



RESEARCH ARTICLE

TEACHING STRATEGIES USED IN MATHEMATICS AND THEIR INFLUENCE ON PERFORMANCE IN PROBABILITY AND STATISTICS IN SECONDARY SCHOOLS IN KERICHO COUNTY, KENYA

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ABSTRACT

This study investigated how instructional methods employed by Mathematics instructors affect students' performance in Probability and Statistics in Kericho Secondary schools in Kenya. The objectives were (a) to investigate how teaching strategies influence performance of students in Probability and Statistics (b) to identify the most effective instructional strategies employed by mathematics teachers when teaching probability and statistics. The research design was survey. The study employed Jerome Bruner's constructivism theory. Mixed methods approach was used. The study population comprised of 16 mathematics teachers and 200 students. The study used stratified sampling technique in selecting public secondary schools from Extra County, County, and sub-County categories. Simple Random sampling method was subsequently employed to choose two (2) schools from Extra County, four (4) from the County, and four (4) from the sub-County categories. Data collection tools included a schedule for Classroom Observations, Questionnaires for both teachers of Mathematics and for students. Three public secondary schools were chosen for a pilot study with Form 4 students and the mathematics teachers to evaluate the instruments' validity and reliability. Quantitative data collected was analyzed using descriptive statistical and inferential analysis as well as Chi-square tests, Kendall tau-b test and Kruskalwallis tests for analysis. Qualitative data was analyzed using thematic framework. The study findings revealed that inquiry-based and cooperative learning are strongly associated with improved student performance, with weaker students showing greater preference for cooperative learning as an equalizing strategy. While problem-based learning was linked to deeper understanding, its effectiveness was hindered by unequal participation and negative learner attitudes. First, teachers prioritize cooperative learning as the most effective and affordable method in resource-constrained schools, while adopting a blended approach that integrates problem-based, inquiry-based, and differentiated strategies to cater for varying learner needs. Second, public schools should tailor these approaches to support struggling learners through cooperation while challenging stronger students with inquiry and problem-solving tasks. The study recommended that Policymakers to strengthen teacher training and resource allocation, particularly in Sub-County and County schools, to ensure equitable access to effective teaching strategies and reduce performance disparities across school types.

INTRODUCTION

The advancement of science and technology is greatly aided by Mathematics. It is an essential tool for the growth of society, politics, and technology (Mwanga & Githua, 2003). To achieve this objective, methods of instruction in education should enable students to apply learned knowledge, and improve self-learning and self-development skills (Sezonova et al., 2016). Education instructors need to use impactful methods of teaching to guarantee that education is centered on equipping today's children for what lies ahead. Teaching strategies are tactics that instructors use while carrying out pedagogy, according to Villota et al. (2017).

In today's data-driven world educating students about Probability and Statistics is of paramount importance because it equips students with the ability to analyze data critically and students learn to base decisions on statistical evidence instead of anecdotal information (Oliveira et al., 2018). According to Dushimimana and Uworwabaye (2020), Probability and Statistics are foundational to numerous fields, including science, engineering, social sciences, economics, and more. Kazungu (2021) observe that a strong foundation in basic mathematical concepts such as arithmetic, algebra, and functions is crucial for understanding more complex topics in Probability and Statistics. Jensen and Kellogg (2022) added that it require abstract thinking, such as understanding the concept of randomness or the large numbers. In Singapore,

mathematics curriculum is designed to encourage deep conceptual understanding through the use of concrete learning materials and visual aids, real-world problem-solving scenarios, rather than rote memorization (Pierrie *et al.*, 2019 ; Lee, 2020). As a result, Singaporean students consistently perform at the top of international assessments, demonstrating the effectiveness of these innovative teaching strategies. In the United States, integration of technology in Mathematics classrooms software tools, online simulations, and interactive platforms allow students to envision data and tryout with statistical models in real time (Schroeder *et al.*, 2021; Jones & Tarr., 2023). Therefore, data literacy in the modern curriculum reflects the growing importance of statistics in various fields, from science to business. In Africa, mathematics curriculum reforms to incorporate more contextualized learning experiences tailored to real-life scenarios and local data into lessons in Probability and Statistics have been witnessed in South Africa (Umugiraneza *et al.*, 2022). Hendricks and Olawale (2023) observe that the contextualized learning experiences applied by teachers in South Africa helps students grasp the practical applications of statistical concepts. Likewise, in Nigeria, inquiry-based learning has gained traction (Ndubisi & Ekwueme, 2018). In Kenya, Mathematics is compulsory subject embed in the curriculum and teaching methodologies like inquiry-based learning, problem-based learning, cooperative learning as well as differentiated learning are recognized in educational research. However, the usefulness of these strategies mainly depends on how they are applied within specific school contexts. Education system in Kenya categorized schools under: Sub-County, County, Extra-County and National schools. This raises important questions about whether teaching strategies are being applied consistently across categories, and to what extent their application explains disparities in student outcomes (Nyangweso *et al.*, 2019; Koskei *et al.*, 2022). Despite government efforts, Mathematics attainment has remained abysmal, with some topics consistently challenging students. The topics in questions includes: Probability and Statistics, Trigonometry, and Geometrical. Despite, ministry of education introducing (SMASSE) program to train instructors on suitable teaching methods to boost performance in Mathematics, incorrect answers in 2023 KCSE was 26% on Probability and Statistics questions caused the overall average mean to drop from 26.44 to 17.39 percent a worrying trend.

Mathematics KCSE results in Bureti Sub County schools for the years (2021, 2022, 2023 and 2024) recorded average scores of 2.543, 2.833, 2.314, and 3.011, respectively. This demonstrates low performance in Probability and Statistics questions in Bureti Sub County secondary schools a gap to be filled.

Objectives of the Study: the objectives of the study were:

- To investigate the influence of teaching strategies on students' performance in Probability and Statistics.
- To identify the most effective types of instructional strategies used by Mathematics teachers when teaching probability and statistics.

Theoretical framework: The present study was based on Jerome Bruner's constructivism theory 1961. This theory argued that education should be based on actual experiences and that students learn most effectively when they interact with their surroundings. He thought that learning occurs through

social interactions, with engagement with others significantly influencing one's comprehension. Dewey's focus on questioning and reflection inspires educators to develop learning settings that promote critical thinking and problem-solving abilities. Further, the idea of scaffolding was introduced, where learners are supported in their learning journey through guidance and structure provided by educators. Lev Vygotsky (1962) significantly influenced constructivism with his idea of the Zone of Proximal Development (ZPD), highlighting the gap between what a learner can accomplish alone and what they can attain with support. Within the framework of secondary education in Kericho County, Kenya, the application of constructivist principles in teaching Probability and Statistics can significantly influence student performance and engagement.

LITERATURE REVIEW

Quitola (2022) studied the factors enhancing statistics and probability performance among senior high school students, focusing on the effects of peer tutoring on Grade 11 students at the Isabela School of Arts and Trades during the 2018-2019 academic year. Results showed a significant improvement in performance post-intervention, suggesting that peer tutoring effectively enhances academic achievement in Statistics and Probability. Mathematics educators are encouraged to implement peer tutoring strategies in their lessons. Mrope and Deogratias (2024) conducted an analysis of the challenges facing students when addressing probability-related problems, particularly concentrating on the advanced certificate of secondary education examination in Tanzania.

Through an examination of examination responses, the research indicates that a significant number of students find probability questions particularly challenging, especially those that pertain to probability distributions such as Binomial and Poisson. It was elaborated in the study that conceptual misunderstandings made learners to experience difficulties in Mathematics problems among other factors like the intricate nature of probability problems.

Additionally, Namuhisa and Ndiku (2023) in Kenya examine the extent to which different school teaching practices affected KCSE performance. A sample of 400 students and 300 teachers was used for analysis. The study found out that learner-centered method such as group discussion, reflective learning, student presentations, and peer-to-peer approach were recognized as the most effective. Despite the contribution to the present study, it was not based in Bureti Sub County and failed to include specific strategies for effectively teaching statistics and probability in mathematics.

RESEARCH METHODOLOGY

The research design for this study was survey. The study adopted mixed method approach which includes both qualitative and quantitative methods (Dulock, 2023). The research method was significant in that it captured the complexity of the mathematics subject concerning to variables statistics and probability and various teaching strategies. The used of quantitative and qualitative data enhanced reliability and validity of the study.

Table 4.1 presented the results as shown below

Statements	SD %	D %	N %	A %	SA %	M %	St.Dev %
For pupils, Probability and Statistics are challenging concepts to grasp	8.3	17.1	0.0	33.3	53.3	4.2	1.028
The instruction and acquisition of Probability and Statistics are improved by the use of appropriate teaching aids	0.0	0.0	4.7	62.0	33.7	3.98	0.289
When asking or responding to questions about Probability and Statistics, students find it difficult to articulate themselves	0.0	5.0	0.0	30.0	65.0	4.56	0.370
It's fun to teach Probability and Statistics	6.7	20	0.0	26.6	46.7	3.6	0.85
I only utilize the required textbooks; I don't use any additional readings or resources	26.7	13.3	6.7	20.0	33.3	3.8	1.430
Students struggle to learn Probability and Statistics	0	13.3	0.0	26.7	60	4.55	0.459
Average score	6.7	10.5	1.9	33.3	47.6	4.28	0.707

Statements	Yes	No
Do you find that the students' comprehension levels of the terminology used in Probability and Statistics themes are low	71%	29%
As a teacher, do you ever encounter pupils who struggle with utilizing calculators to compute measures of central dispersion	100%	0%
Do drawing histograms and cumulative frequency curves pose a challenge for students?	64%	36%
Are there any difficulties for pupils using cumulative frequency curves to determine the quartiles?	71%	29%
Do pupils have any difficulties when linking theoretical probability to situational reality?	79%	21%
Do your pupils struggle to create tree diagrams and use them to calculate various probabilities?	64%	36%
Do you relate probability to actual life experience while teaching students about the outcomes?	100%	36%

Table 4.5. Correlation Between Performance and key Independent Variables

Variables	-1	-2	-3	-4	-5	-6
•Teaching Concepts	1					
•Student performance	0.02	1				
•Inquiry based learning	-0.005	0.425	1			
•Cooperative learning	0.042	0.272	0.308	1		
•Problem based learning	0.025	0.515	0.48	0.45	1	
•Differentiated learning	0.031	0.251	0.226	0.465	0.368	1

Table 4.9. Analysis of Influence of Cooperative learning on Student's Performance

Cooperative learning	Students Performance					
	D	C	B	A	Total	(%)
Strongly Disagree	0%	0%	0%	1%	1	1%
Disagree	1%	1%	0%	1%	3	3%
Neutral	1%	10%	4%	0%	15	15%
Agree	3%	13%	11%	2%	29	29%
Strongly Agree	7%	22%	20%	3%	52	52%
Total	12	46	35	7	100	100%
Pearsons Chi-Square = 80.5 P-Value = 0.000						
Kendall's tau-b = 0.3076 P-value = 0.000						

Teaching Strategy	Students		Teachers	
	Rank	Percentage	Rank	Percentage
Cooperative	Most effective	34%	Most Effective	30%
Inquiry-Based	3 rd Most Effective	26%	Most effective	30%
Problem-based	2 nd Most Effective	20%	Most Effective	30%
Differentiated	3 rd Most effective	20%	Least effective	10%

Study participants: The target population of the current study was 55 public and 4 private secondary schools within Bureti sub- County. Purposive sampling used to select public secondary schools and stratified sampling technique was used to sample secondary school in Extra County, County, and Sub-County. A random sample of form four students from the selected schools were taken to guarantee that each student had an equal opportunity in the study to participate.

Research instruments: Questionnaires and interview were used for data collection in the study. Teacher questionnaires explored their teaching strategies like cooperative learning in teaching Probability and Statistics, and methods for measuring

student engagement and understanding. Students' questionnaires focused on their learning experiences in Mathematics, particularly in Probability and Statistics. Classroom Observation Schedule systematically collect data regarding the efficacy of different mathematics instruction methods, particularly in areas regarding probability and statistics.

Data collection procedures: The study secured an authorization letter from the graduate school at Kenyatta University and got a research authorization from the 'National Commission for Science, Technology, and Innovation'

(NACOSTI). Upon receiving the necessary permissions, questionnaire was distributed to chosen respondents through a drop-off and pick-up approach. Ethical issues were considered. This included privacy of possible and actual participants, voluntarily nature of participants.

Data analysis: Data was analyzed quantitatively and qualitatively.

Quantitative Data Analysis: Quantitative data analysis involved the use of descriptive and inferential statistics with the aid of STATA statistical software. Results from descriptive statistics were presented on frequency tables and bar graphs to illustrate the distribution and enable the comparison of responses across categories.

Qualitative Data Analysis: Qualitative data from interviews were analyzed using thematic analysis, enabling the detection of recurring themes and insights through a coding process. The results were conveyed in a narrative format, supplemented by quotations from participants. The current research followed the principles of thematic analysis according to (Braun and Clarke, 2006).

FINDINGS AND DISCUSSION

The participants were given questionnaires to rate their agreement level on list of statements provided using a Likert scale regarding teaching of Probability and Statistics. 25% agreed while 65% strongly agreed on the statement that when asking or responding to questions about Probability and Statistics, students find it difficult to articulate themselves. This finding implies that there is significant difficulty among students in effectively communicating their understanding of these subjects show that there was a degree of association among the teaching strategies and student performance. Notably, problem-based learning had a coefficient of 0.515 which highlights a moderately high positive association between problem-based learning and students' performance.

Effect of Problem-Based Learning strategy on Students Performance: Table 4.9 results indicate that the distribution of respondents' view was slightly skewed towards the left this would suggest that students who performed dismally in probability and statistics tend to express positive sentiments compared to students who passed their exam. The results show that chi-square test coefficient was 80.5 with a p-value of 0.000. Since the P-value is less than 0.01 the null hypothesis was rejected at 1 percent significance implying that there is a significant association between cooperative learning and students' performance.

To examine the most effective teaching strategy for Probability and Statistics: The results from table 4.11 show that students ranked cooperative learning as the most effective strategy followed by problem-based strategy. Evaluation of teachers' questionnaire results show that they generally agreed that cooperative learning can enhance student performance in Probability and Statistics at secondary schools in Kericho County, Kenya.

CONCLUSION AND RECOMMENDATION

It was revealed that there is a significant and positive association between student performance and inquiry-based learning and Cooperative learning.

The results reveal that students with low grades were more inclined to favor cooperative learning compared to stronger students. Further, while both teachers and students agreed that the strategy leads to deeper understanding and application of probability and statistics, its execution may be affected by unequal participation among dominant and slow learners and psychological factors such as, negative attitudes, lack of interest and morale and by students may also present. The study recommended that teachers should put more emphasis on the design and facilitation of cooperative learning environments, equipping educators with strategies to manage group dynamics and balance the needs of diverse learners. Additionally, policymakers should prioritize targeted teacher training and resource allocation in under-resourced public secondary school categories in Kenya.

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