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Challenges Of Implementation Of Computer Simulation In The Teaching And Learning Of Probability In The Kenyan Education System.

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Abstract:
Background*: From 2012 to 2018, pupils taking the Kenya Certificate of Secondary Education (KCSE) routinely performed poorly in mathematics on a national level. In KCSE Test data from 2012 to 2018, it was noted that probability was one of the mathematical concepts that the majority of pupils found challenging. A novel approach that advocates for the incorporation of computer assisted learning methods like simulation has been put out to address the issue.*
Materials and Methods*: In this study, learner achievement in probability in mathematics was compared to computer-based simulation (CBS) effect in public secondary schools in Kisii County.*
Results*: The results showed that there was a lack of physical infrastructure, computer labs, computer hardware, and software, as well as stable internet connectivity and a dependable power supply. The main finding is that CBS's teaching approach is better than traditional approaches to teaching probability.*
Conclusion: *The objective of the study was to highlight challenges that could be inhibiting the integration of CBS in teaching and learning of topics in Mathematics with a specific focus on Probability. The respondents reported that there is a range of below average to average integration of CBS in teaching and studying mathematics. According to the study's findings, there are a number of obstacles that must be overcome in order for mathematics teachers to embrace and successfully use the CBS approach as a method of instruction for teaching probability in secondary schools in the Kenyan educational system.*
Key Word: *Computer-Based Simulation, Probability, ICT integration, Smartphone Access*

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I. Introduction

Based on existing empirical evidence, incorporating CBS in schools is a challenging procedure. Limited ICT resources, expensive Internet access, limited information sharing, limited skills for CBS integration, and a labor shortage as a result of training institutions failing to produce the ICT technicians and professionals required for the labor market, as reported in Mwalongo, (2011) were among these, according to Swarts and Wachira (2010). According to Smarkola (2007), other obstacles included a lack of energy, smartphone access, and an insufficient quantity of computers.

Hare (2007) identified a lack of regulatory framework, insufficient infrastructure, excessive bandwidth costs, and insufficient in-service teacher training on CBS in education as some of the barriers to CBS integration. While some studies have documented the difficulties associated with CBS in the Kenyan educational system, they were not particular to ICT integration in Mathematics teaching and learning or CBS in Probability. The goal of this study was to get insight into the issues associated with this particular focal area.

Chapman and Tunmer, (1997) affirmed that Students who did well in Mathematics displayed appropriate task-focused conduct and positive learning techniques, but students who were cautious in learning circumstances and avoided problems in Probability did badly (Midgley and Urdan, 1995, Zuckerman, Kieffer & Knee,1998). According to Stohl (2005), teachers' Probability reasoning and knowledge, as well as teachers' deeper understanding of students' misconceptions, have a significant impact on students' Probability reasoning and comprehension. However, research studies on secondary school teachers' knowledge revealed that they lacked the necessary knowledge to teach Probability (e.g., Batanero, Godino, & Roa, 2004; Begg & Edward, 1999; Jacobbe & Horton, 2010), leading to the conclusion that many teachers had little exposure to Probability before the adoption of new mathematics standards and curricula, and that they are now expected to teach probability (Onatsu-Arvillomi and Nurmi, 2002).

Challenges to CBS implementation in schools, according to Mwalongo (2011), include a lack of CBS facilities, expensive internet access, limited information sharing, limited skills for ICT integration, and a loss of labor force due to training institutions' failure to produce ICT technicians and professionals required by the labour market. As cited in Mwangolo, Mendes, Tuijnman, and Young (2003), as well as Swarts and Wachira (2010), repeated the same views. Hesselmark (2003), also supports a lack of electricity in schools, lack of smartphone service, and a lack of computers.

Lack of a regulatory framework, insufficient infrastructure, excessive bandwidth costs, and a lack of in-service training on ICT integration in education were all cited by Hare (2007) as barriers to ICT integration in education. In a study of the extent of use of ICT resources in Tanzania, Mendes et al. (2003) found that there is less emphasis on ICT training in schools due to limited facilities, while Adomi and Kpangban (2010) found that the low rate of ICT adoption in secondary schools in Nigeria is due to poor infrastructure, a lack of ICT facilities in schools, frequent electricity interruptions, a lack of ICT policy implementation strategy, and a lack of manpower.

Some studies identify issues in the Kenyan education system's use of ICT in teaching and learning, but they aren't particular to CBS integration in Probability teaching and learning. This research tried to shed light on the difficulties associated with teaching and learning in this particular field. According to Shaughnessy (1992), there were relatively few studies that looked at the impact of formal education on students' Probability misunderstandings, and even fewer studies that looked at secondary school students on the use of CBS in teaching and learning Probability.

However, most studies focused on students' Probabilistic thinking before teaching, and classroom research that examines the impact of instruction on secondary school students' Probability ideas and learning utilizing CBS is still needed (Jones, Langrall & Mooney, 2007).

Probability misconceptions as one of the challenges for integrating CBS

Students face some misconceptions in their study of Probability. The following are some of the examples of the existing misconceptions about Probability.

Simple and compound events

This occurs when a pupil fails to consider the order of events when comparing a simple event to a compound event (Fischbein & Schnarch, 1997). When tossing two dice at the same time, a student might believe that the likelihood of each die showing 6 is the same as the Probability of one die showing 5 and the other die showing 6. Fischbein and Schnarch (1997) discovered that this misunderstanding was common and consistent across generations.

Equiprobability misconception

This is a situation in which students believe that all possible outcomes of a Probability experiment have the same chance of occurring (Shaughnessy, 2003). Anything can happen, and students frequently make assertions like "50-50 chance." However, the fact that the answer is equally likely to occur is another form of misunderstanding.

Representativeness misconception

When a student evaluates the chance of an event based on how well it represents the parent population, this is what happens (Kargiban, Kahneman & Tversky 1972; Shaughnessy, 2003). For example, in the lottery, a person may believe that random numbers such as 39, 1,17,33,8,27 are more likely to win than pattern numbers such as 1,2,3,4,5,6 (Fischbein & Schnarch, 1997), or in coin tossing, a student may believe that a sequence of five-coin tosses is more likely to be THHTH than HTHTH (Fischbein & Schnarch, 1997). These findings suggested that when confronted with a stochastic circumstance, such as the coin situation described above, participants are more likely to perceive the situation as a random event and to expect "random" consequences. As a result, THHTH is more probable than HTHTH to occur. In research of 277 secondary school students' perceptions of randomness, Batanero and Serrana (1999) discovered that students overemphasized unpredictability and luck to support their attribution of randomness.

Negative and positive recency effect misconception

This occurs when a person feels that a particular outcome of a series of independent occurrences is more or less likely to occur as a result of the absence of that outcome in preceding findings (Fischbein & Schnarch, 1997) For example, if a student tosses a coin five times and the first four times it lands on heads, he or she may believe the coin is more likely or less likely to land on heads the fifth time. Pawlak, (2022) on the other hand, argued that this idea looked to be more in line with computer-assisted coin tossing experiments.

Effect of the time axis misconception

A student believes that an event cannot affect its cause in the future (Fischbein & Schnarch, 1997). Taking one marble at a time from an urn with three yellow and three green marbles, for example. A student with a time axis misperception who never learned the color of the first marble but knew the color of the second would believe that knowing the color of the second marble had no bearing on the Probability of the first marble's color.

This study will use CBS, which will provide real-time replies on an experimental method to learning Probability, to assist students in overcoming some or all of their misconceptions. Cognitive conflict was utilized by Fischbein & Schnarch, (1997) to rectify misconceptions and inconsistencies. Focusing on a single concept may lead to another misunderstanding.

Elimination of Probability misconceptions

The use of various techniques to learning and teaching Probability leads to misconceptions on the side of the students. Using CBS, teachers can still address and try to eliminate any misconceptions during class. Cognitive conflict was employed by Pawlak, (2022) to rectify the learner's misconceptions and inconsistencies. He observed that some of the misunderstandings become more prevalent as people become older, while others become less prevalent. Students will be able to minimize or remove misconceptions and have a good understanding of Probability at all stages of learning if they apply CBS.

II. Material And Methods

Study Design: A research project's methodology is its official plan of action. This study used a mixed method approach that included both quantitative and qualitative research designs. The challenges that social and health science researchers attempt to solve are complicated, and Creswell (2009) contends that using either quantitative or only qualitative methodologies is insufficient to deal with this complexity. According to Cohen, Manion, and Morrison (2011), researchers can simultaneously draw generalizations about a population from the findings of a sample and get a deeper understanding of the phenomena of interest by using both quantitative and qualitative data and data analysis.

The goal of the study was to evaluate how computer simulation (CBS) affected secondary school students' proficiency in probability and mathematics as a whole.

Study Location: The study was carried out in Kisii County, one of Kenya's forty-seven counties. This was necessitated because of the existing problem of poor performance in Probability in Mathematics in Kisii County. The county borders Nyamira, Homa Bay, and Migori counties, and is located in the former Nyanza province. The County was divided into seven (7) Sub-Counties. In the County, there were one hundred and seventy (170) public secondary schools, including four (4) national schools, twenty-four (24) extra-County, thirty-four (34) County, and one hundred and twelve (112) Sub-County schools.

Sample size calculation: According to Kothari (2004), the sample size should technically be sufficient to provide a confidence interval. The study employed Solomon's four-group model of quasi-experimental designs, which produced four streams with an average student population of 50 (Hansen and Kloppfer, 2006). As a result, 198 individuals were chosen as the sample size for the student body. Because most schools in the County had adopted a team-teaching format, the study required at least eight Mathematics teachers including the four Mathematics teachers handling the four test groups. As mentioned in the sampling methodology section, 198 students and 4 Mathematics teachers were recruited from the 4 purposively sampled schools in the County. Thus the total study sample was 202.

Statistical analysis

Factor Analysis was used to assess the data collected for this goal. Other evaluations of internal and external validity were conducted because there were four groups, two experimental and two control. To assess if the pre-test affected the post-test scores, an independent samples t-test was performed on the post-test means of the two experimental groups, one of which was exposed to a pre-test. A t-test was performed on the combined means of the pre-tests and the post-test mean score of the group that was not pre-tested nor treated to see if subject maturation influenced post-test mean scores.

III. Result

Challenges in Integrating CBS in Instruction of Probability

The final objective was to determine the difficulties in implementing CBS in Probability teaching and learning. Mathematics teachers who assisted in the implementation of the intervention were interviewed utilizing the Mathematics Teachers Interview Schedule to achieve this (MTIS). Table 1 summarizes the characteristics of the teachers who took part in the interview and so supplied qualitative data.

Table 1. Interviewee Identity

Participant Code	Type of School
P	E_1
Q	E_2
R	C_1
S	C_2

Table 1 demonstrates that for anonymity, four Mathematics teachers called P, Q, R, and S participated in the interview and thereby provided qualitative data for the study. P and Q came from the experimental research groups, while R and S came from the control groups. The MITS instrument evaluated several topics, including the extent to which CBS tools are used, the obstacles that prevent CBS from being integrated into teaching and learning, and recommended ways for resolving the challenges. The respondents were unanimous in their comments when it came to the extent to which CBS tools, are used in teaching and learning Probability in Mathematics. Due to a "lack of sufficient CBS hardware and software," interviewee P claimed that "below average" use of CBS tools in the teaching and learning process. Interviewees Q, R, and S all expressed similar opinions. Due to a lack of suitable computer hardware and software, respondent Q mentioned that he had to resort to alternate teaching tactics such as the "question and answer approach." Teacher 'R' claimed that his school's "poor conditions," had forced him to revert to "old modes of teaching Mathematics, such as the lecture style. When CBS tools become "available," interviewee S stated that she prefers to use them since they are "learner-friendly and that they promote optimum learner involvement" in the teaching and learning process. Figure 1 summarizes how teachers responded to the challenges of the CBS approach to teaching probability.

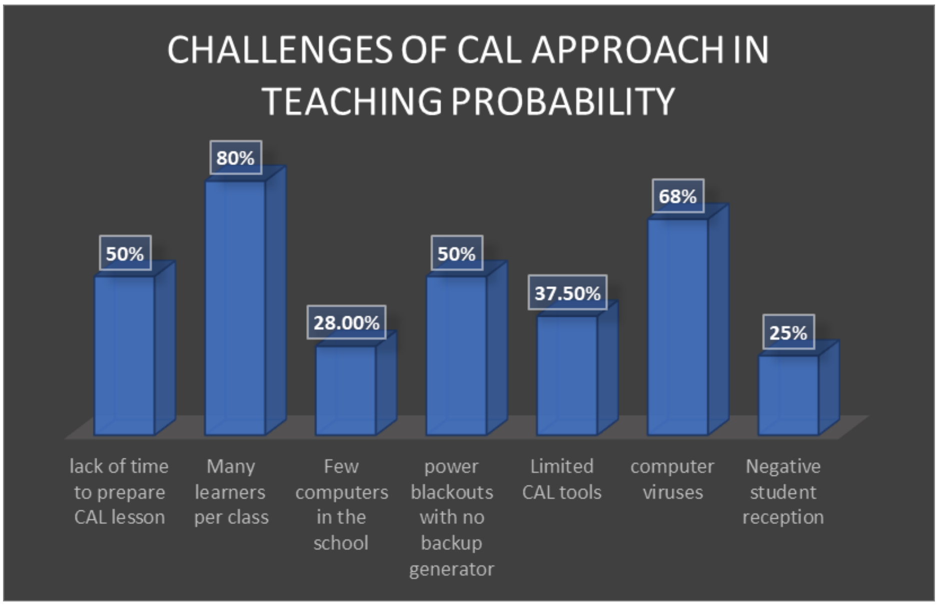

Figure 1 Challenges of the CBS approach in teaching Probability

About time, 50% of the respondents said they did not have enough time to prepare for the lesson, citing the complexity involved in preparing CBS tools, to use for different concepts in Mathematics.

They also mentioned that classes are overcrowded with learners with 80% of the respondents affirming this challenge making it difficult to use the few CBS tools available for all learners. On the issue of the availability of computer hardware, 28% of the respondents confirmed that they are few in schools while the majority agreed that they are available, but not being utilized to teach Probability and Mathematics in general. Power blackouts in most schools were the predominant challenge with 50% of the respondents corroborating the same. About CBS tools, 37.5% of respondents said "Limited CBS tools" did not enable them to fully utilize the CBS approach to teaching Probability posing a challenge in its implementation. Computer viruses posed a great challenge by 'eating up'-destroying the already developed CBS software with 68% of the respondents confirming it which discourages teachers from developing and using CBS software more often. On student perceptions of the use of CBS tools in learning Probability, 25% of the respondents acknowledged that learners exhibited signs of negative attitude towards CBS tools posing a challenge to its implementation.

In general, interviewees felt that while CBS technologies are appropriate for classroom instruction, several factors prevent them from being used in their schools and "over the enrollment of students" resulting in huge class sizes, according to interviewee P. Interviewees Q and R both expressed similar opinions. In addition to the stated impediments, interviewee S regretted the detrimental effects of "restricted physical infrastructure" and "lack of regular power supply" on the usage of CBS tools. As a result, they urge that schools be fully equipped with physical infrastructure including "computer laboratories," "computer hardware and software," "stable internet access," and "reliable power supply including backup generators."

In summary, lack of time to prepare by teachers was found to have a negative effect on teachers' use of CBS implying that teachers' workload could be inhibiting the use of the strategy. Otach (2008) and the public school system is beset by a huge intake of students, crowded classrooms, and outdated facilities that make a mockery of the government's commitment to provide free education, laments UNESCO (2004). The classroom instructor has been overworked and under pressure to manage the class, which may be harming their ability to prepare for using CBS. Teachers indicated a lack of enough CBS tools for teaching and learning Probability in Mathematics. This observation is in accordance with Usluel et al. (2008) who suggested improving accessibility to ICT tools for effective CBS use and Norris et al. (2003) who highlighted the significance of access to technology. On power blackouts, it agrees with Mendes et al (2003) as reported in Mwangolo (2011) that there is less emphasis on ICT training in basic and secondary schools in Tanzania because of poor facilities and power outages in a study on the level of use of ICT resources.

IV. Conclusion

The objective of the study was to highlight challenges that could be inhibiting the integration of CBS in teaching and learning of topics in Mathematics with a specific focus on Probability. The respondents reported that there is a range of below average to average integration of CBS in teaching and studying mathematics. Results showed that factors preventing the use of CBS tools included a lack of adequate physical infrastructure, a lack of reliable power supply, a lack of sufficient physical student enrolment, and big class sizes. According to the study's findings, there are a number of obstacles that must be overcome in order for mathematics teachers to embrace and successfully use the CBS approach as a method of instruction for teaching probability in secondary schools in the Kenyan educational system.

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