EFFECT OF INTELLIGENT TUTOR IN ENHANCING THINK-PAIR-SHARE IN LEARNING OF LIGHT EMITTING DIODE TELEVISION TROUBLESHOOTING

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***Abstract**: The study determined the effect of Intelligent Tutor (IT) in enhancing Think-Pair-Share (TPS) in learning of LED TV troubleshooting. One research question and one null hypothesis tested at .05 level of significance guided the study. The study adopted quasi-experimental design, involving pre-test, post-test, non-equivalent treatment groups A and B using a population of 329 electronic students. Multistage random sampling technique was used to select a sample of 166 electronic students from Technical Colleges offering Radio, Television and Electronic Work trade (RTVE) at National Technical Certificate (NTC) level in North-west, Nigeria. The instruments for data collection is LED TV Troubleshooting Skills Performance Test (TTSPT). The TTSPT and reters' guide along with lesson plans, teacher training manual and tables of specifications were validated by two electronic experts in the Department of Industrial and Technology Education, Federal University of Technology Minna, Niger state and one in the Department of Vocational and Technology Education, Abubakar Tafawa Balewa University Bauchi, Bauchi state. Inter-rater technique was used to find out the reliability of the TTSPT in which three raters used a scoring guide to rate 20 electronic students in the pilot tested class on their LED TV troubleshooting skills. The inter rater reliability was calculated using Kendall's Coefficient of Concordance and the size of the concordance was found to be .87 which shows that there was high agreement among the raters, and therefore, the instrument has score reliability. The internal consistency of the TTSPT was checked using Kuder-Richardson 20 (KR20) and was found to be 0.76. Data was collected by administering TTSPT on treatment groups A and B of TC II electronic students as pre-test and post-test. The mean gain of each group was computed to answer the research question while ANCOVA was used to test the null hypothesis at .05 level of significance. Findings that emerged from the investigation revealed that the effect of IT for enhancing TPS learning method on students' LED TV troubleshooting skills performance is higher than the effect of Traditional Workshop Practice for enhancing TPS learning method. Based on this finding, it was concluded that the IT which was augmented with TPS learning method is a reliable opportunity for enhancing electronic students' skills performance in LED TV troubleshooting. It was therefore recommended that State and Federal Ministries of Education should provide the needed support in terms of facilities and equipment for the planning, inclusion and implementation of IT for enhancing TPS in learning of LED TV troubleshooting in Technical Collages in North-West, Nigeria.*

***Keywords:** Intelligent Tutor, Think-Pair-Share learning, Light Emitting Diode Television, Principles of Operation, Power Subsystem, Picture Subsystem and Sound Subsystem*

1. INTRODUCTION

In the advent of rapid technological advancement, the circuitry of modern electronic devices such as Light Emitting Diodes (LED) Television (TV) are becoming more complex. As such, electronic students are finding it more difficult to understand the principles of operation and how to troubleshoot LED TVs. Various attempts are being made towards improving electronic students' troubleshooting skills performance however, conventional efforts alone which are characterized by poor utilization of multimedia auditory and visual channels (Mayer, 2011) are not yielding satisfactory results. To this end, the role of teachers and trainers is gradually changing from the traditional lock-step givers of knowledge into that of facilitators of learning. Most of the traditional preparation and correction time is now being dedicated to developing educational software in form of Intelligent Tutor (IT), suitable for an individualized delivery approach. Unlike in traditional workshop practice in learning of LED TV troubleshooting, IT brings with it a host of several potential benefits as a learning medium. These include among other advantages: self-paced learning, self-directed learning, and exercising of various human senses of auditory and visual channels (Olawale, 2013).

With self-paced learning, students can move as slowly or as quickly as they can by answering questions which the IT poses to them at the end of each learning session. The learner answers the questions about the lesson and gets immediate feedback. If they want to repeat some task or review some material again, they can do so as many times and according to their levels of cognitive abilities. With self-directed learning, students can decide what they want to learn and in what order. Self-paced and safe-directed learnings have been reported to improve students' achievement in electrochemistry which is related to technology based courses such as LED TV troubleshooting in Nigeria (Oloyede & Adekunle, 2009). Even though the IT could improve students' understanding, it may not give them the full opportunity to manipulate and master the use of working tools and instruments such as mustimeter, oscilloscope and other equipment which are involved in the real life troubleshooting of LED TV. The IT can therefore be augmented with Think-Pair-Share (TPS) learning method for more effective learning of LED TV troubleshooting.

TPS is a cooperative learning method that encourages individual student's participation as he/she practices the LED TV troubleshooting in the company of his/her peers. Dange (2015) reported that students remember only 20% of what they hear, 30% of what they see, but 90% of what they hear, see and practice cooperatively. This may be achieved with the use of IT and TPS learning methods. The steps in TPS learning method according to Endang and Amin (2015) are: (a) Think: Students think independently about the lesson learnt from LED TV troubleshooting IT, recollecting ideas on their own; (b) Pair: Students are grouped in pairs to discuss and practice their thoughts; and (c) Share: Students share their ideas and experiences with a larger group in accomplishing the LED TV troubleshooting task. Thus, students' troubleshooting skills may become more refined through this three-step learning process. Therefore, the integration of IT with TPS learning method may enable students to remember and reconstruct their learning experiences by practicing the troubleshooting with real tools and instruments. More so, TPS learning method is practicable with large class size and across all age groups (McGregor, 2006). This may give the method an edge over other cooperative learning methods such as Student Team Achievement Division (STAD) and Jigsaw in improving students' understanding of the principles of operation of LED TV.

The principles of operation of LED TV involve the process of receiving, selecting and processing TV signals to present video and audio outputs in a high quality manner. Describing this process, Jean (2011) reported that one of the inputs to the LED TV receiver is a composite TV signal from the tuner which is fed to the master Integrated Circuit (IC). The outputs of this IC are sound and video Intermediate Frequencies (SIF and VIF) which are further processed and outputted in the form of video display on the LED TV screen or sound through the speakers. To make this process even more complicated, additional Intelligence Unit (IU) is located in the master IC that is responsible for manipulating the signals for better video quality which a novice may take as the function of the Timing Control Unit (T-CON) (Panasonic, 2013). Therefore in LED TV system, problems or faults in the master IC connectors, such as vertical line defects may be misinterpreted as symptoms that resemble T-CON failure. Similarly, an electronic technician who does not really understand these principles of operation may identify faults that are caused by a broken panel as a RGB (Red-Green-Blue) cable failure.

This misunderstanding of the complex principles of operation of LED TV may be one of the reasons for ‘trial and error’ type of troubleshooting among electronic graduates in Nigeria. Therefore, for efficient troubleshooting of the system to be carried out by graduates, complex concepts must be clearly understood. Sorden (2015) asserted that visual analogy of complex processes can provide high level of content organisation, integration and assimilation among students. In other words, with the help of audio and visual elements as employed in IT, it may be easy to show complex processes that would otherwise need many words and other instructional aides to describe. In addition, combining the IT with TPS learning method may enhance individualised student’s efforts in handling tools and instruments as against traditional methods such demonstration where in most cases, students are passive learners (Slavin, 2011) of LED TV troubleshooting.

Troubleshooting is the act of logically detecting, locating and rectifying faults in electronic systems (Khandpur, 2003). The troubleshooting of LED TV system refers to the logical, systemic diagnosis and rectification of the source of a problem in order to make the system operational again. LED TV screens are made up of liquid-crystal gel sandwiched between two panes of polarized glass. Unlike plasma TV, the liquid-crystal does not create its own light. It requires LED backlight sources which are more efficient than their fluorescent tube counterparts – making the LED TV circuitry more complex. Furthermore, LED TV is broadly divided into three major subsystems which include the Power, Picture and Sound Subsystems (Sony, 2015). The need for troubleshooting these subsystems may arise in the cause of using the LED TV.

The function of the Power Subsystem is to receive 110-240 Volts of electrical energy which is rectified and then stepped down into different levels of Direct Current (DC) for onward distribution to the remaining LED TV circuitry. This function is aided by the major components of the Power Subsystem which according to LG Electronics (2015) include the chopper transformer, transistors, capacitors, diodes and resistors. These circuit components are mounted on a Printed Circuit Board (PCB) making them susceptible to failure under extreme environmental conditions. This is because LED TVs are entertainment devices which people may continue to use even under extreme conditions that are not recommended by their manufacturers. For instance, Sharp (2015) cautioned that LED TVs should be operated only within the scope of 20-80% humidity; and any humidity level beyond or below this scope can cause traces in transistors which are corrosion-prone leaving partial short circuit. Such condition may result to permanent gate biasing thereby influencing the transistor's threshold voltage which could result to a failure in the Power Subsystem that may require troubleshooting.

The troubleshooting of these types of problems may involve following step-by-step procedure to arrive at a solution. Apart from being so complicated, it may be extremely dangerous to troubleshoot the LED TV Power Subsystem in ignorance due to the electrical hazards involved at various voltage levels. This means that the troubleshooting of this subsystem may require much intellectual thought and understanding of the complex circuits using a reliable learning technique such as IT. According to Yasef (2012), in situations where complexity and risk are present, the use of IT may even be irreplaceable. Therefore, learning the troubleshooting of the Power Subsystem from the visual demonstration of the process as employed in IT may not only facilitate deeper understanding but also reduce students' exposure to the electrical hazards. Moreover, segmenting LED TV troubleshooting into frames and branches of lessons that treat this subsystem separately may allow students to achieve mastery at one level before they are allowed to proceed to the next level. Additionally, students' previous experience from the IT may reduce their possible mistakes in the TPS learning of the Power Subsystem troubleshooting. This is more so as failure in the Power Subsystem affects all other parts in LED TV such as the Picture Subsystem (Cheng, 2014).

The Picture or Video Subsystem is what ensures the display of the video contents of the TV signal. The major components of this subsystem include the Master IC, T-CON Board, RGB Cable and LED Panel (Sanyo, 2015). The LED panel or screen may be more prone to external influences because it is projected outside the system. Any ingress of foreign substances such as water can cause failure in this subsystem as there are a lot of wires that provide connections between components behind the LED TV screen. The use of many components in the Picture Subsystem led in part to the existence of subassemblies whose functions extend to other units. This example of increasing sophistications in LED TV subsystems may be why Titus (2016) advocated for the use of interactive techniques such as IT in the teaching of twenty first century employable skills. As such in IT development, attempts are made to combine words, pictures and feedback in ways that maximize learning effectiveness in transforming students from novice to experts. According to Ogwo and Oranu (2006), expertise in practical skills acquisition requires continuous rehearsals in order to master tools handling. This means that augmenting the IT with TPS learning of the LED TV Picture Subsystem troubleshooting could make such learning more permanent. Furthermore, it is worthy of notice that the Video Subsystem does not work in isolation but in conjunction with other units such as the Sound Subsystem.

The Sound Subsystem is responsible for the audio input and process in LED TV. The main components of this Subsystem include the Demodulation IC, Audio Frequency Amplifier (AF Amp) which is a single IC chip, Speaker and a collection of resistors and capacitors on the main circuit board (Panasonic, 2013). This subsystem is so complicated that most of the problems in LED TV such as 'no sound' are caused by such electronic components as ICs and capacitors which are sensitive to overheat (Sharp, 2015). These ICs and capacitors can fail, open or short under high temperature and while replacing them, technicians have to take note of the positions of many plates, screws, cables and wires which they dismantled. This is because it is possible to order for a part that can take months to arrive while the Sound Subsystem remains disassembled. Alternatively, such procedure for dismantling and reassembly of circuit components in the Sound Subsystem can be revisited using the videos and pictures that were incorporated in the IT which the students can use at their own paces of cognitive ability. This may be why Clark and Lyons (2011) asserted that multimedia resources such as IT are more effective in enhancing students' cooperative learning than traditional demonstration since the learner has the ability to control the presentation by slowing it down, stopping it and replaying it at his/her will which could have positive impact on his/her learning experiences.

The experiences students acquired from the IT are likely to be concretely internalized and when they are exposed to TPS learning, they may likely incorporate such experiences into already existing schemas of real life LED TV troubleshooting. Yusuf and Afolabi (2010) found a significant difference when they developed a Computer Assisted Instructional Package

(CAIP) to investigate the performance of students taught biology using the CAIP in cooperative and individualized learning settings and those taught with conventional classroom instruction. The students taught using cooperative computer assisted instruction was higher followed by those taught using individualized computer assisted instruction and then those taught using conventional method. On the contrary, Pichaya (2015) discovered a significant increase in students' achievement and attitude towards Mathematics when traditional lecture method was used to enhance TPS cooperative learning method in India. These contradicting discoveries pose the need to further experiment whether it is more suitable to enhance TPS learning method with the use of IT rather than traditional demonstration of how to troubleshoot LED TV. This can help electronic students in acquiring the much needed practical skills for future employment envisaged in LED TV troubleshooting. Unfortunately, according to the National Board for Technical Education (NBTE, 2001), the current curriculum for TV servicing in Technical Colleges is based on Cathode Ray Tube (CRT) TV. Hence, electronic students from this institution of learning are only equipped with knowledge and skills to troubleshoot CRT TVs after graduation.

Older TV technologies such as CRT and Plasma TVs are gradually becoming outdated compared to LED TVs which are now widely patronized by electronic users (Won *et al*., 2011). Therefore, the era of older TV technologies and the profitability in their troubleshooting is on a speedy decline. In fact, LED TVs are very common in our homes, offices, banks, hotels and other places. They are relatively lighter, more efficient, consume less power, have better picture as well as sound outputs and like other electronic appliances, LED TV can develop faults or breakdown. When this happens, efficient troubleshooting of the system requires the services of competent electronic graduates who are trained through effective instructional strategies. The real understanding of LED TV troubleshooting may require the use of IT to present meaningful links between the complex concepts using audio and visual elements. Mayer (2011) posited that students learn by active selection, organisation and integration of information from auditory and visual channels to real life practice. In other words, combining words, pictures, animations and practice may be more effective in prompting deeper learning of LED TV troubleshooting than the use of words alone. Consequently, it became imperative to compare the effect of IT and Traditional Workshop Practice (TWP) for enhancing TPS in learning of LED TV troubleshooting.

1.1 Theoretical Framework

The Constructivism Learning Theory: This theory is generally attributed to Piaget (1980) who puts forward the mechanisms by which learners internalize knowledge or what may be called meaningful learning. This theorist suggested that through the processes of accommodation and assimilation, individuals construct new knowledge from their experiences. Constructivist learning is based on the belief that learning occurs as learners are actively involved in the process of meaning and knowledge construction as opposed to passively receiving information (Brooks & Brooks, 1999). Consequently, constructivist learning fosters critical thinking, and creates motivated and independent learners. This theoretical assumption holds that learning always builds upon knowledge that a student already has which is called a schema. Because learning is filtered through pre-existing schemas, constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively.

Essentially in constructive learning, students engage in activities through which they develop skills and acquire concepts. In support of this opinion, Brooks and Brooks (1999) added that constructivist learning includes: (1) Learners construct their own meaning and are not passive receptacles. This is because learners do not easily process or transfer what they passively receive. In order to make knowledge useful in a new situation, students must make a deliberate effort to make sense of the information that comes to them and they must own it. They must also manipulate, discover, and create knowledge to fit their beliefs through interaction with the content to be learnt. (2) New learning builds on prior knowledge. In making an effort to make sense of information, students must make connections between old knowledge and new information. They must compare and question, challenge and investigate, accept or discard old information and beliefs in order to progress in cooperative or team assignments. (3) Learning is enhanced by social interaction. The constructivist process works best in social settings such as Think-Pair-Share learning where students can have the opportunity to compare and share their ideas with others (Slavin, 2010). Learning occurs as students attempt to resolve conflicting ideas. Although social interaction is frequently accomplished in small group activities, practical skills acquisitions involving the entire class may provide students the opportunity to vocalize their knowledge and learn from others. (4) Meaningful learning develops through "authentic" tasks. This aspect of constructivism is frequently misinterpreted. Using authentic tasks mean that activities are chosen to simulate and assimilate those tasks that will be encountered in real life assignment. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework of real life situation. This may occur when individuals' experiences are aligned with their internal representations of the world.

This theory is related to the present study as the assumptions of constructivist learning approaches were applied through students' engagement in TPS learning of LED TV troubleshooting after using the IT. The experiences they acquired from the IT were likely to be concretely internalized and when students were exposed to TPS learning, they may incorporate such experiences into already existing schemas of real life LED TV troubleshooting. Consequently, the combination of IT and TPS learning of LED TV troubleshooting as suggested by the assumptions of this theory was able to bring forth effective learning among electronic students; hence, the theory was adopted.

Research Question: What is the effect of IT and Traditional Workshop Practice (TWP) for enhancing TPS in learning of LED TV troubleshooting?

Null Hypothesis: There is no significance difference in the mean skills performance of electronic students taught using IT and TWP for enhancing TPS in learning of LED TV troubleshooting.

2. Methodology

The study adopted Quasi-Experimental design, involving pre-test, post-test, non-equivalent treatment groups which was used to test the effectiveness of the IT on students' skills performance in LED TV troubleshooting. Quasi-experimental design according to Fraenkel and Wallen (2003) can be used when it is not possible for the researcher to randomly sample the subjects and assign them to treatment groups without disrupting the academic programme of the schools involved in the study. This necessitated the use of six already existing (intact classes) randomly assigned to the two experimental groups A and B. Experimental group A was treated with the use of LED TV troubleshooting IT for enhancing TPS in learning of LED TV troubleshooting, while students in Experimental group B were treated with traditional method (TWP) followed by TPS in learning of LED TV troubleshooting. Both groups were given a LED TV Troubleshooting Skills Performance Test (TTSPT) before and after treatments. The design is symbolically illustrated as follows:

Group A: O_1 X_1 O_2

Group B: O_1 X_2 O_2

Where:

O_1 = Pre-test for both groups;

O_2 = Post-test for both groups;

X_1 = Treatment (Group A: Treated with the use of IT followed by TPS in learning of LED TV troubleshooting);

X_2 = Treatment (Group B: Treated with traditional method followed by TPS in learning of LED TV troubleshooting).

2.1 Area of the Study

The study was carried out in North-West, Nigeria. North-West geopolitical zone is made up of seven states, which include: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara states.

2.2 Population of the Study

The population for the study is 329 electronic students in the twelve Technical Colleges in North-West, Nigeria offering RTVE trade at NTC level. The distribution of the population of electronic students by Technical Colleges as obtained from the states' Science and Technical Education Boards (STEB) in the year 2018 is shown in Table 1.

Table 1: Distribution of the Population of Students by School

SN	Technical Colleges	Number of Students
1.	Government Technical College Hadeja, Jigawa	23
2.	Government Technical College Bunza, Kebbi	20
3.	Federal Science and Technical College Zuru, Kebbi	28
4.	Government Technical College Funtua, Katsina	26
5.	Government Technical College Mashi, Katsina	35
6.	Government Technical College Fadan Chawai, Kaduna	39
7.	Government Technical College Malali, Kaduna	30
8.	Government Technical College Binji, Sokoto	20
9.	Government Technical College Runjin Sambo, Sokoto	25
10.	Government Technical College Kano, Kano	36
11.	Government Technical College Wudil, Kano	25
12.	Government Technical College Gusau, Zamfara	22
	TOTAL POPULATION	**329**

Source: STEB (2018)

2.3 Sample and Sampling Technique

Multistage random sampling technique was used to select a sample of 166 electronic students from technical colleges in the area of the study. In the first stage, alphabetical arrangement was made such that the first alphabet of the town in which the school is located was used to select one technical college each from the seven states in North-West, Nigeria. For instance, GTC Bunza was selected in Kebbi state since it is located in a town whose name starts with an alphabet (B) that comes before (Z) in FSTC Zuru when arranged in alphabetical order. This system was used to select GTC Fadan Chawai in Kaduna state, GTC Kano in Kano state; GTC Funtua in Katsina state; and GTC Binji in Sokoto state. Moreover, GTC Hadeja, and GTC Gusau were automatically selected in Jigawa and Zamfara states since they had only one Technical College each offering RTVE trade at NTC level to give a total number of seven (7) Technical Colleges that were used for the study (see Table 1). The second stage involved another alphabetical arrangement of the towns in which the seven (7) schools are located and ranking of the Technical Colleges from First to Seventh for GTC Binji, Bunza, Fadan Chawai, Funtua, Gusau, Hadeja and Kano respectively. The alphabetical arrangements of the odd rank (First, Third, Fifth and Seventh) was assigned to Experimental Group A, with the exception of the 20 students from the First school which is GTC Binji that were used for the formative evaluation of the prototype IT package in accordance with stage eight of the R & D method. This gave a total of (39 + 22 + 36) = 97 electronic students in Experimental Group A. The even rank (Second, Fourth, and Sixth) was assigned to Experimental Group B, which gave a total of (20 + 26 + 23) = 69 electronic students.

2.4 Instrument for Data Collection

The instruments for data collection in this study is LED TV Troubleshooting Skills Performance Test (TTSPT). The TTSPT along with table of specification, rating scale, lesson plans and teachers' training manual were validated by two electronic experts in the Department of Industrial and Technology Education, Federal University of Technology Minna, Niger state and one electronic expert in the Department of Vocational and Technology Education, Abubakar Tafawa Balewa University Bauchi, Bauchi state. The experts were requested to suggest modifications on the structure of the items, organization as well as their appropriateness and then rated them according to their suitability for use in the present study. Inter-rater technique was used to find out the reliability of the TTSPT in which three raters used the scoring guide to rate 18 electronic students in the pilot tested class on their LED TV troubleshooting skills. The inter rater reliability was calculated using Kendall's Coefficient of Concordance and the size of the concordance was found to be .87 which shows that there was high agreement among the raters, and therefore, the instrument has score reliability. The internal consistency of the TTSPT was computed using Kuder-Richardson 20 (KR20) and was found to be 0.76.

2.5 Lesson Plan Development

The lesson plans for using the IT as well as traditional workshop practice for enhancing TPS in learning of LED TV troubleshooting was developed by the researcher in line with specific objectives of this study as follows: (1) the lesson plans for using the IT for enhancing TPS in learning of LED TV troubleshooting was prepared in tabular forms in which an outline of the activities/tasks that a student/teacher will perform in order to learn/teach or complete a major task are presented based on the objectives of each lesson. The number of subtasks or activities to be performed in a particular lesson which is significantly necessary for completion of the main task of LED TV troubleshooting depends on the objectives of the lesson. In this lesson plan, all the activities or subtasks are students-centred and teachers are only allowed to intervene where necessary. Furthermore, a means of evaluating each lesson was embedded in each lesson plan. (2) The lesson plans for using traditional workshop practice followed by TPS in learning of LED TV troubleshooting was prepared in tabular form in which a description of the steps/tasks that a teacher/student must perform in order to teach or complete a major task was presented based on the objectives of each lesson. This lesson plan is more of teacher activities (demonstrations) while students watch carefully and copy notes during the traditional LED TV troubleshooting workshop practice. Thereafter, students were allowed to engage in TPS learning of LED TV troubleshooting and teachers only intervened where necessary. A means of evaluating each lesson was also presented. These lesson plans were validated by three experts in electronic technology from Industrial and Technology Education Department, Federal University of Technology Minna in order to ensure uniformity and standard in each lesson plan. Their comments and observations were considered in preparing the final draft of the lesson plans.

2.6 Experimental Procedure

After the permission to carry out the study has been obtained from school principals, the study was conducted during the normal school lesson period. Two electronic teachers were randomly selected and used for teaching both treatment groups A and B. The IT was installed in the computers in the computer labs of the schools that were to learn using the IT package. The researcher organized a two-weeks training for the participating electronic teachers on how to use the IT, the procedure for TPS learning as well as how to use or rate students' LED TV troubleshooting skills before commencement of lessons. The training was carried out by following a planned training manual prepared by the researcher. Out of the seven (7) schools systematically selected for the study, one (GTC Binji) was used for formative evaluation of the prototype Intelligent Tutor, three were randomly assigned to treatment group A (GTC Fadan Chawai, Gusau and Kano), while the other three (3) were assigned to treatment group B (GTC Bunga, Funtua and Hadeja). Group A learnt using the IT for enhancing TPS in learning of LED TV troubleshooting while group B learnt using traditional workshop practice followed by TPS in learning of LED TV troubleshooting.

The treatment was carried out in four practical lessons conducted in four electronic workshop sessions for four weeks. Each group met once a week for a period of 90 minutes (two periods). The first 45 minutes (one periods) was dedicated to the use of LED TV troubleshooting IT/traditional workshop practice while the remaining 45 minutes were used for TPS learning. The two groups were subjected to a pre-test (TTSPT) before the treatment which was conducted by the teachers who are teaching these groups. The test was marked using the rater's guide prepared by the researcher so as to improve consistency in the award of marks by the teachers. After four weeks of treatment, post-tests (TTSPT) was administered in order to obtain students' scores in LED TV troubleshooting skills Performance.

2.7 Control of Extraneous Variables: The researcher controlled the following extraneous variables in the present study:

(1) Instrumentation: The instrument as well as rater's check list used by participating electronic teachers who assisted the researcher in rating students' LED TV troubleshooting skills Performance during pre-test and post-test were prepared by the researcher. This is in order to control threat that may arise from instrumentation. In addition, the tests question papers were withdrawn from the students and teachers immediately after the pre-test to avoid students becoming test wise.

(2) Experimental fidelity: The researcher organized a two-weeks training for participating teachers on how to use the IT, the procedure for TPS learning as well as how to use or rate students' LED TV troubleshooting skills. This training enabled the teachers to uniformly and correctly implement the experiment to void threats to experimental fidelity.

(3) Hawthorne effect: Students in both groups A and B were not informed about the research process so that student can exhibit their natural behaviors during the experiment to avoid Hawthorne effect. Hawthorne effect is a situation where the performance of research subjects is affected due to the fact that they are conscious of being involved in an experiment. Also, the treatments was administered at the same time and overall treatment time was the same for both groups.

(4) Experimental treatment diffusion: All the groups were located in different states to avoid interaction or treatment diffusion among subjects in the experimental groups during the study.

2.8 Method of Data Collection

Data was collected by administering TTSPT on TC II electronic students by the researcher with the help of research assistants who are electronic teachers in the various Technical Colleges that were involved in the study.

2.9 Method of Data Analysis

Statistical Package for Social Sciences (SPSS, Version 20.0) was used for the computation of data in this study. The mean gain of each group was computed to determine the effect of Intelligent Tutor/Traditional Workshop Practice in enhancing Think-Pair-Share in learning of LED TV troubleshooting while ANCOVA was used to test the hypothesis at .05 level of significance.

3. Results

***Research Question:* What is the effect of the developed IT package in enhancing TPS in learning of LED TV troubleshooting?**

Table 2: Pre-test and Post-test Mean Scores for LED TV Troubleshooting Skills Performance Test of Experiment Groups A and B

GROUP	N	PRE-TEST SCORE $\bar{X}$	POST-TEST SCORE $\bar{X}$	MEAN GAIN $\bar{X}$
A	97	32.44	66.29	33.85
B	69	25.65	44.06	18.41

Key:* $\bar{X}$*= Mean, SD = Standard Deviation

Result presented in Table 2 show that the experiment group A that were taught with IT for enhancing TPS in learning of LED TV troubleshooting had a mean score of 32.44 in the pre-test and a mean score of 66.29 in the post-test making a pre-test, post-test mean gain in this experiment group to be 33.85. The experiment group B that were taught with Traditional Workshop Practice (TWP) for enhancing TPS in learning of LED TV troubleshooting had a mean score of 25.65 in the pre-test and a post-test mean score of 44.06 yielding a pre-test, post-test mean gain of 18.41. With these results, both IT and TWP are effective in enhancing TPS in learning of LED TV troubleshooting, but the effect of IT and TPS learning methods on students' LED TV troubleshooting skills is higher than the effect of TWP and TPS learning methods.

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Null Hypothesis: There is no significant difference in the mean skills performance of electronic students taught using IT and those taught using traditional workshop practice for enhancing TPS in learning of LED TV troubleshooting.

Table 3: Analysis of Covariance (ANCOVA) for Test of Significance of Electronic Students Taught Using IT and Those Taught Using Traditional Workshop Practice (TWP) for Enhancing TPS in Learning of LED TV Troubleshooting

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	21470.263[a]	2	10735.132	122.619	.000	.573
Intercept	29077.880	1	29077.880	332.134	.000	.645
Covariance	16.495	1	16.495	.188	.665	.001
Groups A and B	17075.518	1	17075.518	195.040	.000	.516
Error	16021.393	163	87.549			
Total	664124.000	166				
Corrected Total	37491.656	165				

a. R Squared = .573 (Adjusted R Squared = .568)

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

The result presented in Table 3 shows that the F-calculated value for treatments (Groups A and B) is 195.040 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 (IT and TWP for enhancing TPS in learning of LED troubleshooting) on students' LED TV troubleshooting skills performance. The null-hypothesis is therefore rejected at .05 level of significance. Hence, there is significant difference in the mean skills performance of electronic students taught using IT and those taught using traditional workshop practice for enhancing TPS in learning of LED TV troubleshooting.

4. Discussion of Findings

The data presented in Table 2 provided answer to the research question. Findings showed that both Intelligent Tutor (IT) and Traditional Workshop Practice (TWP) are effective in enhancing Think-Pair-Share (TPS) in learning of LED TV troubleshooting, but the effect of IT and TPS learning methods on students' LED TV troubleshooting skills performance is higher than the effect of TWP and TPS learning methods. The Analysis of Covariance in Table 3 was used to test the null hypothesis at .05 level of significance. Findings indicated that there is a significant difference in the mean troubleshooting skills performance of electronic students taught using IT and those taught using TWP for enhancing TPS in learning of LED TV troubleshooting. This finding is similar to the discovery by Yusuf and Afolabi (2010) who posited that the performance of students taught biology using computer assisted instructional packages in cooperative and individualized learning settings and those taught with conventional classroom instruction indicated a significant difference. The students taught using cooperative computer assisted instruction was higher followed by those taught using individualized computer assisted instruction and then those taught using conventional method. The findings contradict the discovery by Pichaya (2015) who found that traditional demonstration improved students' performance in mathematics. The explanation to this finding is that in the learning of mathematics numbers are involved which may not require auditory and visual effects, hence, demonstration by the teacher was sufficient to improve students' TPS cooperative learning. In the present study which involved practical skills acquisition, combining the IT with TPS learning method enhanced individualized student's efforts in handling tools and instruments that are involved in LED TV troubleshooting as against TWP where in most cases, electronic students became passive learners of the concepts.

The implication of this is that the IT was able to provide coherent verbal and pictorial information for effective tutoring of LED TV troubleshooting. Hence, electronic students learnt LED TV troubleshooting more effectively from words and pictures than from words alone. In accordance with the guidance of this theory also, the IT was able to reduce the cognitive load for a single processing channel by breaking the contents of the LED TV troubleshooting. Therefore, the use of frames and branches in the IT reduced cognitive overload since students were not allowed to proceed to the next level until mastery was achieved at the previous level in learning of LED TV troubleshooting. The findings in this study also supported the Constructivism Learning Theory since electronic students in Technical Colleges were actively involved in the process of meaning and knowledge construction through engagement in TPS learning of LED TV troubleshooting after using the IT. The experiences they acquired from the IT were concretely internalized and incorporated into already existing schemas of real life LED TV troubleshooting. Accordingly, the combination of IT and TPS learning of LED TV troubleshooting as suggested by the assumptions of constructivism learning theory brought forth effective learning among electronic students.

5. Conclusion

The understanding of the principles of operation and troubleshooting of modern and complex electronic gadgets such as LED TV is becoming more difficult due to the rapid technological advancement in electronics. This is necessitating the need for employing more effective learning methods such as IT and TPS for enhancing students' understanding of LED TV troubleshooting so that they can be relevant in the world of work after graduation. Hence, it became imperative to combine the use of IT and TPS learning method to provide student-centered learning experience that is capable of improving their practical skills performance. Findings that emerged from the investigation revealed that the effect of IT for enhancing TPS learning methods in students' LED TV troubleshooting skills performance is higher than the effect of Traditional Workshop Practice and TPS learning methods. Based on these findings, it was concluded that the IT which was augmented with TPS learning method combining text, words, pictures, animations, videos as well as group practice is a reliable opportunity for enhancing electronic students' skills performance in LED TV troubleshooting necessary for employment in the present era of rapid technological advancement.

5.1 Recommendations

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

1. An intervention in form of teacher training/development programmes should be initiated by the States Science and Technical Education Boards in North-West, Nigeria to train existing electronic teachers on the use of IT for enhancing TPS in learning of LED TV troubleshooting.

2. State and Federal Ministries of Education should provide the needed support in terms of facilities and equipment for the planning, inclusion and implementation of IT for enhancing TPS in learning of LED TV troubleshooting in Technical Collages in North-West, Nigeria.

3. The use of IT and TPS learning methods should be incorporated into the teaching of LED TV troubleshooting by National Board for Technical Education which is the board responsible for review and standardization of programmes in Technical Colleges.

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