EFFECT OF SELF-ASSESSMENT STRATEGY ON MATHEMATICS PERFORMANCE OF PUBLIC SECONDARY SCHOOL STUDENTS WITH LEARNING DIFFICULTIES IN HOMABAY, KENYA.

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ABSTRACT

Introduction: There is a paradigm shift in thinking which requires authentic learning which led to focus on formative assessment. This concern has caused a challenge to educators. Educational experts have recommended the integration of student self-assessment strategy in learning process to address this challenge. Self-assessment is a process where learners reflect on the worth of their work, compare their work to the standards, identify gaps and revise appropriately.

Purpose: This study was to determine the effect of self-assessment strategy on mathematics performance of public secondary school students with learning difficulties in Homa-Bay County, Kenya.

Methodology: The study adopted a quasi-experimental, pretest-posttest, nonequivalent control group design. The study was carried out in secondary schools in Homa-Bay County. The population of the study consisted secondary school learners' context, while the sample consisted of 60 form three learners. The instruments were determined as validated and reliable having been used in previous thesis studies after getting permission to use.

Results: This study found out that the experimental group mean improvement index and standard deviation were higher than those of the control group. Even though the experimental group had a greater mean improvement index as well as the standard deviation, this was statistically insignificant from the t-test. The study concluded that student' self-assessment strategy was effective in mathematics among secondary school students with learning difficulties.

Recommendations: The study recommended that there was need for a step-up in the integration of the alternative assessment strategies in the classrooms as formative assessment methods to enhance more meaningful learning especially student self-assessment. Further, efforts should be made to ensure both teachers and students embrace the alternative forms of assessments especially self-assessments more so in this era of authenticity.

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PUBLIC INTEREST STATEMENT

The outcome of this study may assist education planners and designers of curriculum by providing information useful in enriching the curriculum and realizing better strategic actions for educational programs. The outcome will further enrich classroom practices regarding self-assessment. Additionally, the information from this study will be useful in enriching the literature that surrounds fruitful instructional approaches fostering self-regulated learning in the classroom.

INTRODUCTION

Self-assessment is a process where learners make a reflection on the worth of their work, compare the nature of their work explicitly to the expected standards, and make judgment on how well their work resembles the criteria set (Andrade, 2010). This means that self-assessment is an element of formative assessment. According to policies of formative assessment, student self-assessment is useful in improving students' learning (MacPhail & Halbert, 2010). There is evidence that suggests that self-assessment contributes positively to learning outcomes, but its effects are highly variable, with many threats to its validity (Brown & Harris, 2013). A pivotal rationale for self-assessment is to provide feedback useful in deepening learners' mastery and improving their achievement. The limited nature of feedback in the classrooms is caused by the fact that many teachers lack adequate time to address each student's work. Moreso, there is a demonstration from research by Andrade (2010) that learners are the main origin of response in current thinking about the place of learners in assessment.

Mathematics remains a compulsory subject in Kenya within the basic education learning levels and is also a core requirement in the most valued courses, e.g., engineering, medicine, among others. According to Mbugua et al. (2012), society perceives mathematics as the basis of technological and scientific understanding, which is core to the social and economic growth of a nation. Despite being a crucial subject, performance in mathematics has been poor in the past decade, more so in mixed secondary schools in Kenya. Amunga, J. K., & Musasia, A. M. (2011) assert that performance in mathematics among public schools in Kenya has been poor despite the fact that it is a career subject and has vast applications in many fields. One of the factors that contribute to dismal performance in mathematics is the teaching methods employed by teachers. Various teaching strategies employ various assessment methods during learning. Formative assessment, of which self-assessment is part, has been hailed as core to enhancing learning.

There are three types of self-assessment identified by Brown and Harris (2013) in K-12: Self-grading or marking, self-ratings, and rubric-based or criteria-based assessments Self-marking or grading is undertaken using a rubric, scoring guide, or model answer. In self-rating, students judge aspects of their work qualitatively or quantitatively through the use of a rating system. The third type of self-assessment is the use of rubrics to verify the worth of any work written or performed by an individual. All of the three types may be similar to the model of 'self-marking' in higher education. The difference between the three is that some may use a grade or a mark, while some may just describe the worth of the student's work.

Self-assessment is founded on the scholarship of self-regulated learning. Ambrose et al. (2010) describe self-regulated learners as those who are able to know the requirements of a given work, judge their own abilities, design their own perspective, track their development, and modify learning methods as required. Zimmerman (2002), as cited in Nilson, (2013), asserts that self-regulated learning consists of three stages: the forethought stage, which takes place before the onset of learning; the performance stage, which is the learning stage; and the self-reflection stage, which occurs after learning. Self-reflection is where students create self-judgments and make perspectives on their level of performance.

Self-assessment can enable students to set realistic goals, pinpoint gaps in their own skills, track their own advancement, identify areas which need more attention during learning and revise their work (Andrade & Valtcheva, 2009). Self-assessment creates a positive self-reaction which boosts self-achievement. Self-assessment in the context of self-regulated learning engages cognitive processes like memory, attention, perception as well as higher reasoning. Research by Johnson and Gelfand (2013) suggests that self-assessment prepares students for life-long learning and enables them to critique themselves and reflect on their performance in a manner to know whether they are meeting the requirements or not. Self-assessment enables students to be more responsible (Bercher, 2012), and increases students' metacognition and learning (Siegesmund, 2016). Self-assessment promotes the development of metacognitive skills among learners.

Kathryn (2016) did a study in the USA to investigate the effects of student self-assessment on academic performance in mathematics among 3rd grade classroom students. The purpose of the study was to determine whether or not self-assessment and self-directed learning impacted students' performance in a 3rd grade mathematics classroom. The study found out that the intervention had a significant effect on student performance.

Sharma et al. (2016) carried out a study on the effect of students' self-assessment on their learning. The impetus of this study was to examine the effect of undergraduate medical students' self-assessment on their subsequent academic achievement. This study rested on the judgment of two theory assessments, which consisted of short response items as well as essay items. These tests were administered to the eighty-nine year-old MBBS students. The outcomes indicated that there was a remarkable advancement in academic attainment after the execution of the self-assessment exercise (p <0.001). Similarly, there was a remarkable positive correlation witnessed (r = 0.79) between both the teacher and learner markings. The study concluded that the intervention of self-assessment

strategy could improve the learners' level of motivation as well as interest in the disciplines, resulting in improved learning and enhanced academic attainment.

Karaman (2021) did a meta-analysis study on the effect of self-assessment on academic achievement. The impetus of this study was to harmonize the outcomes of quasi-experimental and experimental studies that inspected the impacts of self-assessment interventions on students' academic achievement from primary learning levels to higher education levels. A total of 16 academic works with 46 outcome sizes consisting of at least 7650 people were part of the analysis. The study found out that there was a small influence of self-assessment intervention on academic performance (g=0.37, p<0.05). It also found out that the conventional self-assessment interventions with no comments from the teachers or tutors possessed a substantially great influence (g=047, p<0.05) as compared to self-assessment with comments from the teachers (g=028, p=0.05) on pedagogical achievement.

This study was guided by the cognitive and constructivist theories of learning developed by Noam Chomsky, Herbert Simon, and Jerome Bruner. The theories are based on what takes place in an individual's mind. The following are some of the tenets of these theories:

1. Knowledge is not innate, nor is it passively or actively acquired.
2. Learning takes place as an individual learner actively engages with the environment.
3. All kinds of knowledge are constructed as the environment of the learner influences how and what he/she thinks.
4. Knowledge is personal. Learners have distinctive views about the nature of the world.

Based on these theories, learning requires active engagement of the learner and is determined by the processes in peoples' heads. Interest is in the mind as a function of the brain. Learning depends on how people construct meaning and make sense of the world through organizing structures, concepts and principles in mental models (schemas).

Prior knowledge is crucial factor according to constructivists' theory in determining the capacity of a student to learn. These theories emphasized problem-solving as a crucial skill in knowledge construction.

The teacher's role is to assist learners in interpreting abstract problems concretely. Since prior learning is important in influencing new learning, formative assessment is crucial in pedagogy as it's necessary to elicit students' mental models through classroom discussions and concept mappings so as to support their comprehension of knowledge frameworks and provide them with contexts for far reaching transfer of knowledge.

STATEMENT OF THE PROBLEM

Despite being a core subject, research indicates that mathematics students do perform dismally. One of the STEM fields essential to guiding the world toward the accomplishment of the sustainable development goals is mathematics. The performance in mathematics needs to be improved. Additionally, there is evidence in the literature showing the beneficial effects of self-assessment on mathematics performance. On the other hand, research indicates that teachers either do not use student self-assessment or, if they do, are incompetent at doing so (Taras & Davies, 2013). In a similar vein, they apply self-assessment because it is required of them. The goal of this study was to determine the effect of student self-assessment as a self-regulated learning technique on mathematics performance among learners in public secondary schools. This intervention intended to address some gaps cited within the literature by Zimmerman (2011) that requires educators to improve their classrooms activities in order to promote self-regulated learning.

PURPOSE OF THE STUDY
1. To determine the effectiveness of self-assessment in improving performance in mathematics among secondary school students with learning difficulties.
2. To determine the presence of any significant statistical difference between the experimental and the control groups mean improvement indices of the scores of secondary school students with learning difficulties.

HYPOTHESES
1. Self-assessment strategy is not effective in improving performance in mathematics among secondary school students with learning difficulties.
2. There is no any significant statistical difference between the experimental and control groups mean improvement indices of the scores of secondary school students with learning difficulties.

METHODOLOGY
Research Design

This study used a quasi-experimental, pretest-posttest, nonequivalent control group design. According to Cook and Campbell (1979), a quasi-experimental design is one in which there is manipulation of the independent variable and random assignment of participants to groups.

Population and Sample

The population for this study consisted of all the secondary schools within Rachuonyo-East sub-county, Homa-Bay County of Kenya. The target population was 1950 of which were form three students within the sub-county. The sample for this study consisted of 60 form three secondary school students from one of the schools within the sub-county.

Sampling Technique

This study employed purposive sampling to identify a suitable school where the quasi-experiment would be conducted. The school had to be a mixed school with below-average academic performance, especially in mathematics, and with form three population of at least 60. There are 48 public secondary schools in Rachuonyo—East Sub-County. 42 of these schools are sub-county schools (the lowest cadre), whose mean score in the national examinations ranges between 2.0 and 7.0 out of 12. The two units to be

taught are handled in forms 1 and 2, and so form 3 was chosen for the experiment, having been taught the topic before.

Instruments for Data Collection

A pre-and post-test was used in the design. The same instrument was used as pre-test and post-test and was based on the two units: System of linear equations (Form one Unit 17 from the Kenya Institute for Curriculum Development) and Linear Inequalities (Form Two Unit 16 from the Kenya Institute for Curriculum Development). The test had 11 questions, 10 of which were multiple-choice questions of one point each, and 1 was a constructed response question worth four points. The test was adapted from the Edusoft District-Mandated Tests, which are part of the Riverside Publishing Company's Standard-based Testing System (Riverside Publishing). This instrument had previously been created and used in an unpublished thesis, but permission was requested and granted for adoption. Consequently, the tool had through psychometric development methods ensuring validity and reliability.

Procedure for Data Collection

The pre-test was administered and scored. The pre-assessment was based on the two units: System of linear equations (Form one Unit 17 from the Kenya Institute of Curriculum Development) and Linear Inequalities (Form Two Unit 16 from the Kenya Institute of Curriculum Development). The results formed the basis of grouping the students into two homogenous sets. One group was experimental and the other was control. The control set was taught using the conventional method while the experimental set was taught using self-assessment strategy. The first topic taught were the System of Linear Equations and Linear Inequalities. For the control set, both the classwork and homework assignments were given and checked for completion by the teacher. The teacher checked the class assignments for correctness. The teacher answered any questions from the students that originated from the formative assignments. The learners did not score

their work or rectify the errors in their work.

Self-assessment strategy was used to guide the students in the use of rubrics. The rubrics to be used were created to reflect those used to score students' work by the Kenya National Examination Council (K.N.E.C). For short assignments, the teacher wrote the solutions on the board for students. Additionally, the students in this set were provided with self-scoring sheets at the start of each topic with activities and the assignments they would be doing. From all these topics, the following skills were expected to be acquired by the students: solving linear equations by graphical method, solving linear equations by elimination and substitution, graphing and solving linear inequalities.

Students scored their work guided by the projected rubrics. The students recorded their scores on the self-scoring sheets. The teacher emphasized the need for the learners to revise the areas where they performed dismally. The students were also informed by the teacher that the assignments would be verified for completion and that the scores of students would not affect their grades but be used to guide and enhance self-monitoring. A post-assessment was administered about one week after the treatments to the two sets. The pre-assessment was used as the post-assessment. The researcher scored all the items from all the students in the two sets and recorded their marks. The mean improvement indices were computed from both sets for analysis.

Methods of Data Analysis

Quantitative method of data analysis was employed since the data used in the study was numerical. The mean improvement indices and standard deviation of the scores were computed. An independent t-test was employed to determine if the difference in the two mean improvement indices was statistically significant.

RESULTS
Hypothesis 1: Self-assessment strategy is not effective in improving performance in mathematics among secondary school students with learning difficulties.

Table 1: Improvement indices for the two groups

GROUP	N	Mean	S.D	Std. Error Mean
Experimental	30	9.4457	15.27819	2.78940
Control	30	5.5557	8.84462	1.61480

From table 1, the mean and standard deviation for the experimental group were 9.4457 and 15.27819 respectively while the mean score and standard deviation for the control group were 5.5557 and 8.84462 respectively. Both the mean improvement index and the standard deviation of the experimental group were greater than that of the control group. This means that the group taught using the self-assessment strategy had a greater improvement aggregately compared to the group taught using the conventional strategies. From the result in table 1, self-assessment strategy was effective in improving performance in mathematics among secondary students with learning difficulties.

Hypothesis 2: There is no any significant statistical difference between the experimental and control groups mean improvement indices of the scores of secondary school students with learning difficulties.

Table 2: An independent t-test analysis of means of students' improvement scores for Experimental and Control groups.

Group	T	Df	Sig. (2 tailed)	Mean difference	Std. Error Difference	95%confidence interval of the difference	
						Lower	Upper
Improvement	1.207	58	0.232	3.89000	3.22310	-2.56173	10.34173
index	1.207	46.475	0.234	3.89000	3.22310	-2.59597	10.37597

Source: Researcher

From table 2, an independent t-test found the difference in the means to be statistically insignificant, t (46.475) = 1.207 and p>0.05 i.e. p=0.234.Since the p-value is greater than the alpha i.e. (0.234> 0.05), the null hypothesis is accepted. This implies that there is no significant statistical difference between the mean improvement indices of the control and the experimental groups. The difference in the mean improvement indices of the groups could be due to chance.

DISCUSSIONS
This section provides a discussion of the study findings based on the objectives.
Objective 1: To determine the effectiveness of self-assessment in improving mathematics performance among secondary school students with learning difficulties.
The study found that the mean improvement index of the experimental group was greater than that of the control group. This implied that a self-assessment strategy was effective in improving performance in mathematics among

secondary school students with learning difficulties. This finding was in agreement with those of Martinez et al. (2020), who did a study on the e-self-assessment as a strategy to improve the learning process at university. The aim was to analyze if e-self-assessment improved student performance using tests for objective and short answers. The study found an improvement in student achievement and an enhanced degree of student satisfaction as a result of e-self-assessment. The finding of this study is also in tandem with that of McDonald (2009), who carried out a study on the academic performance of males trained in self-assessment. The study discovered that the males trained on self-assessment skills outperformed their untrained counterparts.

Objective 2: To determine the presence of any significant statistical difference between the experimental and control groups' mean improvement indices of the scores of secondary school students with learning difficulties.

The study found that there was no significant statistical difference between students in the experimental group and those in the control group. This implied that self-assessment could not provide a statistically significant effect on academic performance in mathematics among secondary students with learning difficulties. In spite of the literature advocates for use of self-assessment as important strategy in enhancing learning, this finding is the opposite. This could be attributed to the short period of study (four weeks), which might not have been adequate to realize the full effect of the strategy. As asserted in their study entitled "Working inside the Black Box: Assessment for Learning in the Classroom", Black et al (2004) argue that self-assessment yields better results if the teacher assists the low achievers to develop the skill, and this may take a relatively longer time. This finding also concur with that of Hotard (2010). In his quasi-experimental study to determine the effect of self-assessment on academic performance in mathematics, he found no

significant statistical difference between the control and the experimental groups.

CONCLUSION
The purpose of this study was to determine the effect of self-assessment strategy on mathematics performance of public secondary school students with learning difficulties in Homa-Bay County, Kenya. Based on the findings of this study, this study concluded that self-assessment was effective in enhancing academic performance in mathematics among secondary school students with learning difficulties.

RECOMMENDATIONS
From this study the following are recommended:
1. There is need to step-up the use of self-assessment strategy in school to enhance the mathematics performances of students with learning difficulties.
2. Efforts should be made to ensure that alternative forms of assessment, particularly self-assessments, are adopted by both teachers and students, especially in this era of authentic learning.

Conflicts of Interest: The authors declare no conflict of interest.

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Authorship and Level of Contribution
Zacharia Oloo contributed to the development of the abstract, introduction of the study, purpose of the study, the hypotheses and methodology. He also generated the results, references and did

the proofreading of the whole work. He is the lead author of the paper.

Dr. Karen Odhiambo developed the study topic, the statement of the problem, purpose of the study and the literature review. She also developed the study methodology, results of the study, the discussion of the findings, proofreading and recommendations. She also made the necessary corrections in the paper.

Disclaimer Statement

This work is part of a project report submitted for the award of a Masters of Education in Measurement and Evaluation in the Department of Psychology of the University of Nairobi in the year 2020. The title of the project is "Effect of Students' Self-assessment on Academic Performance. The amount of work from the project includes: introduction, statement of the problem, literature review, methodology, results, recommendations, and conclusions.

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