

## Evaluation on Effect of Type of Electric Circuit on Achievement of Physics Students on Ohm's Law

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### Abstract

The paper evaluated the effect of analogue and digital electric circuits on achievement of physics students on Ohm's law. A research question and a hypothesis guided the study. A quasi-experimental of the pre-test post-test non-randomized group design involving intact classes was used for the study. Purposive sampling done gave a sample size of 246 physics students drawn from a population of 6,887 SS1 physics students in Anambra State of Nigeria. Two groups of physics students were taught Ohm's law using locally-made digital electric circuit and standard analogue electric circuit respectively. The instrument used for data collection was Achievement Test on Ohm's law (ATOL) which is an objective test with reliability co-efficient of 0.89 using Kuder-Richardson formula. Mean and standard deviation were used in answering the research question. ANCOVA was used in testing the hypothesis at 0.05 level of significant. Result obtained showed that physics students taught Ohm's law with locally-made digital electric circuit has higher mean achievement score than those taught with standard analogue electric circuit. Hypothesis tested ( $F = 288.504$ ,  $P = 0.000$ ) showed that there was a significant difference in the mean achievement scores of the two groups of physics students.

**Keywords:** *Electric circuit, Ohm's law, Achievement, Physics students*

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### **Background to the Study**

Science contributes a lot to national development. Ezema and Ali (2011), acknowledged that one of the factors needed for development in Nigeria is adequate exposure and utilization of science and technology in the nation. Due to its importance, teaching and learning of science is part of the activities in secondary school. Among the science subjects that exist in secondary school is physics. Physics is a science that deals with the study of properties of matter and energy, and their relationship. Physics is required for the growth and development of human society because the technological products utilized for the well being of man have bearing with physics. Mbanisi (2010) pointed out that physics is a basic science and development in the world is anchored on physics.

Despite the importance of physics in technological development, some stakeholders in physics education observed that students are not well taught the science subject (Isola, 2011; Achor, Taangahar and Musa, 2011; Falomuwa, Nwosu, Nkamuo and Adinu, 2013). The West Africa Examination Council (WAEC) Chief Examiner Reports from 2014 - 2018 show that great number of secondary school physics students do not perform well in physics in external examination ([waeconline.org.ng/e-learning/physics/physmain.html](http://waeconline.org.ng/e-learning/physics/physmain.html)).

Among the major branches of physics which secondary school students are taught and examined is current electricity. Current electricity, as a branch of physics, is concerned with properties and effects of electrical charges in motion (Nwosu, Odigwe and Nwoye, 2015). Current electricity appears to be prominent and of great demand in this modern era as can be seen in the existence of power supply, telecommunication, computer, and information technology (Nwosu, 2019).

A prominent and fundamental topic being taught and learnt in current electricity is Ohm's law. Ohm's law gives a direct proportional relationship between potential difference (ie voltage) across a conductor and current flowing through the conductor. In verification of Ohm's law, a graph of the potential difference against the current will ideally be a straight line passing through the origin. The slope of the straight line graph gives the resistance value of the conductor. Due to experimental error, the graph obtained during an experiment for verification of Ohm's law may indicate erroneous deviation from the ideal one. The knowledge and application of Ohm's law is essential for effective understanding of topics in current electricity. Nwosu (2019), pointed out that Ohm's law is relevant in electrical science and technology as can be seen in: determination of unknown resistance of a conductor, determination of equivalent resistance of resistors in series or parallel in an electrical circuit, derivation of formula for electrical energy, determination of shunt and multiplier value for conversion of basic meter to ammeter and voltmeter respectively, and determination of fuse rating in electrical installation.

To achieve effective teaching and learning of Ohm's law, as expected in other topics in physics, instructional materials are required. Instructional materials are those devices or resources that enable a teacher effectively impact knowledge, skills and attitude to learners within an instructional situation. Instructional materials are resources which are information carriers

designed to accomplish curriculum objectives in a teaching-learning situation (Okoro and Ali-Okoro, 2016). Provision of instructional material for the teaching and learning of Ohm's law demands formation of electric circuit.

Electric circuit is a connection of electrical components to form a path for movement of electric charge. In the formation of electric circuit, as an instructional material for teaching and learning of Ohm's law, measuring instruments which are ammeter and voltmeter for measurement of current and potential difference respectively are required. The measuring instruments in the circuit can be analogue or digital in nature, giving rise to analogue electric circuit and digital electric circuit respectively. Usually, analogue instrument indicates its readings using pointer, while digital instrument displays its readings in numerical form. As acknowledged by Nwosu (2019), analogue instrument is associated with the problems of not observing readings with ease and manifestation of parallax error; while digital instrument usually displays numerical readings in fast and accurate manner.

However, analogue ammeters and voltmeters are usually used in senior secondary schools in Nigeria; the digital instruments are scarce and so they are not commonly used in the schools (Nwosu, Odigwe and Nwoye, 2015). The lack in the use of digital instruments is also witnessed in secondary schools in Anambra State of Nigeria. The use of locally-made digital electric circuit can fill the worrisome gap in the scarcity and ineffective utilization of digital instructional material in teaching and learning of Ohm's law in the State. The use of electric circuit as an instructional material can be associated with achievement. Adeyemi and 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. Achievement is an important educational variable that expresses the educational outcomes, in terms of success or failure, of a teaching and learning process. It can be regarded as the accomplishment of academic goals, or the extent to which a student or a teacher has achieved the stated educational objectives.

Associating instructional material with achievement can be anchored on theory of cognitive development propounded by Jean Piaget in 1985. In the theory, Piaget stated that true learning is not something handed down by the teacher, but the basis of all learning is the child's own activity as the child interacts with the physical environment. When the child interacts with the physical environment, there is assimilation of new objects by making accommodation that build new cognitive structure. The study gives insight to Piaget's theory of cognitive development on the basis that the instructional material acts as a physical object which physics students can interact with to enhance their cognitive understanding of Ohm's law.

It can be deduced that an instructional material can have effect on physics students' academic achievement. Therefore, the study focuses on evaluation on effect of type of electric circuit on achievement of physics students on Ohm's law.

### **Statement of the Problem**

Achievement in physics has a bearing with use of instructional material. Instructional material for teaching Ohm's law in physics is an electric circuit. An electric circuit serving as an

instructional material for teaching Ohm's law may be of analogue or digital type. Digital electric circuit is not used in teaching Ohm's law in Senior Secondary Schools in Anambra State of Nigeria because it is scarce. Only standard analogue electric circuit is usually used in the state. But locally-made digital electric circuit can serve as a digital instructional material in teaching and learning of Ohm's law. The problem of the study is evaluation on effect of type of electric circuit on achievement of physics students on Ohm's law.

### **Purpose of the Study**

The purpose of the study is to evaluate the effect of standard analogue electric circuit and locally-made digital electric circuit on the mean achievement score of physics students on Ohm's law.

### **Research Question**

What is the effect of standard analogue electric circuit and locally-made digital electric circuit on the mean achievement score of physics students on Ohm's law?

### **Hypothesis**

There is no significant difference in the mean achievement scores of physics students taught Ohm's law using standard analogue electric circuit and those taught Ohm's law using locally-made digital electric circuit.

### **Method**

A quasi-experimental of the pre-test post-test non-randomized group design was used for the study. The study was carried out in Anambra State of Nigeria which has six education zones. Population of the study comprised of 6,887 senior secondary school class one (SS1) physics students in Anambra State government-owned schools. Three education zones were selected for the quasi-experiment. A purposive sampling technique was used in selection of two co-education schools from each of the 3 zones used for the study. The sample size for the study was two hundred and forty six (246) SS1 physics students obtained by choosing an intact class from each of the six sampled schools. The researchers discussed with and trained six regular physics teachers of the intact classes for their teaching of Ohm's law to the physics students. The quasi-experiment consisted of analogue and digital groups. Three intact classes of different education zones formed the analogue group taught with standard analogue electric circuit; the other three intact classes of different education zones formed the digital group taught with locally-made digital electric circuit. Pre-test and post-test on achievement of the analogue and digital groups were done for collection of data. Pre-test on achievement was carried out prior to treatment. Post-test was carried out immediately after the treatment that lasted for two weeks.

The instrument used for data collection in the pre-test and post-test was Achievement Test on Ohm's Law (ATOL) developed by the researchers. The ATOL, which was prepared based on three levels of cognitive domain of Bloom's taxonomy of education, was a 30-item 4-option multiple choice objective test anchored on SS1 physics syllabus on Ohm's Law. Face validation was done on ATOL by two experts in educational measurement and evaluation,

and three (3) experts in physics education. The content validity of the instrument was carried out using a table of specification. Kuder-Richardson Formula 20 (K-R-20) was used to calculate the Reliability Co-efficient of the instrument. That was done using 36 SS1 physics students of a co-education 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 0.89 which showed that the ATOL was reliable.

The data obtained from the ATOL were analyzed for evaluation on effect of type of electric circuit on achievement of physics students on Ohm's law. Mean and standard deviation were used in answering the research question. The hypothesis was 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 question and hypothesis that guided the study.

**Research Question:** What is the effect of standard analogue electric circuit and locally-made digital electric circuit on the mean achievement score of physics students on Ohm's law?

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

Electric circuit group	N	Pre-test		Post-test		Mean gain	Mean gain difference
		X	SD	X	SD		
Analogue	122	10.36	3.26	14.52	3.28	4.16	
Digital	124	10.29	3.09	19.40	2.43	9.11	4.95

The results in table 1 shows that the mean achievement score of 122 students taught with standard analogue electric circuit 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 124 students taught with locally-made digital electric circuit 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. Hypothesis: There is no significant difference in the mean achievement scores of physics students taught Ohm's law using standard analogue electric circuit and those taught Ohm's law using locally-made digital electric circuit.

**Table 2:** Analysis of covariance (ANCOVA) of physics students' mean achievement score based on electric circuit group

Source	Type III sum of squares	Df	Mean square	F	Sig.	Decision
Corrected model	2238.215 <sup>a</sup>	2	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
Error	1228.749	243	5.120			
Total	66091.000	246				
Corrected Total	3466.963	245				

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

Table 2 shows that type of electric circuit was a significant factor on students' achievement on Ohm's law ( $F = 288.504$ ,  $P = 0.000$ ). This is because the F value of 288.504 in respect of electric circuit 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 Ohm's law using standard analogue electric circuit and those taught Ohm's law using locally-made digital electric circuit.

### Discussion

Table 1 shows that standard analogue electric circuit and locally-made digital electric circuit has a positive effect on the mean achievement score of physics students on Ohm's law. This is because the use of both electric circuits resulted to an increase in mean achievement score. However, the locally-made digital electric circuit has more effect on the mean achievement score of the physics students than the standard analogue electric circuit. Table 2 further shows that there was a significant difference in the mean achievement scores of physics students taught Ohm's law using standard analogue electric circuit and those taught Ohm's law using locally-made digital electric circuit. The finding of this study is consistent with the reports of Achor, Taangahar and Musa (2011), and Mbotu, Ndem and 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 circuit could be that the ease in display of numerical values by the electric circuit probably arouse the interest and enhance attention of the physics students in the learning of Ohm's law.

### Conclusion

Evaluation on the effect of type of electric circuit on achievement of physics students on Ohm's law showed that both the analogue and digital type has the potential, as instructional

material, in enhancing learning. The assertion is on the basis that the use of both electric circuits resulted to an increase in mean achievement score as seen from the pre-test and post-test made.

However, the mean gain in achievement of physics student taught Ohm's law with locally-made digital electric circuit was significantly higher than that of those taught with standard analogue electric circuit. Thus, the use of locally-made digital electric circuit has greater effect on achievement of physics students on Ohm's law than standard analogue electric circuit.

### **Recommendations**

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

1. Physics teachers and students should have high interest and positive attitude towards the use of locally-made digital electric circuit in the teaching and learning of Ohm's law.
2. Government and educational administrators should provide funds and incentives that will encourage the use of electric circuit, especially locally-made digital type, as instructional material in the teaching-learning situation.
3. Education authorities concerned with physics education should ensure that training is given to physics teachers on the technology of building locally-made digital electric circuit.

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