IMPACT OF THE FIVE KEY FORMATIVE ASSESSMENT STRATEGIES ON LEARNER'S ACHIEVEMENT IN MATHEMATICS INSTRUCTION IN SECONDARY SCHOOLS: A CASE OF NANDI COUNTY, KENYA

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ABSTRACT

Formative assessment approaches are very efficient in improving learners' achievement in Mathematics instruction. However, there is paucity in literature in Kenya on the impact of the five key formative assessment strategies on learners' achievement 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 determine the Impact of the five key Formative Assessment Strategies (FAS) on Learner's Achievement in Mathematics instruction in secondary schools in Nandi County, Kenya. The study utilized Pre-Posttest control Quasi-experimental mixed method intervention design. A sample of 534 Form three students (54% male and 46% female) and 33 teachers (76% male and 24% female) participated in the study with 227 students and 15 teachers in the experimental group and 307students and 18 teachers in the control group. Both groups were taught same topic in Mathematics for duration of six weeks with experimental group taught using the five FAS, while the control group taught using normal methods. Pretests and posttests were administered to both groups and data was collected using Student Mathematics Achievement Test (SMAT), observation schedule and teachers' focus group interviews. Data was analyzed using independent sample t-test, means, and thematic analysis. The findings from the study revealed that there was a positive impact on learners' achievement ($p= 0.00$, <0.05 with $F=11.23$, $t=14.82$). Reasons for positive impact were: FAS eased the teachers' workload, raised learners 'attitudes & interest, improved learners' critical thinking and teachers and students enjoyed using FAS. Also it was revealed that the five FAS improved learners' acquisition of problem solving skills ($M=1.77$, $M=4.57$) before and after the intervention respectively (increased learners' motivation, collaboration, participation, response to questions, reasoning ability). It was concluded that the five key FAS have a positive impact on learners' achievement in terms of performance improvement and acquisition of problem solving skills. The study recommends that Mathematics instructors should increase the use of five key FAS during instruction. They should also embrace social constructivism by frequent assessment of learners' Zone of proximal development, use right scaffolds and emphasize on the importance of More Knowledgeable others and understanding of learners' context in Mathematics instruction. The findings will give an insight to Mathematics Educators, curriculum reviewers to rethink effective implementation of the five key FAS to improve learners' achievement towards sustainable development goals.

Key Words: *impact, five key formative assessment strategies, achievement, mathematics instruction*

INTRODUCTION

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). Although Mathematics is an important subject in the school curriculum, the performance of students in the subject worldwide and at Kenya Certificate of Secondary Education is deplorable and alarming (Mwei, 2009; Chemeli, 2013). 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). Kenya is currently undergoing curriculum reform from 8.4.4 to competence based curriculum (CBC) where formative assessment is core.

According to Cambridge international (2015), Building on the formative assessment work by Michael Schriven 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. 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. Formative assessment has been highly touted for its purported positive impact on student learning (Black &Wiliam,2010; Organization for Economic Co-operation and Development, 2005).

Research shows that the use of formative assessment has a positive effect on student achievement (Lee, Harrison & Black 2004; Popham,2005). 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). 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; Bordohet al., 2013; Brookhart &Nitko, 2013; Confrey, 2015; Earl, 2012; Kilpatrick, 2014; Pinto & Santos, 2012).

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.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).

Ali, Iqbal (2013), Kingston and Nash, 2011) posits that effective implementation of formative assessment practices in a Mathematics classroom results in students 'improved learning and achievement directly or indirectly. They further claimed that formative assessment classroom practices improve students' motivation, confidence and self esteem because of its pedagogical potential (Kiplagat, 2016). The present study therefore observed impact of the five FAS on the acquisition of problem solving skills including: student motivation/engagement, participation, collaboration, response to questions and student reasoning ability as part of learners' achievement.

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, labor market integration and youth unemployment challenge. 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 and that teachers' use of formative assessment to inform instruction is an essential piece of effective pedagogy Ayers (2014).

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 meta-cognitively about their learning and Collaboration where teachers and students are partners in learning. 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).

Several other researchers (Leahy, Lyon,Thomson and Wiliam, (2005) Thomson and Wiliam (2008), Bennett R.E (2011), Oswalt G, (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 including: 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 impact of 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 Wiliam and Thompson (2007) to test whether they were really effective in the Kenyan context. Formative classroom assessment approaches have been shown 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, 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 and acquisitions of problem solving strategies. 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. In glimpse of the advantages which Kenyan education system can reap from the usage of formative assessment approaches effectively in classroom instruction, the study filled the gaps by determining the impact of the five key formative assessment strategies on learner achievement in terms of performance improvement and acquisition of problem solving skills in Mathematics instruction in secondary schools in Kenya.

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 Roble (2015), the three types of drumes (learning goals or success criteria used by the teacher and students to compare actual levels of learning to the predetermined goals (Heritage, 2010) were rooted in behaviorism or social constructivism. The underlying driver of Black, P., Harrison, C., & Lee, C. (2004) formative assessment model is social constructivism. Second driver is teacher knowledge as the teacher is responsible for determining the learning goals of the session and success criteria that students need to meet. How the teachers position themselves on the behaviorist to social constructivist continuum will greatly impact the classroom practices and questions used. Teacher knowledge and learning progressions are the driving force in the Heritage (2010) model. These progressions help to identify the big picture of student learning and use a pathway driven by learning goals and success criteria. These goals and the criteria are then used with formative assessment to help determine students' current level of understanding in relationship to the established goals. The progression also helps teacher determine the current learning status of their students by identifying what is to be learned where students are compared to the goals and what students need to accomplish to meet the learning goals and success criteria. This justified the need for the trio to support the study.

An overall theoretical framework which indicated the components from each one that informed the study as depicted in figure 1. The 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 Heritage(2010) model of formative assessment, the researcher picked the following: Learning progression, Identifying the gap, Teacher knowledge & skills and closing of the gap. The formative assessment framework of Dylan Wiliam (2007), presents the five key formative assessment strategies 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 three agents in the classroom are; teacher, learner and peer. Three questions to be answered during instruction; where the learner is going? Where the learner is now? and How to get there?

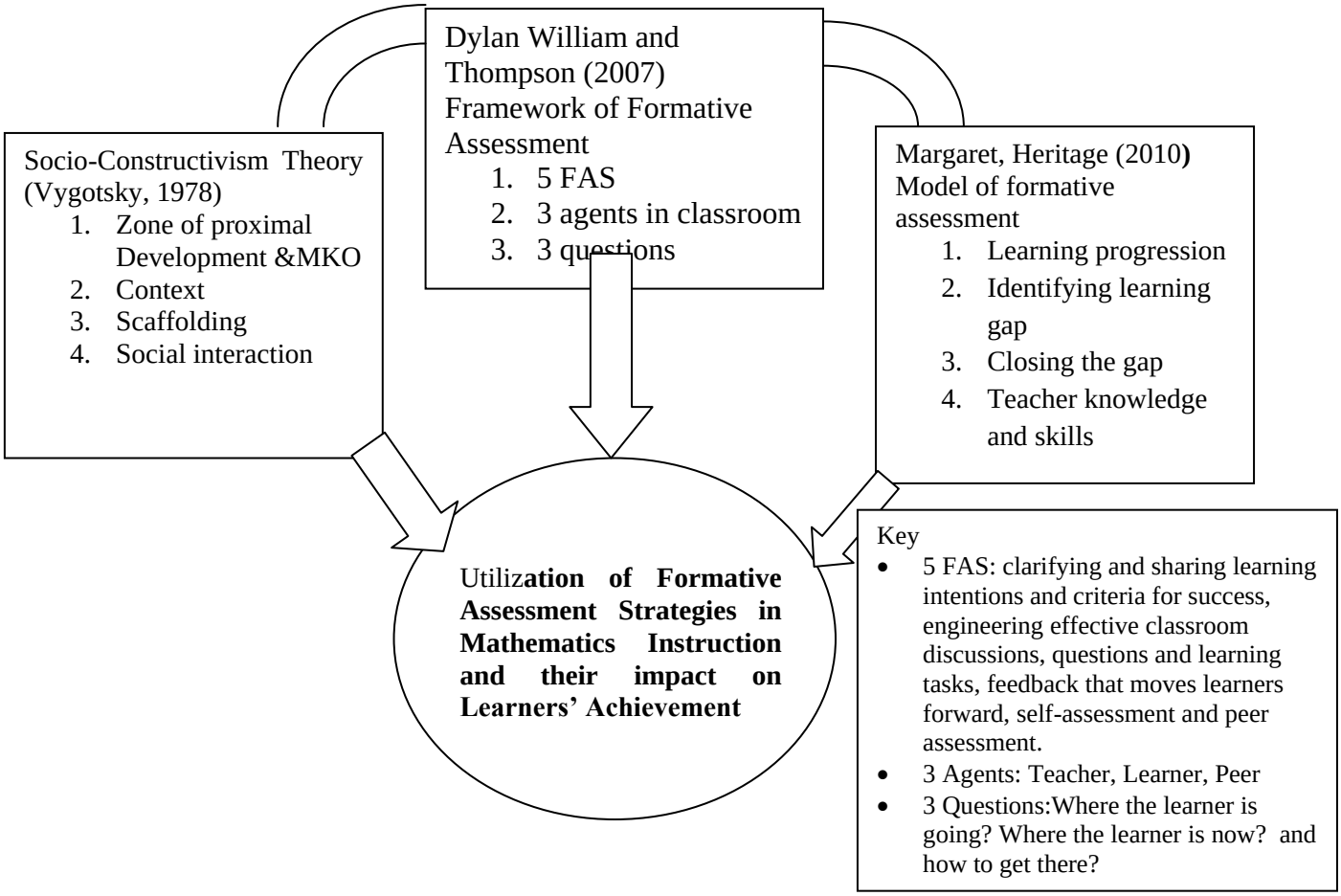

Figure 1: An overall theoretical framework on the impact of the five key formative assessment strategies

LITERATURE REVIEW

Black and Wiliam (2011), 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.Most claims about the benefits of formative assessment begin with the Black and Wiliam (2011) 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.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).

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.

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.

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 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).

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.

METHODOLOGY

The study was carried out in Sub-County secondary schools in Nandi County, Kenya. The target population of the study was all form three students and their Mathematics teachers found in Nandi County. Proportionate stratified random sampling was used to select twelve schools while simple random sampling was used to select classes and subjects; 534 Form three students (54% male and 46% female) and their 33 Mathematics teachers (76% male and 24% female). The study employed Pre-Posttest control Quasi-experimental mixed method intervention research design. This study adopted an explanatory sequential mixed methodology before and after the intervention. Quantitative data were collected using pretest and posttest on Student Mathematics Achievement Test (SMAT) and researchers' observation schedule analyzed by independent sample t-test and Means. Qualitative data were collected using focus group interview and analyzed thematically. Simple random sampling method was used to group classes into experimental and control groups. From a sample of 534 students in 12 intact classes and their 33 teachers, experimental group were 227 students and 15 teachers while control group were 307 students and 18 teachers. Same topic in Mathematics was taught to both groups of students at the same time with the experimental group taught using the five FAS, while the control group taught using normal methods for duration of six weeks. Both groups were administered SMAT and researcher observed lessons before and after the intervention to determine the impact of treatment. The five key formative assessment strategies in the William and Thompson framework (2007) were investigated on their impact on learner achievement in terms of learner performance improvement scores and acquisition of problem solving skills as observed by the researcher (increased learners' motivation/engagement, collaboration, participation, response to questions, reasoning ability).

FINDINGS AND DISCUSSION

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.

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 1: 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 1, 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 1 below.

Table 2: 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 3: 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.

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 4.

Table 4: Learners' acquisition of problem solving skills as observed by the researcher

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.

Table 4: Interpretation of Means table on five likert scale

Mean	Interpretation
1.0- 1.74	None
1.75- 2.74	Poor
2.75- 3.74	Fair
3.75- 4.49	Good
4.50- 5.0	Excellent

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. From the table 4 on interpretation of means, experimental group display poor & excellent (M=1.77, M=4.57) before and after the intervention and for the control group display poor & none (M=1.82, M=1.72) before and after intervention. There was need to explore on the quantitative finding and teachers' views in focus group interviews were analyzed on the experimental group teachers after the intervention period and teachers were of the opinion that use of the five key formative assessment strategies impacted positively in performance improvement and acquisition of problem solving skills in the teaching and learning of Mathematics whereby FAS eased the teachers' workload, raised learners 'attitudes & interest, improved learners' critical thinking and teachers and students enjoyed using FAS, enable students to develop confidence, made students active and cooperative, enhance acquisition of knowledge from one another, made learners self disciplined, assist teachers to know the progress of their learners Also it was revealed that the five FAS improved learners' acquisition of problem solving skills.

The findings from the study analyzes revealed that there was a positive impact on learners' achievement ($p= 0.00$, <0.05 with $F=11.23$, $t=14.82$). Reasons for positive impact were: FAS eased the teachers' workload, raised learners 'attitudes & interest, improved learners' critical thinking, self discipline, love for each other, and teachers and students enjoyed using FAS. Also it was revealed that the five FAS improved learners' acquisition of problem solving skills (M=1.77, M=4.57) before and after the intervention respectively in terms of increased learners' motivation, collaboration, participation, response to questions and reasoning ability.

CONCLUSION AND RECOMMENDATION

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. Use of the five key FAS improve acquisition of problem solving skills (increased learners' motivation, collaboration, participation, response to questions, reasoning ability). The study recommended that for improvement in Mathematics achievement of the learners, Mathematics instructors must increase the use of five FAS during instruction. Encourage frequent assessment of learners' Zone of proximal development, use right scaffolds and emphasize on the importance of More Knowledgeable others in Mathematics instruction. The findings added valuable insight to curriculum reviewers, Mathematics educators and quality assurance & policy makers on the need to rethink more use of the five FAS for quality education and achievement of vision 2030.Suggestion for further research include a comparative study on the same topic in different contexts.

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