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ASSESSMENT ON EFFICACY OF LOCALLY-MADE DIGITAL INSTRUCTIONAL MATERIAL ON ACHIEVEMENT OF PHYSICS STUDENTS ON CURRENT ELECTRICITY

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ABSTRACT

Problem in the use of analogue electric circuit is observing of readings in uneasy manner and manifestation of parallax error, but use of digital electric circuit is advantageous for it displays readings in fast and accurate manner. This paper focused on assessment on the efficacy of locally-made digital instructional material on physics students' achievement on current electricity. Two research questions and two hypotheses guided the study. A quasi-experimental research design was used for the study such that experimental group and the control group were taught with locally-made digital instructional material and standard analogue instructional material respectively. The two groups were subjected to pre-test and post-test. Two independent variables in the experiment were instructional material type and gender; a dependent variable was achievement. Population of the study comprised of all SS1 physics students in Anambra State. Purposive sampling was used in selection of 264 students. The instrument used for data collection was Achievement Test on Current Electricity (ATOCE) which is a 40-item 4-option multiple choice objective test with reliability co-efficient of 0.87. Mean and standard deviation were used in answering the research questions. The hypotheses were tested at 0.05 level of significant using ANCOVA. Result obtained showed that

physics students taught current electricity with locally-made digital instructional material has higher mean achievement score than those taught with standard analogue instructional material. Hypothesis tested (F = 288.504, P = 0.000) further showed that there was a significant difference in the mean achievement scores of the two groups of physics students. Result also showed that female physics students had a slightly higher mean achievement score than their male counterparts; but hypothesis tested (F = 0.469, P = 0.494) showed that there was no significant difference in the mean achievement scores of male and female physics students. It was concluded that the locally-made digital instructional material was efficacious in enhancing achievement of physics students on current electricity, and it was also gender-friendly. Recommendations made focused on supporting the production and use of locally-made digital instructional material.

Keywords: Locally-made digital instructional material, current electricity, achievement, physics students

INTRODUCTION

An aspect of science is physics. Physics is a science that deals with the study of properties of matter and energy, and their relationship. Without the knowledge and application of physics, technological development in the world would not have been possible. Despite the technological value of physics, stakeholders in physics education observed that secondary school students in Nigeria are not well taught in the science subject (Isola, 2011; Achor, Taangahar & Musa, 2011; Falomuwa, Nwosu, Nkamuo & Adinu, 2013). The WAEC Chief Examiner Report on WASSCE from 2010 - 2015 shows that great number of secondary school physics students do not perform well in physics in external examination

(waeconline.org.ng/elearning/physics/physmain.html). Some of the major branches of physics being taught in secondary schools for examination of students are electricity (static and current), mechanics, heat, light, sound, magnetism, and modern physics.

All the branches of physics mentioned are vital, but current electricity appears to be more popular in this technological age. Current electricity is concerned with properties and effects of electrical charges in motion (Nwosu, Odigwe & Nwoye, 2015). Current electricity has brought a lot of technological advancement in this modern era as can be seen in emergence of information and communication technology.

To achieve effective teaching and learning in current electricity, instructional materials are required. Instructional materials are resources or devices which a teacher uses in making a lesson understandable by transmitting organized knowledge, skills and attitude to learners within an instructional situation (Eya, 2004). Babagbemi (2006) explained that well chosen instructional material helps to create interest and motivation in learning. Learners profit more during instructional delivery when their interest is aroused in the instruction. It can be stated that instructional materials are materials or objects which a teacher utilizes to ensure that learning become more effective by motivating the learner and directing his/her attention properly.

Provision of instructional material for the teaching and learning of current electricity demands formation of electric circuit, which usually consists of standard measuring instruments and non-measuring instruments found in physics laboratory. Examples of non-measuring

instruments are cell/battery, rheostat, resistor or metallic material, key, and wires. Familiar measuring instruments are ammeter and voltmeter for measurement of current and potential difference respectively.

The measuring instruments can be analogue or digital in nature. Analogue instrument indicates its readings using pointer; while digital instrument displays its readings in numerical form. Use of analogue instruments is associated with the problems of not observing readings with ease and manifestation of parallax error. Digital instruments usually do not have such problems for they usually display numerical readings in fast and accurate manner.

However, in senior secondary schools, analogue ammeters and voltmeters are usually used; the digital instruments are scarce and so they are not commonly used in the schools (Nwosu, Odigwe & Nwoye, 2015). This unfortunate state of digital ammeters and voltmeters not usually being used in the circuit for teaching current electricity in senior secondary schools exist in Anambra State of Nigeria, despite that modern era is gearing towards digitalization. What are commonly used in the schools in the State are analogue ammeters and voltmeters, despite the problems associated with their usage.

To enhance teaching and learning in current electricity in Anambra State, it will be necessary to embark on production of a digital electric circuit by ensuring that ammeter and voltmeter in the circuit are of the digital type, thereby displaying readings in numerical form. With the spirit to encourage local production, a locally-made digital electric circuit, serving as instructional material, can be formed to mitigate the problems associated with analogue circuit during the teaching of

current electricity.

The act of engaging in local production of instructional material can be anchored on theory of diffusion of innovation, simply termed innovation theory, propounded in 1962 by Everett M. Rogers. Diffusion of innovation theory is concerned with how something new moves from creation to use. Diffusion of innovation is a theory that seeks to explain how, why, and at what rate new ideas and technology spread (Rogers, 2003). Assessment on the locally-made digital instructional material will help to determine its adoption and acceptability as a teaching aid.

It is essential to assess the efficacy of the locally-made digital instructional material for teaching current electricity by checking its effect on physics students' achievement. This is pertinent because some studies have shown that instructional material is associated with achievement (Onasanya & Omosewo, 2011; Oladejo, Olosunde, Ojebisi & Isola, 2011; and Mboto, Ndem & Stephen, 2011). Adeyemi & Olaleye (2010) viewed academic achievement as the scholastic standing of a student at a given moment which states individual's intellectual abilities, which can be measured by grades obtained from examinations or continuous assessments. Assessment on the efficacy of the locally-made digital instructional material can also involve checking if it is gender friendly. There is need for that for some studies has shown that effect of gender can be checked on students' achievement (Achor, Taangahar & Musa, 2011; Okeke, 2011). Maduewesi (2005) noted that gender is a set of characteristics and roles distinguishing between male and female. Based on the discussions above, the researchers embarked on production of a

locally-made digital instructional material. For the sake of checking its acceptability and adoption in physics education, they assessed its efficacy on the achievement of physics students on current electricity.

STATEMENT OF THE PROBLEM

In Senior Secondary Schools in Anambra State, it appears that standard digital measuring instruments, for formation of an electric circuit serving as an instructional material, are not used. Only standard analogue measuring instruments are usually used, as part of the instructional material, in the teaching of current electricity. Problem in the use of analogue electric circuit is observing of readings in uneasy manner and manifestation of parallax error. Digital electric circuit usually does not have such problem because it displays readings in fast and accurate manner. The problem associated with analogue electric circuit can impair effective teaching and learning of current electricity.

The problem in the use of analogue instrument is an unfortunate situation for modern technology is gearing towards the use of digital systems. Thus, there is need for assessment on the efficacy of locally-made digital instructional material on physics students' achievement on current electricity.

Purpose of the Study

The general purpose of this study is assessment on efficacy of locally-made digital instructional material on achievement of physics students on current electricity. Specifically, this study was embarked upon to:

1. Find out the effect of locally-made digital instructional material and standard analogue instructional material on the

mean achievement score of physics students on current electricity.

2. Find out the influence of gender on the mean achievement score of physics students on current electricity.

Research Questions

To guide the study, the following research questions were formulated:

1. What is the effect of the locally-made digital instructional material and standard analogue instructional material on the mean achievement score of physics students on current electricity?
2. What is the influence of gender on the mean achievement score of physics students on current electricity?

Hypotheses

To undertake the study, the following hypotheses were formulated and tested at 0.05 level of significant ($P<0.05$):

1. There is no significant difference in the mean achievement scores of physics students taught current electricity using locally-made digital instructional material and those taught current electricity using standard analogue instructional material.
2. There is no significant effect of gender on the mean achievement score of physics students on current electricity.

Method

A quasi-experimental research design was used for the study. In the quasi-experiment, intact classes were randomly assigned to experimental and control groups. The experimental group and the

control group were taught with locally-made digital instructional material and standard analogue instructional material respectively. The two groups were subjected to pre-test and post-test for collection of data needed for assessment on the efficacy of locally-made digital instructional material on physics students' achievement on current electricity. The experiment involved two independent variables (instructional material type and gender) and one dependent variable (achievement).

The study was carried out in Anambra State of Nigeria which has six educational zones. Population of the study comprised of all senior secondary school class one (SS1) physics students in Anambra State government owned schools. The sample for this study consisted of two hundred and sixty four (264) SS1 students from three (3) schools each drawn from a different education zone. A purposive sampling technique was used. Two intact classes were used in each school so as to have experimental and control groups.

The instrument used for data collection was Achievement Test on Current Electricity (ATOCE) developed by the researchers. The ATOCE was a 40-item 4-option multiple choice objective test based on SS1 physics curriculum on current electricity. Table of specification or test blueprint was used in preparing the ATOCE which was based on three levels of cognitive domain of Bloom's taxonomy of education.

Face validation was done on ATOCE by two (2) experts in educational measurement and evaluation, and three (3) experts in science (physics) education. The content validity of the instrument was carried out using a table of specification. For determination of the internal consistency

of the ATOCE item, Kuder-Richardson Formula 20 (K-R-20) was used to calculate the Reliability Co-efficient of the instrument. That was done using 39 SS1 physics students of a school in an education zone in Anambra State different from the zones used for the quasi-experiment but share the same characteristics with the students under investigation. The value of the reliability co-efficient obtained was 0.87 which showed that the ATOCE was reliable.

For the study, the researchers discussed with and trained three (3) regular physics teachers working in the sampled schools. Prior to experimental treatment, pre-test on achievement was carried out on the control and experimental groups using the ATOCE. Post-test using the ATOCE was carried out immediately after the experiment that lasted for four weeks during which the subjects were assigned to two groups (locally-made digital instructional material group and standard analogue instructional material group). The data obtained from the experiment were analyzed to find the efficacy of the digital instructional material on the physics students' achievement on current electricity.

Mean and standard deviation were used in answering the research questions. The hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA).

Results

The data collected in the study were analysed and presented in tables based on the two research questions and two hypotheses that guided the study.

Research Question one: What is the effect of the locally-made digital instructional material and standard analogue instructional material on the mean achievement score of physics students on current electricity?

The results in table 1 shows that the mean achievement score of 131 students taught with standard analogue instructional material increased from 10.36 with standard deviation of 3.26 to 14.52 with standard deviation of 3.28 in the pre-test and post-test respectively; thus a mean gain of 4.16 was obtained., The mean achievement score of the 133 students taught with locally-made digital instructional material increased from 10.29 with standard deviation of 3.09 to 19.40 with standard deviation of 2.43 in the pre-test and post-test respectively; resulting to a mean gain of 9.11. The mean gain difference obtained from the two mean gains was 4.95.

Research Question two: What is the influence of gender on the mean achievement scores of physics students in Ohm's law?
The results in table 2 shows that the mean achievement score of 129 male students used in the study increased from 10.29 with standard deviation of 3.02 to 16.85 with standard deviation of 3.48 in the pre-test and post-test respectively, which resulted to mean gain of 6.56. For the 135 female students used in the study, the mean achievement scores increased from 10.36 with standard deviation of 3.32 to 17.12 with standard deviation of 4.03 in the pre-test and post-test respectively, which resulted to mean gain of 6.76. The values of the two mean gains indicated that the mean gain difference was 0.20, which indicated that there is little gap in the mean gain of male and female students.

Hypothesis one: There is no significant difference in the mean achievement scores of physics students taught current electricity using locally-made digital instructional material and those taught current electricity using standard analogue instructional material.

Table 3 shows that type of instructional material was a significant factor on students' achievement on current electricity (F = 288.504, P = 0.000). This is because the F value of 288.504 in respect of instructional material group is shown to be significant at 0.000 level, indicating that it is significant at 0.05 level. Since the probability value of 0.000 is less than the level of significance set at 0.05, the null hypothesis was rejected. So, there was significant difference in the mean achievement scores of physics students taught current electricity using locally-made digital instructional material and those taught current electricity using standard analogue instructional material.

Hypothesis two: There is no significant effect of gender on the mean achievement score of physics students on current electricity.

Table 3 shows that gender was not a significant factor on physics students' achievement on current electricity (F = 0.556, P = 0.456). The reason is that F value of 0.556 in respect of gender is shown to be significant at 0.456 level, and so was not significant at 0.05 level of significance. Since the probability value of 0.456 is more than the level of significance set at 0.05, the null hypothesis was accepted. Therefore, there was no significant effect of gender on the mean achievement scores of physics students on current electricity.

DISCUSSION

Table 1 shows that locally-made digital instructional material and standard analogue instructional material has a positive effect on the mean achievement score of physics students on current electricity. This is because the use of both instructional materials resulted to an increase in mean achievement score. However, the locally-made digital instructional material has more effect on the mean achievement score of the physic students than the standard analogue instructional material. Table 3 further shows that there was a significant difference ($F = 288.504$, $P = 0.000$) in the mean achievement scores of physics students taught current electricity using locally-made digital instructional material and those taught current electricity using standard analogue instructional material. The finding of this study is consistent with the reports of Achor, Taangahar & Musa (2011) and Mboto, Ndem & Stephen (2011) that use of improvised (locally-made) instructional material helps physics students obtain high achievement scores compared with the achievement scores obtained using standard instructional material. The higher achievement scores by physics students taught with the locally-made digital electric device could be attributed to the ease in display of numerical values which probably captured the interest of the physics students, thereby helping them concentrate in their learning of current electricity.

The result in table 2 showed that female physics student had a higher mean achievement score than their male counterparts; but the difference in the mean achievement score is not much. Further analysis using Analysis of Covariance (ANCOVA) in table 3 showed that there was no significant difference in the mean achievement score of male and female physics students in current electricity. That showed that the

higher mean achievement score accrued to female students might be due to chance factor. The result obtained from this study is in agreement with the findings of Orabi (2007) and Iwende (2007) that gender has no significant effect on achievement in science. Oladejo, Olosunde, Ojebisi & Isola (2011) also found out that there was no significant effect of gender on students' achievement in physics; although, female physics students did better than males. The finding of this study does not agree with the observation by Ezirim (2006) and Okwo & Otubar (2007) that gender has significant influence on science achievement. The result of this study indicates that the locally-made digital electric device is gender-friendly in fostering physics students' achievement on current electricity.

CONCLUSION

Assessment on the efficacy of the locally-made digital instructional material in terms of its effect on achievement showed that the instructional material has potential in enhancing learning. This is so because the mean achievement score in the post-test of physics students taught with the locally-made digital instructional material was higher than those of physics students taught with standard analogue instructional material.

It was found that the locally-made digital instructional material did not discriminate between male and female physics students in terms of their mean achievement scores. Therefore, the locally-made digital instructional material is a gender-friendly device, and so it can be used in teaching of current electricity to both male and female physics students.

RECOMMENDATIONS

The following recommendations were made based on the findings of the study:

1. Stakeholders in physics education should ensure that training is given to physics teachers on the production of locally-made digital instructional material.
2. The use of locally-made digital instructional material in the teaching and learning of current electricity should be well embraced by physics teachers and students.
3. Government and educational administrators should provide funds and incentives that will help in the production and use of locally-made digital instructional material in senior secondary school physics.

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Tables

Table 1: Mean achievement scores and standard deviation of physics students

Instructional material type	No of physics students	Pre-test		Post-test		Mean gain	Mean gain difference
		$\bar{X}$	SD	$\bar{X}$	SD		
Standard analogue	131	10.36	3.26	14.52	3.28	4.16	4.95
Locally-made digital	133	10.29	3.09	19.40	2.43	9.11	

Table 2: Mean achievement scores and standard deviation of physics students with reference to gender

Gender	N	Pre-test		Post-test		Mean gain	Mean gain difference
		$\bar{X}$	SD	$\bar{X}$	SD		
Male	129	10.29	3.02	16.85	3.48	6.56	0.20
Female	135	10.36	3.32	17.12	4.03	6.76	

Table 3: Analysis of covariance (ANCOVA) of physics students' mean achievement score based on instructional material group and gender

Source	Type III sum of squares	df	Mean square	F	Sig.	Decision
Corrected model	2238.215[a]	3	559.554	109.292	0.000	
Intercept	2891.929	1	2891.929	564.853	0.000	
Pretest	778.961	1	778.961	152.147	0.000	
Group	1477.078	1	1477.078	288.504	0.000	Significant
Gender	2.849	1	2.849	0.556	0.456	Not significant
Error	1228.749	260	5.120			
Total	66091.000	264				
Corrected Total	3466.963	263				

a. R squared = 0.646 (Adjusted R squared = 0.640)

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