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Full Length Research Paper

Effect of Construction of a Transistor Amplifier on Students' Learning Retention in Electronics Works in Technical Colleges in Rivers State, Nigeria

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ABSTRACT: Electronics works are one of the key subjects in technical colleges that enable students to perform repairs, maintenance, and construction of basic electronic systems. This study was centered on the appropriate method of carrying out the best teaching that will yield better learning retention of students on electronics works in technical colleges in Rivers State. The study also ascertained the influence of gender on students' learning retention in electronics works. Two research questions guided the study and two hypotheses were tested at a 0.05 level of significance. The design of the study was a pre-test, post-test non-equivalent quasi-experimental study. A sample size of 112 students drawn from a population of 267 students in Rivers State technical colleges was used. To obtain the sample, two technical colleges were purposively selected and two intact classes were randomly selected and assigned to experimental and control groups. The Transistor Amplifier Retention Test (TART) of 30 question items was the instrument developed for the study. The instrument was validated by three experts in technology and vocational education. A reliability coefficient of 0.67 was obtained using Kuder-Richardson 20. Data collected were analyzed using mean with standard deviation to answer the research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses at a 0.05 level of significance. Findings revealed among others that students taught with constructed method retained better than those taught with the conventional method in electronics works. Based on the findings, it was recommended that electronics works teachers should be encouraged to be exposed to practical intricacies associated with the constructed method. This will expose the gray areas that need attention and hence give room for improvement in students' learning retention in electronics works.

Keywords: Construction, transistor, amplifier, students, learning, retention, electronics, works, technical, colleges

INTRODUCTION

A good look at the present educational system all over the world clearly show that many nations are gradually giving priority to a learning process that will give rise to mastery of practical skills instead of theories. According to Nugent (2020), practical skill educational programmes are the owners of the future society. One of such programmes is technical education. Technical education is the study of technology in which students learn about the processes and knowledge related to technology. As a field of study, it covers the individual ability to shape and change the physical world in order to meet the needs of the society, by manipulating materials and tools with techniques. UNESCO (2001) defined technical education as an aspect of education designed to lead an individual to the acquisition of technological skills and related sciences, as well as basic practical skills, attitudes,

understanding and knowledge that will enable the individual adequately be equipped for self-reliance or employment in the industries. In Nigeria, technical education programmes are offered at post primary school level in technical colleges and other related vocational institutions.

Technical colleges are vocational training institutions that give admission to students at post primary levels, and are provided with full vocational courses for duration of between three to six years (Okoro, 2006). Technical colleges are regarded as one of the key vocational institutions in Nigeria that provide practical skill training. They prepare the students for entry into specific engineering trades by offering several subjects that will enable the students' prepare for employment after graduation and one of such subjects is electronics works.

Electronics works in technical colleges has to do with the repairs, maintenance and construction of basic electronics systems. It enables students in technical colleges to learn basic electronics theory that are needed to understand circuit designs in order to install, operate, maintain and repair electronic circuits (Robinson, 2012). Electronics works as a subject primarily deals with the design and applications of electronic devices and circuits such as passive and active components. These components which are used in electronics systems control the flow of electrons which emanates from atom. National Teachers Institute (2007) described electronics works as a technology subject which involves some scientific knowledge and practice to solve electronic problems. With the skills involved in electronics works, technical college students can work as members of an engineering team in the areas of installation, maintenance, manufacturing, product development and other applications of electronics products and devices. They can also work in the servicing industry in customer support and field engineering. Other industries such as utilities and telecommunications can also employ many electronics craft graduates from technical colleges. Electronics works in technical college consists of several topics that are used to assess students' learning retention, and transistor amplifier is one them.

Generally amplifier is an electronic device that can increase the power of a signal (voltage or current that are time-varying). An amplifier can either be a separate piece of equipment or an electrical circuit contained within another device. Amplification is fundamental to modern electronics, and amplifiers are widely used in almost all electronic equipment. Amplifiers can be categorized in different ways. One is by the frequency of the electronic signal being amplified or by their physical placement in the signal chain; a preamplifier may precede other signal processing stages. Presently in the world of electronics, most amplifiers use transistors, hence those type of amplifiers are referred to as transistor amplifiers (Agarwal and Lang, 2005). The transistor raises the strength of a weak signal and hence acts as an amplifier. A transistor amplifier is a two-port electronic circuit that uses electric power from a power supply to increase the amplitude of a signal applied to its input terminals, producing a proportionally greater amplitude signal at its output (Glisson, 2011). Figure 1 shows how a transistor looks like when connected as an amplifier. The DC bias voltage applied to the emitter base junction makes it remain in forward biased condition. The input signal or weak signal is applied across the emitter base and the output is obtained to the load resistor RL which is connected in the collector circuit. The DC voltage V_{EB} is applied to the input circuit along with the input signal to achieve the amplification. In technical colleges, transistor amplifier is an important topic because it can be found in several electronic equipments. Besides, electronics works students are usually taught how to repair and maintain amplifier as equipment.

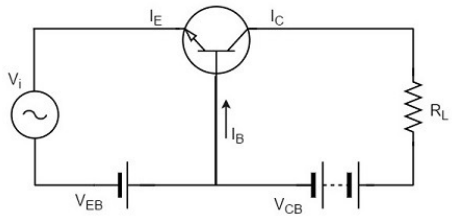

Figure 1: Transistor amplifier.

Electronics works is a subject that has to do with skill, and its learning requires adequate presence and use of instructional resources. Aina (2000) opined that the adequate use of instructional resources in a technical college is the heart of craftsmanship training. This implies that instructional resources are very important in technical college training. The lack of adequate use of instructional resources can affect the acquisition of sufficient practical skills which are the core objectives of the programme. Instructional resources are usually prepared to give occupational direction in order to enhance acceptable work habits and procedures. In electronics works, some of these instructional resources are circuit boards, power supplies, amplifiers, multivibrators, voltage stabilizers and radio receivers. Instructional resources are any collection of materials including animate and inanimate objects that a teacher may use in a teaching and learning process to help achieve desired learning objectives (Lewis, 2018). They ensure that the learners see, hear, feel, recognize and appreciate learning, utilizing the five senses modalities at the same time. It is known that, no technical college programme can be functional without instructional resources being utilized during the classroom experience in order to inculcate technology skills for maximum national development (Idialu, 2007). However, with government crying daily for lack of funds to sponsor

education generally and to provide instructional resources in particular, construction of electronic devices as instructional resources becomes inevitable. The fact remains that it is virtually impossible to acquire all the instructional resources required for sound and quality electronics works teaching in technical colleges. This makes it imperative for technical teachers to think of how best to make use of their manipulative skills; by constructing electronic devices as instructional resources in order to achieve their lesson objectives.

In electronics, construction of electronic devices refers to the interconnection of individual electronic components such as resistors, transistors, capacitors, inductors, diodes and integrated circuits; which are connected by conductive wires or traces through which electric current can flow to form a circuit. The combination of components and wires allows various simple and complex operations to be performed in the circuit, hence becoming electronic devices. For instance, signals can be amplified, computations can be performed, and data can be moved from one place to another (Robinson, 2012). There are different ways of constructing electronic circuits depending on the tools available and how permanent a solution is required. When creating a new circuit it is common to first create a prototype using a breadboard or similar before the circuit is made permanent using solder. This allows any problems to be identified at an early stage where it is easier to change the design than removing soldered components. The final design is normally created onto something more permanent such as a printed circuit board, or strip-board. According to Kaplan and White (2003), constructed devices are important in teaching, and its use for the teaching of electronics subjects will help students to easily grasp basic rules and principles in electronics. However, the essence of construction of electronic devices in technical colleges is to enhance the teaching and learning processes by ensuring that the persistent problem of inadequacy of instructional resources will not seriously affect the learning retention of students.

In electronics works, the onus of construction of electronic devices for a teaching and learning process lies on the shoulder of the teacher (Umah and Maaji, 2010). It is the teacher's responsibility to construct unavailable instructional resources that will best suit a teaching learning process. Similarly, Umar (2005) pointed out that, despite the inevitable need for the construction of electronic devices in technical colleges, the teachers' responsibility to construction is seriously lacking; this could lead to very poor students' learning retention. According to Umar and Maaji (2010), lack of teachers' responsibility to the construction of electronic devices is becoming a persistent problem in the technical colleges. Apart from the problem of learning retention in relation to construction, the issue of gender differences also persists in learning retention of students.

Gender is a socially ascribed attributes which differentiate male from females. It is sex discrimination applied in the education system which affects male and female during and after their education experience. Sex discrimination in technical education, especially in electronics works is in favour of the males. There is a common assumption that technical education is more prone to male students than females as a result of the fact that psychomotor skills are involved to a very high extent (UNESCO, 2004). According to research findings by Imogie (2007); boys achieve significantly higher than girls in psychomotor skills. Kelley (2003) also reported similar findings in the United Kingdom. Contrary to Imogie's view of boys performing better than girls, Amaechi (2014) reported that female students performed better than their male counterparts in some science subjects. Nnachi (2008) in a study reported that there is no much difference in the performance and retention abilities of boys and girls in any subject including the science and technology subjects. The researchers therefore see the need for a teaching technique that might improve the learning retention of male and female students in electronics works.

In education, learning retention refers to the ability to retain facts and figures in memory after teaching (Wikipedia, 2008). Students must retain information taught in classes in order to show benefit of learning. The teachers' job is not over according to Amasuomo (2015) until he/she has assisted the learner in retaining the information. For students to retain information taught, they should be able to interpret and apply the taught information to new situations (Abbamondi, 2004). Therefore Abbamondi concluded that students' scores on delayed tests is a good measurement of learning retention.

The problem of poor students' learning retention is seen in their inability to pass aptitude tests on electronics works after graduation (FME, 2017). Similarly, from the exams and record office of the Rivers State Post Primary Schools Board, electronics works students had recorded an average failure rate of over 48% in NTC/NBC examinations from May/June 2008-2017. The board also lamented at a less than 25% employment rate of electronics works students after graduation due to their inability to pass aptitude test. These situations are quite disturbing and call for urgent attention in order to avoid total depletion of students' enrolment in electronics trade in technical colleges.

Many reasons have been given for the poor state of electronics works. Some are of the opinion that teachers' incompetence is the factor, while others are of the opinion that teachers' use of conventional method of teaching is a major factor. Conventional method of teaching in this context refers to a talk-chalk method of teaching in which only the chalkboard is used for a teaching and learning process. It is a lecture method of teaching in which no appropriate instructional resources were used during teaching and learning process in the

absence of the real.

It is regrettable that many electronics works teachers prefer the use of the conventional method of teaching which is devoid of the use of instructional resources. Umah and Maaji, (2010) attributed teachers' preference for the use of the conventional method of teaching due to the persistent problem of inadequacy of instructional resources in the technical colleges workshops. Teachers have completely neglected the place of constructed electronic devices method as a result oriented teaching technique in electronics works to a non result oriented teaching technique like the conventional method. Hence, it is the view of the researchers that technical teachers' preference for the use of the conventional method of teaching over result oriented one like the constructed method in teaching might be a major reason for students' poor learning retention in electronics works. Therefore, the need arises to determine the effect of construction of a transistor amplifier on students' learning retention in electronics works in technical colleges in Rivers State.

Purpose of the study

The main purpose of the study was to determine the effect of construction of a transistor amplifier on students' learning retention in electronics works in technical colleges in Rivers State. Specifically the study sought to determine:

(a) The mean retention scores of the students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State.
(b) The mean retention scores of male and female students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State.

Research questions

The following research questions guided the study:

(a) What are the mean retention scores of students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State?
(b) What are the mean retention scores of male and female students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State?

Hypotheses

The following null hypotheses (Ho) were tested at, 0.05 level of significance;

(a) There is no significant difference in the mean retention scores of students taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State.
(b) There is no significant difference in the mean retention scores of male and female students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State.

METHODOLOGY

This study adopted a quasi-experimental research design. Specifically, the design is a pretest posttest non-equivalent control group quasi experimental group design. The population for the study consisted of 267 students. There are three technical colleges offering Electronics Works in Rivers State which are; Government Technical College Port Harcourt, Federal Science Technical College Ahoada and Government Technical College Tombia. The population for each college was as follows: Government Technical College Port Harcourt, 99 students; Federal Science Technical College Ahoada, 93 students and Government Technical College Tombia, 75 students.

The sample for the study consisted of 112 students of Electronics Works, which represents 42% of the population. The sample was obtained using purposive sampling technique to select two technical colleges for the study considering location as a factor. There are two intact classes; the researcher randomly assigned these intact classes to experimental group (E) and control group (C) using balloting method. The experimental group had a sample size of 52 students, while the control group had 60 students.

The instrument used for data collection was the Transistor Amplifier Retention Test (TART) which was constructed and developed by the researchers. It is a well-structured test from the content of Electronics Works in the NABTEB syllabus with five items for each selected sub-topic. The instrument contained a total of 30 items with four-point multiple choice responses. The development of the instrument was based on a table of specification. The instrument was subjected to face and content validation by three experts from technology and vocational education. Their observations were used to improve the instrument in content, grammar, spellings and language.

The reliability index of the instrument was determined by subjecting Transistor Amplifier Retention Test (TART) to internal consistency test using Kuder-Richardson 20 formula. The reliability coefficient was 0.67, which was considered adequate to be used for the study. The experiment carried out for a period of six weeks. A pretest was given to the students in each group a day

before the teaching began using the Transistor Amplifier Retention Test (TART). A posttest was also administered on the sixth week during the revision of all taught sub-topics.

The research questions were answered using mean with standard deviation, while the hypotheses were tested at a 0.05 level of significance using one-way and two-way analysis of Covariance (ANCOVA).

RESULTS

The analysis of data in relation to each of the research questions and hypotheses are presented as follows;

Research question 1

What are the mean retention scores of students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State? Table 1 shows the mean retention scores of the methods of teaching. From Table 1, the pretest mean retention scores for constructed method and conventional method are 1.92 and 2.40 respectively. Again from Table 1, the posttest mean retention score for constructed method (experimental group) was 23.63 with a standard deviation of 3.06; and the posttest mean retention score for conventional method (control group) was 13.94 with a standard deviation of 2.76. This revealed that the posttest mean retention score for constructed method was higher than conventional method. Similarly, the mean gain score for constructed method and conventional method were obtained as 21.71 and 11.54 respectively. Revealing that, constructed method had a higher mean gain than the conventional method. It all implies that students taught with constructed method retained better than those taught with conventional method.

Research question 2

What are the mean retention scores of male and female students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State? Table 2 shows the mean retention scores of the methods of teaching on gender. From (Table 2), the posttest mean retention score of constructed method (experimental group) for male was 23.63 with a standard deviation of 4.16, while the female posttest mean retention score of constructed method (experimental group) was 23.28 with a standard deviation of 3.89. The posttest mean retention score of conventional method (control group) for male was 14.00 with a standard deviation of 2.98 while the female posttest mean retention score of conventional method (control group) was 14.06 with a standard deviation of 3.11. This revealed that the mean retention score of female students when taught with constructed method was higher than conventional method. Similarly, the mean retention score of male students when taught with constructed method was higher than conventional method. This implies that the male and female students retained better when taught with constructed method than conventional method. Again the mean gains of male and female students taught with constructed method are 21.65 and 21.42 respectively, while the mean gains for male and female students taught with conventional method are 11.42 and 11.84 respectively. This implies that male students retained better than the female students using constructed method, while the female students retained better than the male students using the conventional method.

Hypothesis 1

There is no significant difference in the mean retention scores of students taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State. Table 3 shows students retention with respect to methods of teaching. For methods of teaching, the SPSS F – value of 4.211 was found significant at a 0.041 level of significance, which is less than the 0.05 level of significance. Therefore, method of teaching is significant. The null hypothesis is rejected. This means that there is significant difference in the mean retention scores of students taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State.

Hypothesis 2

There is no significant difference in the mean retention scores of male and female students when taught transistor amplifier using constructed method and those taught same topic using conventional method in technical colleges in Rivers State. Table 4 shows students retention with respect to gender. For gender, the SPSS F – value of 0.912 was found significant at a 0.412 level of significance, which is higher than the 0.05 level of significance. Hence, gender is not significant. The null hypothesis two is not rejected. This means that there is no significant difference in the mean retention scores of male and female students. On interaction for hypothesis two (methods and gender), the SPSS F – value of 1.023 was found significant at 0.313 level of significance which is higher than 0.05 level of significance. Hence, the null hypothesis two is not rejected. This means, there is no significant difference in the mean retention scores of male and female students when taught transistor amplifier

Table 1: Mean retention scores with standard deviations due to methods of teaching.

		Pretest		Posttest		
Methods	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Constructed Method	52	1.92	0.69	23.63	3.06	21.71
Conventional Method	60	2.40	0.81	13.94	2.76	11.54

Table 2: Mean retention scores with standard deviations due to methods of teaching on gender.

	Male (N=79)				Female (N=33)					
	Pretest		Posttest		Pretest		Posttest		Male	Female
Methods	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**MG**	**MG**
Constructed Method	1.98	0.86	23.63	4.16	1.86	0.66	23.28	3.89	21.65	21.42
Conventional Method	2.58	0.75	14.00	2.98	2.22	0.80	14.06	3.11	11.42	11.84

Where MG = Mean Gain

Table 3: One-way ANCOVA on students' retention due to methods of teaching

Source	Type III sum of squares	df	Mean Square	F	Sig.	Dec.
Corrected Model	22.488	6	3.748	6.578	0.000	
Intercept	2852.386	1	2852.386	5006.000	0.000	
Methods	4.800	2	2.400	4.211	0.041	S
Gender	0.520	1	0.520	0.912	0.412	NS
Methods and Gender	0.583	2	0.583	1.023	0.313	NS
Error	96.330	172	0.570			
Total	4222.000	173				
Corrected Total	220.952					

Table 4: Two-way ANCOVA on students' retention due to methods of teaching on gender

Source	Type III sum of squares	df	Mean Square	F	Sig.	Dec.
Corrected Model	22.488	6	3.748	6.578	0.000	
Intercept	2852.386	1	2852.386	5006.000	0.000	
Methods	4.800	2	2.400	4.211	0.041	S
Gender	0.520	1	0.520	0.912	0.412	NS
Methods and Gender	0.583	2	0.583	1.023	0.313	NS
Error	96.330	172	0.570			
Total	4222.000	173				
Corrected Total	220.952					

using constructed method and those taught same topic using conventional method in technical colleges in Rivers State. It implies that gender was not found significant with respect to retention.

DISCUSSION

The study revealed in Research Question 1 that students taught with constructed method (experimental group) had a higher mean retention score in electronics works compared to those taught with conventional method (control group). Hypothesis 1 further confirmed a high retention rate by indicating that method of teaching was a significant factor in the retention of students in electronics works content. This means that the students who were taught using constructed method have the better ability to retain after a long while. The reason for the better retention with constructed method might be that the students were able to link the new concepts to constructed method that are related to their everyday environment. Thus, the result of the study revealed that the adoption of constructed method that is related to students' everyday environment enhances learning retention in electronics works. This study is supported by Amasuomo (2015) view that students develop greater ability of retention when they are involved with the teacher in the preparation and use of constructed method. The study further revealed in Research Question

2 that, male and female students taught with constructed method (experimental group) had a higher mean retention score than their counterparts taught with conventional method. Moreover, Hypothesis 2 reveals that gender has no significant effect on students' retention in electronics works. This agrees with Nnachi (2008) findings that there is no much difference in the performance and retention abilities of boys and girls in any subject including the science and technology subjects. The results in this study, however, disagree with UNESCO (2004) findings that technical education is more prone to male students than females as a result of the fact that psychomotor skills are involved to a very high extent. On the average, it implies that retention does not depend on gender rather it depends on the methods of teaching in electronics works.

Conclusion

Conclusion was made based on the findings of the study. The results of the study provided the empirical evidence that constructed method enhanced students' learning retention in electronics works. This implies that, for an effective teaching process in electronics works, constructed method should be used instead of the conventional method. Thus, retention in electronics works is depended on methods of teaching. This finding was irrespective of gender; male and female students retained better with constructed method instead of conventional method. Again this implies that gender is not significant with respect to learning retention. In essence, constructed method has proved to be viable in enhancing meaningful learning when used in electronics works instead of conventional method.

Recommendations

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

(a) Electronics works teachers should be encouraged to be exposed to practical intricacies associated with constructed method. This will expose the gray areas that need attention and hence give room for improvement in students' learning retention in electronics works.
(b) Authors of electronics work text books should gradually introduce in their texts, illustrations that can create effective constructed method that will enhance teaching and learning process in electronics works.
(c) Government and technical college administrators should provide easy access of materials that will encourage constructed method and discourage conventional method in electronics works.

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