Comparative Effects of Cognitive & Traditional Task Analysis-Based Instructional Guides on Students' Skills Achievement in Electronics Work

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Abstract - This study was designed to determine the comparative effects of cognitive and traditional task analysis-based instructional guides on technical college students' skills achievement in electronics work. The study adopted a quasi-experimental design. The population of the study was 174 Technical college III (TC III) students of all the technical colleges offering Electronics Work in North central, Nigeria. The entire population of 174 students was used for the study from which 90 TC III students comprising of 79 male and 11 female constituted treatment group assigned to cognitive task analysis-based instruction, and 84 TC III students comprising 65 male and 19 female constituted another treatment group assigned to traditional task analysis-based instruction. Two research questions and three null hypotheses, tested at 0.05 level of significance, guided the study. The instrument used for data collection was Electronics Work Troubleshooting Skills Achievement Test (EWTSAT). The instrument was subjected to face validation by three experts in vocational and technical education. The inter-rater reliability was employed to determine the reliability of the EWTSAT. The inter-rater reliability was calculated using Kendall's Coefficient of Concordance and the size of the concordance was found to be 0.76. Mean was used to answer the research questions; while ANCOVA was employed to test the hypotheses. The study found out that cognitive task analysis-based instructional guide is more effective in improving students' skill achievement in electronics work than traditional task analysis-based instructional guide. There was an effect of gender on students' skill achievement in electronics work favouring boys. The study found out that there are no significant interaction effects of treatment and gender on technical college students' skill achievement in electronics work. It was therefore, recommended among others that Electronics teachers should adopt the use of cognitive task analysis-based instructional guide in teaching electronics, and More encouragements should be provided to the female students to improve their performance in skills-related courses such as electronics.

Index Terms – Cognitive Task Analysis, Traditional Task Analysis, Skill Achievement, Electronics Work, Instructional Guide, Troubleshooting and Technical Colleges

Introduction

Electronics work is a course offered at technical college level in Nigeria. The major objective of this course according to the [1] is to train craftsmen to acquire skills to be able to troubleshoot electronics equipment effectively. However, due to the present rapid advancement in electronics technology, troubleshooting electronics equipment is increasingly becoming complex. In the same vein, learning to troubleshoot electronics equipment and training to do so is also becoming difficult. Literature has shown that task analysis could be used to enhance skills training in complex task [2]**.** A task is an observable and measurable unit of work activity that forms a significant part of a job. Task analysis (TA) therefore, is a process of breaking down large tasks into smaller tasks manageable by learners. Clark [3] described TA as the process of breaking down complex learning or tasks into simpler parts, then sequencing those parts for more predictably efficient training. The author further noted that people learn best when complex tasks are broken down into smaller, more manageable tasks and mastered separately. TA in essence, is the analysis of how a task is accomplished, including a detail description of both manual and mental activities, task element duration, task frequency, task allocation, task complexity, environmental conditions, necessary tools and equipment and any other unique factors involved in or required for one or more people to perform a given task.

TA according to [4] is classified into two major categories: Traditional task analysis (TTA) and cognitive task analysis (CTA). TTA refers to a breakdown of observable task performance into a series of overt observable behaviours that support the performance. CTA on the other hand, is the extension of traditional task analysis techniques to yield information about the thought processes that underlie observable task performance. CTA provides a systematic process for identifying the cognitive elements and activities needed for task performance. TTA segments a job into behaviourally distinct tasks and their component activities, and then determines the skills needed for each. In CTA, skills are analyzed in substantially more detail based on their cognitive components [5]. The distinction between TTA and CTA mainly lies on overt physical actions and covert cognitive process. In essence, TTA focuses only on observable behavior and does not offer information on overall organization of knowledge, while CTA goes further to determine the critical decisions

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and thought processes necessary for task performance and also identify the knowledge needed to perform the tasks at various levels, thus providing a holistic view of task performance and enhancing flexibility in learning. TTA also known as behavioural task analysis is concerned with the physical steps that the learner must go through in order to complete a task, while CTA is concerned with what the learner must know or be able to do in order to complete a task [6]. TA according to [7] is performed for several purposes including designing instruction in education. Task analysis performed for the purpose of designing instruction is concerned with articulating what the learner is required to do in terms of actions and/or cognitive processes to achieve identified objectives.

TTA and CTA are useful in practical skills instruction as they both highlight key aspects of a task. TTA process majorly involves breaking a task down into functional behavioural units. The key strength of the TTA is the ability to examine overt behaviours required to complete a task. TTA largely ignore cognitive skills required to perform a task. CTA goes beyond TTA and provides systematic approach for obtaining, from multiple subject-matter experts (SME), accurate and complete expert knowledge and cognitive skills required to perform a task. SME is a person with extensive experience who is able to perform a class of tasks rapidly and successfully [8]. Through observations and interviews with multiple SMEs, followed by the analysis and synthesis of different experts' versions of a task, the most essential knowledge and skills are captured by the analyst and incorporated into skills instruction [9]. The authors further noted that CTA is a relatively new educational approach that has been used in complex tasks with great success in the military and the health care field. Hence, cognitive task analysis is an approach that uses a variety of strategies to capture a description of the decisions and knowledge that experts use to perform complex tasks. Complex tasks are defined as those where performance requires the integrated use of both declarative (conceptual) and procedural (strategic) knowledge to perform tasks that often extend over many hours or days [10]. Therefore, when the mental models used by experts can be elicited and represented by CTA, there is good evidence that it can be captured in an instructional guide and taught to students in order to improve skills performance [11]. In other words, skills performance in electronics work may be improved with the use of task analysis-based instructional guide.

An instructional guide is defined as step-by-step information for carrying out instruction which contains brief explanations and graphic or pictorial illustrations as needed [12]. Task analysis-based instructional guide is therefore, a step-by-step information on the procedure for carrying out practical tasks which is developed by breaking down complex or large tasks into smaller ones for easy learning. Instructional guide provide a systematic step-by-step instructions that take learners from start to finish of a learning activity. Miller [13] stated that an instructional guide provides a planned and logical organization of practical content and the instructional process designed to meet a given educational goal. The author further noted that instructional guide requires the selection and use of tools, equipment and materials. Appropriate checks and standards are also included so that the users know when a step is performed properly. Instructional guide provides a platform for instruction that engages all students in rigorous and dynamic learning which is necessary for practical skills acquisition. Task analysis-based instructional guide has the potentials to promote learning which may result in better mastery of skills in electronics. Therefore, it may be used to improve student skills achievement.

Skills achievement connotes students' performance in practical skills. Practical skills therefore, refer to individuals' expertise or ability to perform a given task which is developed in the course of training and experience [14]. Practical skills relate to the application of knowledge, theory and/or skills students have acquired to complete real life tasks. Ochiaga [15] stated that practical skills are those skills acquired through the use of tools or equipment to perform tasks that are related to a field of study which include procedural and manipulative skills, observational skills, drawing skills, reporting and interpretative skills. The increasing unemployment is an indication that graduates lack these practical skills. Hence, the need to improve students' skills achievement.

Skills achievement in technical education, especially electronics work has also been linked to gender, as it is believed that technical trades and related tasks belong to the male students. For instance, [16] opined that males perform better than females on tasks requiring logical operation. This may be responsible for the ratio of males and females students' enrolment in technical colleges. Task analysis-based instructional guide may offer tools for reducing gender differences in instructional setting. Even though gender issues contribute to student academic performance in vocational courses like electronics works, a review of literature suggest that relatively little empirical efforts has been applied on investigating the effects of gender on student's skills achievement in electronics work.

Electronics work students as noted earlier are expected to troubleshoot or trace faults and repair electronics appliances. Troubleshooting in electronics according to [17] is the act of detecting, locating and rectifying faults in electronics systems. Electronics troubleshooting is a complex activity that needs to be

taught with effective instructional approach like task analysis. It is in this regard that [18] suggested that task analysis should be used when a task is complex, when it is difficult to learn and when tasks are not pre-sequenced. It can therefore, be deduced that the acquisition of practical skills especially in troubleshooting which is a major part of electronics work can be studied with the use of task analysis-based instructional guide because the educational benefits for learning skills related courses such as electronics work with the instructional guide are promising. Although TTA and CTA are purported to have the potential to enhance skills acquisition, it is not quite certain whether TTA or CTA may be more effective in achieving better learning outcome in electronics work. It is on the above premise that the study sought to determine the comparative effects of cognitive and traditional task analysis-based instructional guides on technical college student's skills achievement in electronics work.

Theoretical Framework

A theory is a set of interrelated constructs, definitions, and propositions that present a rational view of phenomena by explaining or predicting relationships among those elements. Theoretical framework therefore, is a set of theoretical assumption that explains the relationships among a set of phenomena [19]. Consequently, the following theories of learning are reviewed:

Behaviorism theory: Behaviorism theory was propounded by John Broadus Watson (1878-1958) in 1913. The theory states that human behaviour is a connection among stimuli, respond and reinforcement. The theory focuses on the objective and observable components of behaviour and the type of learning that is best explained by this theory is task-based learning. Although J.B Watson propounded the theory, his work was based on the experiments of Ivan Pavlov's classical conditioning. Other major proponents of this theory include: B.F Skinner, Edward L. Thorndike, Edwin Guthrie and William Kaye Estes. The behaviorist theory is based on the principle of "stimulus response". That is, all behaviors are caused by external stimuli. This theory perceived human behavior as connections among stimuli, reinforcement and response [20]. For instance, if a radio receiver is not loud enough and a student in turning the volume control, the loudness increases; any other time such low output is observed, the student will turn the particular knob to increase the loudness. It can be said that the student has learnt how to increase the volume of the radio receiver as a result of association between a stimulus and the response. The theory of behaviorism concentrates on the study of overt behaviors that can be observed and measured [21]. Hence, the theory is based on observable changes in behaviour. It views the mind as a "black box" in the sense that response to stimulus can be observe quantitatively, totally ignoring the possibility of thought processes occurring in the mind. Therefore, the behaviorist learning theory centered on that which was observable, not considering that there is anything occurring inside the mind.

B.F Skinner is known for the theory of operant conditioning. The most established learning theory before operant conditioning was classical conditioning by Ivan Pavlov who believes that behaviour consisted of involuntary physical responses to external stimuli [22]. Pavlov's theory heavily influenced thoughts about learning until B.F Skinner proposed operant conditioning (foundation for Behaviourism). Skinner felt that human learners could exercise mental control over their behaviour and their responses to stimuli could be shaped by the type of reinforcement they received. Teachers, in Skinner's view, are expected to arrange the contingencies of reinforcement in ways that promoted and supported students learning [23]. Skinner identified several situations that could shape learner behaviour: Punishment, positive, and negative reinforcement. Skinner's operant conditioning hinges on the fact that learning best occurs when a reward is provided after an organism makes the desired response (operant). When a response occurs and is reinforced, the probability that it will occur again in the presence of similar stimuli is increased. Learning therefore occurs when behavioral change has occurred.

Skinner rejects inner mental causes of behaviour. Such entities as desires, intentions, decisions and inherited tendencies according to him have nothing to do with influencing behaviour because they are not only observable, but because they are of no explanatory value. He asserts that all human behaviour is a function of environmental variables such as stimulus and response [22]. Stimulus and response conditioning also known as behaviourism relies on the teacher directed approaches, student receptiveness, curriculum sequencing from prerequisite to advanced skills, mastery, systematic instructional design and objective testing to assess competence.

This theory is very important because it helps the instructional designer to analyze situation and sets a goal. Individual tasks are broken down and learning objectives developed. This can effectively facilitate mastery of the content of a profession. Furthermore, behaviourism theory applies to this study as the type of learning that is best explained by this theory is task-based learning. Similarly, since behaviourism is based upon observable behaviours, it is easier to quantify and collect data and information when conducting research. Hence the theory is adopted for this study.

Cognitive Learning theories: Cognitive learning theories are learning theories of psychology that attempts to explain human behaviour by understanding the thought process. These theories include that of gestalt psychologists and that of cognitive revolution psychologists. The gestalt psychologists led by Max Wertheimer (1880-1946), Wolfgang Kohler (1887-1967) and Kurt Koffka (1886-1941) made substantial contribution to gestalt psychology and emphasized the importance of organizational process of perception, learning and problem solving. The prominent cognitive psychologists involved in cognitive revolution in response to behaviourism are Jean Piaget (1896-1980) and Lev Vygotsky (1896-1934). Cognitive psychologists challenge the limitation of behaviorism in its focus on observable behavior. They incorporate mental structure and process into their learning theories. Hence, cognitivism is based on the thought process behind any behavior. Changes in behavior are observed, and used as indicators as to what is happening inside the learners mind [24]. Cognitive theorists recognize that much learning involves associations established through contiguity and repetition. They also acknowledge the importance of reinforcement, although they stress its role in providing feedback about the correctness of responses over its role as a motivator. However, even while accepting such behaviorist concepts, cognitive theorists view learning as involving the acquisition or reorganization of the cognitive structures through which humans process and store information [21]. Cognitivism focuses on the inner mental activities. That is, considering what happens in the human mind is valuable and necessary for understanding how people learn. Mental process such as thinking, Memory, knowing, and problem-solving need to be explored. Therefore, the major cognitive theory of learning reviewed in this study is gestalt cognitive theory.

Gestalt cognitive theory states that for leaning to take place, there must be unobservable changes in mental or cognitive structures. Therefore, changes in behaviour are observed and used as indicators as to what is happening inside the learners mind. Cognitive theorists view learning as involving the acquisition or reorganization of cognitive structures through which humans process and store information. Gestalt psychologist believed that knowledge comes from more than just experience; it also involves the knower actively imposing organization on sensory data. They emphasized the importance of organizational process of perception, learning and problem-solving [25].

Furthermore, [25] noted the following as general educational implications of cognitive theories: (a)Cognitive processes influence learning. (b)Learning difficulties often indicate ineffective or inappropriate cognitive processes. (c)As children grow, they become capable of increasingly more sophisticated thought. (d)People organize the things they learn. Therefore, teachers can facilitate students learning by presenting information in an organized manner (e)New information is most easily acquired when people can associate it with things they have already learned. Teachers should then show how new ideas relate to previous learning (f)People control their own learning. Ultimately student, not their teachers determines what things will be learned and how they will be learned. Cognitive theory is significant to the entire learning process because, it stresses on human intelligent and its potential for helping learners to retain, process and apply acquired information in future [12]. This theory encourages problem-solving learning which is necessary in teaching troubleshooting in Electronics. For instance, [26] stated that cognitivism is suited well for problem solving, where the concepts are complex and must be broken down into smaller parts. Ideas and concepts from these problems are linked to prior knowledge which in turn helps the learner develop a stronger comprehension. Based on this assumption, the theory of cognitivism becomes important to this study and it is therefore adopted for this study.

The review of literature on behaviourism and cognitivism has shown that behaviorism and cognitivism are both objective in nature and they both support the practice of analyzing a task and breaking it down into manageable chunks, establishing objectives, and measuring performance based on those objectives.

Purpose of the Study

The general purpose of the study is to determine the comparative effects of cognitive and traditional task analysis-based instructional guides on student's skills achievement in electronics work. Specifically, the study determined the effect of:

1. Cognitive and traditional task analysis-based instruction on students' skills achievement in electronics work.
2. Gender on the skills achievement of students taught electronics work with task analysis-based instructional guides.

Research Questions

The following research questions guided the study:

1. What is the effect of cognitive and traditional task analysis-based instruction on students' skills achievement in electronics work?
2. What is the effect of gender on the skills achievement of students taught electronics work with task analysis-based instructional guides?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the skills achievement mean scores of students taught electronics work with cognitive task analysis-based instructional guide and those taught with traditional task analysis-based instructional guide.

HO_2: Gender will have no significant effect on the skills achievement mean scores of students taught electronics work with task analysis instructional guides.

HO_3: There is no significant interaction effect of treatment given to students and their gender with respect to their skills achievement mean scores in electronics work

Methodology

The study adopted a quasi-experimental design. Specifically, the Pre-test Post-test non-equivalent control group design was used. The study was conducted in four technical colleges offering Electronics work in North-Central States of Nigeria. These include Federal Science and Technical College Shiroro-Kuta in Niger state, Federal Science Technical College Orozo, FCT Abuja, Government Technical College Assakio, Nassarawa state, Government Technical College Markudi, Benue State. The Population for the study consisted of all the 174 technical college III (TC III) student of all the four technical colleges offering Electronics work in North Central States of Nigeria. The entire population of 174 students was used for the study from which 90 TC III students which comprised 79 male and 11 female constituted treatment groups assigned to cognitive task analysis-based instructional guide, and 84 TC III students which comprised of 65 male and 19 female constituted another treatment groups assigned to traditional task analysis-based instructional guide. The instrument that was used for data collection is: Electronics Work Troubleshooting Skill Achievement Test (EWTSAT). The instrument was face and content validated by three experts in Vocational Education. The inter-rater reliability was employed to determine the reliability of the EWTSAT. The inter-rater reliability was calculated using Kendall's Coefficient of Concordance and the size of the concordance was found to be 0.76. Data were collected by subjecting two treatment groups to Pre and Post-tests, in which the EWTSAT was used to collect data on students' scores on skill achievement in Electronics work. Data collected were analyzed using Mean and ANCOVA. Mean was used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance.

Result

Research Question 1

What is the effect of cognitive and traditional task analysis on students' skills achievement in electronics work?

Table 1

Pretest and Posttest Mean Scores of Treatment Groups Taught Electronics Work with Cognitive and Traditional Task Analysis in Electronics Work Troubleshooting Skills Achievement Test

GROUP	N	PRETEST SCORE $\bar{X}$	POSTTEST SCORE $\bar{X}$	MEAN GAIN $\bar{X}$
CTA	90	24.69	65.60	40.91
TTA	84	24.05	57.18	33.13

The data presented in Table 1 show that the treatment group taught electronics work with cognitive task analysis had a mean score of 24.69 in the pretest and a mean score of 65.60 in the posttest making a pretest, posttest mean gain in the treatment group taught with cognitive task analysis to be 40.91. The treatment group taught electronics work with traditional task analysis had a mean score of 24.05 in the pretest and a posttest mean of 57.18 with pretest, posttest mean gain of 33.13. With these results, both cognitive and traditional task analysis are effective in improving students' skills achievement in electronics work, but the effect of cognitive task analysis on students' skill achievement in electronics work is higher than the effect of traditional task analysis.

Research Question 2

What is the effect of gender on the skills achievement of students taught electronics work with task analysis instructional techniques?

Table 2

Pretest and Posttest Mean Scores of Male and Female Students Taught Electronics Work with Cognitive and Traditional Task Analysis in Electronics Work Troubleshooting Skill Achievement Test.

	COGNITIVE TASK ANALYSIS				TRADITOINAL TASK ANALYSIS			
Gender	**N**	**PT_1 $\bar{X}$**	**PT_2 $\bar{X}$**	**MG $\bar{X}$**	**N**	**PT_1 $\bar{X}$**	**PT_2 $\bar{X}$**	**MG $\bar{X}$**
Male	79	23.37	67.70	44.33	65	24.23	27.37	3.14
Female	11	24.00	62.18	38.18	19	23.42	26.53	3.11

*PT_1 = PRETEST SCORE
PT_2 = POSTTEST SCORE
MG = MEAN GAIN

The data presented in Table 2 show that male students taught Electronics work with cognitive task analysis had a mean score of 23.37 in the preset and a mean score of 67.70 in the posttest making a pretest, posttest mean gain in the male students taught with cognitive task analysis to be 44.33. Female students taught electronics

work with cognitive task analysis had a mean score of 24.00 in the pretest and a posttest mean of 62.18 with a pretest, posttest mean gain of 38.18. Also, male students taught with Traditional task analysis had a mean score of 24.23 in the pretest and a mean score of 27.37 in the pretest making a pretest, posttest mean gain in the male student taught with traditional task analysis to be 3.14. Meanwhile, female students taught electronics work with Traditional task analysis had a mean score 23.42 in the pretest and a posttest mean of 26.53 with a pretest, posttest mean gain of 3.11. These results shows that male and female student taught electronics work with cognitive task analysis had higher mean gain scores than male and female students taught electronics work with traditional task analysis in the skill achievement test. The result further shows that male students in both cognitive and traditional task analysis groups had higher mean gain scores than female students in the same groups in the skill achievement test. Hence there is an effect attributed to gender on the skill achievement of students taught electronics work with cognitive and traditional task analysis.

Hypotheses

$H0_1$: There is no significant difference in the skills achievement mean scores of students taught electronics work with cognitive task analysis-based instructional guide and those taught with traditional task analysis-based instructional guide.

$H0_2$: Gender will have no significant effect on the skills achievement mean scores of students taught electronics work with task analysis instructional techniques.

$H0_3$: There is no significant interaction effect of treatments given to students and their gender with respect to their skills achievement mean scores in electronics work.

Table 3

Summary of Analysis of Covariance (ANCOVA) for Test of Significance of Three Effects: Treatments, Gender and Interaction Effect of Treatments and Gender on Students Skills Achievement in Electronics Works.

SOURCE	SUM OF SQUARE	DF	MEAN SQUARE	F	SIG. OF F
Covariate	82.165	3	27.388	.878	.454
	68490.728	3	22830.243	182.400	.000
Intercept	141420.372	1	141420.372	1.130E3	.000
Treatment	13418.060	1	13418.060	107.202	.000
Gender	6879.589	1	6879.589	54.964	.000
Treatment *Gender	62211.023	1	6221.023	49.702	.542
Error	21278.221	170	125.166		
Total	458229.000	174			
Corrected Total	89769.948	173			

***Significant at Sig of F<.05**

The data presented in Table 7 shows F-calculated values for three effects: treatment, gender and interaction effect of treatments and gender on students' skills achievement in Electronics work. The F-calculated value for treatment is 107.202 with a significance of F at .000 which is less than .05. This result shows that there is a significant difference between the effect of treatments (cognitive task analysis-based instructional guide and traditional task analysis-based instructional guide) on students skills achievement in Electronics work. The null-hypothesis is therefore rejected at .05 level of significance, while the alternative hypothesis is accepted. Hence, there is significant difference in the skills achievement mean score of students taught electronics work with cognitive task analysis-based instructional guide and those taught with traditional task analysis-based instructional guide.

The F-calculated value for gender is 54.964 with a significance of F at .000 which is less than .05. This result implies that there is a significant difference between the effects of gender on students' skills achievement in electronics work. Therefore, the null hypothesis of no significant effect of gender (male and female) on students' skill achievement mean scores in electronics work is rejected at .05 level of significance. Hence, there is significant effect of gender on the skills achievement mean score of students taught electronics work with task analysis instructional techniques. The interaction of treatments and gender has F-calculated value of 49.702 with significance of F of .542 which is higher than .05. This result implies that there is no significant interaction effect of treatments and gender. Therefore the null hypothesis is accepted. Hence, there is no significant interaction effect of treatments given to students and their gender with respect to their skills achievement mean scores in electronics work.

Findings of the Study

Based on the data collected and analyzed, the following findings emerged from the study:

1. Cognitive and traditional task analysis-based instructional guides were effective in improving students' skills achievement in electronics work but cognitive task analysis-based instructional guide was more effective than traditional task analysis-based instructional guide.

2. Gender had an effect on the skill achievement of students in electronics work in favour of male students.

3. There was a significant difference in the skill achievement mean score of students taught

electronics work with cognitive task analysis-based instructional guide and those taught with traditional task analysis-based instructional guide.

4. There was a significant effect of gender on student skills achievement in electronics work in favour of boys

5. There was no significant interaction effect of treatments given to students and their gender with respect to their skill achievement mean score in electronics work

Discussion

The data presented in Table 1 provided answer to research question one. Findings revealed that Cognitive and Traditional task analysis-based instructional guides are effective in improving students' skills achievement in electronics work but the effect of cognitive task analysis-based instructional guide (CTA) is higher than the effect of traditional task analysis-based instructional guide (TTA) as it was observed that those taught with CTA had higher post test mean scores than those taught with TTA. Analysis of covariance was used to test the first hypothesis, Table 3. At the calculated F-value (107.202), significance F (.000) and confidence level of .05, there was a statistically significant difference between the effect of treatments (cognitive and traditional task analysis-based instructional guides) on students' skills achievement in electronics work. The finding confirmed that the difference between the effect of cognitive and traditional task analysis-based instructional guides was statistically significant. The implication of this finding is that cognitive task analysis-based instructional guide is more effective than traditional task analysis-based instructional guide in improving students' skills achievement in electronics work. This finding is similar to the finding of [27], who compared effect of cognitive and traditional task analysis instruction and reported that cognitive task analysis-based instruction is more effective than traditional task analysis-based instruction. A possible explanation of this finding could be the fact that in cognitive task analysis, skills are analyzed in substantially more detail based on their cognitive components such as knowledge, mental processes and decisions that are required for task performance [5]. Similarly, in the view of [6], while traditional task analysis focuses only on observable behaviour in skills performance, cognitive task analysis goes further to determine the critical decisions and thought process necessary for task performance. Therefore, the greater effect of cognitive task analysis-based instructional guide over traditional task analysis-based instructional guide is attributed to the fact that cognitive task analysis-based instructional guide developed from the product of a more detailed analysis facilitated a better performance of the treatment group assigned to cognitive task analysis.

Furthermore, data presented on Table 2 provided answer to research question two. Findings revealed that male students taught with task analysis had higher mean scores than female students in the Electronics Work Skills Achievement Test. Analysis of covariance was used to test the second hypothesis, Table 3, at the calculated F-value (54.964), significance of F (.000) and confidence level of .05, there was a significant difference between the main effect of gender (male and female) on students' skills achievement in electronics work which confirmed that the difference between the skills achievement of male and female students in electronics work was statistically significant favouring boys. The implication of this finding is that there was an effect attributable to gender on skills achievement of students in electronics work. This finding might be due to the fact that male student are generally perceived as superior to female in manipulative skills. This finding is similar to the findings of other studies that had been conducted on the effect of gender on skills achievement of male and female students in technical education. For instance, [16] and [28] in their separate studies reported that the skills performance of male is better than their female counterparts in technical education. This implies that males are superior to females in skills related areas such as technical education. Furthermore, [31] pointed out that generally, boys are found to be consistently performing better than girls in vocational and technical skills achievement tests. Thus, the superiority of male in vocational and technical skills is responsible for their improved skills achievement in electronics work after being taught with task analysis-based instructional guides.

Analysis of covariance was used to test the third hypothesis, Table 3. At the calculated F-value (49.702), significance of F (.542) and confidence level of .05, there was no significant interaction effect of treatments given to students taught with task analysis-based instructional guides and their gender with respect to their mean scores on Electronics Work Skills Achievement Test. This result indicates that the effectiveness of task analysis- based instruction does not depend on the level of gender. Hence, there were no differential effect of treatments over level of gender (male and female), which implies that cognitive task analysis-based instructional guide is more effective than traditional task analysis-based instructional guide in improving students skills achievement in electronics work regardless of gender levels.

Additionally, even though cognitive task analysis-based instructional guide is more effective than traditional task analysis-based instructional guide in improving students skills achievement, both instructional guides have positive effect on students achievement. The improved

skills achievement in cognitive and traditional task analysis treatment groups support the cognitivism and behaviourism learning theories as behaviourism emphasizes that for learning to have taken place, there must be observable changes in the behaviour while cognitivism concentrates on the thought process behind the behaviour; and these are the major components of cognitive and traditional task analysis-based instructional guides.

Conclusion

The present rapid electronics technology development which has lead to the complexity and difficulty of electronics troubleshooting experienced by technical college students has given rise to the need of task analysis-based instruction in order to assist electronics graduates to acquire adequate skills necessary for employment in the changing workplace. Consequent upon this, the study determined the effect of cognitive and traditional task analysis-based instructional guides on students skill achievement in electronics work and found out that cognitive task analysis-based instructional guide is more effective than traditional task analysis-based instructional guide in enhancing students' skills achievement in electronics work. In addition, the study revealed that there was an effect attributed to gender on students' skills achievement in electronics work. The study however found no significant interaction effect of treatment and gender on students' skills achievement in electronics work. This implies that the effectiveness cognitive task analysis-based instruction in improving student achievement does not depend on gender. It then therefore mean that cognitive task analysis-based instruction is a dependable option for teaching and learning in the present era of rapid technological development as it promote active and efficient learning which can lead to the acquisition of necessary skills for employment.

Recommendations

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

1. Electronics teachers should adopt the use of cognitive task analysis-based instructional guide in teaching electronics troubleshooting.
2. Cognitive task analysis-based instructional guide should be incorporated into the teaching of electronics work by National Board for Technical Education as the board is responsible for standardization and harmonization of programmes in technical colleges.
3. More encouragements should be provided to the female students to improve their performance in skills-related courses such as electronics.

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