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Original Research Article

Effects of Computer Simulation on Learners' Participation in Physics in Selected Secondary Schools in Kangundo Sub-County

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Abstract

This study examined the use of e-learning technologies as predictors of students' academic performance in public secondary schools in Kangundo subcounty, Machakos county, Kenya The study was guided by three objectives, three research questions and hypotheses. The population of the study comprised of 31 academic staff, 1560 students of 31 secondary schools in Kangundo subcounty, Machakos county, Kenya. The sample size for this study was 266 respondents, representing 10-30% of the entire population. The sampling technique was a proportionate stratified random sampling. The instruments were questionnaire and teacher made test, used for the study to generate date. The instruments were validated and it reliability were tested using Kuder Richardson method, which yielded coefficients of 0.84 and 0.82 for The Use of E-learning Technologies Scale (TUETS) and Teacher Made Test Scale (TMTS) respectively. The research questions were answered while the hypotheses were tested with Chisquare associated with simple regression at 0.05 level of significance. The findings revealed that the use of computer Simulated models helped learners participate fully and more in class than conventional methods thus enhancing performance of students in Kangundo subcounty, Machakos county, Kenya, while smartphone as e-learning technologies predicts students' academic performance in public secondary schools in Rivers State to a high extent. Based on the findings, it was recommended among others that the government who are the owners of public secondary schools should ensure that all schools have functional laptop computer laboratories, accessible to both teachers and students with trained personnel to help them acquire relevant ICT skills that will aid teaching and learning process for improve both the participation and hence the academic performance of students. Also, parents should explore all positive means to provide smartphones, constant strong Wi-Fi connection, browsing data, constant power supply for students with strict monitoring by the school PTA to guide, orientate and control students on how they can use the smartphones available to them to their own advantage, as all of these will enhance effective academic learning activities with minimal distraction.

Keyword: E-learning, Technologies, Students, Academic Performance.

INTRODUCTION

Participation is the involvement of both the selected teachers and selected learners in a physics lesson in classroom. Academic performance of physics in secondary schools is poor compared to other subjects and some of the mentioned possible reason was due to teacher's pedagogical approaches that are not involving the learners in the lesson. Computer simulation has been used by scholars in different nations in teaching science to help students observe scientific phenomena that we could not accurately do in real life. It enhances student content knowledge and facilitates conceptual change when simulation is used instead of the conventional methods (Smetana *et al.*, 2014; Janal, Jalil & Ahmad, 2020). The study aimed at investigating whether computer simulation method of teaching enhanced the same when used in physics subject. Teachers of statistics are always searching for new or alternative teaching methods to improve statistics instruction in hope of enhancing student learning and to improve student attitudes toward statistics. This has

recently been the wish of several physics teachers in Kenya. The numerous recommendations to offer computer simulated models (CSMs) as teaching and learning tool are valuable solution to this problem. CSMs offers students the opportunity for unique and concrete learning experiences where an individual construction of meaning and ideas about statistics concepts is obtained.

A study conducted by Kabigting (2020) evaluated the effect of computer simulations verses conventional teaching in physics learning concept in Philippines' high school students and found out that learners were fully involved in use of computer simulation technique. In Nigeria, simulation techniques are more effective with students at basic education level than the lecture method (Bello, Ibi & Bukar, 2016). This maintained that simulation games combined unique characteristics which made it suited to learning among Nigerian physics learners, since it stressed on interactive learning. This study keenly investigated both experimental and control group and established that experimental group taught by computer simulation fully were involved and participated in classes as compared to control group who were observed to be passive listeners.

The study revealed that computer simulations offers a great variety of opportunities for modeling concepts and also acts as a bridge between students' prior knowledge and learning physical concept helping students understand better through active learning. Inadequate teacher qualification as well as use of poor pedagogical content delivery led to poor performance in physics (Nyamu, Gatere & Kithinji, 2018). Many students consider physics as difficult, abstract and theoretical due to this poor method of teaching centered on the teacher that hinders learners' the opportunity to explore hypothetical content, experiencing knowledge on themselves and also deters reflection by learners (Ambusaidi *et al.,* 2018). Involvement in meaningful practical work improves performance of learners in physics (Musasia *et al.,* 2016; Lee *et al.,* 2018). Teacher centered approach of teaching physics is poor, students are supposed to interact during the lesson thus eradicating boredom in the lesson. There is need to balance teacher-student ratio which tend to improve on the delivery of the physics curriculum. This is attained by employing enough physics teachers thus reducing the teaching load of physics. In order for teachers to be well prepared to meet the challenges of teaching physics in a school with limited teaching/learning resources, it is important for student-teachers to interact (Njiru *et al.,* 2015).

Goal of education should be able to engage learners in science subject and by so doing, students are believed to learn best in constructing knowledge through interaction, experiences and interpretation thus promoting learning (Grimalt-Álvaro, 2020; Binu, 2022). Computer technology has been viewed by many scholars to have huge capabilities to make learning better by allowing learners participate in the lesson (Aksela, 2019; Mehar & Arora, 2021). The researcher aimed at finding if the same is true when applied in physics lesson. Greatest benefit of computer simulation is that, it granted a paradigm shift from teacher centered to student centered instruction (Otoo, 2022; Oberdörfer *et al.,* 2020). Physics teachers therefore need to incorporate simulation in class to find out the effectiveness in allowing learners to participate fully during the lesson which makes it enjoyable. There being little information on learners' participation in physics class, the researcher chose to conduct this study.

RESEARCH METHODOLOGY

Study Area

The study was conducted in Kangundo subcounty, one of the 8 subcounties in Machakos County. The subcounty is located in the eastern part of Kenya between latitude: -1° 17' 52.51" S and longitude: 37° 20' 49.38" E it is located 63km southeast of Nairobi. The subcounty has the following administrative wards: Kangundo North; Kangundo Central; Kangundo East and Kangundo West.

Research Design

The study adopted nonequivalent group pre-test post-test quasi experimental design advanced by Reichardt (2019). Secondary schools in Kenya currently are not using computer simulation techniques of teaching, this design allowed the researcher to introduce the use of computer simulated models in classroom and test its significance. The design was aimed at determining if the treatment applied to the experimental group impacted the study findings (Creswell & Creswell, 2017).

Research methodology

This study employed qualitative research methods to enable researcher record observations on learners' participation in physics lesson in selected secondary schools taught with computer and those without.

Target Population

The study targeted 1560 students in form one classes and 31 physics teachers in 31 Kangundo sub-county secondary schools.

Table 1: Research design description

Group	Pretest	Treatment	Posttest
Control		C	
Experimental		X	

Key: X-computer simulation instructional method; C-Conventional method

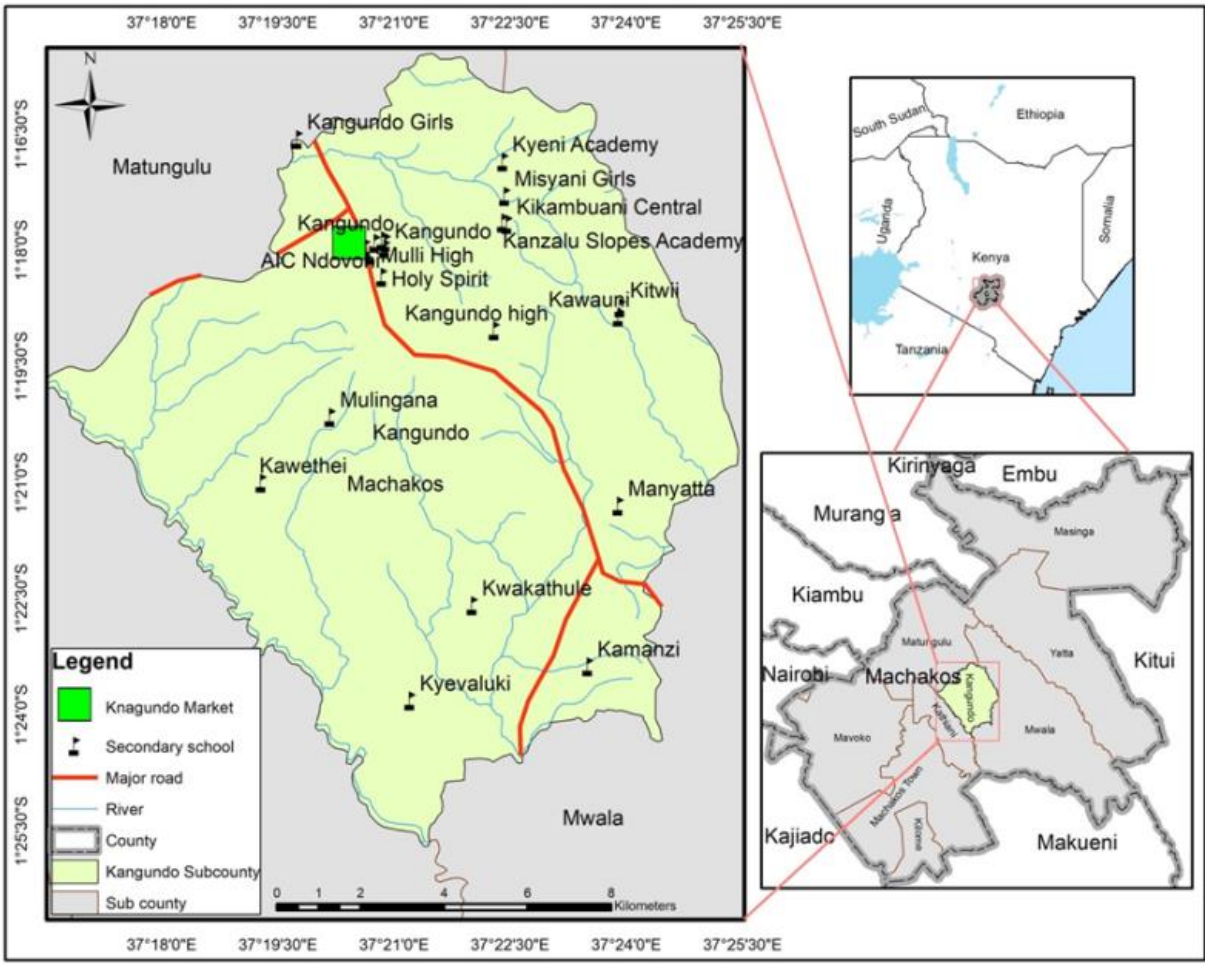

Figure 1: Study area map

Sampling Procedure

The researcher stratified Kangundo subcounty into 4 wards and 2 wards were chosen. Kenya secondary schools are grouped into 4 categories namely; national, extra county, county and private schools. Kangundo subcounty has the following categories of schools that is; extra county, county and private secondary schools. In the 3 categorizations of schools, there were those with computers and those without computers. In each category of schools, 1 with computer and 1 without computer were chosen randomly. All teachers teaching physics in form 1, in the selected secondary schools were purposively chosen as respondents. Purposive sampling technique involved considering the right respondent for the study (Hardesty, Crossman & Haselschwerdt,2022; Cohen & Holliday, 1979; Schofield, Mehta, & Stonham, (1996). Schools offering computer and physics subjects were sampled randomly to come up with working sample schools.

Sample size

Total number of students and teachers used in the research were determined using Mugenda and Mugenda (2003) who concluded that 10% to 30% respondents from the target population would make a suitable sample size for the study. 6 teachers out of 31 and 260 students out of 1560 students in the selected secondary schools in Kangundo subcounty formed the sample of the study.

Data Collection Instruments

The study used observation checklists, Teachers' and Students' questionnaire as research instruments.

Validity and Reliability

The researcher used expert judgement to assess content validity of research findings. The researcher also conducted pilot study which existed as a form of

pretest that ensured construct validity of the study instruments. Reliability of the tools were determined through the use of test-retest technique.

Data Collection Procedures

By use of demonstration, the researcher inducted selected teachers in experimental schools on how to teach the topic of pressure using computer simulation for 2 days. The researcher then allowed teachers to teach under supervision for 3 weeks so that the entire topic was covered. The researcher went to class when the lesson began and observed how the lesson was covered alongside learners' participation. Using observational checklists, the researcher was able to record the activities done by learners as the lesson being taught using computer simulation and conventional methods progressed. Lastly, the researcher issued the questionnaire and coded them on the fourth week.

Data Analysis Techniques

Quantitative data obtained were coded on SPSS while qualitative data was analyzed thematically.

RESULTS AND FINDINGS

There were one hundred and ninety-six (196) students issued with questionnaires. Out of the total, one hundred and three (103) were female constituting (52.60%). The assessed students who had not been trained on how to use a computer were majority 119 (60.70%) while the rest had been trained. Majority of the student stated that they had been using computers for a period of less than one year (85.60%) while few had been using for a period of between 1 and 2 years (4.60%) as illustrated in Table 1

Table 1: Demographic characteristics of the learners

Question	Attribute	Frequency	Percent (%)
What is your gender?	Male	93	47.40
	Female	103	52.60
	Total	196	100.00
Have you been trained on how to use a computer?	Yes	77	39.30
	No	119	60.70
	Total	196	100.00
How long have you been using a computer?	None	113	57.90
	<1 years	54	27.70
	1(2 years	9	4.60
	3(4 years	9	4.60
	>4 years	10	5.10
	Total	195	100.00

For the teachers, both male and female had equal proportions (50.00%). Majority (66.70%) of teachers were in the age group of 25-35 years while a lower proportion of them were in the age group of less than 25 years as illustrated in Table 2. All assessed teachers had Bachelor's degree as their highest education qualification with greater than five years of experience but less than ten years (83.30%). In terms of experience in teaching Physics subject, all the assessed had been in the teaching field for less than ten years (100.00%) with majority having been trained on how to integrate ICT in teaching 5 (83.30%) as illustrated in Table 2.

Table 2: Demographic characteristics of the teachers

Question	Attribute	Frequency	Percent (%)
What is your gender?	male	3	50.00
	female	3	50.00
	Total	6	100.00
To what age group do you belong?	<25 years	1	16.70
	25(35 years	4	66.70
	35(45 years	1	16.70
	Total	6	100.00
What is your highest professional qualification?	Bachelors' degree	6	100.00
How many years of experience do you have in teaching physics	>5 years	5	83.30
	< 1 year	1	16.70
	Total	6	100.00
Have you been trained on how to integrate ICT in teaching Physics	yes	5	83.30
	no	1	16.70
	Total	6	100.00

Questionnaire and observation checklists were used to assess the effects of computer simulation on learners' participation between control and experimental group. Several statements which aimed for responses from teachers and learners were provided. Table 3 below shows the percentages of the responses and their hypotheses testing.

Table 3: Learners' participation in physics by use of computer simulation

Statement	Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Chi square (χ^2)
There were enough resources for everyone	learners	68 (35.40%)	49 (25.50%)	33 (17.20%)	21 (10.90%)	21 (10.90%)	χ^2= 21.6217, d.f.=4, p = 0.0002
	teachers		4 (66.70%)	2 (33.30%)	-	-	χ^2 = 11.56, d.f.=1, p = 0.0007
There is always use of resources in physics class	learners	64 (33.90%)	75 (39.70%)	17 (9.00%)	29 (15.30%)	4 (2.10%)	χ^2 = 53.3, d.f.=4, p = 0.0000
	teachers	1 (16.70%)	5 (83.30%)	-	-	-	χ^2 = 43.56, d.f.=1, p = 0.0000
This method allowed students to participate in the lesson more than the previous lesson	learners	83 (43.20%)	63 (32.80%)	27 (14.10%)	14 (7.30%)	5 (2.60%)	χ^2 = 59.6, d.f.=4, p = 0.0000
	teachers	4 (66.70%)	1 (16.70%)	1 (16.70%)	-	-	χ^2=49.9581, d.f.=2, p = 0.0000
Learners used all the resources available in the lesson without any difficulties	learners	55 (28.90%)	67 (35.30%)	22 (11.60%)	33 (17.40%)	13 (6.80%)	χ^2 = 27.4, d.f.=4, p = 0.0000
	teachers	1 (16.70%)	3 (50.00%)	1 (16.70%)	1 (16.70%)	-	χ^2 = 32.64, d.f.=3, p = 0.0000
Learners were more comfortable participating in the lesson due to the instructional method used	learners	95 (50.30%)	61 (32.30%)	18 (9.50%)	10 (5.30%)	5 (2.60%)	χ^2 = 82.9, d.f.=4, p = 0.0000
	teachers	2 (33.30%)	4 (66.70%)	-	-	-	χ^2 = 11.56, d.f.=1, p = 0.0007

From the responses in the table 3 above, majority of the learners strongly agreed that there were enough resources for everyone 68(35.40%) followed by those who agreed 49(25.50%) while a few of them disagreed and strongly disagreed with a significant difference (χ^2= 21.6217, d.f.=4, p = 0.0002). The same was echoed by teachers. The findings are in line with (Alarabi *et al.,* 2022) that majority of learning institutions are trying their level best to equip computer laboratories with computers which they can assist in learning. The same was echoed by (Awuor & Okono, 2022) who pointed out that it takes a lot of effort to understand how problems can be solved because learning physics is frequently thought of by teachers and students as a challenging endeavor. On the statement that there is always use of resources in physics class, majority of the learners agreed with the statements 75(39.70%) followed by those who strongly agreed 64(33.90%) with a significant difference (χ^2 = 53.3, d.f.=4, p = 0.0000). The same statement was agreed on by the majority of the teachers 5(83.30%). It is a widely held idea in research that students have a set of assumptions and intuitions about physical phenomena that are mostly based on their daily lives. These belief and intuition systems have been referred to as misunderstandings or alternative conceptions since they are typically at odds with scientific ideas and knowledge.

On the statement that this method allowed students to participate in the lesson more than the previous lesson, majority of the learners strongly agreed 83(43.20%) followed by those who agreed 63(32.80%) with a significant difference (χ2 = 59.6, d.f.=4, p = 0.0000). The same was echoed by teachers who strongly agreed with the statement 4(66.70%) with a significant difference (χ2= 49.9581, d.f.=2, p = 0.0000) as illustrated in table 3. The findings are in line with those of Rahim and Chandran (2021) who acknowledged that computer virtual learning empowered instructors for better teaching performance which involved paradigm shift from conventional ways of teaching to an interactive and involving method which allowed learners to use of senses. According to Miheso, (2020) computer simulation was used to promote critical thinking of student as well as deepening their comprehension on the subject matter since it offers experiences in learning sciences. Majority of learners agreed 67(35.30%) that learners used all the resources available in the lesson without any difficulties with a significant difference from those strongly disagreed which was also echoed by teachers. Similarly, respondents (learners and teachers) also agreed that learners were more comfortable participating in the lesson due to the instructional method used as illustrated in table 3. Respondents were asked to state

any other ways computer instructional method enabled learners to participate in the lesson than before. Learners added that "it helped to participate in any lesson with confidence, one can make it better than before and it enabled them to create group discussions" as illustrated in Figure 1.

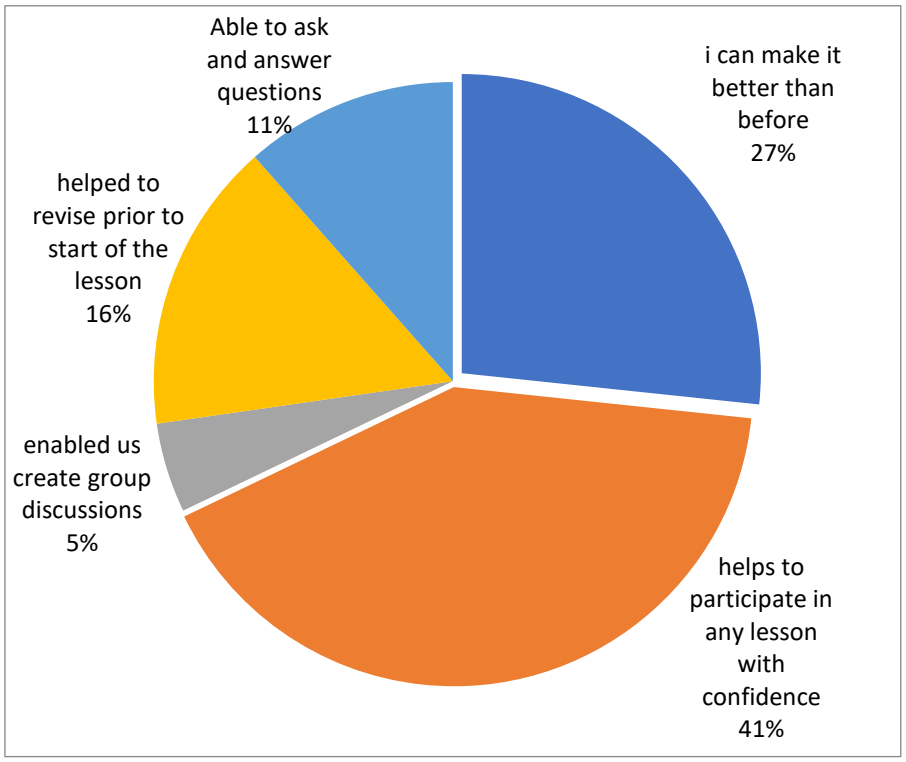

Figure 1: Learners' responses on other ways CS enabled their participation in physics lesson than before

Teachers added that "the instructional method enabled learners to participate in the lesson than before since it enhanced information retention" as illustrated in figure 2.

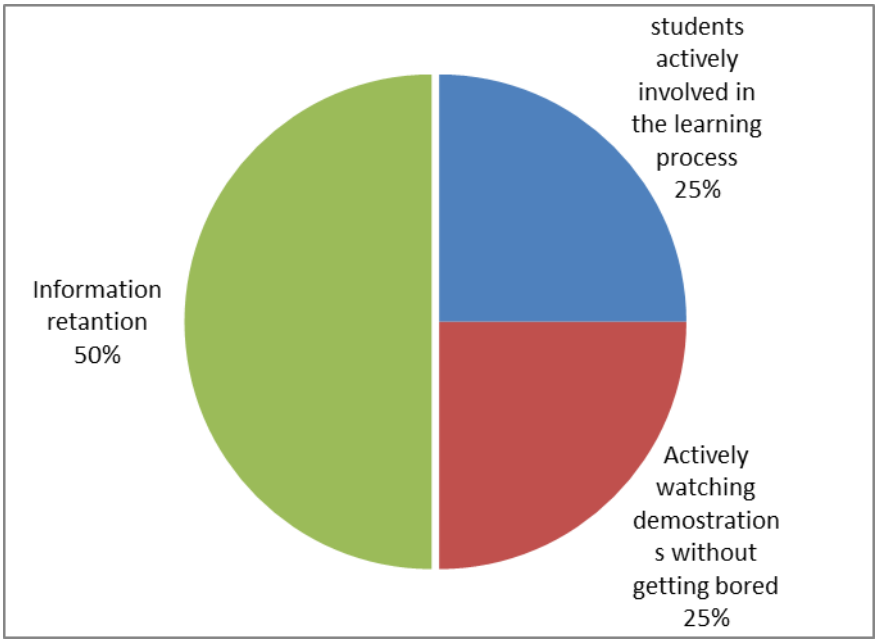

Figure 2: Teachers' responses on other ways Computer Simulation enabled learners to participate in physics than before

The results of the research show that computer simulation improved students' participation in class because it encouraged individual learning, encouraged students to solve problems, connect, prioritize, and incorporate conceptual knowledge, affected how students' attitudes and values developed, and

encouraged social and intellectual experience. Akpan et al. (2020) added that computer simulations provide the opportunity to recreate aspects of the real world that would otherwise be too complex, time-consuming, or hazardous to do in a traditional classroom setting, which supports the previous findings. The researcher also analyzed qualitative data from the observation checklists to also help investigate the effects of computer simulation on learners' participation in physics instruction between the 2 groups. To achieve this objective, the researcher observed and recorded on how learners were involved in each stage of the lesson as planned. The experimental group learners were attentive. The teacher set up the computer and simulated pressure concepts in physics class. Thereafter, learners by the guidance of their teacher's replayed the concepts taught on their own and applied the same in the problems on the lesson topic. On conclusion stage of the lesson, the learners raised hands to ask and answer questions for formative checks. This implied that learners in experimental group fully participated in the lesson and therefore obtained necessary experiences to tackle and apply in the problems thus raising their performance.

These findings are in line with the study conducted by Kabigting (2020) who evaluated the effect of computer simulations verses conventional teaching in physics learning concept in Philippines' high school students and found out that learners were fully participated on use of computer simulation technique. Similarly, in Nigeria, simulation technique was effectively applied in basic education level than the lecture method (Bello, Ibi & Bukar, 2016). This is because simulation games combined unique characteristics such as modelling which made it suitable to learning among Nigerian physics learners since it stressed on interactive learning which equipped them with necessary experiences. In the other hand, learners in the control group were attentive in the introduction of the lesson they lost focus as the lesson was being developed. Textbooks were the resources used which didn't stimulate the learners. Teachers acted as facilitators and learners were passive listeners. Very few students could tackle questions appropriately with many finding it difficult. At the conclusion stage, few learners asked and answered questions on lesson topic. This shows that conventional method of teaching does not allow learners to participate fully in the lesson hence not able to enhance their performance. These results were consistent with a study by Nyamu, Gatere and Kithinji (2018) that posited that poor pedagogical content delivery contributed to students' poor performance in physics because many students thought the subject was challenging, abstract, and theoretical due to a teacher-centered approach that prevented students from exploring and experiencing knowledge for themselves.

Additionally, a study by Knekta and Sundström (2019) Nigerian students found physics to be boring and unenjoyable because it didn't engage them in any activities, which turned them into passive listeners. The same was also true for Tanzanian female students who were not at all motivated by this passive subject (Rutakomozibwa, 2022). This caused the interest of high school students to decline, which led to significant, ongoing failure in the results of physics examinations. The research found that there was a significant mean difference between the two groups, indicating that students preferred participating more in computer simulated teaching than in traditional teaching, which refuted the final null hypothesis, which claimed that there is no significant difference between students' participation between groups taught using computer simulation and groups taught using conventional method. This resulted in the null hypothesis being rejected.

CONCLUSION

For the final null hypothesis that stated that there is no significant difference between students' participation between groups taught using computer simulation and group taught using conventional method, the research established that there was a significant difference noting that student enjoyed participation more in computer simulated teaching in comparison to the traditional teaching method. This again led to rejection of the null hypothesis.

RECCOMMENDATION

Computer simulation method should be adopted by all the physics teachers in teaching concepts in physics in order to improve students' participation during physics lesson. Based on the findings of this study, students taught through computer simulation method participated fully in redoing the demonstration on different subtopics in pressure hence retaining the content thus performing better in SPAT (post-test) hence this method is recommended for teaching and learning of Pressure. The findings of the study will also assist curriculum planners and developers in the organization of content in teaching approaches for effective delivery.

REFERENCES

- Akpan, I. J., Shanker, M., & Razavi, R. (2020). Improving the success of simulation projects using 3D visualization and virtual reality. *Journal of the Operational Research Society*, *71*(12), 1900–1926.
- Aksela, M. (2019). Towards Student-Centred Solutions and Pedagogical Innovations in Science Education through Co-Design Approach within Design-Based Research. *LUMAT: International Journal on Math, Science and Technology Education*, *7*(3), 113–139.
- Ambusaidi, A., Al Musawi, A., Al-Balushi, S., & Al-Balushi, K. (2018). The impact of virtual lab

learning experiences on 9th grade students' achievement and their attitudes towards science and learning by virtual lab. *Journal of Turkish Science Education*, *15*(2), 13–29.

- Bello, S., Ibi, M. B., & Bukar, I. B. (2016). Effect of Simulation Techniques and Lecture Method on Students' Academic Performance in Mafoni Day Secondary School Maiduguri, Borno State, Nigeria. *Journal of Education and Practice*, *7*(23), 113–117.
- Binu, P. (2022). *The Effect of Online Interaction via Microsoft Teams Private Chat on Enhancing the Communicative Competence of Introverted Students*.
- Cohen, L., & Holliday, M. (1979). *Statistics for education and physical education*. Harper.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Grimalt-Álvaro, C. (2020). STEM Needs Active Participation of Teachers, Children and their Families in Dialogue. *Key points for early childhood stem education and involving parents*, 43.
- Hardesty, J. L., Crossman, K. A., & Haselschwerdt, M. L. (2022). Grounded Theory Methods. In *Sourcebook of Family Theories and Methodologies: A Dynamic Approach* (pp. 315–333). Springer.
- Janal, M. A. B., Jalil, Z. B. A., & Ahmad, Z. B. (2020). The Effectiveness In Using Packet Tracer Simulation Software In Improving The Skills Among Computer System And Networks Programme Students. *International Journal Of Technical Vocational And Engineering Technology (IJTveT)*, *2*(1), 38–49.
- Kabigting, L. D. C. (2021). Computer simulation on teaching and learning of selected topics in physics. *European Journal of Interactive Multimedia and Education*, *2*(2), e02108.
- Knekta, E., & Sundström, A. (2019). 'It was, perhaps, the most important one'students' perceptions of national tests in terms of test-taking motivation. *Assessment in Education: Principles, Policy & Practice*, *26*(2), 202–221.
- Lee, M. C., & Sulaiman, F. (2018). The effectiveness of practical work on students' motivation and understanding towards learning Physics. *International Journal of Humanities and Social Science Invention*, *7*(8), 2319–7714.
- Mehar, R., & Arora, N. (n.d.). Contribution of computer simulation in conceptual understanding of science.
- Mugenda, O. M., & Mugenda, A. (2003). Research methods: Quantitative and. *Qualitative. Approaches. Nairobi*.
- Musasia, A. M., Ocholla, A. A., & Sakwa, T. W. (2016). Physics Practical Work and Its Influence on Students' Academic Achievement. *Journal of Education and Practice*, *7*(28), 129–134.
- Njiru, S. M., & Karuku, S. (2015). *An exploration of factors that contribute to low performance in physics: A case of a secondary school in Kenya*.
- Nyamu, P., Gatere, R., & Kithinji, W. (2018). Evaluation of Utilization of Simulation as a Teaching and Learning Strategy at Kenya Medical Training College, Nairobi. *International Journal of Current Aspects*, *2*(5), 12–28.
- Oberdörfer, S., Elsässer, A., Schraudt, D., Grafe, S., & Latoschik, M. E. (2020). Horst-The teaching frog: Learning the anatomy of a frog using tangible AR. In *Proceedings of Mensch und Computer 2020* (pp. 303–307).
- Otoo, S. (2022). *Experiential Learning Strategies for Implementing Computer-Based Simulations with Middle Schoolers*.
- Reichardt, C. S. (2019). *Quasi-experimentation: A guide to design and analysis*. Guilford Publications.
- Rutakomozibwa, A. M. (2022). *Effect of computer simulations on female students' motivation for and engagement with physics learning: A case of secondary schools in Tanzania*.
- Smetana, L. K., & Bell, R. L. (2014). Which setting to choose: Comparison of whole-class vs. Small-group computer simulation use. *Journal of Science Education and Technology*, *23*, 481–495.

