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"EFFECT OF COMPUTER SIMULATIONS IN TRANSVERSE WAVES ON PHYSICS ACHIEVEMENT IN SECONDARY SCHOOLS IN KENYA"

Lipuku Sween Natecho
Department of Science and Mathematics Education,
Masinde Muliro University of Science and Technology, Kakamega,
Kenya

Amadalo Maurice Musasia
Kaimosi Friends University College,
Kaimosi
Kenya

Lipuku Belidina Shibalira
Department of Science and Mathematics Education,
Masinde Muliro University of Science and Technology,
Kakamega
Kenya

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Abstract

The study investigated the effect of computer simulations in transverse waves on physics achievement in secondary schools in Kenya. It established whether there is any difference in students' achievement and determines gender differences in achievement of students taught properties of transverse waves when taught by integrating computer simulations compared to conventional methods in Kakamega East sub-county, Kakamega County, Kenya. It involved 618 form two students from 16 mixed schools. Eight schools supplied with electricity and equipped with computers were purposively sampled for experiment while eight others were selected randomly as a control group. Students' Physics Tests were used to collect data. A two group pre-test, post-test quasi experimental design was used. Students in the experimental group had a higher mean gain of 25.98 compared to 6.75 of the control group. In the gender comparison, boys lead in both experimental group and control group with mean scores 58.97 and 43.55 respectively compared to the girls 54.96 and 43.18.There was a positive significant influence of integration of computer simulations in waves on boys than girls.

1. Introduction

Physics is one of the most useful subjects taught in schools. It is acknowledged as key to industrial development. Currently, throughout the world there are certain skills that have been indentified that students need to have in order to cope with the world in and out of the classroom (Intel Corporation, 2008.) A situational analysis has revealed that learners enjoy learning mathematics and science when there is a deliberate effort to make them understand the applicability of the content in real life situations and careers (CEMASTEA, 2012).

As teaching and learning are culturally dependent, there is the challenge to shift the balance from the more conventional, systematic approaches to physics teaching towards the more progressive, problem and process oriented ways. For many years, researchers in physics education have focused on students understanding of specific content areas such as mechanics, electric circuits or heat and temperature (McDermott and Redish, 1999). A common theme has been the focus more on what students are unable to do (from an experts point of view) rather than what they are able to do and how they do it.

Creativity and innovation are becoming increasingly important for the development of the 21st century knowledge society. According to Redecker (2008), creativity and innovation entail alteration in the way young people learn and understand. Teachers have to attract students' interest and attention in a new way, and as a result, the development of creative approaches is called for (Simplicio, 2000). According to Cohen (1980), information is obtained about the progress of an educational program by observing directly selected aspects of its development and implementation. Selection of the curriculum and various ways in which it is introduced to the pupils is the more specialized meaning of a teaching method (Pinset, 1962).

The Kenya National Examinations Council (KNEC) attributes the poor performance and low understanding of the basic physics concepts and skills on ineffective teaching and learning methods (KNEC Report, 1996-2000). Balozi and Njunge (2004) explain that teaching and learning of physics have been subjects of debate for a long time. The debate is often centred not only on what is taught (curriculum content and relevance) but how it is taught (teaching approach and methodology).

Much evidence indicates that technology has great potential to increase learners motivation, provide learners with abundant sources of information, support collaborative learning and allow teachers more time for facilitation in classrooms. Integrating Information and Communication Technology (ICT) into teaching and learning has therefore become the latest of focus for many educators, especially the physics classroom teachers (Cemastea, 2012).

The students' study of the topic waves provides an opportunity for the student to demonstrate what they can do on their own. The study of sound waves in air is useful to musicians, architects, biologists and psychologist who wish to understand human perception. Sound waves in liquids or solids are the domain of scientists who study electronic devices. Water waves are very important in the fields of oceanography and coastal engineering. Seismic waves are of considerable interest to geologists. The study of electromagnetic waves is vital to scientists in such fields as optical communication, satellite communication, portable electronics, laser, optical lenses, radar perception, and x-ray crystallography. The wave nature of matter has become important to chemists, material scientists, and electrical engineers and generally anyone who works in the area in which atomic level understanding is required (Feynman, 1963).

In the Kenyan secondary school physics curriculum, the topic on "waves" is key to understanding other selected topics like sound, electro-magnetic spectrum, electro-magnetic induction and optics in general. ICT integration is regarded as an innovative and powerful method of instruction which provides teachers with interesting activities to teach concrete as well as abstract concepts. The government of Kenya, through Strengthening Mathematics and Science Secondary Education (SMASSE), In-Service Training (INSET) and Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) has made an effort to train teachers on integration of ICT in the teaching and learning of physics.

All topics related to waves are examined in the Kenya Certificate of Secondary Education (KCSE) examinations at the end of form four level. These are usually found in physics paper 2. This is a clear indication that a student who does not have a good mastery of content in waves may not score well in paper 2 hence affecting the overall grade. The poor performance may have a ripple effect, leading to other students in lower classes developing a negative attitude towards physics, hence low enrollment. Secondary schools have continued to have low enrollment and poor results in physics over the years. This study seeks to investigate whether using ICT mediated waves has an effect on students' achievement in physics in Kakamega East sub-county, Kakamega County. The focus of the experience is on properties of transverse waves.

2. Objectives Of The Study

Specifically the objectives of the study were:

i. To establish whether there is any difference in students' achievement on properties of transverse waves when taught by integrating computer simulations compared to conventional methods.
ii. To determine whether there is any difference in achievement according to gender of students taught properties of transverse waves by integration of computer simulations and those taught using conventional methods.

3. Research Hypothesis

H01: There is no difference in achievement of students taught properties of transverse waves by integrating computer simulations and those taught using conventional methods.

H02: There is no difference in achievement according to gender of students taught properties of transverse waves by integrating computer simulations and those taught using conventional methods.

4. Research Design

The study adopted a two group pre-test, post-test quasi experimental design as illustrated below.

Table 1: Illustration of a two group pre-test, post-test quasi experimental design

Group	**Pre-test**	**Treatment**	**Post-test**
Experimental	0_1	X	0_2
Control	0_3	C	0_4

Key : 0_1, 0_3 are pre-tests

0_2, 04 are post-tests

4.1 Research Instruments

The instruments the researcher used in collecting data to address the objectives of the study were two Students Physics Tests (SPTs) i.e. pre-test and post-test. The instruments aimed at both the experimental and control groups. The tests were used to measure the effectiveness of integrating computer simulations in teaching waves.

4.2 Students' Physics Test (SPT 1)

SPT1 was a pre-test that was used to determine students' entry behavior for both experimental and control groups. It had nine short answer questions with a total of fifteen marks. It was used to obtain the pre-test scores. It investigated general matters on waves. It was administered to the groups before treatment was done.

4.3 Students' Physics Test (SPT 2)

SPT2 was a post-test that was administered to both experimental and control groups. It was used to obtain the post-test scores. The scores represented achievement by both experimental and control groups. It had six items with subsections, with a total of thirty marks. It covered questions on waves, properties of transverse waves, transverse stationary waves and applications in problem solving.

5. The Procedure

There was actual teaching using conventional methods and using computer simulations for four weeks before post-test data collection. Data was collected at two levels. First the form two respondents were given a pre-test before intervention. Then a post-test was given at the end of the instruction. The pre-test scores were used to determine the entry behavior of the group. The post-test was given after teaching to determine progression.

The form two physics teachers in the selected schools were the research assistants. The researcher trained them on how to teach transverse waves using computer simulations. Their role was to teach, administer, mark and record the scores for the SPTs. The researcher then personally collected the test scores from the research assistants for further data analysis.

5.1 Data Analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS). The quantitative data was coded and entered into the computer. It was analyzed using descriptive and inferential statistics. Mean, standard deviation and percentages were used to report data. ANOVA and t-test were used for higher analysis. To compare the actual performance of the experimental and control groups, t-test was used. ANOVA was used to determine if use of computer simulations has significant effect on students' achievement according to gender. A pair wise comparison of t-test was done to show the direction of favor. A significance level of 0.05 was used to determine confidence level in testing the hypotheses.

5.2 Pre-test and Post-Test Achievement

Pre-test percentage scores in the SPT1 were analyzed descriptively by computing mean scores, mean gains and standard deviations and the results were as shown in table 2

Table2: Pre-test Achievement Results

Group	Mean score	SD	t-test	t-critical
Experimental	37.03	4.825	3.36	6.31
Control	36.11	3.779		

Table 2 reveals that in the pre-test, the experimental group had a mean of 37.03, while the control group had a mean of 36.11, hence a relatively small margin difference of 0.92 in the pre-test achievement mean scores. To determine the significance of the two means, an independent samples t-test was done. It yielded a t-value of 3.36 which is less than the critical value of 6.314 at 0.05 alpha level. This indicates that the mean scores of the experimental and control groups in the SPT1 were not significantly different at 95% confidence level. This is a good pointer of homogeneity and similar achievement entry behavior of students in both experimental and control groups. Any difference in the mean groups was attributed to chance.

Post-test percentage scores in the SPT2 were also analyzed descriptively by computing mean scores, standard deviations and gains. A comparison of pre-test and post-test scores is as shown in table 3

Table 3: Comparison of Pre-test, Post-Test Scores

Group	**Pre-test**		**Post test**		**Gain**
	Mean	**SD**	**Mean**	**SD**	
Experimental	37.03	4.82	63.01	4.84	25.98
Control	36.11	3.78	42.86	9.03	6.75

Table 3 reveals that in the post-test, the experimental group had a mean of 63.01 while the control group had a mean of 42.86, hence a margin of 20.15 in the two post-test achievement mean scores. The mean gain for the experimental group was bigger(25.98) while that of the control group was smaller(6.75).The experimental group had a smaller SD of 4.84 compared to 9.03 of the control group. This implies that the two groups were significantly different in achievement. Thus, the experimental group methodology is better than the control group. The null hypothesis is rejected

5.3 Students' Post-test Achievement According to Gender

The post-test achievement of students in both the experimental and control groups was also analyzed by comparing the achievement mean scores according to students' gender. Results of this analysis is as shown in table 4

Table 4: Students' post-test achievement mean scores by gender

GROUP	BOYS	GIRLS
	Mean	**Mean**
Experimental	58.97	54.96
Control	43.55	43.18

An examination of table 4 reveals that in SPT2, the boys in the experimental group obtained a mean score of 58.97, which was higher than that of the girls, whose mean was 54.96. The same observation was made in the control groups in that the mean of the boys was 43.55while that of the girls was 43.18.The mean scores of both boys and girls in the experimental group was higher than that of their counterparts in the control groups. To determine whether these differences were statistically significant, inferential testing was employed using one-way ANOVA at the 0.05 alpha level of statistical significance. Table 5 shows the results for this analysis.

Table 5: One way ANOVA on students' post test achievement scores

	Sum of squares	DF	Mean Square	F
Between	73008.728	1	73008.728	1889.36
Within	23631.115	617	38.642	
Total	96639.843	618		

As revealed in table 5, one way ANOVA performed on the four mean scores yielded an F-ratio of 1889.36which exceeds the critical value of 3.8566 at alpha 0.05.This implies that the four achievement mean scores were significantly different. Further inferential testing was needed to determine the direction of the difference. This was carried out using stepwise t-test, whose results were as shown in table 6.

Table 6: Stepwise t-test on Students' Post Test Achievement Scores

Pair	T	P	Conclusion
BE vs GE	1.0282	0.271	not significant
BE vs BC	24.8326	0.001	significant
BE vs GC	13.9347	0.001	significant
GE vs BC	18.8291	0.001	significant
GE vs GC	35.9382	0.001	significant
BC vs GC	0.9998	0.382	not significant

KEY:

BE = Boys Experimental BC = Boys Control

GE = Girls Experimental GC = Girls Control

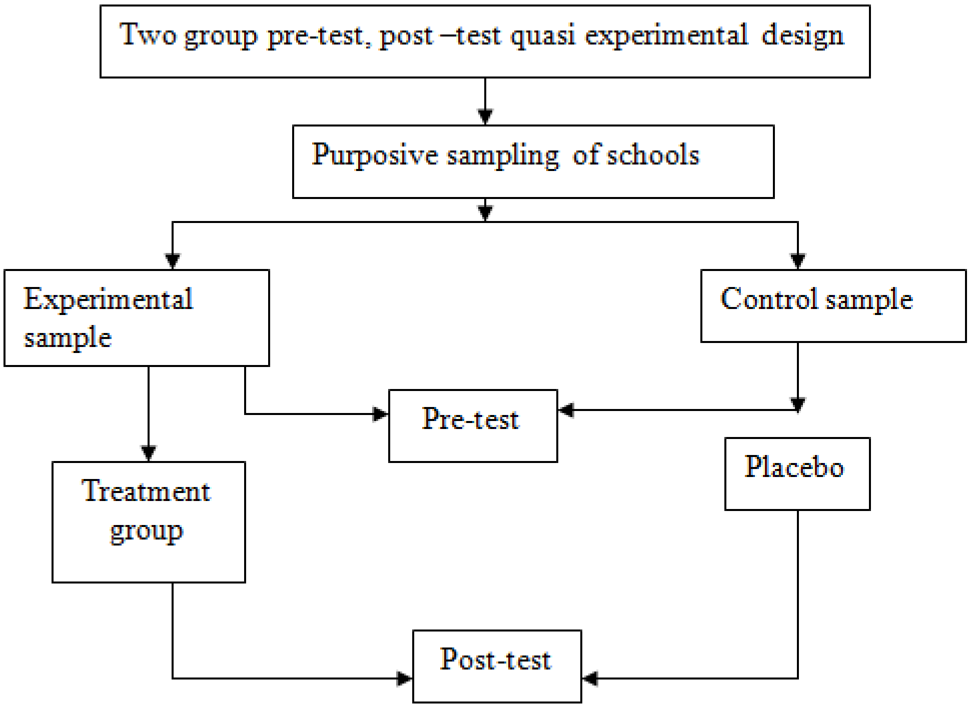

Figure 1: Illustration of research design that was used

As shown in table 6, independent samples t-test performed on the post-test mean scores in stepwise manner yielded significant t-values when both boys and girls in the experimental group were compared against their counterparts in the control group. This implies that the post-test scores for the boys and girls in the experimental group were not different from each other. Similarly, boys and girls performed similarly in the control group but the experimental groups differed from the control groups.

From the findings, stepwise t-test on post-test showed that BE vs GE and BC vs GC were not significantly different. However, BE vs GC and GE vs BC were significantly different. Similarly, BE vs BC and GE vs GC were also different. Therefore, the second null hypothesis that there is no difference in achievement according to gender of students taught properties of transverse waves by integrating computer simulations and those taught using conventional methods was rejected.

6. Discussion Of The Findings

In the overall post-test results, students in the experimental group obtained a significantly higher achievement mean score than their counterparts in the control group. They had a higher mean gain of 25.98 compared to 6.75 of the control group. This signifies performance difference in between the experimental group and control group. These findings are in unison with Michel et al,(1999) whose study found out that computer simulations was effective on students academic achievement. Simulations were observed to promote learners' active participation in the subject. According to Beishuizen (1992), this is because the computer simulation used in the topic guarantees retention of the acquired concepts and facts by concretizing the concepts. A similar study by Hownsell and Hill (1989)on the achievement and attitudes of secondary school students in a Biology class revealed that the students who were exposed to ICT integration achieved significant high scores on both attitude and achievement tests than those in conventional methods of instruction treatments.

In the gender comparison, boys lead in both experimental group and control group with mean scores 58.97 and 43.55 respectively compared to the girls 54.96 and 43.18. This means that the instructional method used in the experimental groups was considerably better than the control group. By analysis of variance, the two groups were found to be statistically comparable where F-value (1889.36) exceeded the critical value of (3.8566) at $\alpha=0.05$. This is in agreement with Kinzie and Joseph (2008) who surveyed 42 middle school students on their game activity preferences. The explorative mode of play was the most appealing for all students, but particularly for girls.

These findings are however inconsistent with Rieber (2005) who found out that a game might negatively affect learning. Students who used simulations and games scored lower on a post-test of physics concepts than students who did not have the game. Freshier and Combiasso (2001) in a study of use of computer simulations in chemistry by tenth grade students found out that using computer simulations only improves the academic achievement of female students. In fact, their study implied that while the computer simulations had a non-significant impact on students' achievement, it made them to set lower academic targets

7. Limitations And Future Research

It was not possible to investigate all factors that affect learning outcomes in physics education using computer simulations due to constraints like time, resources and scope of the study. With regard to research on challenges facing the teaching and learning of physics, many gaps may still exist. To bridge some of these gaps, a similar study could be carried out in other selected topics in physics apart from transverse waves. It would also be more fruitful for future research to consider collecting data from different school settings to compare the differences of the empirical findings

8. Conclusion

This study attempted to explore the effect of integration of computer simulations in transverse. waves in physics achievement in secondary schools and found that there was a significant difference in achievement between students who were taught properties of transverse waves using computer simulations and those taught using conventional approaches. In terms of gender it was established that there was a positive significant influence of integration of computer simulations in waves on boys than girls. The findings, the discussions and the implications of this study were definitely important to the study and implementation of computer technology in an educational context.

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