
1d:Activating students as the owners of their own learning (Self Assessment)						
1	My teacher encourage the learners to do self-assessment during the lesson	**1**	**2**	**3**	**4**	**5**
2	During the lesson, my teacher encourages individual criticisms of tasks and activities	**1**	**2**	**3**	**4**	**5**
3	My teacher engage us in self reflection and letting us keep track of our learning	**1**	**2**	**3**	**4**	**5**
4	My teacher encourages us to develop self actualization and self esteem	**1**	**2**	**3**	**4**	**5**
5	My teacher uses evidence generated through our self-assessments to inform future teaching and learning	**1**	**2**	**3**	**4**	**5**
1e:Activating students as the instructional resources for one another (Peer assessment)						
1	My teacher encourage us to assist one another in solving problems during the lesson	**1**	**2**	**3**	**4**	**5**

2	My teacher encourage us to assess each other's work during the lesson	**1**	**2**	**3**	**4**	**5**
3	My teacher encourages small group discussions during the lesson	**1**	**2**	**3**	**4**	**5**
4	My teacher encourages us to participate in collaborative tasks, activities and responses	**1**	**2**	**3**	**4**	**5**
5	My teacher engages us in dialogue with our peers comments on each others' work	**1**	**2**	**3**	**4**	**5**

Section C: Learners perception in relation to the use of the five effective formative assessment strategies

For each of the statements below indicate your level of agreement as:

(1) Strongly Disagree, (2) Disagree, (3) Agree, (4) Strongly Agree

1	I enjoy Mathematics lessons	**1**	**2**	**3**	**4**
2	I can handle Mathematics tasks with an ease during the lesson	**1**	**2**	**3**	**4**
3	I understand the procedures of success in every Mathematics lesson	**1**	**2**	**3**	**4**
4	I enjoy working in small groups during Mathematics lessons	**1**	**2**	**3**	**4**
5	I can assess my work in Mathematics lessons comfortably	**1**	**2**	**3**	**4**
6	I like peer assessment in Mathematics lessons	**1**	**2**	**3**	**4**
7	Teacher's feedback improves my learning during the lesson	**1**	**2**	**3**	**4**

APPENDIX IV: OBSERVATION SCHEDULE

To be used to observe utilization of Formative Assessment Strategies in mathematics lessons. Detailed description will be recorded during classroom teaching.

Sub-County _____ School code _____

Date: _____ Number of Students in Class: _____

Domain A: Clarifying learning intentions and criteria for success	Rating					Notes
	None	Poor	Fair	Good	Excellent	
a) Connection to previous learning						
b) Learning objective quality						
c) Learning objective implementation						
d) Presentation of criteria for success (Rubrics)						
Domain B:Engineering effective classroom discussion (questioning)						
a) Questioning pattern (more probing questions)						
b) Wait time for responses						
c) Eliciting evidence of learning (reveal students' thinking)						
d) Determining progress of the learners						
e) Use of evidence to adjust instruction						
Domain C: Engineering effective classroom discussion (collaboration)						
a) Classroom climate						
b) Use of small group discussion						
c) Use of student view points						
d) Communicating expectations to the						

learners						
e) Classroom interactions(Teacher-Student, Student-Teacher and Student-Student)						
Domain D: Learning Tasks						
a) Connection to learning objective (Congruence)						
b) Clarity of tasks (Transparency)						
c) Relevance of tasks to real life problems (Authenticity)						
d) Student autonomy (Student consultation on tasks)						
e) Individualized tasks (Student capabilities)						
Domain E: Feedback on instruction						
a) Focused and action oriented feedback						
b) Related to learning goals						
c) Self assessment						
d) Individualized feedback						
e) Peer assessment						
f) Feedback Loops						
Domain F: Acquisition of problem solving skills						

a) Student motivation						
b) Student participation						
c) Student collaboration						
d) Student response to questions						
e) Student reasoning ability						

APPENDIX V: STUDENTS' MATHEMATICS ACHIEVEMENT TEST (SMAT)

NANDI COUNTY FORM 3 MATHEMATICS CONTINUOUS ASSESSMENT POST-TEST

Name: .....School.....

Adm No.....Date.....

Instructions: Answer all Questions in spaces provided.

1. The terms of an arithmetic sequence are; 2,5,8,11……..
   a. Find
      i. The common difference of the sequence (1mrk)

      ii. The next two terms of the sequence (2mrks)

      iii. The 30^{th} term of the sequence (2mrks)

   b. The sum of the first n terms of a sequence is 5430, given that the last term is 179 find n, the number of terms of the sequence (3mrks)

   c. Calculate the sum of the first 50 terms of the sequence (3mrks)

2. The second term of a geometric sequence is 24 and the 5^{th} term is 192, find the first term of the sequence (3mrks)

3. a) Find A^{-1} , the inverse of a matrix $A \begin{bmatrix} 5 & 6 \\ 7 & 9 \end{bmatrix}$ (4 mrks)

b) Okello bought 5 physics books and 6 mathematics books for a total of Kshs 2440. Ali bought 7 physics books and 9 mathematics books for a total of 3560

i) Form a matrix Equation to represent the above information (2mrks)

ii) Use matrix method to find the price of a physics book and that of a mathematics book.(4mrks)

c) A school bought 36 Physics books and 50 mathematics books. A discount of 5% was allowed on each physics book whereas a discount of 8% was allowed on each mathematics book. Calculate the percentage discount on the cost of all books bought (4mrks)

APPENDIX VI: TEACHERS' INTERVIEW GUIDE (ONE TO ONE INTERVIEW)

Thank you very much for agreeing to participate in our formative assessment study. I am Janeth Chemeli from Moi University, school of Education. I am conducting a study on: Utilization of Effective formative assessment strategies in mathematics instruction and their impact on learner's achievement. The information that will be gathered here will be of a significant importance to the teachers, students, head teachers and curriculum reviewers and in improving learner achievement in mathematics.

Do you have any questions about the study before we begin?

1. Tell me about your current position and your background in education. (i.e., # years as teacher, # Highest level of education).
2. What do you understand by Formative Assessment Strategies (FAS)?
    a) What formative assessment strategies do you use in your mathematics lessons? (are you familiar with the five effective formative assessment strategies)
    b) When do you incorporate FAS strategies during the lesson? (Introduction, development, conclusion)
    c) How often do you use FAS strategies?
    d) Describe how you use the FAS strategies
3. How does FAS impact on learners' achievement? (Performance and acquisition of problem solving skills).
4. How do you perceive the use of FAS in the teaching and learning of mathematics? (need /importance, enjoy using, use with ease, share ideas with colleagues)
5. In your opinion how do students, perceive the use of FAS in mathematics instructions? (learner motivation, participation, interest)
6. What kind of support does the school provide for the implementation of the FAS strategies in mathematics instruction? (Curriculum, material, technology)
7. What challenges do you encounter in the implementation of formative assessment strategies in mathematics instructions?

Thank you

APPENDIX VII: TEACHERS' FOCUS GROUP INTERVIEW GUIDE

CONSENT FORM FOR TEACHERS' FOCUS GROUP INTERVIEW ON THE UTILIZATION OF FORMATIVE ASSESSMENT STRATEGIES IN MATHEMATICS INSTRUCTION AND THEIR IMPACT ON LEARNER ACHIEVEMENT IN KENYA (28TH AUGUST, 2017)

This research study is being conducted as part of Doctoral Dissertation in Mathematics Education, Moi University under the supervision of Dr, Anne Kisilu and Dr. Sammy Chumba and Prof. Dr. Karsten speck of Oldenburg University, Germany. You are being requested to participate in this FGI because you are the mathematics teachers selected to participate in the experimental group of this study which was undertaken between June and July, 2017.

Your response in this focus group interview will be treated with utmost confidentiality, and will not be used for any other purposes except this study. You may also request the researcher to inform you about the findings of this study later on. Please sign in the spaces provided if you accept to participate in this FGI.

Yours faithfully,

_____	_____
Janeth Chemeli	**Date**
_____	_____
Participant	Date

TEACHERS' FOCUS GROUP INTERVIEW GUIDE ON THE UTILIZATION OF FORMATIVE ASSESSMENT STRATEGIES IN MATHEMATICS INSTRUCTION AND THEIR IMPACT ON LEARNER ACHIEVEMENT IN KENYA (28TH AUGUST, 2017)

Thank you for agreeing to participate. We are very interested to hear your valuable experiences on the utilization of formative assessment strategies in mathematics instruction and their impacts on learner achievement in Kenya.

- The information you give us is completely confidential, and we will not associate your name with anything you say in the focus group.
- We would like to tape the focus groups so that we can make sure to capture the thoughts, opinions, and ideas we hear from the group. No names are attached to the focus groups and the tapes will be destroyed as soon as they are transcribed.

An opening prayer to be offered by one of the group members and thereafter every member of the focus group to first introduce him/herself

1. Let's start the discussion by each member giving a story on their experiences with the use of the five effective formative assessment strategies (each member to use 5 minutes.
2. What changes in your students did you notice after using the five formative assessment strategies (student's involvement, understanding of concepts, motivation/engagement, participation in response to questions and students' perceptions).
3. (i) After using the five strategies of FAS, how do you now perceive the use of FAS in the teaching and learning of mathematics? (is it effective, ease of use, the need of use).

   (ii) From the five effective strategies used, describe how you can rank them;

   (a) According to their ease of use during the experiment.

   (b) According to how students enjoyed/liked using them

   (c) What do think is the relationship between FAS and learners achievement?

   (d) Comment on context and the use of the five FAS(school context, learners context, societal/cultural context
4. How did the use of FAS impact on learners' achievement? (Improvement in performance and acquisition of problem solving skills).

5. (a) What challenges did you encounter during the use of the five formative assessment strategies in mathematics instructions? (Support from the school, time, and resources).

   (b) Give any other challenges which you encountered

7. What advice can you give to all mathematics teachers concerning the utilization of FAS?

THANK YOU!

APPENDIXVIII: SCHOOL PRINCIPALS' INTERVIEW GUIDE

Thank you very much for agreeing to participate in our formative assessment study. I am Janeth Chemeli from Moi University, school of education. I am conducting a study on: *Utilization of Effective formative assessment strategies in mathematics instruction and their impact on learner's achievement.* The information that will be gathered here will be of a significant importance to the county director of education, teachers, students and the school in improving learner achievement in mathematics.
We are talking with you today to get a sense of how your school/government support teachers in their formative assessment practice.

Do you have any questions about the study before we begin?

1. Tell me about your current position and your background in education. (i.e., # years as headteacher, # years as teacher and subject/grade level, advanced degree, # of years in current position).

2. From your own understanding explain the meaning of formative assessment?

After the headteacher answers this question i will share with them the definition of formative assessment for purposes of this study so that they can use this to frame their answers to the next questions about formative assessment in this interview.
From this research, formative assessment is: the extent to evidence about how student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited." The key strategies in formative assessment practice as identified by this research are:

- Clarifying and sharing learning intentions and criteria for success
- Engineering effective classroom discussions, questions, and learning tasks
- Providing feedback that moves learners forward
- Activating students as the owners of their own learning
- Activating students as instructional resources for one another

3. From your position, to what extent are teachers incorporating FAS during mathematics instructions? (When, frequency)

4. What impacts do you think the use of FAS has on learners' achievement in mathematics? (importance/need).

5. (a) What support has the government/school provided for the implementation of FAS (Technology, training, materials, curriculum inclusion)

(b) What types of support do you believe teachers need in order to effectively implement formative assessment within their classrooms? (future plans)

(c) What do you believe are some of the challenges for your teachers in implementing formative assessment in their classrooms?

(d) Are there any challenges external to the school that make the use of formative assessment challenging? (describe)

THANK YOU

APPENDIX IX: RESEARCH AUTHORIZATION LETERS

MOI UNIVERSITY
Office of the Dean School of Education
Tel: (053) 43001-8
(053) 43555
Fax: (053) 43555
P.O. Box 3900
Eldoret, Kenya

REF: EDU/D.PHIL.CM/1009/16 **DATE:** 16th May, 2017

The Executive Secretary
National Council for Science and Technology
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: **RESEARCH PERMIT IN RESPECT OF CHEMELI JANET – (EDU/D.Phil.CM/1009/16)**

The above named is a 2nd year Postgraduate Higher Degree (PhD) student at Moi University, School of Education, Department of Curriculum, Instruction and Educational Media.

It is a requirement of her PhD Studies that she conducts research and produces a dissertation. Her research is entitled:

"Utilization of Formative Assessment Strategies in Mathematics Instruction and their Impact on Student Achievement in Secondary Schools in Nandi County, Kenya."

Any assistance given to enable her conduct research successfully will be highly appreciated.

Yours faithfully,

MOI UNIVERSITY SCHOOL OF EDUCATION 16 MAY 2017 P. O. Box 3900 - 30100, ELDORET

PROF. J. N. KINDIKI
DEAN, SCHOOL OF EDUCATION

THIS IS TO CERTIFY THAT:
MS. JANETH CHEMELI
of MOI UNIVERSITY, 8101-30100
ELDORET,has been permitted to conduct
research in *Nandi County*

on the topic: *UTILIZATION OF FORMATIVE ASSESSMENT STRATEGIES IN MATHEMATICS INSTRUCTION AND THEIR IMPACT ON STUDENT ACHIEVEMENT IN SECONDARY SCHOOLS IN NANDI COUNTY KENYA*

for the period ending:
18th July,2018

Permit No : NACOSTI/P/17/08923/18162
Date Of Issue : 18th July,2017
Fee Recieved :Ksh 2000

.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 14982

CONDITIONS: see back page

NATIONAL COMMISSION FORSCIENCE,
TECHNOLOGY ANDINNOVATION

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Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/08923/18162** Date: **18th July, 2017**

Janeth Chemeli
Moi University
P.O. Box 3900-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Utilization of formative assessment strategies in mathematics instruction and their impact on student achievement in secondary schools in Nandi County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Nandi County** for the period ending **18th July, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nandi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nandi County.

The County Director of Education
Nandi County.

REPUBLIC OF KENYA

MINISTRY OF EDUCATION
STATE DEPARTMENT FOR BASIC EDUCATION

Email: cdenandicounty@yahoo.com
Telephone: 0773044624
When replying please quote

COUNTY DIRECTOR OF EDUCATION,
NANDI
P.O BOX 36 – 30300,
KAPSABET.

Ref:NDI/CDE/RESEARCH/1/Vol.II/64/68

13th February, 2017

Janeth Chemeli,
Moi University,
P.O Box 3900-30100,
ELDORET.

RE: RESEARCH AUTHORISATION

The above named person has been granted permission by the County Director of Education to carry out research on ***"Utilization of formative assessment strategies in Mathematics instruction and their impact on student achievement in Secondary schools,"*** in Nandi County Kenya for the period ending **18th July, 2018.**

Kindly provide her all necessary support she requires.

For: County Director of Education
NANDI COUNTY

Clare Kusa
For: County Director of Education,
NANDI COUNTY.

THE PRESIDENCY

MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Tel: 053 5252621, 5252003, Kapsabet
Fax No. 053 – 5252503
E-mail:
nandicountycommissioner@gmail.com
When replying, please quote

Ref: No.NC.EDU/4/1/VOL. IV/(143)

County Commissioner's Office,
Nandi County
P.O. Box 30,
KAPSABET.

13th February, 2018

Janeth Chemeli
Moi University
P.O. BOX 3900-30100,
ELDORET.

RE: RESEARCH AUTHORIZATION

This is in reference to letter No. NACOSTI/P/17/08923/18162 dated 18th July, 2017 from the Director General/CEO, National Commission for Science, Technology and Innovation on the above subject matter.

You are hereby authorized to conduct a research on **"Utilization of formative assessment strategies in mathematics instruction and their impact on student achievement in secondary schools in Nandi County"** for the period ending **18th July, 2018.**

Wishing you all the best.

THE COUNTY COMMISSIONER
NANDI.

JACINTAH K. MUKHULA,
For: COUNTY COMMISSIONER
NANDI.

APPENDIX X: MAP OF THE STUDY AREA