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Impact of Improvised Instructional Materials on Secondary School Students' Academic Achievement In Optical Concepts

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Abstract
The adoption of talk-chalk instructional method in Nigerian Science classrooms is due to the lack of instructional materials for science teaching. The method has been adjudged to be ineffective in making learners acquire functional science knowledge and skills. This problem is more prominent in Physics related concepts, particularly optics. Scholars advocated for improvisation to make for the unavailable instructional materials. In this study, the effect of some improvised optical materials (glass block, triangular prism and biconvex lens) on students' academic achievement in optical concepts was tested. The study employed a pre-test-posttest quasi experimental-control groups design. 58 students from 4 senior secondary schools (2 males and 2 female schools) under the Bichi Zonal Education, Kano state Nigeria, were randomly selected and used for the study. The experimental group (N=30) was exposed to the improvised materials while the control group (N = 28) was exposed to the standard material. The results revealed a no significant difference in the performance of the experimental and control groups (t (56) = 0.584; p > 0.05). Similarly, the results showed that the improvised materials were gender friendly, as it shows no significant difference among the sexes (t (28) = 1.147; p > 0.05). The study recommends among others that government should employ plastic industries to mold and produce cheap plastic optical instruments for effective classroom instructions.

Keywords: *improvised materials, standard materials, academic performance, optical concepts.*

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I. Introduction

Science teaching in under developed and developing nations around the world generally and especially in Nigeria is not producing the desired results (Badmus, & Omosewo, 2018). This is evidenced in the various comments passed by governments and stake holders on the students' academic performance in public examinations (Badmus, & Omosewo, 2018; Omorogbe & Ewansiha, 2013). The students' failure has been attributed to the typical pedagogical pattern employed by teachers which is mainly the talk-chalk approach (Badmus, & Omosewo, 2018; Omorogbe & Ewansiha, 2013). The simple reason alluded by classroom teachers for adopting the teaching approach even in situations where practicals are required is the lack of instructional materials to teach science (Ayua, 2012; Akinkugbe, 2007). With this, students hardly acquire the desired scientific skills and are forced into learning by rote!

Female students are the worst hit by this trend of underperformance due to gender stereotyping (The Guardian, 2019; Akanbi, 2004, Ogunsola-Bandele, 2001). This is because, in most Nigerian societies, science is seen as a male activity and 'a no go area' to female (The Guardian, 2019; Akanbi, 2004). This abnormal sex roles influence female participation in science. Arop, Umanah and Effiong (2015) concurring with Nwaigbe (2001) further stressed that one of the major factors that scare female from science is the lack of use of instructional materials in teaching. Thus Arop, Umanah and Effiong (2015) concluded that allowing girls to participate in activity based learning encourages their performance.

The above and several reasons made science educators to advocate for instructional procedures that will give students concrete experiences through the use of effective instructional materials (Arop, Umanah and Effiong, 2015). They suggested that in a situation where a given instructional material is lacking, it should not result to 'no practicals'. The teacher should improvise. Akinkugbe (2007) stressed that a scientist or science teacher who waits for the most perfect set of equipment to conduct his duties will never succeed. This statement made Peni and Abubakar (2005) to improvise a substitute glass block while Peni and Bunkure (2010) developed a substitute lens for instructions in optics. They standardized and established the functionality of the materials.

They however could not establish the effectiveness of the improvised materials on students' academic achievement and skill in optics. This study therefore finds out the efficacy of the improvised materials on students' performance in optical concepts. The study answers the following research questions.

Research questions

i. What is the impact of improvised optical instruments on students' academic performance in optical concepts?

ii. What is the difference in the academic performance of male and female students taught optical concepts through the use of improvised optical materials?

To answer these research questions, the following research hypotheses are stated.

Research Hypothesis

Ho_1 There is no significant difference in the academic performance of students taught optical concepts using Improvised Optical instruments compared to those taught with the standard optical instruments.

Ho_2 There is no significant difference in the academic performance of male and female students taught optical concepts using Improvised Optical instruments;

II. Methodology

The study employed a pretest-posttest quasi experimental-control groups design. 58 students from four senior secondary schools (two males and two females) under the Bichi Zonal Education Kano state, Nigeria, were randomly selected and used for the study. It is important to note that there are no coeducational schools in the zones thus the selection of the four schools to cover the gender variable. The selected schools were made into two groups each containing a male and a female school. The students were pretested using Optics Achievement Test (OpAT) to ensure they are comparable abilities before the treatment. After, they were randomly assigned into experimental and control groups. The experimental group was taught using the improvised optical instruments while the control groups were taught using the standard optical instruments. Both treatments were given for three weeks. At the end of the three weeks, the groups were post tested using the OpAT.

Instrumentation

The OpAT was developed by the researchers for the purpose of this study. It comprises of 10 objective test items and two practical test items that are expected to make students display skills acquired after instructions using the optical instruments. The instrument was face validated by Physics Educators and experts in Measurement and Evaluation from the Federal College of Education (Technical) Bichi, Kano State, Nigeria. The validation was done to correct ambiguous questions, assess the appropriateness and meaningfulness of the items with reference to the purpose of the study. The reliability coefficient of the instrument was statistically assessed through a test retest using the Pearson's correlation on SPSS 23 to be 0.63.

The improvised materials

The improvised optical instrument used for the treatment of the experimental group include:

1. The rectangular glass slab/block;
2. The triangular prism; and,
3. The biconvex lens.

The instruments were developed by making plastic industries to produce the hollow shapes and provide points were water could be added using injection syringes. The water provides the optical activity.

III. Results

The data obtained were analyzed using the independent sample t test to test the null hypothesis earlier stated. The results are presented in tables 1 and 2.

Hypothesis 1 sought for the difference in the academic performance of students in the experimental and control groups. The data were subjected to independent sample t-test.

Table 1: t-test comparison of the results of experimental and control groups.

Groups	N	Mean	SD	df	t	p value
Experimental	30	18.06	6.79			
				56	0.584	0.561*
Control	28	17.07	6.12			

*Not significant

Table 2: t-test comparison of posttest male and female students scores in experimental group.

Groups	N	Mean	SD	df	T	p value
Male	18	19.22	6.27			
				28	1.147	0.261*****
Female	12	16.33	7.45			

*Not significant

From table 1, the t (58) = 0.584; p>0.05 reveals that there is no significant difference in the mean scores of the experimental group (taught with the improvised instructional materials) and the control group taught with the standard materials. Thus the null hypothesis 1 is retained. This shows that students taught optical concepts using improvised materials did not differ significantly from those taught using the standard.

From table 2, the t (30) = 1.147; p>0.05) reveals that there is no significant difference in the mean scores of male and female students in the experimental group (taught with the improvised optical instructional materials). Thus the null hypothesis 2 is also retained. This shows that male and female students taught optical concepts using improvised materials did not differ significantly.

IV. Discussion

This study investigated the effects of improvised optical instructional materials (rectangular Glass slab, Triangular glass prism and biconvex lens) on students' academic performance in optical concepts. The results of the data analysis reported in table 1, revealed that improvised optical instructional materials are as effective as the standard materials in giving the students the desired skills and enhancing their academic performance. This finding agrees with those of Onasanya and Omosewo (2011) & Mari and Peni (2010), who reported that improvised instructional materials have the potentials to be effective in enhancing students learning.

Another significant finding of this study is the confirmation that female students performed equally well with their male counterparts (table 2). This shows that improvised optical instructional materials are gender friendly. This finding agrees with that of Arop, Umanah and Effiong (2015) who confirmed that instructional materials are important at enhancing female participation in science. Although there was no significant difference in the performance of students in the experimental group based on their gender (table 2), the mean of the male students (19.22) is relatively higher than that of the female. This could be due to the skepticism of the female students due to gender stereotyping of science by the society (Kerkhoven, Russo, Land-Zandstra, Saxena, Rodenburg (2016); Akanbi, 2004). Similarly, Hernandez, and Cudiamat (2017 stressed that instructional processes that are gender friendly and which uses good instructional materials enhance girls' participation and encourage their performance.

V. Conclusion

There is an ardent need for the provision of instructional materials due its dearth in Nigerian schools. However, due to inadequacy of funds, the provision of instructional materials for Science teaching becomes difficult. Several researches canvassed for improvisation of teaching resources to make for the unavailable and nonfunctioning ones. This study tested the efficacy of improvised materials for instructions in optics. The findings revealed that improvised optical instruments are effective in giving the students the desired skills in the students. Based on the above, the following recommendations are put forward.

VI. Recommendation

The following recommendations are put forward for the effective development, utilization and standardization of the materials.

1. The optical instruments so improvised were made from simple plastic materials. Government should employ plastic industries to mold the shapes to enable schools gain cheap instructional materials;
2. Education resource centers at all levels of governance should champion the campaign for the use of improvised materials in classrooms. Regular workshops and education fairs should be organized to enhance the showcasing of locally made/improvised materials for awareness and effective utilization.
3. Teachers should develop more gender friendly measures at enhancing the girl child's participation and performance in science subjects.

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