JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

Development of Intelligent Tutor for Enhancing Think-Pair-Share in Learning of Light Emitting Diode Television Troubleshooting

Hassan Yunusa Jamilu[1]; Emmanuel Raymond[2]; Garba Aliyu Usman[2]; Usman Abraham Usman[3]
[1]*Science and Technology Education Department*
Bayero University Kano, Kano State, Nigeria
[2]*Industrial and Technology Education Department*
[3]*Electrical Engineering Department*
Federal University of Technology Minna, Niger State, Nigeria

ABSTRACT
The study was designed to develop an Intelligent Tutor (IT) for enhancing Think-Pair-Share (TPS) in learning of Light Emitting Diode Television (LED TV) troubleshooting using Research and Development (R & D) method. Three research questions and one hypothesis tested at .05 level of significance guided the study which was carried out in Northwest, Nigeria involving a population of 109 subjects. The instrument for data collection was Intelligent Tutor Assessment Questionnaire (ITAQ). Hypertext Mark-up Language (HTML) and Cascading Style Sheets (CSS) were used for the user interface design, while Python (Django framework) was used for the logic and database in the development of the IT. Findings that emerged revealed that the appropriate contents of a four-model IT which are Domain Model involving the principles of operation and how to troubleshoot Power, Picture and Sound Subsystems in LED TV as well as the Student, Tutoring and User Interface Models for enhancing TPS learning can be developed into a complete IT package. It was therefore recommended based on this finding that: (1) The National Board for Technical Education should review the curriculum for Radio Television and Electronic Work to include the appropriate contents for LED TV troubleshooting that were developed and validated in the present study; and (2) An intervention in form of teacher development programme 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.

ARTICLE INFO
Article History
Received: June, 2019
Received in revised form: August, 2019
Accepted: December, 2019
Published online: January, 2019

KEYWORDS
Multimedia; Intelligent Tutor; Think-Pair-Share Learning; Light Emitting Diode Television; Student, Tutoring, User Interface and Domain Models

INTRODUCTION

The world of electronic technology is swiftly changing from analogue to digital, smart and nano technology leading to the extensive emergence of more sophisticated electronic devices. This has increased difficulties in the understanding of the principles of operation and troubleshooting of modern electronic gadgets among students. Technology educationists are therefore compelled to seek for more effective learning approaches such as the use of multimedia resources to improve students' understanding of modern electronic technology. According to Dani and Naseer (2016), multimedia tools such as

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

Intelligent Tutor (IT) can provide programmed instruction to learners by simulating a human instructor. By IT, it means a computer software package with which learners interact when being taught by a computer; and development in this context refers to the assembly of various components or software through computer programming into a complete IT package that can be used for individualized instruction. Unlike other multimedia resources such as projectors and hypertext, IT combines rich interactive elements such as text, audio, video and animation to facilitate personalized learning of subjects that are otherwise difficult to understand. Based on the number of components that are included in the system, there are four-model and three-model ITs (Nkambou *et al*, 2010). The four-model IT which is the concern of this study, presents lessons in user-paced segments and consists of four basic components. These components include: Student Model, Tutoring Model, Domain Model and User Interface Model.

The Student Model accounts for each student's learning history by performing diagnosis of the state of the students' knowledge for selecting optimal pedagogical strategies so as to present subsequent domain information to the students in connection with the Tutoring Model (Nkambou *et al.,* 2010). The Tutoring Model controls the method of presentation of the course contents. It accepts information from the Domain and Student Models and makes choices about tutoring strategies and actions. The User Interface Model is excluded in the three-model ITs that are designed to present lessons as a continuous unit. This is against the assertions of multimedia theorists such as Mayer (2011) who opined that students learn better from a multimedia lesson that is presented in user-paced segments than as a continuous unit. In essence, the Student, Tutoring and User Interface components of the four-model IT in this study are programmed computer instructions that are concerned with how to teach the learner. These contents of the IT on how to teach the learner can be obtained from literature on existing Intelligent Tutoring Systems (Bourdeau & Grandbastien, 2010) and subjected to scrutiny by experts in educational technology. This is in line with Gambari and Yusuf (2014) assertion that a Computer Assisted Instructional Package (CAIP) cab be developed in conformity with experts' validation in terms of durability, simulation, functionality in tasks performance and smooth interface between the Student, Tutoring, User Interface and Domain Models.

The Domain Model is where the course contents such as Light Emitting Diode Television (LED TV) troubleshooting skills which are to be taught to the learner are integrated. These contents of the Domain Model can be developed through systematic approach of obtaining from Subject Matter Experts (SME) accurate and complete LED TV troubleshooting skills for inclusion in the IT. In a related study, Oloyede and Adekunle (2009) discovered that an Electrochemistry Concept Instructional Package they developed sufficiently covered the required areas of electrochemistry in appropriate and sequential manner as indorsed by SMEs. The SMEs in the present study refer to LED TV industrial personnel and electronic teachers in universities as well as those in technical colleges. Electronic teachers in the universities may be more updated with current trends in electronic technology than their counterparts in technical colleges due to their experience and expertise in research to solve problems in their subject area (Matter, 2015). However, according to the Federal Republic of Nigeria (FRN, 2013), electronic teachers in technical colleges are also expected to be updating themselves through Continuous Professional Development. In the same vein, LED TV

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

industrial personnel who often carry out the troubleshooting of the latest versions of LED TVs in Sony, Samsung and other electronic companies may be more current concerning LED TV troubleshooting techniques. This perceived difference in the opinions of SMEs on appropriate and complete LED TV troubleshooting skills for inclusion in the Domain Model of the IT necessitates further investigation.

The developed contents of the Domain Model in LED TV troubleshooting skills together with the Student, Tutoring and User Interface Models can be coded using computer programming into a complete IT package. The IT can then be used to logically present frames and branches of lessons to the learner in a manner that Alessi and Trollip (2001) described as a Drill and Practice method of instruction. The frame poses questions to the learner at the end of each learning session. The learner answers the questions about the lesson and gets immediate feedback. The branches are videos and animations that the learner can twig into as learning progresses. This type of programmed learning, which is tailored towards improving students' knowledge and understanding of difficult concepts, may have positive impact on their cognitive process. According to Jabbour (2012), individualized student's interaction with course contents, process and product through programmed learning can provide an active learning opportunity. Olawale (2013) discovered in a similar study that the colours, texts, pictures, videos and animations in the CAIP were suitable for students to use and it enhanced their performance in the learning of physics. Therefore in the present study, the IT is likely to enhance students' understanding of the principles of operation as well as LED TV troubleshooting; but it may not give them the full opportunity to manipulate and master the use of working tools and instruments such as multimeter, 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 understanding 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 process. The steps in TPS learning process according to Aditi *et al.,* (2013) are: (a) Think: Students think independently about the lesson learnt from LED TV troubleshooting IT, recollecting ideas on their own within about 2-3 minutes; (b) Pair: Students are grouped in pairs to discuss and practice their thoughts in about 2-5 minutes; and (c) Share: Students share their ideas and experiences with a larger group in accomplishing the LED TV troubleshooting task in about 3-10 minutes. In a study by Alpusari and Putra (2013) students were given only 5-10 minutes each for the three stages of cooperative learning TPS method. Therefore, in order to engage students in an effective TPS learning, five elements must be present in the TPS setting which include: positive interdependence, face-to-face interaction, and individual accountability through deeper thinking, interpersonal & social skills, and group processing (Kose *et al.,* 2010). Thus, students' troubleshooting skills may become more refined through this three-step learning process. Therefore, the integration of IT with TPS learning process may enable students to remember and reconstruct their learning experiences by practicing the troubleshooting with real tools and instruments. More so, TPS learning process is practicable with large class size

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

and across all age groups (McGregor, 2006). This may give the process an edge over other cooperative learning processes such as Student Team Achievement Division (STAD) and Jigsaw in improving students' understanding 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. Consequently, LED TVs are more difficult and complex to troubleshoot not just because of the lighting complications but in addition due to frequent use of integrated circuits (ICs) combining several functional units. This modular technology and the use of integrated circuits lead in part to subassemblies whose functions extend to other units which may lead to confusion in understanding how to troubleshoot the system. To this end, LED TV is broadly divided into three major subsystems which include the Power, Picture and Sound Subsystems (Sony, 2015) and the need for troubleshooting these subsystems may arise in the course of using the LED TV. Experts in electronic troubleshooting such as Schaafstal *et al.* (2000) opined that understanding how to troubleshoot complicated electronic system and subsystems, such as LED TV circuitry can be enhanced if students are fully conversant with the principles of operation of that system.

The principles of operation of LED TV involve the process of receiving, selecting and processing TV signals to present picture and sound 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 which is a sub-unit of the Picture and Sound Subsystems that is responsible for manipulating the signals for better video quality when the system is powered (LG Electronics, 2009). A novice may take this function as that of the Timing Control Unit (T-CON) which is rather responsible for delivering the Low Voltage Differential Signalling to the LED TV screen (LVDS) (Panasonic, 2013; and Sanyo, 2015). 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 and the interaction of electronic components in the Power, Picture and Sound subsystems 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

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

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 which would otherwise need many words and other instructional aides to describe. In addition, combining the IT with TPS learning process 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. Electronic students in technical colleges need effective instructional strategies in acquiring the much needed practical skills for future employment envisaged in LED TV troubleshooting. 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 becomes imperative to develop an Intelligent Tutor for enhancing Think-Pair-Share in learning of LED TV troubleshooting.

Aim and Objectives of the Study

The study developed an Intelligent Tutor (IT) for enhancing Think-Pair-share (TPS) in learning of Light Emitting Diode Television (LED TV) Troubleshooting. The objectives of the study are to:

1. Develop appropriate contents of the Domain Model of the IT for enhancing TPS in learning of LED TV troubleshooting
2. Develop appropriate contents of the Student, Tutoring and User Interface Models of the IT for enhancing TPS in learning of LED TV troubleshooting
3. Determine the suitability of the developed IT package for enhancing TPS in learning of LED TV troubleshooting

Research Questions

The following research questions were formulated in line with the objectives:

1. What are the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of LED TV troubleshooting?
2. What are the appropriate contents of the Student, Tutoring and User Interface Models of the IT for enhancing TPS in learning of LED TV troubleshooting?
3. How suitable is the developed IT package for enhancing TPS in learning of LED TV troubleshooting?

Research Hypothesis

The following null hypothesis tested at .05 level of significance was formulated:

HO: There is no significant difference in the mean ratings of SMEs on the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of principles of operation as well as how to troubleshoot Power, Picture and Sound Subsystems in LED TV

THEORETICAL FRAMEWORK

Cognitive Theory of Multimedia Learning

The proponent of this theory was Mayer (2005). The theory states that there are two separate channels which are auditory and visual for processing information within a limited capacity; and that learning is an active process of filtering, selecting, organizing, and integrating information. This theory proposes three main assumptions when it comes to learning with multimedia resources such as IT: (1) There are two separate channels (auditory and visual) for processing information; (2) Each channel has a limited (finite) capacity or cognitive load; and (3) Learning is an active

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

process of filtering, selecting, organizing, and integrating information based upon prior knowledge. The theory sprouted out of advances in cognitive psychology of learning.

According to Mayer (2011), the learner processes visual and verbal information so that during learning, auditory narration goes into the verbal system whereas animation, videos, pictures and other forms of pictorial representations of information go into the visual system. In learning with IT therefore, the learner engages in three important cognitive processes. The first cognitive progress which is 'selecting' is applied to incoming verbal and visual information to yield an audio and image base sub-systems respectively. The second cognitive process which is 'organizing' is applied to the word and image bases to create some verbally-based and visually-based models respectively. Finally, the third process which is referred to as 'integrating' occurs when the learner builds connections between the corresponding events (or states) in the verbally-based and visually-based models (Mayer, 2011). Multimedia researchers generally define multimedia as the combination of text and pictures; and suggest that multimedia learning occurs when we build mental representations from these words and pictures (Moore *et al.*, 2004). The words can be spoken or written, and the pictures can be any form of graphical image including illustrations, photos, animation or video multimedia.

In multimedia learning such as the use of IT, the information processing model suggests several information stores (memory) that are governed by processes that convert stimuli to information (Moore *et al.*, 2004). Hence, people learn more acutely from words and pictures than from words alone. Consequently, the interrelated components of cognitive theory of multimedia learning served as guidance to the researcher in the development of the IT. The implication of this is that the IT was able to provide coherent verbal and pictorial information for effective tutoring of LED TV troubleshooting. The words or verbal information can be spoken or written, and the pictures can be any form of graphical imagery including relevant illustrations, photos, animations, or videos that can be used to utilize the auditory and visual channels in electronic students' working memory. Moreover, the IT was able to teach to the learners through suitable selection of relevant words and images. This was done through literature review and consultation of Subject Matter Experts (SMEs) who validated the contents of the LED TV troubleshooting IT. This is in line with the theorist's suggestion that in multimedia design, summarized and relevant rather than extraneous contents are more easily assimilated by students (Mayer, 2011).

In accordance with the guidance of this theory also, the IT was able to reduce the cognitive load for a single processing channel. This was done by breaking the contents of the LED TV troubleshooting in accordance with the specific objectives of this study. 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 of LED TV troubleshooting. The IT also took into cognizance the issue of individual differences. Here, students were known by the IT through the inbuilt 'Student Model' to accommodate and recognize different learners so that they can be treated individually. In such way, each student was able to start or stop a lesson at his own phase of cognitive ability. Therefore, the theory forms the foundation upon which some of the principles of multimedia design were originated. This theory is related to the present study as it provided some insights which the researcher found useful in the development of the IT for enhancing Think-

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

Pair-Share in learning of Light Emitting Diode television troubleshooting. Hence, the theory was adopted.

RESEARCH METHODOLOGY

The study adopted Research and Development (R & D) design to produce an Intelligent Tutor (IT). The R & D method according to Gall *et al.* (2007) is concerned with the development of educational products and consists of ten stages. The 1st to 6th stages of the R & D method guided the researchers in ascertaining the instructional goals, students' characteristics, entry-level skills and expectations, assessment instruments and instructional strategies in the IT to perform the intended instruction on the Principles of operation as well as troubleshooting of Power, Picture and Sound Subsystems. These expectations were carefully sorted out to produce a document known as Software Requirement Specification (SRS). The SRS document tells us 'what' software does and as such became the input of the software requirement analysis stage, which tells us 'how' a software system should work (Munassir & Govardhan, 2012).

The Module design phase in this study which is the 7th stage in the R & D method was considered as the phase of the IT prototype development using V-Model of Software Development Life Cycle (SDLC). As such, Hypertext Mark-up Language (HTML) and Cascading Style Sheets (CSS) were used for the user interface design, while Python (Django framework) was used for the logic and database. The criteria for selecting Python was based on: multimedia capability, data handling capability, ease of use and level of configuration with little or no difficulty on installation that met the software requirements specifications of LED TV troubleshooting IT. The integration of every part of the Intelligent Tutor prototype was then tested to ensure that it works properly according to the SRS acceptable standard. The prototype was modified and refined at various stages to correct or include some functions which were not originally included in the design specifications. For instance, the audio clip (cheering of students) when the feedback on the exercises attempted is popped-up was included as suggested by one of the validators during the validation process. The main menu of the IT package consisted of introduction, students' registration, and list of lessons such as lesson 1, 2, 3 and 4. The developed IT package was then debugged by Computer Experts using the section C of the Intelligent Tutor Assessment Questionnaire to detect and correct any programming error.

The 8th stage of the R & D method which is on formative evaluation involved the testing of the developed IT prototype in Government Technical College Binji, Sokoto state using 20 electronic students who used the IT and rated it using the section D of the Intelligent Tutor Assessment Questionnaire. Stage nine involved the revising of the IT package based on the result from the formative evaluation and expert validation at various stages of the IT development into an operational product.

The area of the study was Northwest, Nigeria using a population of 109 subjects. This consisted of 19 computer programming experts and 17 experts in educational technology from various universities in the area of the study; 27 industrial personnel in LED TV companies (only those that are concerned with the troubleshooting of faulty LED TVs); 26 electronic teachers (12 in universities and 14 in technical colleges) and 20 electronic students. The instrument for data collection was Intelligent Tutor Assessment Questionnaire (ITAQ). The ITAQ is made up of sections A, B, C and D. Section A which contains 38 structured items and was completed by electronic teachers and industrial personnel in LED TV companies.

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

They assessed how appropriate are the contents of the Domain Model for inclusion in the IT on LED TV principles of operation, as well as how to troubleshoot the Power, Picture and Sound Subsystems. Similarly in section B, educational technologists assessed how appropriate are the contents of the Student, Tutoring and User Interface Models of the IT for enhancing TPS in learning of LED TV troubleshooting. This section is made up of 14 structured items. The response options in sections A and B are: Highly Appropriate (HA), Appropriate (A), Undecided (U), Inappropriate (I) and Highly Inappropriate (HI). These response options were weighed as follows: HA = 5, A = 4, U = 3, I = 2 and HI = 1.

The computer programmers indicated in section C the suitability of the Unit, Integration and System of the complete IT package for enhancing TPS in learning of LED TV troubleshooting. This was necessary so that each step of the IT Software development was validated by the computer experts in accordance with the provisions of V-Model (SDLC). Therefore, this section contains 12 structured items concerned with the suitability of the programming language that was employed for the development of the IT; the programming environment used and so on. Correspondingly in section D, electronic students in technical colleges indicated the suitability of the complete IT package during the IT acceptance test on: (1) clarity of words, videos, animations and pictures presented in the IT package; (2) the means of navigation and interaction with contents of IT on LED TV troubleshooting and so on. This section contains 16 structured items. The response categories for sections C and D are: Highly Suitable (HS), Suitable (S), Undecided (U), Unsuitable (US) and Highly Unsuitable (HU). These response options weighed as follows: HS = 5, S = 4, U = 3, US = 2 and HU = 1. The information from part TWO of the ITAQ was used to answer research questions one and two in this study.

Sections A and D of the ITAQ was validated by three electronic experts from the Department of Industrial and Technology Education, Federal University of Technology Minna, Niger state. Section B and C of the ITAQ were validated by three Educational Technologists in the Departments of Educational Technology and three computer programmers in the Department of Computer Science, Federal University of Technology Minna, Niger state. The reliability of the ITAQ was established during the pilot testing of the developed IT package. Data obtained was computed using Cronbach alpha method to determine the internal consistency of the sections A, B, C and D of the ITAQ which was found to be 0.86; 0.89; 0.82 and 0.80 respectively. The ITAQ was then administered to industrial personnel in LED TV companies, electronic teachers, students and computer experts to ascertain the appropriateness/suitability of the Intelligent Tutor for enhancing Think-Pair-Share in learning of LED TV troubleshooting. Statistical Package for Social Sciences (SPSS, Version 20.0) was used for the computation of data in this study. Statistical mean and SD were used to answer the research questions, while ANOVA was used to test the null hypothesis at .05 level of significance. For the purpose of making decisions on the appropriateness/suitability of the contents of the IT package, the mean ratings of respondents was used. Therefore, items with mean score of 3.00 and above were considered appropriate/suitable, while items with mean scores of 2.99 and below were considered inappropriate/unsuitable.

RESULT

Research Question 1: What are the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of LED TV troubleshooting?

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

Table 1: Appropriate Contents of Domain Model of the IT on LED TV Troubleshooting Skills

SN	Items	X	SD	Remark
	Principles of Operation of LED TV			
1	Extent of coverage and sequencing of principles of operation of LED TV	4.43	0.50	Appropriate
2	Categories of LED TV signal input ports	4.25	0.73	Appropriate
3	Description of LED TV panel and signal drivers	4.30	0.46	Appropriate
4	Description of LED TV master Integrated Circuit	3.83	0.38	Appropriate
5	Production of 12 Volts, 15 Volts and 2.5 Volts for operation of LED TV circuitry	4.36	0.48	Appropriate
6	Discussion on video and sound signal procession in the master Integrated Circuit	4.00	0.59	Appropriate
7	Production of 5 Volts standby power from the AC mains	4.43	0.77	Appropriate
8	Description of audio amplifier, filters and speaker	4.20	0.72	Appropriate
9	Exercises at the end of lesson on principles of operation of LED TV	3.92	0.73	Appropriate
10	Conversion of Red-Green-Blue data to dual 14 bit Low Voltage Differential Signalling (LVDS)	4.38	0.49	Appropriate
	How to Troubleshoot Power Subsystem in LED TV			
11	How to test the LED TV for operation at different stages of troubleshooting of power subsystem	4.53	0.50	Appropriate
12	How to check for continuity or integrity of the power supply cord	3.73	0.69	Appropriate
13	Pictures, videos and animations contents used to describe how to troubleshoot LED TV power subsystem	4.04	0.73	Appropriate
14	How to identify the components of LED TV power subsystem	3.64	0.59	Appropriate
15	How to use senses of smell, touch and sight to identify damaged components such as resistors and capacitors	3.28	0.91	Appropriate
16	Text fonts, spacing and language used in describing how to troubleshoot LED TV power subsystem	4.02	0.89	Appropriate
17	How to use multimeter to test/measure quantities at various stages of the power subsystem	4.41	0.77	Appropriate
18	Exercises presented at the end of lessons on the troubleshooting of LED TV power subsystem	4.28	0.84	Appropriate
19	Five minutes for the 'Thinking Step' on how to troubleshoot LED TV power subsystem	4.04	0.94	Appropriate
	How to Troubleshoot Picture Subsystem in LED TV			
20	Description of possible faults associated with picture subsystem	4.13	0.90	Appropriate
21	How to be free of electrostatic charges	3.87	0.48	Appropriate
22	Uncovering of LED TV receiver to check the standby power connector for the presence of various voltages on the main board	3.51	0.72	Appropriate
23	Reassembling and testing of repaired LED TV picture subsystem	3.77	0.75	Appropriate
24	Carrying out flash light test on the TV screen while the system is on.	3.98	0.90	Appropriate

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

25	How to check the voltage dropped on the LED driver of the picture subsystem	3.81	0.39	Appropriate
26	Text fonts, spacing and language used in describing how to troubleshoot LED TV picture subsystem	3.57	0.93	Appropriate
27	Pictures, videos and animations contents used in describing how to troubleshoot LED TV picture subsystem	3.25	0.90	Appropriate
28	Exercises presented at the end of lesson on the troubleshooting of LED TV picture subsystem	3.77	0.98	Appropriate
29	Five minutes allocated for the 'Thinking Step' on how to troubleshoot LED TV picture subsystem	3.45	0.50	Appropriate
	How to Troubleshoot Sound Subsystem in LED TV			
30	Description of possible faults that may occur in sound subsystem	3.98	0.73	Appropriate
31	Text fonts, spacing and language used in describing how to troubleshoot LED TV sound subsystem	4.08	0.43	Appropriate
32	Identification of the components of sound subsystem	3.98	0.64	Appropriate
33	Uncovering the LED TV to inspect the four capacitors and other components of the sound subsystem	3.92	0.58	Appropriate
34	Voltage measurement in the speaker of the sound subsystem	4.00	0.90	Appropriate
35	Checking the audio amplifier of the sound subsystem using different methods	3.71	0.69	Appropriate
36	Removal and replacement of faulty audio amplifier IC of the sound subsystem	4.19	0.40	Appropriate
37	Exercises presented at the end of lesson on the troubleshooting of LED TV sound subsystem	4.52	0.77	Appropriate
38	Five minutes allocated for the 'Thinking Step' on how to troubleshoot LED TV sound subsystem	4.13	0.34	Appropriate

Data presented in Table 1 reveals that based on the mean cut-off of 3.00 and above, the respondents rated all the contents of the Domain Model of the IT as appropriate for enhancing TPS in learning of LED TV troubleshooting. The respective standard deviations which are low (0.34 to 0.98) indicated that respondents consistently agreed on the appropriateness of the items.

Research Question 2: What are the appropriate contents of the Student, Tutoring and User Interface Models of the IT for enhancing TPS in learning of LED TV troubleshooting?

Table 2: Educational Technologists' Opinion on Contents of the Student, Tutoring and User Interface Models of the IT

SN	Items	$\bar{X}$	SD	Remark
	Student Model			
1	Storage and update of students' information in the LED TV troubleshooting IT package	3.71	0.69	Appropriate
2	Provision of user 'log-in and out' of the LED TV troubleshooting IT package	3.94	0.75	Appropriate

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

SN	Items	$\bar{X}$	SD	Remark
3	Recognition of individual students by the LED TV troubleshooting IT package	4.06	0.66	Appropriate
4	Identification of individual students through their passwords	3.70	0.85	Appropriate
	Tutoring Model			
5	Texts, diagrams, pictures, audios and video clips on LED TV troubleshooting	4.12	0.78	Appropriate
6	Controlling the presentation of the instructional knowledge	4.53	0.80	Appropriate
7	Adaptive presentation of lessons on LED TV troubleshooting by the IT package	4.23	0.90	Appropriate
8	Consistency of the format of presentation of lessons on LED TV troubleshooting	4.12	0.70	Appropriate
9	Clarity of the title screen, online help	4.06	0.75	Appropriate
10	Sequencing and selection of domain knowledge	3.53	0.80	Appropriate
11	Presentation and selection of lessons on LED TV troubleshooting based on the output of Student Model	4.06	0.66	Appropriate
	User Interface Model			
12	Time taken in responding to options selected by students	3.82	0.95	Appropriate
13	Clarity and ease of operation and selection of menus in the LED TV troubleshooting IT package	3.59	0.87	Appropriate
14	Ease of communication between students and other aspects of the LED TV troubleshooting IT package	3.53	0.80	Appropriate

The analysis in Table 2 shows that all the contents of the IT for enhancing TPS in learning of how to troubleshoot Sound Subsystem in LED TV scored above the mean score of 3.00 which indicates that they are all appropriate. The respective standard deviations mean that respondents consistently agreed on the appropriateness of the items.

Research Question 3: How suitable is the developed IT package for enhancing TPS in learning of LED TV troubleshooting?

Table 4.6: Computer Programmers' Opinion on the Suitability of the developed IT

Computer Programmers				
SN	**Items**	$\bar{X}$	**SD**	**Remark**
Unit Testing				
1	Programming language used to develop the IT package	3.68	0.67	**Appropriate**
2	Programming environment used to develop the IT package	4.16	0.69	**Appropriate**
3	Programming procedure used to develop the IT package	4.21	0.71	**Appropriate**
4	Design of the LED TV troubleshooting IT package	3.89	0.66	**Appropriate**
Integration Testing				
5	Interface of the internal modules within the LED TV troubleshooting IT package	3.95	0.77	**Appropriate**

Corresponding author: Hassan, Y. J *jy2000.hj@gmail.com* *Science and Technology Education Department, Bayero University, Kano.*

SN	Items	$\bar{X}$	SD	Remark
Computer Programmers				
6	Simulation of the programmes included in the LED TV troubleshooting IT package	3.68	0.75	**Appropriate**
7	Interface between various software in the LED TV troubleshooting IT package	3.53	0.90	**Appropriate**
System Testing				
8	Functionality in terms of task performance of the LED TV troubleshooting IT package	4.05	0.97	**Appropriate**
9	Typography of the typeset in the LED TV troubleshooting IT package	3.79	0.42	**Appropriate**
10	Legibility of the contents of the LED TV troubleshooting IT package	3.37	0.90	**Appropriate**
11	The ease and adequacy of navigation while using the LED TV troubleshooting IT package	3.32	0.75	**Appropriate**
12	Durability of the LED TV troubleshooting IT package	3.11	0.32	**Appropriate**
Electronic Students				
13	Clarity of words, videos, animations and pictures presented in the LED TV troubleshooting IT package	3.45	0.93	**Appropriate**
14	The means of navigation and interaction with contents of IT on LED TV troubleshooting	3.30	0.89	**Appropriate**
15	Clarity of illustrations in the LED TV troubleshooting IT package	3.60	0.52	**Appropriate**
16	Examples used in the various cases of LED TV troubleshooting in the IT package	3.90	0.79	**Appropriate**
17	Colours used for the texts, pictures, animations and videos in the LED TV troubleshooting IT package	3.70	0.87	**Appropriate**
18	The exercises presented in the IT package in terms of covering the topics taught on LED TV troubleshooting	3.55	0.89	**Appropriate**
19	The pictures, videos and animations used in the IT package	4.05	0.68	**Appropriate**
20	Coherent presentation of both visual and auditory contents of LED TV troubleshooting	4.15	0.91	**Appropriate**
21	Clarity of voices (audios) used in the videos and animations included in the LED TV troubleshooting IT package	3.90	0.64	**Appropriate**
22	Presentation of LED TV troubleshooting in the IT package from simple to complex	3.45	0.94	**Appropriate**
23	Ability to control learning of LED TV troubleshooting at own pace	3.40	0.82	**Appropriate**
24	Sequential arrangement of contents of the IT on LED TV troubleshooting	3.20	0.52	**Appropriate**
25	The language used in the presentation of ideas on LED TV troubleshooting IT package	3.90	0.68	**Appropriate**
26	The rate at which feedback is provided on exercises attempted in the IT package	4.35	0.87	**Appropriate**

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

Computer Programmers				
SN	**Items**	$\bar{X}$	**SD**	**Remark**
27	Engagement and interaction while learning LED TV troubleshooting with the IT package	3.70	0.94	**Appropriate**
28	Time to think about the troubleshooting task to be accomplished practically	4.15	0.81	**Appropriate**

Data presented in Table 3 indicated that based on the mean cut-off of 3.00 and above, all the items were adjudged suitable by the computer programmers and electronic students for enhancing TPS in learning of LED TV troubleshooting. The respective standard deviations mean that respondents consistently agreed on the appropriateness of the items.

Research Hypothesis

HO: There is no significant difference in the mean ratings of SMEs on the appropriate contents of Domain Model of the IT for enhancing TPS in learning of LED TV troubleshooting.

Table 4: Analysis of Variance (ANOVA) on the Mean Ratings of SMEs on the Appropriate Contents of the Domain Model of the IT for Enhancing TPS in Learning of LED TV Troubleshooting

Principles of Operation	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	.006	2	.003	.027	.973
Within Groups	5.605	50	.112		
Total	5.611	52			
Power Subsystem					
Between Groups	.635	2	.317	.898	.414
Within Groups	17.674	50	.353		
Total	18.309	52			
Picture Subsystem					
Between Groups	.246	2	.123	.412	.665
Within Groups	14.957	50	.299		
Total	15.203	52			
Sound Subsystem					
Between Groups	.080	2	.040	.408	.667
Within Groups	4.883	50	.098		
Total	4.963	52			

Significant at Significance of F < .05
Key: df = Degree of Freedom; Sig = Significance

The result presented in Table 4 shows F-calculated values for the mean ratings of SMEs with a significance of F(s) at 0.973, 0.414, 0.665 and 0.667 which are greater than .05. This result shows that there is no significant difference between the mean ratings of SMEs on the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of the principles of operation as we as how to troubleshoot LED TV Power, Picture and Sound Subsystems respectively. The null-hypothesis is therefore accepted at .05 level of significance. Hence, There is no significant difference in the mean ratings of LED TV industrial personnel, electronic teachers in the universities as well as those in technical

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

colleges on the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of principles of operation and how to troubleshoot Power, Picture and Sound Subsystems in LED TV.

DISCUSSION OF FINDINGS

The data presented in Table 1 provided answer to research question one. Finding revealed that the following are the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of the principles of operation as well as how to troubleshoot Power, Picture and Sound Subsystems in LED TV: (1) Description of the production of 5 Volts standby power from the AC mains; (2) Extent of coverage and sequencing of principles of operation of LED TV; (3) Conversion of Red-Green-Blue data to dual 14 bit LVDS; (4) Production of 12 Volts, 15 Volts and 2.5 Volts for operation of LED TV circuitry; (5) How to test the LED TV for operation at different stages of troubleshooting of power subsystem; (6) How to use multimeter to test/measure quantities at various stages of the power subsystem; (7) Exercises presented at the end of lessons on the troubleshooting of LED TV power subsystem; (8) Pictures, videos and animations used to describe how to troubleshoot LED TV power subsystem; and (9) The five minutes allocated for the 'Thinking Step' on how to troubleshoot LED TV power subsystem. The data presented in Table 4 is the Analysis of Variance for the null hypothesis at .05 level of significance. The result showed that there is no significant difference in the mean ratings of LED TV industrial personnel, electronic teachers in Universities and electronic teachers in Technical Colleges on the appropriate contents of the Domain Model of the IT for enhancing TPS in learning of LED TV troubleshooting.

These discoveries are in line with the contents in Sanyo (2015) servicing manual where it is stated that the RGB data of the TV signal is converted into dual 14 bit LVDS and outputted to the LED TV panel via LVDS cable. The findings also agree with the contents in LG Electronics (2009) users' manual in which the description of the production of 12 Volts, 15 Volts and 2.5 Volts for operation of LED TV circuitry was stated. Even though this study focused on the development of LED TV troubleshooting IT unlike that of Oloyede and Adekunle (2009) who developed a computer package on electrochemistry, the findings in this study supported their assertion that an IT package can be developed to sufficiently cover the required areas of a topic such as principles of operation of LED TV in appropriate and sequential manner. The explanation to these findings is that albeit LED TVs are produced by various electronic manufacturers such as Sanyo (2015) and LG Electronics (2009), the principles of operations of LED TVs are very similar. More so, analogous to various LED TV manufacturers, the Subject Matter Experts (SMEs) who are LED TV industrial personnel, electronic teachers in universities and electronic teachers in technical colleges concurrently agreed with the contents in the Domain Model of the IT.

In terms of the five minutes allocated to the 'thinking step', the finding in this study is similar to that of Alpusari and Putra (2013) and differed with the time allocated to similar thinking step by Aditi *et al* (2013) who allowed students to think for just two to three minutes. The simple explanation to this is that in Aditi *et al* (2013), students were given less time to express their thinking via writing, while in the present study which is practically based, students needed more time to think. This is necessary based on the submissions of Kose *et al* (2010) who recommended that individual accountability through deeper thinking of the audio-visual schema that electronic students experienced in the IT is one of the five effective means of successful TPS cooperative learning. However, the

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

finding did not agree with the assertions of Matter (2015) who stated that electronic teachers in the universities may be more updated with current trends in electronic technology than their counterparts in technical colleges due to their experience and expertise in research to solve problems in their subject area. Since there is no significant difference in the mean rating of SMEs, it implies that both LED TV industrial personnel, electronic teachers in universities and technical colleges are current in terms of the appropriate contents of the IT for enhancing TPS in learning how to troubleshoot LED TV.

The data presented in Table 2 provided answer to research question two. Findings revealed that the following are the appropriate contents of the Student, Tutoring and User Interface Models of the IT for enhancing TPS in learning of LED TV troubleshooting. For Student Model: (1) Recognition of individual students by the LED TV troubleshooting IT package; (2) provision of user 'log-in and out' of the LED TV troubleshooting IT package; For Tutoring Model: (3) Controlling the presentation of the instructional knowledge; (4) Adaptive presentation of lessons on LED TV troubleshooting by the IT package (5) Consistency of the format of presentation of lessons on LED TV troubleshooting; For User Interface Model: (6) Time taken in responding to options selected by students; (7) Clarity, ease of operation and selection of menus in the LED TV troubleshooting IT package; and (8) Ease of communication between students and other aspects of the LED TV troubleshooting IT package. This finding is concurrent with that of Oloyede and Adekunle (2009) who developed a computer package on electrochemistry (ECIP) for secondary schools in Nigeria and found that the design of the ECIP conformed to the acceptable standards of Educational Technologists in terms of legibility, simulation and navigation.

The data presented in Table 3 provided answer to research question six. Findings indicated that computer programmers rated the IT suitable in the unit, integration and system testing as follows: For the unit testing, programming procedure and programming environment used to develop the IT package are suitable. For the integration testing, interface of the internal modules within the IT package; simulation of the programmes included in the IT; as well as interface between various software in the LED TV troubleshooting IT package are suitable. For the system testing, functionality in terms of task performance; typography of the typeset as well as legibility of the contents of the LED TV troubleshooting IT package are suitable. This finding is similar to that of Gambari and Yusuf (2014) who found that the design and development of their CAIP conformed to acceptable standards of computer science experts in terms of durability, interface between software, simulation and functionality in tasks performance. Furthermore, electronic students adjudged suitable the coherent presentation of both visual and auditory contents as well as the pictures, videos and animations used in the IT package. Others aspects marked suitable by electronic students are the examples used in the various cases of LED TV troubleshooting as well as the language used in the presentation of ideas in the IT package. The rest are the clarity of voices (audios) used in the videos and animations included in the LED TV troubleshooting IT package as well as the rate at which feedback is provided on exercises attempted. In line with this finding, Olawale (2013) discovered that the colors, texts, pictures, videos and animations in the computer assisted instructional package (IT) he developed were suitable for students to use.

The findings in this study also supported the Cognitive Theory of

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

JOURNAL OF SCIECNCE TECHNOLOGY AND EDUCATION 8(1), MARCH, 2020
ISSN: 2277-0011; Journal homepage: www.atbuftejoste.com

Multimedia Learning. The theory states that there are two separate channels which are auditory and visual for processing information within a limited capacity; and that learning is an active process of filtering, selecting, organizing, and integrating information. 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 in accordance with the specific objectives of this study. 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.

CONCLUSION

In the advent of rapid technological advancement, modern electronic devices such as LED TVs are becoming more complex. As such, electronic students are experiencing difficulties in understanding the principles of operation as well as how to troubleshoot LED TV. 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 are not yielding satisfactory results. To this end, the present study developed a complete multimedia instructional package in form of Intelligent Tutor for enhancing TPS in learning of LED TV troubleshooting. Findings that emerged from the investigation revealed that the appropriate contents of a four-model IT which are Domain Model involving the principles of operation and how to troubleshoot Power, Picture and Sound Subsystems as well as the Student, Tutoring and User Interface Models for enhancing TPS learning can be developed into a complete IT package. Moreover, the IT package so developed was found to be suitable for enhancing TPS in learning of LED TV troubleshooting. Based on these findings, it was concluded that the IT which was augmented with TPS learning method combining words, pictures, animations, videos and group practice can be a reliable opportunity for enhancing electronic students' skills performance in LED TV troubleshooting necessary for employment in the present era of rapid technological advancement.

RECOMMENDATIONS

It was therefore recommended based on the findings that:

(1) The National Board for Technical Education should review the curriculum for Radio Television and Electronic Work to include the appropriate contents of principles of operation as well as how to troubleshoot Power, Picture and Sound Subsystems in LED TV that were developed and validated in the present study.

(2) An intervention in form of teacher development programme 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.

REFERENCES

Aditi, K., Rwitajit, M., Sahana, M. & Sridhar, L. (2013). Effect of think-pair-share in a large computer science class: 83% sustained engagement.

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

Journal of Computer Science, 4(3), 345-351.

Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development* (3rd ed.). USA: Pearson.

Alpusari, M. & Putra, R. A. (2013). The application of cooperative learning think-pair-share model to increase the learning of science skills in class IV elementary school. *International Journal of Science and Research,* 4(4), 2805-2808.

Bourdeau, J. & Grandbastien, M. (2010). Modelling tutoring knowledge. In R. Nkambou, J. Bourdeau & R. Mizoguchi (Eds.), *Advances in intelligent tutoring systems: Studies of conceptual intelligence* (pp. 123-144). Heildelberg: Spring Verlag Press.

Dange, K. (2015). Learning and experience: A step model. *The Online Journal of New Horizons in Education,* 5(3), 101-108.

Dani, A & Nasser, R. (2016). Use of intelligent tutor in post-secondary mathematics education in the United Arab Emirates. *The Turkish Online Journal of Educational Technology*, 15(4), 152-162.

Federal Republic of Nigeria. (FRN, 2013). *National policy on education* (6th ed.). Lagos: NERDC Press.

Gall, M. D., Gall, J. P. & Borg, W. R. (2007). *Educational research: An introduction,* (8th ed.). USA: Pearson Education Inc.

Gambari, I. A. & Yusuf, O. M. (2014). Development and validation of computer instructional package on physics in Nigeria. *Educational Research International,* 3(1), 112-130.

Jabbour, K. K. (2012). Multimedia principles in teaching lessons. *Acta Didactica Napocensia,* 5(4), 1-16.

Jean, M. (2011). *Light emitting diode television technical guide*. Japan: Panasonic Service and Technology Company.

Khandpur, S. (2003). *Troubleshooting electronic equipment*. New Delhi, India: McGraw Hill.

Kose, S., Sahin, A., Ergun, A. & Gezer, K. (2010). The effects of cooperative learning experience on eighth grade students' achievement and attitude toward science. *Education,* 131(1), 169-180.

LG Electronics. (2015). *Light emitting diode service manual.* Korea: LG Electronics Company.

Matter, W. T. (2015). *Public research universities: Why they matter*. Cambridge: American Academy of Arts and Sciences.

Mayer, R. E. (2011). *Applying the science of learning*. Boston: Pearson.

McGregor, D. (2006). *Developing thinking developing learning: A guide to thinking skills in education.* London: McGraw Hill.

Munassar, N. M. & Govardhan, A. (2010). A comparison between five models of software engineering. *International Journal of Computer Science Issues,* 7(5), 94 – 101.

Nkambou, R., Mizoguchi, R. & Bourdeau, J. (2010). *Advances in intelligent tutoring systems.* Heidelberg: Springer.

Olawale, S. K. (2013). Development and validation of computer assisted instructional package for teaching motion in senior secondary school physics. *International Journal of Educational Technology*, 3(3), 50-63.

Oloyede, S. O. & Adekunle, S. O. (2009). Development and validation of a computer package on electrochemistry for secondary schools in Nigeria. *International*

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.

Journal of Education and Development Using Information and Communication Technology, 5(2), 88-104.

Panasonic (2013). *Light emitting diode television service manual.* USA: Panasonic Company.

Sanyo (2015). *Sanyo light emitting diode owner's manual.* Chinghai, China: Sanyo electronics Inc.

Schaafstal, A., Schraagen, J. M. & VanBelo, M. (2000). *Cognitive task analysis and innovation of training. The case of structured troubleshooting*. Retrieved on 27th May. 2014 from www.troubleshooting.com

Slavin, R. E. (2011). Instruction based on cooperative learning. In R. E. Mayer & P. A. Alexander (Eds.), *Handbook of research on learning and instruction* (pp. 344-360). New York: Taylor & Francis.

Sony (2015). *Sony light emitting diode television service manual*. United Kingdom: Sony Corporation Sony UK Service Promotions Department.

Sorden, S. D. (2015). A cognitive approach to instructional design for multimedia learning. *Information Science Journal,* 8(2), 263-279.

Corresponding author: Hassan, Y. J jy2000.hj@gmail.com Science and Technology Education Department, Bayero University, Kano.