

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$a^2 + b^2 = c^2$$

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EFFECTS OF SCAFFOLDING TECHNIQUE ON SECONDARY SCHOOL PHYSICS STUDENTS' ACADEMIC ACHIEVEMENT IN MALUMFASHI LOCAL GOVERNMENT, KATSINA STATE, NIGERIA

By

Yahaya Isa Bunkure & Muhammed Saifullahi

Abstract

This study investigated the Effects of Scaffolding Technique on Secondary School Physics Students' Academic Achievement in Malumfashi Local Government, Katsina State, Nigeria. Two research question and two hypotheses were raised and tested at 0.05 levels of significance. The study adopted pre-test post-test quasi-experimental design. The population of the study consisted of one thousand and two (1,002) SSII Physics students from which a total of one hundred and twenty three (123) were drawn from two intact classes participated in the study. The schools were randomly assigned to experimental and control group. A forty (40) items multiple-choice "Physics Achievement Test" (PAT) was used for data collection. The instrument was validated by specialist in physics education and psychology and its reliability was established using Spearman Brown's formula and yielded index of 0.85. The collected data was analyzed using SPSS Version 23 to answer the research questions using descriptive statistics (mean and standard deviation) and testing the null hypotheses using Z-test. The findings of the study revealed that students taught using scaffolding technique performed higher than students taught using Lecture method, there is no significant difference in the mean achievement scores between male and female physics students taught using scaffolding techniques. On the basis of these findings, the study recommended that, physics teachers should be encouraged to use scaffolding technique in teaching the subject and other science subjects at secondary school because it improves student' academic achievement for both male and female students.

Keywords: *Scaffolding Technique, Academic Achievement and Physics Students*

Introduction

Science education is the underlying basis for national progress by protecting human communities from ignorance, illiteracy, diseases and poverty (Bunkure, 2019). It is a field of specialization concerning with two basic aims, which are the production of scientifically interactive society and technological manpower. Aderonke and Awobodu (2013) stressed that the development of any nation depends on its innovation due to science and technology as a result emphases are laid on science learning. The science related disciplines that will enable learner to have true knowledge of science and be able to use it in solving problem are Physics, Chemistry, Biology and Mathematics.

Physics is a branch of science that deals with the study of matter in relation to energy, it is a school subject that plays an important role in life, it is important because it is the basic science subject for the development of many study fields such as mechanical engineering, electronics, nuclear sciences, and digital information system. It plays a major role in the area of health,

economic development, energy and environment; the x-rays, radioisotope, nuclear energy, microscope, and synchrotron radiator among other advances in medicine depend on physics (Kola & Taiwo, 2013). Teaching and Learning of physics is bedeviled with problems such as poor instructional techniques and inadequate instructional materials among others which result into negative outcome of the academic achievement of students (Mekonnen, 2014). These problems make students to find it difficult to understand and relate Physics to the real world. To teach Physics effectively, teachers needs to employ technique including students-oriented methods that will enable students to learn more, retain more and apply what is learned by participating in an important activities such as cooperative learning and apprenticeship and scaffolding technique may be good in this aspect.

Scaffolding technique is an instructional strategy that drives its source from Lev Vygotsky socio-cultural theory and the notion of zone of proximal development. In education, scaffolding technique refers to various instructional strategies that help teacher move his students forward to a stronger understanding of what they are learning and to a greater independence in their own learning process and development (Bansal 2017). Scaffolding is an instructional technique whereby teacher model the desired learning task, then gradually shift responsibility to the students (Ahmad, 2016). This teaching strategy is described as the strategy that focuses on raising student's ability one step at a time and removing the support as students' progress. Like scaffold that support construction workers in building, educational scaffold can be added, modified and removed according to the need of the group that an educator is working with (Akani 2015). In scaffolding technique, the learning activities should include the need of different learners. Therefore teacher must identify and determine the following in order to carry out scaffolding strategy: (1) what a student can accomplish independently (2) what a student can accomplish with guidance (determination of students zone of proximal development). The teacher then should provide the instructions that are just enough to support the learners in the task beyond the reach without teachers support (Olubunmi & Ese, 2018). If the potentials of scaffolding technique are fully utilized, the academic achievement of students of subjects like Physics and other science subject could improve.

Academic achievement is a measure of what a person has accomplished after exposure to an educational programme. Jimoh (2010) opined that students' academic achievement corresponds to their performance in school subjects as symbolized by a score on achievement test. It is commonly measured through examination or continuous assessments. Some studies such as Nwali, (2014), Omiko & Ndem, (2015) revealed that poor students' academic achievement in Physics is due to poor teaching method, inadequate practical apparatus and lack of well equipped science and computer laboratory. Fatokun, Egya and Uzoechi (2016) found that the students' achievement depend on several factors among which are learning environment and instructional methods. Teachers with good teaching method mobilized students to work at higher intellectual level, gain sound academic achievement for better outcome. In this study, the researcher prepared physics learning activities based on scaffolding technique and determines its strength in enhancing students' academic achievements taking gender into consideration.

In a typical classroom that is co-educational in nature, where male and female interact and receive lessons together, the existent of male and female is called gender. Gender is any physical and behavioral difference between male and female which are socially, culturally based (Eze).

2013). Researches on gender and academic achievement like that of Abumchukwu and Okeke (2020) and Ayu, Jufriadi and Sujito (2018), observed that boys achieved better than girls, but study by Dahiru (2013) pointed out that girls achieved better than boys. Okoyefi (2014) reported that female students performed better in physics than male counterpart, while Omwirhim (2015) revealed that gender influences students' understanding of science subject in favor of male. Consequently, therefore, this study is set to investigate the effects of scaffolding technique on secondary school physics students' academic achievement in Malumfashi Local Government, Katsina State, Nigeria.

Statement of the Problem

The performance of students in science (Physics) has been quiet disappointing over the years. The West African Examination Council (WAEC, 2015-2019) has persistently shows that students' academic achievement in physics is poor. According to chief examiner report for the year 2015-2019, the repeatedly poor performance of students in Physics was due to poor understanding of how to explain, draw a diagram and solve problems involving the concept of mechanics, heat, electricity and optics (WAEC, 2015-2019). This consistent poor performance of students in physics at Senior Secondary School Certificate Examination leaves one in doubt about the effectiveness of teaching methods popularly used by teachers for teaching the subjects. Against this backdrop, the researcher's attention was drawn to investigate the effects of scaffolding techniques on secondary school physics students' academic achievement in Malumfashi Local Government, Katsina State, Nigeria.

Theoretical Framework

Vygotsky's Developmental Theory (1978) is the theoretical stand point upon which this research is based. Vygotsky was interested in the development of higher mental functioning such as voluntary attention, logical reasoning, conceptual thinking, categorical perception and self-regulation of learning. He believes that higher mental functioning is acquired through interacting with other people. According to Vygotsky, social interaction is translated into psychological functioning via psychological tools which direct the mind and change the process of thinking. Symbol, sign, and language are examples of psychological tools and they differ from culture to culture. During the development, an individual's higher mental function is at different level. He stated that students can accomplish more difficult task with the assistance of more capable others, which is more accurate indicator of their developmental level. Based on this he introduced the concept of Zone of Proximal Development (ZPD) and believe that it is a more accurate measure to predict learner's cognitive development (Bansal, 2017).

The implication of Vygotsky theory is that every student is able to learn Physics if appropriate support is provided in their Zone of Proximal Development, this means that, students differ in the amount of assistance they need for learning to take place. Therefore it is importance to know learner's ZPD before selecting task that are in their ZPD.

Objectives of the Study

- The specific objectives of this study are set to:
- i. Determine the effects of scaffolding techniques on secondary schools physics students' academic achievement.
 - ii. Investigate the effects of scaffolding techniques on secondary schools physics students' academic achievement among male and female.

Research Questions

In line with the objectives of the study, the following research questions are raised to guide the study:

- i. What is the difference in the mean achievement score between students taught physics using scaffolding techniques and those taught physics using Lecture method.
- ii. What is the difference in the mean achievement score between male and female students taught physics using scaffolding techniques.

Research Hypotheses

Based on the stated research questions, the following null hypotheses are formulated and tested at 5% level of significance.

H_{01} There is no significant difference in the mean achievement score between students taught physics using scaffolding techniques and those taught physics using Lecture method.

H_{03} There is no significant difference in the mean achievement score between male and female students taught physics using scaffolding techniques.

Methodology

The study adopted a quasi-experimental of pretest posttest non-equivalent group design. This is because quasi experimental design is a type of experimental design that does not provide for full control of extraneous variable, because of lack of random assignment of subject to group (Creswell, 2012). This design is considered appropriate for this study because intact classes were used to avoid interruption of normal lesson. In this design both groups were subjected to pretest and posttest before and after the treatment respectively. This is illustrated in figure 1:

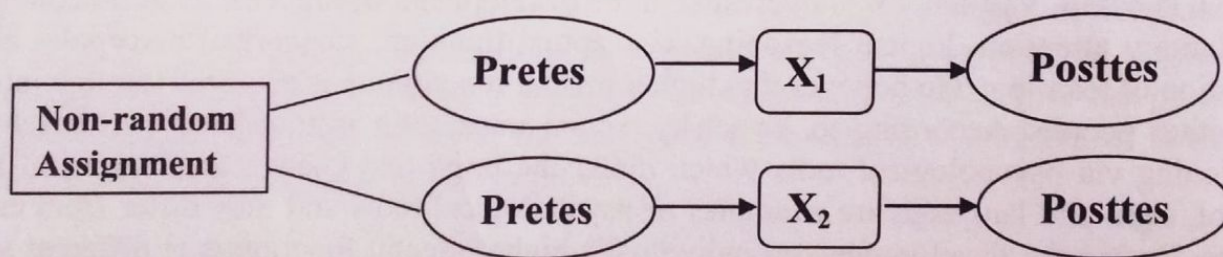


Figure 1: Research Design

Key:

X_1 : treatment of experimental group (using Scaffolding Technique)

X_2 : treatment of control group (using Lecture Method)

The concept taught are mechanic and the sub-topic including Newton's law of motion, linear momentum, impulse, and collision. The choice of the concept was due to the fact that, it was among the area of students difficulties in Physics at secondary school level. Mechanics featured predominantly in the physics curriculum of senior secondary school (Bunkure, 2019). The target population of the study comprises all senior secondary school two (SSII) physics students in all (16) public senior secondary school in Malumfashi Local Government, Katsina State. The population for this study consisted of all senior secondary school two (SSII) physics students in public co-educational school with a total number of one thousand and two (1002) physics students, comprising 595 males and 407 females. The choice of co-educational schools is based on consideration of gender as a variable in the study. Simple random sampling technique was use

to select two public schools from the eight schools in the population. One school was assigned as experimental group while the other serve as control group. The schools were selected using balloting. However, an intact senior secondary school two Physics students class from the two selected schools were used in order to avoid interruption of normal lessons. One hundred and twenty three (123) senior secondary school two (SSII) Physics students were sampled comprising seventy six (76) males and forty seven (47) females and took part in the study.

Physics Achievement Test (PAT) was used as an instrument for data collection in this study. The items of the instrument were adapted from the physics senior secondary school certificate examination (SSCE) past question (WAEC & NECO, 1998-2018). It consisted of forty (40) multiple-choice items with option ranging from A-D from which students are expected to choose the correct responses. The adaption of the items of the instrument was employed in order to simplify the wordings to the level of students. The items of the instrument were scored one mark for each correct answer and were scored zero for each incorrect answer. Marking guide was prepared in order to guide the marking of the students' script. The maximum score is 40 marks while the minimum score is 0 marks. Physics Achievement Test (PAT) was validated by two senior lecturers from Science and Technology Education Departments, Bayero University Kano; One professor from Education Department, Umaru Musa Yaradu'a University, Katsina and one experience physics teacher at secondary school level with 16 years teaching experience. Their corrections were considered in the construction of the final instruments. Two schools apart from those selected for the main study were used for pilot testing of the instrument. The reliability of the Physics Achievement Test (PAT) was established using split-half reliability method; the coefficient was calculated using Spearman Brown's formula and it was found to be 0.858. This shows that there is a high correlation between students academic achievement in the tests.

The researcher visited the sampled schools and seeks for their permission to conduct the study and addresses the principals and physics teachers on the duration and nature of the treatment of the study. At the beginning of the study, experimental and control group were subjected to pretest to determine their entry behavior and their Zone of Proximal Development (ZPD). Experimental group was taught using scaffolding techniques while control group was taught using Lecture method. The students in both groups were taught for six week. Immediately after the instruction, the researcher administered the post-test Physics Achievement Test to both experimental and control group. The script (both pre-test and posttests) were marked by the researcher and the students' scores were recorded. The data obtained from the pre-test and posttest were marked and subjected to data analysis using (SPSS v. 23.0) for both descriptive and inferential statistical tool. Mean and standard deviation were used to answer the research question while the hypotheses were tested at 0.05 significance level using Z-test statistical tool.

Result
Research Question One: What is the difference in the mean achievement score between students taught physics using scaffolding techniques and those taught using Lecture method?

Table 1: Mean and Standard Deviation of Achievement Scores of Physics Students Taught Using Scaffolding Technique and Lecture Method

Group	N	Mean	S.D	MD	Std Error Mean
Experimental	58	27.78	4.28	7.38	0.561
Control	65	20.40	3.58		0.444

Table 1 indicates that, students exposed to scaffolding technique had a mean achievement score of 27.78 and standard deviation of 4.28 while those exposed to Lecture method had a mean achievement score of 20.40 and standard deviation of 3.58. The mean difference between the groups is 7.38 and this result indicates that students taught using scaffolding technique had high mean achievement scores than those taught using Lecture method. The result shows that experimental group exposed to scaffolding technique performed better than control group. However, the responses of students in control group were closely around the mean with S.D of 3.58.

Research Question Two: What is the difference in the mean achievement score between male and female students taught physics using scaffolding techniques?

Table 2: Mean and Standard Deviation of Achievement Scores of Male and Female Physics Students Taught Using Scaffolding Technique

Group	N	Mean	S.D	MD	Std Error Mean
Male	40	27.98	4.56	0.65	0.704
Female	18	27.33	3.93		0.925

Table 2 indicates the mean achievement score of male and female physics students taught using scaffolding technique. The result revealed that male students exposed to scaffolding technique have mean achievement score of 27.98 and standard deviation of 4.56 while female students had a mean achievement score of 27.33 and standard deviation of 3.93. The mean difference between male and female achievement score is 0.65. This indicates that in the experimental group male physics students performed slightly higher than female counterpart though the difference is not significant. However, the scores of female student's responses were closely around the mean than male counterpart.

Hypothesis Testing

H_{01} There is no significant difference in the mean achievement score between students taught physics using scaffolding teaching techniques and those taught physics using Lecture method.

Table 3: Independent Sample Z-test for Posttest Mean Achievement Scores of the Physics Students in Experimental and Control Group

Group	N	Mean	S.D	df	z-value	p-value	Decision
Experimental	58	27.78	4.28	121	10.4	0.000	Significant
Control	65	20.40	3.58				

Table 3 present the result of independent sample z-test analyses for posttest mean achievement scores of the experimental and control groups, the observed p-value is 0.000 and the alpha-value

is 0.05 with $df=121$. Therefore, the observe p-value is less than the alpha-value and thus the null hypothesis is hereby rejected. Therefore, there is significant difference in the mean achievement score between physics students taught using scaffolding teaching techniques and those taught using Lecture method in favor of experimental group ($z\text{-crit}=10.4$, $df=121$, $p=0.000<0.05$).

H₀₂ There is no significant difference in the mean achievement score between male and female students taught physics using scaffolding techniques.

Table 4: Independent Sample z-test for Posttest Mean Achievement Scores of the Male and Female Physics students in Experimental Group

Group	N	Mean	S. D	df	z-value	p-value	Decision
Male	40	27.98	4.56	56	0.525	0.601	Not significant
Female	18	27.33	3.93				

From Table 4, the observed p-value is 0.601 with $df=56$ and the alpha value is 0.05. The observe p-value 0.601 is greater than the alpha value 0.05. The null hypothesis two is hereby retained or accepted. The reason for acceptance of the null hypothesis is because the observe p-value is greater than the alpha value. Therefore, there is no significant difference in the mean achievement score between male and female physics students taught using scaffolding techniques. Hence scaffolding technique is gender friendly teaching strategy.

Discussion of the Result

The finding of this study revealed that there is significant difference in the mean achievement score between physics students taught using scaffolding techniques and those taught using Lecture method in favor of those exposed to scaffolding technique. This means that the use of scaffolding technique in teaching physics concepts enhance students academic achievement in the subject. This finding is in agreement with the findings of Abumchukwu and Okeke (2020), Ayu, Jufriadi and Sujito (2018), Olubunmi and Ese (2018), Bansal (2017), Owenvbiugie and Iyoha (2017), Chukwuagu (2016), Ahmad (2016) and Akani (2015) whom found students learning based on scaffolding technique have higher achievement than students who learned through Lecture method. The reason for this finding could be as a result of nature and process involved in the technique used. In scaffolding lesson students were allowed to learn and participate fully in the lesson; the learning activities includes the need of different learners. The learning was model by teacher followed by students in small group and then by students individually, therefore students were allowed to learn independently and become self-evaluated.

It was also observed in this study that, there is no significant difference in the mean achievement score between male and female physics students taught using scaffolding techniques. The possible reason that could be attributed to the equal performance across the gender in this study includes equal opportunities given to both male and female students to explore and learn at their own zone of proximal development, relating learning activities with the real life situation, allowing students to learn in group and student were allowed to learn independently and become self-evaluated. The result of this study is in accordance with the findings of Abumchukwu and Okeke (2020), Ayu, Jufriadi and Sujito (2018), Owenvbiugie and Iyoha (2017), Ahmad (2016)

and Akani (2015) who reported that no significant difference in the mean achievement score between male and female was found after students received the treatment.

Conclusion

- i. The used of scaffolding technique in teaching physics concept improved students academic achievement on the concept of mechanics in physics.
- ii. The used of scaffolding technique in teaching physics concept help in improving male and female students academic achievement as indicated by non significant difference in the academic achievement of male and female physics students taught using scaffolding technique.

Recommendations

1. The study recommended that, physics teachers should be encouraged to use scaffolding technique in teaching the subject and other science subjects at secondary school because it improves student' academic achievement for both male and female students.
2. To achieve science standard for all students irrespective of gender physics and other science subjects should be taught in such a way that legal understanding and application of the physics and science concepts are put into the daily life activities.

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