

Cognitive Apprenticeship Modelling Method and Technical College Students' Academic Performance in Electronics Works in Akwa Ibom State

Michael Ime EFFIONG
Industrial Technical Education
University of Uyo, Uyo, Nigeria
Email: mfonobonge75@gmail.com

Abstract

This study sought to determine the effect of cognitive apprenticeship modelling method and technical college students' academic performance in electronics works in Akwa Ibom State, Nigeria. A quasi-experimental pre-test post-test control design was adopted for the study. The population of the study was 98 senior technical two students in the six public technical colleges in Akwa Ibom State, Nigeria. A random sampling technique was used for selection of two technical colleges for the study. The sample size comprised 48 students from two intact classes. The instrument used for data collection was "Electronics Works Performance Test (EWPT)". Cognitive apprenticeship modelling lesson plans and that of the demonstration methods were developed by the researcher for the treatment of the experimental and the control groups. The research questions were analysed using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The study, among other findings, shows that there is a significant difference between the mean of students' scores in Electronics Works when exposed to Cognitive Apprenticeship Modelling method of teaching than in demonstration teaching method, with students in the modelling method class performing better than the students in demonstration class. It is recommended, among others, that the Electronics Works teachers should adopt the use of cognitive apprenticeship modelling method of teaching students in Electronics Works.

Keywords: Academic, Apprenticeship, Cognitive, Modelling, Performance

Introduction

Education is changing daily based on changes in technology in the present century. A lot of strategies have been developed to help teachers provide effective teaching and to help students learn with the ability to remember learnt instructions. Electronics is among the subjects that its methods of teaching by teachers should adopt the modern technology of teaching due to shift in modern method of teaching and students' needs of learning. Electronics Works is one of the trade subjects taught in technical colleges. Electronics is a branch of engineering which deals with the study of conduction of electricity in a vacuum, in gases and in semiconductors (Mehta & Mehta, 2018). It is concerned with methods of generating and

controlling charge carriers such as electrons, holes and ions, for example, electron tubes and transistors, and with application of such devices (Amos & Amos, 2018).

Electronics deals with the use of emission, circuits or devices using transistors, microchips, semiconductors and other components. Electronics uses active devices to control electron flow. Oduntuyi (2017) posited that the study of electronics entails the learning of its concepts, principles, established laws, theories and also substantial activity-oriented-laboratory works. Unfortunately, electronics by its very nature is abstract. Consequently, many teachers perceive some concepts in electronics as difficult to teach and many students also find some concepts difficult to learn and understand.

Among the Electronics concepts perceived by both teachers and learners as difficult are semiconductors. This is because semiconductor materials such as silicon (Si), germanium (Ge) and gallium arsenide (GaAs) have electrical properties somewhere in the middle between a “conductor” and an “insulator” which is mostly so difficult to troubleshoot. Moreover, semiconductors are not good conductors or good insulators (hence their name “semi”-conductors). Semiconductors have very few “free electrons” because their atoms are closely grouped together in a crystalline pattern called a “crystal lattice” but electrons are still able to flow upon their characteristics, which needs special conditions for troubleshooting by the teacher with appropriate methods to be adopted for teaching to enable students’ retention to be established. When troubleshooting a board to detect fault, the components have to be tested or troubleshot one after another. Moreover, changes in electronics technology keep changing the world of electronics from analogue to digital and to hybrid, this influences even the teacher’s method of teaching and the students’ ability to retain the instruction taught (Barnerjee, 2014). Ugwu (2014) asserted that various researchers believe that reasonable level of the difficulties in the teaching of Electronics Works and any other subject can be reduced through the use of effective teaching methods or strategies.

A teaching method comprises the principles and methods used by the teachers to enable students learn. Tebabai and Kahssay (2018) posited that teaching methods are classified into two major groups: teacher-centered and student-centered approaches. Teacher-centered approach allows students to simply obtain information from the teacher without building their engagement level with the subject being taught. This approach is less practical, more theoretical, emphasise memorizing, and does not apply activity-based learning to encourage students to learn real life problems based on applied knowledge. Student-centered approach helps to promote interest, analytical skill, critical thinking, motivates goal-oriented behaviour among students and hence would help to improve students’ retention in their subject (Slavin, 2016). One of the student centred teaching method that is relevant to this study is cognitive apprenticeship method.

Cognitive apprenticeship modelling method is a teaching method utilized by educators to teach students how to solve problems, understand tasks, perform specific tasks, and deal with difficult situations (Collins *et al.*, 2017). It is a teaching method by which learners learn from a more experienced person by way of cognitive and metacognitive skills and processes (Idris, 2017). According to Beena and Asha (2023), cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that obtained in the traditional “craft apprenticeship”. Under this method, the students become an “apprentice” to the teacher. Yarriswamy and Murugeshi (2023a) defined an apprentice as someone who learns a skill or trade under the guidance of a more knowledgeable and experienced person. Thus, cognitive apprenticeship is a method of teaching aimed primarily at teaching the processes that experts use to handle complex tasks. The focus of this learning through guided experience is on cognitive and meta-cognitive skills rather than on the physical skills and processes of traditional apprenticeship. Applying apprenticeship methods to largely cognitive skills requires the externalization of a process that is usually carried out internally. Cognitive apprenticeship method emphasizes two issues: the teaching process to handle complex tasks and the cognitive processes involved in learning. Thus, the cognitive apprenticeship method focuses on bringing internal thought processes into the open so they can be observed and learned by students (Beena and Asha, 2023). When the students observe the processes by which an expert listener or reader thinks and practices those skills, it can help the learners learn on their own more skillfully (Collins *et al.* 1987).

This study focused on cognitive apprenticeship modelling method. Modelling is a teaching strategy where a teacher explicitly shows the students how to complete an activity or assignment before the students begin. Modelling is also an excellent class management technique to indicate with the words “do as I do, and as I say” (Barker & Makar, 2013). Modelling in Cognitive Apprenticeship means showing how a process unfolds and giving reasons why it happens that way (Beena & Asha, 2023). The authors noted that there are two kinds of modelling that can be used in education: One is modelling of expert performance which includes making the problem-solving process of experts explicit to students. The second is modelling of processes in the world which includes making invisible parts of a process visible. Beena and Asha (2023) stressed that a cognitive modelling strategy with teachers and competent students serving as cognitive role models, is a key characteristic of cognitive apprenticeship. The models should put their thoughts and reasons into words while explaining and demonstrating certain actions, because students cannot otherwise monitor the thinking process. These think-aloud actions allow students to build a conceptual model and acquire an integrated set of cognitive and meta-cognitive skills through the process of observation.

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situations (Collins *et al.*, 2017). It is a teaching method by which learners learn from a more experienced person by way of cognitive and metacognitive skills and processes (Idris, 2017). According to Beena and Asha (2023), cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident in craft apprenticeship. Like the apprentice electrician, cognitive apprenticeship seeks to engage learners in real world scenarios in which they act and interact to achieve useful outcomes. Yarriswamy and Murugeshi (2023a) noted that cognitive apprenticeship method emphasizes two issues: the teaching process to handle complex tasks and the cognitive processes involved in learning. Thus, a cognitive apprenticeship focuses on bringing internal thought processes into the open so they can be observed and learned by students. Cognitive apprenticeship is a method of teaching aimed primarily at teaching the processes that experts use to handle complex tasks. The focus of this learning through guided experience is on cognitive and meta-cognitive skills rather than on the physical skills and processes of traditional apprenticeship. Applying apprenticeship methods to largely cognitive skills requires the externalization of a process that is usually carried out internally. When the students observe the processes by which an expert listener or reader thinks and practices those skills, it can help the learners learn on their own more skillfully (Collins *et al.* 1987)

Many scholars such as Dennen and Burner (2017), Yarriswamy and Murugeshi (2023a) and Beena and Asha (2023) contended that cognitive apprenticeship components include modelling, coaching, articulation and exploration. Modelling in cognitive apprenticeship involves demonstrating thought processes (Dennen and Burner, 2017). In this method, the expert (teacher) models the activity while the learner observes. Coaching entails encouraging the students as they try to complete tasks on their own (Beena and Asha, 2023). In cognitive apprenticeship, it involves the teacher assisting and supporting learners' cognitive activities.

Ibrahim and Mohammed (2020) made a comparison of the traditional apprenticeship and cognitive apprenticeship as shown in Table 1

Table 1: Comparison of traditional and cognitive apprenticeship Methods of Learning

Traditional Apprenticeship	Cognitive Apprenticeship
Simple tasks	Complex tasks
Physical skills and processes	Cognitive and metacognitive processes
One-on-one learning in the workplace	Learning with several students set in the classroom and laboratory
Tasks performed by observation	Tasks and processes performed by reasoning
Learning by doing physical tasks	Learning by externalizing thought processes in diagnosing problems

Learning from modelling,
coaching and fading of
performance

Learning from modelling, coaching,
fading, articulation, reflection, and exploration

Job determined by tasks

Learning determined by goals

Cognitive apprenticeship method emphasizes that knowledge can be applied in real world settings as in the traditional apprenticeship where the student is the apprentice (someone who learns a skill or trade under the guidance of a more knowledgeable and experienced person) while the teacher is the master craftsman. It is hoped that application of cognitive apprenticeship teaching and learning principles such as modelling, coaching, exploration, articulation and reflection on performance by technology teachers. Asikhai (2019) posited that effective teaching methods help to improve students' learning and academic performance in Electronics.

Eshiet (2015) asserted that most teachers find modelling concepts difficult because of their poor content knowledge, inability to diversify their teaching methods, depending heavily on the methods they are comfortable with, and ill-equipped laboratories. When a teacher teaches students with modelling method, the students will be able to develop cognitive apprenticeship required concepts and experiences through active participation in the teaching and learning process. Modelling method also offers opportunities for teachers to help learners learn meaningfully and improve their academic performance (Udo, 2015).

Academic performance is the scholastic standing that could be explained as the grades obtained in a subject, course or group of courses taken (Owoyemi, 2018). According to Nwagbo (2020), academic performance in teaching and learning process has to do with attainment of a set of objectives of the instruction. It is an indication of the general ability of students concerning their offered subjects compared to a specified standard called "Pass Mark" which is relative and can be arbitrarily defined as 40 percent or 50 percent. Eze *et al.* (2016a) pointed out that academic achievement could be high, average or low/poor. They described a high academic achievement as one where the score is above the pass mark while a poor academic achievement is any performance score that falls below a desired standard or pass mark.

Statement of the Problem

Poor academic performance of students in Electronics Works has been attributed to poor teaching methods by the teachers leading to poor students' interest towards the subject (Mnanwu, 2019). The researcher observes that the poor academic performance of students in Electronics Works may be attributed partly to inappropriate instructional methods used by teachers to communicate facts and knowledge to the students. May be, the gap existing between boys and girls (gender) as posited by Akpan (2005) may hinder students with perception that

the subject is difficult. It may also be that students of Electronics Works do not perform enough practical. It may as well be that consistent low performance of students in Electronics Works in technical colleges in the study area may be due to issue of teacher's use of traditional teaching strategies which might lead to poor students' interest in the subject (Nsa, 2002). This may be traced to poor classroom interaction pattern obtained when using the conventional teaching methods. This study is, therefore, motivated by the desire to help solve the problem of poor classroom interaction patterns among technical college students in Akwa Ibom State, Nigeria.

Purpose of the Study

The main purpose of this study was to determine the effect of Cognitive Apprenticeship Modelling Method on Technical College Students' Academic Performance and Retention in Electronics Works in Akwa Ibom State. Specifically, the study sought to:

- i. Determine the difference in academic performance of students when taught semiconductor devices in Electronics Works using cognitive apprenticeship modelling and demonstration method in Technical Colleges in Akwa Ibom State.

Research Question

The following research questions were answered.

- i. What is the difference in mean academic performance of students when taught semiconductor devices in Electronics Works using cognitive apprenticeship modelling and demonstration method in Technical Colleges in Akwa Ibom State?

Research Hypothesis

The null hypothesis that was formulated to guide the study and that was tested at 0.05 level of significance is:

- i. There is no significant difference in mean academic performance of students when taught semiconductor devices in Electronics Works using cognitive apprenticeship modelling and demonstration method in Technical Colleges in Akwa Ibom State.

Methodology

The study adopted a quasi-experimental pre-test post-test and non-equivalent control group design. This design was considered appropriate for the study since it investigated the effect of an instructional technique on students' academic performance. Moreover, this design is usually adopted when it is not possible to randomly sample the subjects and assign them to groups without disrupting the academic programmes of the schools used in the study. Two intact classes of Senior Technical Two (ST2) Electronics Works students were studied. The design of the study is presented diagrammatically as follows:

O ₁	x ₁	O ₃	(E ₁)
O ₂	x ₂	O ₄	(C)
Where: O ₁	-	pre-test of the experimental group	
O ₂	-	pre-test of the control group	
O ₃	-	post-test of the experimental group	
O ₄	-	post-test of the control group	
X ₁	-	experimental treatment condition	
x ₂	-	control treatment condition	
E ₁	-	the experimental group	
C	-	Control group	

The study was conducted in Akwa Ibom State. The population of the study consisted of 98 Senior Technical Two (ST11) students offering Electronics Works in Akwa Ibom State in the 2022/2023 academic session. A sample size of 48 Senior Technical Two Electronics Works students was used for the study. Purposive sampling technique was adopted for the study. This was appropriate because only respondents who offer Electronics Works were used in both experimental and control groups. Intact class for experimental group was 20 respondents while intact class for control group was 28 respondents.

The criteria that were used in selecting the sampled schools were:

- Schools that were co-educational with many students in an arm of Senior Technical 2 class.
- Schools that are currently presenting candidates for the National Business and Technical Examinations (NABTEB) in Electronics Works.
- Schools that have graduates of Electronics Works as teachers with a minimum of at least five years of teaching experience.
- Schools in which Electronics Works theory and practice have been taught already.

The two schools selected were randomly assigned to treatment and control groups.

Data for the study was collected using "Electronics Works Performance Test (EWPT)". The Electronics Works Performance Test (EWPT) consisted of 50 multiple choice items on Electronics Works. It was used as pre-test post-test and delayed post-test (retention test) after being reshuffled after administration. The procedure that was adopted in carrying out the study is outlined below:

Permission to use the schools for the study: The researcher personally presented letter of introduction to the principals of each of the schools and explained the aim of his visit. The researcher sought for permission to conduct an experiment using the school. The researcher in the process also sought the principal's permission to interact with the Electronics Works teachers (subject teachers) in each school; and with the principal's permission, the researcher briefed the teachers and gave relevant materials to those who accepted to cooperate with him.

Teaching was done for four weeks according to the scheme of work and school's Time Table. This was to reduce the incidence of loitering and making sure enough time was given for the treatment to make an impact and avoid creating study awareness on the part of the subjects under study.

In order to reduce experimental bias, the researcher worked with the subject teachers. Training programme was organised for the participating Electronics Works teachers. The teacher of the experimental group was given guidelines on the use of the experimental learning lesson plan and how to incorporate the experimental learning strategies into the lesson. This training lasted for two days. The teacher for the control group was also briefed on the use of demonstration lesson plans and the general requirement of the research. The question was not given to the participating teachers until the time they administered the test to the students.

To reduce or minimize novelty effect in the context of human performance which results from non-familiarity of the researcher to the students, the researcher visited the experimental group school before the start of the experiment. The subject teacher was used in creating the necessary rapport. To reduce this effect, the teaching periods for the study were within the schools' normal timetable in order to avoid disruption of the school calendar or timetable. This study used two intact classes with 48 students in the control class and 50 students in the experimental class; this amounted to 98 students for the study.

The use of pre-test was to enable the researcher to determine the level of students' understanding of the subject matter before the start of experiment while post-test was used to check students' level of understanding and performance after the experiment. Testing and instrumentation, testing was controlled here because pre-testing led to high post-test scores, the advantages may be equal for both experimental and control groups.

The data collected were analysed using descriptive statistics, mean with standard deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used for testing the null hypotheses with pre-test scores as covariates. The choice of ANCOVA was to ensure comparability and equality of the groups. All hypotheses were tested at .05 alpha level.

Results

What is the difference in mean academic performance of students when taught semiconductor devices in Electronics Works using cognitive apprenticeship modelling and demonstration methods in Technical Colleges in Akwa Ibom State?

Table 2 Summary of Mean Pre-test and Post-test scores of students in Electronics works when taught with Cognitive Apprenticeship modelling and Demonstration methods

S/n	Group	N	Pre-test		Post-test		
			$\bar{X}$	SD	$\bar{X}$	SD	Mean Gain
1	Experimental	50	44.44	5.98	63.72	3.57	19.28
2	Control	48	44.25	4.61	53.46	2.09	9.21

The data in Table 2 is a summary of the mean pre-test and post-test scores of students taught semiconductors using cognitive apprenticeship modelling and demonstration instructional methods. The result shows that the mean pre-test and mean post-test scores of students in the experimental group who were taught with cognitive apprenticeship modelling method are 44.44 and 63.72 respectively with standard deviations of 5.98 and 3.57. The corresponding figures for those students in the control group who were taught with demonstration method are 44.25 and 53.46 respectively with standard deviations of 4.61 and 2.09 respectively. It could be observed that students who were taught with cognitive apprenticeship modelling method had a higher mean gain of 19.28 as against 9.21 obtained by those who were taught using demonstration method. This signified that teaching semiconductors with cognitive apprenticeship modelling method enhances students' academic performance than using demonstration instructional method.

Discussion of Findings

Academic Performance of Students when taught Semiconductor Devices in Electronics Works using Cognitive Apprenticeship Modelling and Demonstration Method

The superiority in academic performance by students in the experimental group could be attributed to the fact that cognitive apprenticeship modelling method tries to enculturate students into authentic practices through activity and social interaction in a way similar to that obtained in the traditional "craft apprenticeship". Also, the method allows learners to learn cognitive and metacognitive skills and processes from a more experienced person (an expert) who performs or models the activity for learners to observe. This accounts for their superior performance than those taught with the demonstration method.

The findings of the present study is in agreement with that of Eze, Obidike and Okotubu (2020a) who studied the effect of cognitive apprenticeship instructional method on academic achievement of auto mechanics technology students in technical colleges in Delta State. The findings revealed that students taught auto mechanics technology using cognitive

apprenticeship instructional method achieved better than those taught with demonstration method. The present finding also agreed with that of Onwusa and Nwaosa (2020) who investigated the effect of cognitive apprenticeship instructional method on students' skill achievement, problem-solving in metal work technology in technical colleges in Delta State. The findings revealed that students taught metal work technology using cognitive apprenticeship instructional method had better accomplishment, possessed better problems solving skills than those taught with lecture-demonstration teaching method.

Recommendations

Based on the findings of the study the following recommendation were made:

- i. Curriculum planners and instructors should adopt the cognitive apprenticeship modelling method as a core instructional approach in electronics works. This means emphasizing modelling, coaching, scaffolding, articulation, reflection, and exploration in both theory and practical lessons.
- ii. Technical School Management should organize regular capacity-building workshops for technical college teachers to enhance their skills in using cognitive modelling techniques. Teachers should learn how to think aloud, demonstrate problem-solving strategies, and progressively transfer responsibility to students.
- iii. Electronics teachers should provide students with opportunities to observe real-life demonstrations followed by guided practice. For example, after a teacher models how to test or assemble a circuit, students should practice under supervision before working independently.

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