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Adopting Activity Based Learning in Kenya: Emphasis on Achievement in Secondary School Mathematics

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Abstract

The study purposed to investigate the effect of activity-based learning on the achievement of Mathematics in public schools in Machakos County, Kenya. Application of activity-based learning involving learners in forms two and three in different public school categories were investigated. Hypothesis formulated for the study tested the effect of activity-based learning on achievement in Mathematics among learners. The study targeted 112 Mathematics teachers and 60,354 learners. The study employed descriptive survey design. Questionnaires and interviews used to elicit data on classroom activities and achievement in Mathematics. Purposive sampling was used to identify participating teachers while learners were chosen through a simple random sampling technique. Descriptive statistics was used to interpret results while z-test was used to compare mean scores at $\alpha = 0.5\%$. Findings revealed a strong relationship between activity-based learning and achievement in Mathematics. Further it was found that problem solving skills of learner participants were enhanced by activities used during the learning process. The study recommended encouragement of Mathematics teachers to use activity-based learning to improve learner achievement. The study also recommended a similar study to be done in private schools to corroborate the findings reported in this study.

Keywords: Activity based learning, Achievement, Mathematics

Introduction

The need to attract graduates of secondary school education to Mathematics related disciplines has raised concern among educators, parents and other stakeholders in education. This has been occasioned by a worrying trend of achievement in Mathematics as learners consistently register unsatisfactory achievement in Mathematics examinations (Telima, 2011). Ihendinihu (2013) affirms this assertion in observing that the low performance in Mathematics is a perennial problem that needs curriculum planners and implementers to recommend and adopt a variety of teaching strategies that accommodate

varied student learning styles. The Kenya National Examinations Council in its 2004 report confirms that the national mean score in Mathematics examinations for the five years spanning 2000 to 2004 stood at 19.39%. According to the Kenya National Examinations Council (2010), the mean score in national Mathematics examinations ranged between 18.38% in 2007 and 23, 05% in the year 2010.

Further, in the recent past, performance in Mathematics has remained far below the average. For instance, in the KNEC individual subject analysis for the period 2015 and 2019, the mean scores in Mathematics ranged between 25.52% and 31% in paper one and 28.23% and 23% in paper two (KNEC, 2015; KNEC, 2019), indicating a marginal change in the state of affairs. This necessitates establishing the causal factors of this state and rethinking the remedial measures for reversing the trend, such as the adoption of innovative strategies of teaching the mathematics. A possible causal factor to unsatisfactory performance in Mathematics could be the instructional strategies employed by teachers. In a congress on Mathematics held in Nairobi, African Mathematical Union echoed these concerns for under achievement in Mathematics by urging African governments to device new strategies aimed at improving the teaching of Mathematics in schools and colleges (Kuku, 1991). This implied the need for adoption of alternative strategies of teaching Mathematics for any gains to be realized towards bettering the achievement in the subject.

Mathematics instruction at the high school level has overwhelmingly been teacher-centered emphasizing on the use of lecture methods and textbooks as the only resources instead of guiding learners to think critically across subject areas and applying their knowledge to real-world situations (Cobb, Wood, Yackel & McNeal, 1992; Cohen, McLaughlin and Talbert, 1993; Landson-Billings, 1997). According to Origa (2000) Mathematics teaching in Kenya, emphasizes teacher-centered approaches with ultimate goal of completing the prescribed syllabus and engaging learners in drill and practice purposed to improve scores in national Mathematics examinations. However, there have been efforts to improve methods and methodologies of teaching Mathematics in Kenya. For instance, the Activities, Student Experiments and Improvisation (ASEI) alongside the Plan-Do-See and Improve (PDSI) have been adopted as alternative instructional approaches for Mathematics in Kenya to help raise the level of Mathematics achievement.

However, in a study that investigated the effectiveness of SMASSE teacher training programme on KCSE performance in Mathematics and Chemistry subjects in Kikuyu District in Kenya, Kiige and Atina (2016) revealed that while the SMASSE INSET programme did not have any impact on the performance of Mathematics and chemistry, influenced the teachers' capacity to deliver in their teaching despite many challenges. This indicated that some strategies of teaching Mathematics if properly implemented, can improve teachers' ability to teach the subject, which may result to

improved performance in the subject. Gitaari, Nyaga, Muthaa and Reche (2013) echoed the sentiments expressed by Origa (2000) by citing ineffective teaching strategies coupled with the pressure to complete the syllabus and post good grades as the main causes of low performance in Mathematics in the Tharaka South district of Kenya. Similarly, in a study focused on factors that contribute to poor academic performance on the Kenya Certificate of Secondary Education (KCSE) in Kenya, Onderi, Kiplagat and Awino (2014) identified poor teaching and assessment methods as major contributors to students' poor performance in most subjects, including Mathematics.

Despite positive impact of learning activities on students' opportunity to learn, their influence on knowledge construction has received modest thought in the domain of Mathematics teaching and learning (Boaler, 1999; Samuelsson, 2008). In the words of Cobb (1998), learner-based activities in the classroom and focused actions in which students and instructors engage in the learning process generates new understanding. This forms a foundation for quality learning at higher cognitive functioning and learner's use of problem-solving skills. Aitkin & Zukovsky (1994) opine that different instruction styles can have varying impacts on learner achievement. Wentzel (2002) concurs with the position that instructional approaches should be chosen to make a significant impact on learner achievement. Activity based learning adopted in this study offers a captivating experience to capture the attention, interest and creativity of learners. Additional insight and evidence of positive relationship between achievement and varied classroom settings across subject areas is provided by Teddlie and Reynolds (2000). Case (1996) argues that a variation of instructional methods as is witnessed during activity-based learning, draws attention of the learner to diverse competencies in Mathematics.

In the opinion of Omondi, Origa, & Gatotoh, (2023) learners taught using inquiry-based approach acquire mathematics process skills better than those taught using traditional approach. Activity-based learning seem to possess the potential of supporting student's initiative towards developing requisite competency to enhance achievement in Mathematics. While concurring to this viewpoint, a study that focused on the impact of activity-based teaching on students' academic achievements in Physics at secondary level observed that activity-based teaching is more effective for the development of higher order skills in students which immensely contributed to improved learner academic achievement (Khan, Muhammad, Maqsood, Saeed and Aman 2012). In a related study, Anwer (2019) argued that conducting lessons using activity-based teaching enhances students' motivation which contributes to improved academic achievement. Further, in a study that focused on the impact of activity-based learning on learner motivation and academic achievement, Albadi and David (2019) revealed that students reported that activity-based learning enhanced their understanding, increased a sense of responsibility, created appealing learning environment and contributed positively to their improved academic performance.

Theories of learning hint that the nature of classroom activities and tasks influence student abilities to learn effectively (Doyle, 1983; Hiebert & Wearne, 1993). Such tasks and activities are inbuilt in activity-based learning with the intent of boosting achievement in Mathematics. Bransford, Brown & Cocking (1999) put it that learners with connected knowledge structures are capable of engaging in reasoning, productive problem-solving episodes during activity-based learning and are well endowed to apply learning to new contexts. Successful problem-solving episodes are a precursor for achievement. In a similar argument Hiebert & Carpenter (1992) opine that structured task inherent in activity-based learning facilitate and support learners' conceptual understanding of Mathematics, nurturing deep connections among mathematical ideas for improved achievement. In a related study, Hiebert & Wearme (1993) observed that learners who spend time in the classroom on assigned tasks improve their potential to advance their thinking and understanding. Similarly, Amuthavalli and Sivakumar (2014) hold the view that tasks in activity-based learning should be structured to facilitate learning in a particular way, thus enhancing students' comprehension of Mathematics leading to improved performance. This points to the importance of differentiated instructional methodologies that incorporate creative and structured tasks in activity-based learning during Mathematics lessons. Such methodologies facilitate mastery of concepts learnt resulting in superior achievement. Therefore, planning for instruction should target adoption of differentiated instructional methods and tasks as precursor to effective instruction. In addition, instructional planning should eliminate a mismatch between tasks, learners' level of understanding, providing a balance between challenging the learner, reducing frustration, and minimizing misconceptions and conceptual errors. Reducing mismatch by differentiated instructional methods and tasks is expected to result in higher learner achievement in Mathematics.

Methods

The study adopted a descriptive survey design involving 6 public secondary schools, 30 teachers and 180 students. In the words of Bryman (2012), a survey is a cross-sectional research design in which data are collected by questionnaires and structured interviews. A descriptive survey was appropriate for collecting data from students and teachers at a single point in time for the purpose of detecting patterns of association between variables such as learning activities and achievement in Mathematics. Stratified random sampling was used to pick a sample of 2 girls' schools, 2 boys' schools and 2 mixed public boarding secondary schools in Mutituni Division of Machakos County, Kenya. Teachers from private schools did not receive in-service training on activity-based learning and methods hence were not included in the study. Each participating school produced two classes, one form two and one form three class. Five Mathematics teachers per school were selected using simple random sampling

technique translating to 30 Mathematics teachers. The teachers who participated in the study were in-serviced through SMASSE programme to improve their skills on activity-based learning and methods. Participating learners were selected by a simple random sampling procedure, 15 learners per class per school.

Instruments used in the study to elicit data were the questionnaire and the interview schedule. Two sets of questionnaires were used to source data from learner participants and teachers on adoption of differentiated instructional methodology, tasks and learner achievement in Mathematics. Students were the recipients of the classroom activities and hence had relevant information while teachers had a role in the choice and assignment of instructional activities and assignment of tasks.

Results

Majority of the teachers interviewed (73%) had, at the time of the interview, adopted the activity-based learning which came on board as an intervention program to mitigate against the low levels of achievement in Mathematics. The intervention successfully persuaded Mathematics teachers to advocate for and adopt activity-based approaches to the learning of Mathematics. The adoption of activity-based approaches to the learning of Mathematics was successful and Mathematics teachers are able to design differentiated instructional methods and tasks aligned to learners' prior knowledge. Results of the study indicate that the intervention improved the capacity of Mathematics teachers to expand learners' conceptual understanding of the subject. Learners transiting to the secondary tier of the Kenyan education system did so with a stable foundation on which to develop higher order Mathematics concepts.

Table 1: Foundation for transiting learners

N	Valid	172
	Missing	8
Mean		70.4535
Median		72.0000
Std. Deviation		10.67232
Minimum		40.00
Maximum		89.00

Source: Field Data

The mean score of 70.5% in Mathematics learner participants attained at the previous level confirms their readiness to learn Mathematics at the secondary level. The

high values for measures of central tendency (mean of 70.4535 and median of 72.0000) reaffirm the preparedness of the participants to learn secondary school Mathematics. This is so since the information displayed in table 1 reflects the results of norm-referenced standardized national examinations in Mathematics. A standard deviation of 10.6723, a mean of score 70.4535 and median value of 72.0000 is indicative of the fact that there are few extreme scores especially on the lower tail of the distribution of the scores. It is, therefore, evident that learners exiting from primary schools to secondary schools require only a small nudge in the form of activity-based learning to foster achievement in secondary school Mathematics.

Results for a teacher made test administered to the learners after the activity-based intervention had a mean score 51.53%, median value of 51% and a standard deviation of 19.5 as shown in table 2

Table 2: Results for teacher made test

N	Valid	172
	Missing	8
Mean		51.5291
Median		51.0000
Std. Deviation		19.50781
Minimum		7.00
Maximum		87.00

Source: Field Data

Given a sample size of 172, sample mean score of 51.5, sample standard deviation of 19.5 and a historical value of 19,3 for the population mean, the Z-test was used to test for the population mean using the null hypothesis H_o: $\mu < 19.3$ against the alternative hypothesis $H_{1:}$ $\mu \geq 19.3$ at $\alpha = .05$. Since the test value for Z was found to be greater than the critical value of Z at $\alpha = 0.05$, a decision was made to reject the null hypothesis. Subsequently, it was concluded that there is enough evidence to support the claim that activity-based learning yielded improved mean score and a superior achievement in Mathematics. This is consistent with the assertion of Omondi, Origa, & Gatotoh, (2023) that activities involving inquiry-based approach are a precursor to higher achievement in mathematics.

The bar graph in figure 1 below displays the mean scores of 4.25, 4.374 and 5.13 for the years 2010, 2011 and 2012 respectively before intervention on a scale of 0 to 12. The same figure also displays the mean scores of 5.91, 6.48 and 6.58 for the years 2020,

2021 and 2022 respectively after intervention on a similar scale. It is evident from the bar graph that learners realized higher mean scores in the post intervention years. This significant change is attributed to the activity-based learning organized and implemented by SMASSE. The intervention not only influenced the adoption of activity-based learning but also made a notable contribution towards improved achievement in Mathematics.

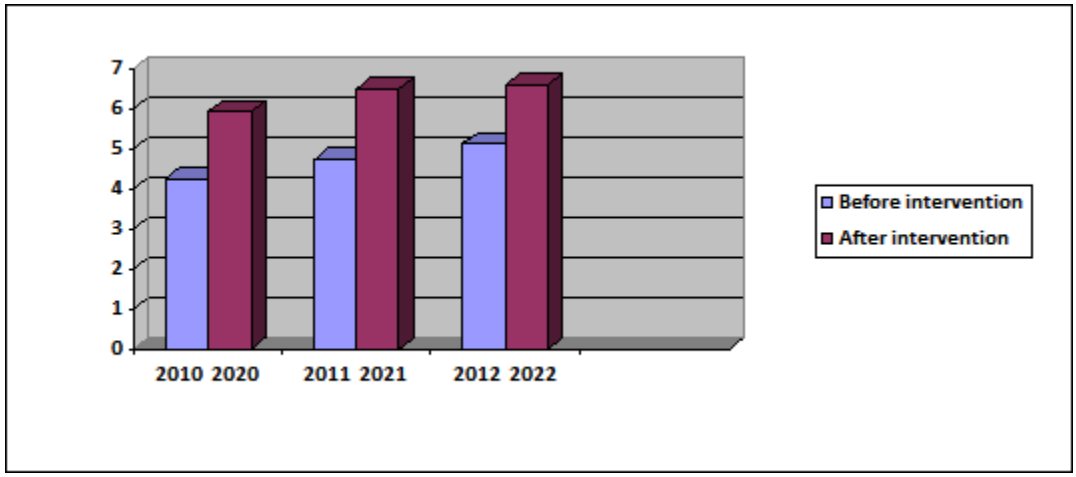

Figure 1: Comparing mean scores before and after intervention

The findings are in agreement with those of Cobb (1998) and Teddlie and Reynolds (2000) who opined that the activities in the learning environment, the frequent actions in which learners and teachers engage, have direct influence on knowledge produced and hence improved learner achievement. Activity based learning improved the mean score from a low of 4.25 in 2010 to high of 6.58 in 2021 before marginally dropping to 6.48 in 2022.

Notable improvements have also been reported on the national front by the national examining body, the Kenya national examinations council on improvement on achievement in Mathematics in the post intervention period. Machakos County where the study was conducted has similarly reported improvement in the mean achievement in Mathematics examinations after the intervention focusing on learner-based activities. Data for Machakos County is captured in the bar graph below;

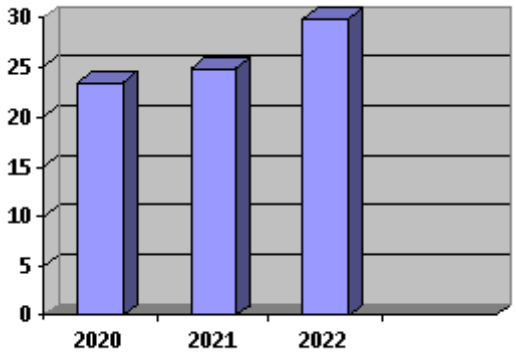

Figure 2: Data for Machakos County

Source: Field Data

The data divulge an upward trend in the mean score suggestive of a positive contribution from the intervention that focused on activity-based learning. The upward trend is evidence that activities implemented in the intervention period led to improvement in Mathematics achievement.

Conclusion

The findings of the study have established that activity-based learning organized and implemented by SMASSE have a noteworthy effect on the achievement in Mathematics among public secondary schools in Mutituni division of Machakos county, Kenya. The study was purposed to investigate the effect of SMASSE activities on the achievement of Mathematics in public schools in Machakos County Kenya. The findings showed that various SMASSE activities are indeed positively related to Mathematics achievement in public secondary schools.

Recommendations

The study recommends that Mathematics teachers be encouraged to use activity-based learning so as to improve learner achievement. The study also recommends a similar study to be done in private schools to corroborate the findings reported in this study. Interventions focused on learner activities should be up scaled at the national level to boost the impact of learner-based activities already initiated and implemented. Problem solving should also be included into the secondary school Mathematics curriculum to inject problem-based learning purposed to improve conceptual understanding of

Mathematics and consequently improve learner achievement in Mathematics.

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