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# EFFECTS OF SCAFFOLDING AND COLLABORATIVE INSTRUCTIONAL APPROACHES ON SCIENCE AND TECHNICAL SCHOOL STUDENTS' ACHIEVEMENT IN BASIC ELECTRONICS IN NORTH-CENTRAL NIGERIA

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**ABSTRACT**– This study determined effects of scaffolding and collaborative instructional approaches on science and technical school students' achievement in Basic Electronics in north-central states of Nigeria. The study adopted quasi-experimental research design; specifically the pre-test post-test non-equivalent control group experimental design. Purposive sampling technique was used to sample 105 Senior Secondary two (SS 2) students, comprising of 77 males and 28 females. Students' performance in Basic Electronics was obtained after being taught with scaffolding and collaborative instructional approach. Instrument used was Basic Electronics Cognitive Achievement Test (BECAT). Reliability testing of BECAT was determined using Kuder-Richardson formula 20 (K-R 20) and a reliability coefficient of 0.88 was obtained. Data collected were analyzed using mean and ANCOVA at 0.05 level of significance. Results revealed that scaffolding and collaborative instructional approaches are effective in improving student achievement in Basic Electronics. However, collaborative instructional approach is more effective than scaffolding instructional approach. Also, gender had no significant influence on students' achievement in Basic Electronics when taught using scaffolding and collaborative instructional approaches. It was concluded that collaborative instructional approach is a viable teaching method for improving students' achievement in Basic Electronics. It was recommended that teachers adopt collaborative instructional approach for teaching Basic Electronics.

**Keywords:** Basic Electronics; Scaffolding Instructional Approach; Collaborative Instructional Approach; Cognitive Achievement; Gender.

## 1 INTRODUCTION

Basic Electronics is one of the vocational courses offered at the upper level of the Nigerian secondary school system. It is a branch of science and technology which deals with the study of the flow and control of electrons in electrical circuits and their behaviour and effects in vacuums, gases, and semiconductors. The objectives of the curriculum are to: (i) give understanding of the basic electronic components in addition to circuits (ii) lay good foundation for communication system and control system, (iii) provide foundation for creativity and technological development in electronics, and (iv) stimulate, develop and enhance entrepreneurial skills in electronics; for its products (Nigerian Educational Research and Development Council (NERDC), 2007). For these objectives to be realized, teachers who are the implementers of the curriculum, apart from being versed in the subject matter, the selection of an appropriate instructional methodology and its effective use greatly determine their level of success which itself is measured by their students' achievement (Ofojebe, 2010).

In recent time, there have been reports that the academic achievement of students has been below expectation (Joshua, Ekpoh, Edet, Joshua, and Obo, 2004). According to Ogundola, Abiodun and Jonathan (2010) this failure to meet expected standard is attributable to the continuous use of unsuitable instructional methodologies (mostly traditional instructional approach) by teachers in teaching their students. Consequent upon this, teachers of courses like Basic Electronics are therefore faced with the challenge of presenting relevant classroom activities that can facilitate conceptual change, allow understanding, and recognize individual differences amongst students. The instructional technique having these qualities is the constructivist-based instructional approaches.

Cholewinsky (2009) construed constructivist-based instructional approaches to be teaching approaches that places the locus of control and the manner in which knowledge is processed with the learner, who is encouraged to generate self-relevant knowledge through critical, interactive and collaborative inquiry. Constructivist instruction has a number of important approaches and they are; situated learning, concept mapping, collaborative instructional approach, anchored instruction, problem based learning, cognitive apprenticeship, discovery learning, and scaffolding (Seitz, 1999; Rowe, 2006; Cholewinski, 2009; Mark and Dabbagh, 2003; Jackson, 2006; Lai-chong and Ka-ming, 1996). But this study will focus on scaffolding and collaborative instructional approach.

According to Reiser (2004), scaffolding refer to the process by which a teacher, an instructor or a more knowledgeable peer assists a learner, altering the learning task so the learner can solve problems or accomplish tasks that would ordinarily be impossible for him and to learn from the experience. While McNamara and Brown (2008) defined Collaborative instructional approach as a successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject. If the potentials of scaffolding and collaborative instructional approach are fully utilized, the academic achievement of student of subjects like Basic Electronics could improve.

In line with Bloom's taxonomy of educational objectives, and from past question papers of the examination bodies testing students at the secondary level in Nigeria, the type of testing employed for a subject like Basic Electronics, measures both cognitive and psychomotor achievement. But this study focused only on cognitive achievement. Cognitive achievement reveals how well the educational objectives in the cognitive domain have been realized by a student. It is measured using a cognitive achievement tests. When designing achievement tests, whether it is product or process assessment, care is often taken so that it is not gender bias.

Gender refers to state of being male or female. For a long time, gender was listed by researchers as one of the factors that influenced the academic achievement of the child (Gupta, Sharma and Gupta, 2012; Abubakar and Oguguo, 2011). Hence, there has been a lot of debate on whether gender really affects academic achievement. Some researchers believed that boys often out-perform their girls counterparts in most subject areas, while some conclude the other way round (Maliki, Ngban and Ibu, 2009; Jabor, Machtmes, Kungu, Buntat, and Nordin, 2011). But current trends show that the gap that once existed between genders is fast closing (Abubakar and Bada, 2012). This suggests that women are getting more exposure to educational activities more than ever.

### **1.1 Statement of the Problem**

Joshua *et al.* (2004) revealed that despite the huge resources expended by Nigerian stake holders in the educational sector, mass failure in public examinations, especially in Science and Technology related areas which include Basic Electronics, is still being recorded every year. Recent statistics of academic achievement among students of Basic Electronics over a period of five years (2008-2012) corroborates this. During this period 2,176 candidates sat for examination in the subject in Nigeria. Out of this number, only 771 candidates scored a credit grade or higher, representing a paltry 35.4% success rate (National Examinations Council, NECO, 2013).

It was observed by chief-examiners of Basic Electronics (NECO, 2010) that this mass failure could be attributed to teachers' use of unsuitable instructional methodologies, especially traditional method, which is teacher-centred, in teaching the subject. Hence, teachers need to adopt a learner-centred

instructional approach, which will emphasize contextualized and constructive processes, and equip the students with higher-order thinking skills for easy adaptability and flexibility.

Moreover, studies carried out by many researchers have indicated that constructivist approaches are very effective teaching techniques in modern day teaching. Because students taught using the approaches demonstrated a higher academic achievement than those taught using the traditional approach. Since constructivist-based approaches are learner-centred, they emphasize contextualized and constructive processes, and equip the students with higher-order thinking skills (Cholewinsky, 2009). Literature also revealed that scaffolding and collaborative instructional approach are among the most popularly adopted of constructivist approaches. Therefore, the problem of this study is since constructivist-based instructional approaches are more effective than traditional approaches, which of them is the most effective? Hence, the present study was designed to find out the Effects of Scaffolding and Collaborative Instructional Approaches on Science and Technical School Students' Achievement in Basic Electronics in North-Central Nigeria, with a view of finding out between scaffolding approach and collaborative instructional approach which is more effective.

The specific objectives of the study were to determine the effect of:

- Scaffolding and collaborative instructional approaches on students' cognitive achievement in Basic Electronics.
- Gender on students' cognitive achievement in Basic Electronics when taught with scaffolding and collaborative instructional approaches.
- What is the effect of scaffolding and collaborative instructional approaches on students' cognitive achievement in Basic Electronics?
- What is the effect of gender on students' cognitive achievement in Basic Electronics when taught with scaffolding and collaborative instructional approaches?

### 1.3 Hypotheses

The researcher tested the null hypotheses stated below at 0.05 level of significance:

- H<sub>01</sub>** There is no significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach.
- H<sub>02</sub>** with There is no significant difference between the mean scores of male and female students when taught scaffolding and collaborative instructional approaches in Basic Electronics Cognitive Achievement Test.
- H<sub>03</sub>** their There is no significant interaction effect of treatments given to students and their gender with respect to their mean scores on the Basic Electronics Cognitive Achievement Test.

## 2 METHODOLOGY

The study adopted quasi-experimental research design; specifically the pre-test post-test non-equivalent control group experimental design was used. A sample of 105 (77 males and 28 females) was drawn using purposive sampling technique from all the 122 SS II students of Basic Electronics in the 8 secondary schools offering Basic Electronics in North-Central. This was because schools offering Basic Electronics in the area of study were few and their student population was small. Students' performance was obtained after being taught with scaffolding and collaborative instructional approaches. The instrument used was Electronics Cognitive Achievement Test (BECAT). The instrument (BECAT) was validated by three senior staffs ; One of them is a lecturer of Electrical Electronics Technology drawn from Department of Industrial and Technology Education , Federal

University of Technology, Minna; the second is an experienced teacher of Electronics at the secondary school level in Abuja and the third is an experienced staff of the Department of Examination Development, National Examinations Council, who was a teacher of Basic Electronics before joining the council as a Basic Electronics examination officer. The topics covered were; electrical conduction properties of elements, majority and minority charge carriers, p-n junction diode, diode parameters, electrical rectification and dc power supplies. BECAT was scored a total of 50 marks. The researcher prepared two (2) sets of lesson plans for teaching of the six Basic Electronics topics selected for the study. Each set contained six lesson plans that were used to teach the students. Each contact lasted for 80 minutes (double periods). Since the test items are multiple-choice type, reliability testing of BECAT was carried out with the use of Kuder-Richardson 20 (K-R 20) and a reliability coefficient of 0.88 was obtained. Data collected were analyzed using mean and ANCOVA at .05 level of significance.

### 3 RESULTS

#### Research Question 1

What is the effect of scaffolding and collaborative instructional approaches on students' cognitive achievement in Basic Electronics?

**Table 1: Pre-test and Post-test Mean Scores of Treatment Groups Taught Basic Electronics with Scaffolding and Collaborative Instructional Approaches in the Cognitive Achievement Test.**

Group	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean Gain $\bar{X}$
Experimental Group A	52	11.19	35.60	24.41
Experimental Group B	53	11.25	25.51	14.26

Table 1 shows that Experimental group A (group treated with Collaborative Instructional Approach) had a pre-test mean score of 11.19 and a post-test mean score of 35.60, this gave a pre-test, post-test mean gain of 24.41. However, Experimental group B, (group treated with Scaffolding Instructional Approach) had a pre-test mean score of 11.25 and a post-test mean score of 25.51, giving a pre-test, post-test mean gain of 14.26. With these results, the students in Experimental Group A performed better in the cognitive achievement test than the students in Experimental Group B. Hence, collaborative instructional approach is more effective than scaffolding instructional approach in Basic Electronics.

#### Research Question 2

What is the effect of gender on students' cognitive achievement in Basic Electronics when taught with scaffolding and collaborative instructional approaches?

**Table 2: Pre-test and Post-test Mean Scores of Male and Female Students Taught Basic Electronics with Scaffolding and Collaborative Instructional Approaches in the Cognitive Achievement Test**

Gender	Scaffolding Instructional Approach			Collaborative Instructional Approach				
	N	Pretest	Posttest	Mean Gain	N	Pretest	Posttest	Mean Gain
		$\bar{X}$	$\bar{X}$	$\bar{X}$		$\bar{X}$	$\bar{X}$	$\bar{X}$
Male	40	11.15	25.73	14.11	38	11.47	36.00	24.53
Female	13	11.62	24.85	13.23	14	10.43	34.50	24.07

Table 2 shows that male students taught Basic Electronics using Scaffolding Instructional Approach had a pre-test mean score of 11.15 and a post-test mean score of 25.73, giving a pre-test, post-test mean gain of 14.11, while their female counterparts taught using Scaffolding Instructional Approach, Approach had a pre-test mean score of 11.62 and a post-test mean score of 24.85, giving a pre-test, post-test mean gain of 13.23. Also, male students taught Basic Electronics using Collaborative Instructional Approach had a pre-test mean score of 11.47 and a post-test mean score of 36.00 giving a pre-test, post-test mean gain of 24.53, while their female counterparts taught using Collaborative Instructional Approach, had a pre-test mean score of 10.43 and a post-test mean score of 34.50 giving a pre-test, post-test mean gain of 24.07. From these results, male and female students taught Basic Electronics using Collaborative Instructional Approach had a higher mean gain than those taught using Scaffolding Instructional Approach in the cognitive achievement test. Also male students performed better than the females. This could be pointing to the existence of an effect attributable to gender on the achievement of students taught Basic Electronics.

### Hypotheses

- HO1: There is no significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach.
- HO2: There is no significant difference between the mean scores of male and female students when taught with scaffolding and collaborative instructional approaches in Basic Electronics Cognitive Achievement Test.
- HO3 There is no significant interaction effect of treatments given to students and their gender with respect to their mean scores on the Basic Electronics Cognitive Achievement Test.

**Table 3: Summary of Analysis of Covariance (ANCOVA) for Test of Significance of Three Effects: Treatment, Gender and Interaction on Students' Cognitive Achievement in Basic Electronics.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	15764.673	4	3941.168	265.228	.000
Intercept	276.267	1	276.267	18.592	.000
Pretest	200.050	1	200.050	13.463	.000
Gender	1.188	1	1.188	.080	.778*
Treatment	11915.704	1	11915.704	801.888	.000*
Gender * Treatment	1.326	1	1.326	.089	.766
Error	1485.955	100	14.860		
Total	74324.000	105			
Corrected Total	17250.629	104			

\*Significant at sig. of F < .05

The data in Table 3 shows the F-calculated values for Three Effects: treatment, gender and interaction on students' cognitive achievement in Basic Electronics. The F-calculated value for treatment is 801.888 with a significance of F at

.000 which is less than .05. This result shows that there is a significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach. The null-hypothesis one is therefore rejected at .05 level of significance. The F-calculated value for gender is .080 with a significance of F at .778 which is greater than .05. This result shows that there is no significant difference between the mean scores of male and female students when taught with scaffolding and collaborative instructional approaches in Basic Electronics Cognitive Achievement Test. The null-hypothesis two is therefore accepted at .05 level of significance. Also, the interaction of treatments and gender has an F-calculated value of .089 with significance of F of .766. From this, .766 is obviously greater than .05. Hence, there is no significant effect of treatments given to students on their gender with respect to their mean scores on the Basic Electronics Cognitive Achievement Test. The null-hypothesis three is therefore accepted at .05 level of significance.

### **3.1 Findings of the Study**

The following were the findings recorded:

1. Scaffolding and collaborative instructional approaches are effective for improving students' cognitive achievement. However, collaborative instructional approach was more effective than scaffolding instructional approach.
2. There was an effect of gender on students' cognitive achievement in Basic Electronics. There was a significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach, in favour of collaborative instructional approach.
3. There was no significant effect of gender on students' cognitive achievement in Basic Electronics.
4. There was no significant interaction effect of treatments given to students and their gender with respect to their mean scores on the Basic Electronics Cognitive Achievement Test.

## **4 DISCUSSION OF FINDINGS**

The data in Table 1 provides answer to research question one. The finding revealed that Scaffolding and collaborative instructional approaches are effective for improving students' cognitive achievement. However, collaborative instructional approach was more effective than scaffolding instructional approach. Analysis of Covariance was used to test hypothesis one, Table 3, at the F-calculated value of 801.888, a significance of F at .000 and at a confidence level of .05. This showed there was a significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach, in favour of collaborative instructional approach. This confirmed that the difference between collaborative instructional approach and scaffolding instructional approach was statistically significant.

This implies that scaffolding and collaborative instructional approaches are effective for teaching Basic Electronics. However, collaborative instructional approach is more effective than scaffolding instructional approach. This finding is similar to that of Gokhale (1995) who found that students who participated in collaborative instructional approach performed significantly better on the critical-thinking test than students who studied individually like in scaffolding. Similarly, Dooly (2008)

discovered that in collaborative instructional approach, students actively exchange, debate and negotiate ideas within their groups, and this increases the students' interest in learning. Importantly, by engaging in discussion and taking responsibility for their learning, students are encouraged to become critical thinkers. By working in small groups, students tend to learn more of what is being taught and retain the information longer and also appear more satisfied with their classes. Therefore, the difference observed between the two groups is as a result of collaborative instructional approach being more effective in improving students' cognitive achievement in Basic Electronics than scaffolding instructional approach.

The data in Table 2 provides answer to research question two. From the results, there was an effect of gender on students' cognitive achievement in Basic Electronics. In the same vein, analysis of covariance was used to test hypothesis three (Table 3) for interaction of treatments and gender had an F-calculated value of .089, a significance of F at .766 and at level of confidence at .05, indicating that there was no significant interaction effect of treatments given to students and their gender with respect to their mean scores on the Basic Electronics Cognitive Achievement Test. Also, analysis of covariance was used to test hypothesis two, Table 5, the F-calculated value for gender was .080, with a significance of F at .778 and at a confidence level of .05. With these results, there was a significant difference between the mean scores of students in Basic Electronics Cognitive Achievement Test when taught using scaffolding instructional approach and those taught with collaborative instructional approach, in favour of collaborative instructional approach.

This implies that both scaffolding and collaborative instructional approaches are not gender bias in teaching of subjects like Basic Electronics. This finding is similar to findings of several other studies that have been conducted on effects of gender on achievement of male and female students in sciences and other fields. For instance, Nwagbo and Obiekwe (2010) affirmed that there was no significant difference between male and female students' achievement. This view was reiterated by Afolabi and Akinbobola (2009) who discovered that there was no significant gender difference in the performance of students taught with problem based learning technique in a physics achievement test. Abubakar and Bada (2012); Ogbuanya and Owodunni (2013) also supported this when they revealed that gender is not significant in the academic achievement between females and males. Hence, these findings confirmed that when males and females are exposed to academic activities in subjects like Basic Electronics, under the same environment, conditions, and taught by the same teacher using the same methodology, their performance level would be the same. With none of them having any significant edge over the other. This means that the gender effect detected by the mean statistics, though insignificant, was not due to the effect of treatment on gender.

## **5 CONCLUSION**

The need to find the most appropriate instructional approach to assist Basic Electronics students in their academic activities, stimulate and sustain their interest is very important. This is because interest is a key ingredient for recording high achievement in any academic pursuit and especially in technology education. This study therefore, ascertained the Comparative Effects of Scaffolding and Collaborative Instructional Approaches on Secondary School Students' Achievement in Basic Electronics in North-Central Nigeria. The study found out that collaborative instructional approach is more effective in improving students' cognitive achievement in Basic Electronics than scaffolding instructional approach. Also the study revealed that, gender had no influence on students' cognitive achievement in Basic Electronics. The study also revealed that collaborative and scaffolding instructional approaches are not gender bias. Therefore, the effectiveness of collaborative instructional approach on students' cognitive achievement in Basic Electronics does not depend on gender. Students recorded higher cognitive in Basic Electronics when collaborative instructional approach is used for teaching the subject irrespective of gender. These results therefore show that collaborative instructional approach is a workable teaching method for Basic Electronics.



## **Recommendations**

Based on the findings of this study, the following recommendations are made:

1. Teachers of Electronics and other related subjects in secondary schools should adopt collaborative instructional approach for teaching their subjects.
2. Nigerian Educational Research and Development Council (NERDC) should consider incorporating collaborative instructional approach into the teaching of Basic Electronics when next they are reviewing the curriculum.
3. Government and other stakeholders in the provision of qualitative technology education should provide schools with state-of-the-art tools and equipment needed for the teaching and learning of Basic Electronics.
4. The National Universities Commission (NUC) along with other sister agencies in collaboration with the Ministries of Education both at federal and states levels, should organize training and retraining workshops, seminars and conferences to enlighten teachers of technology education with a view of improving their knowledge with skills on the use of collaborative instructional approach from time-to-time.

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