TECHNIQUES AND TECHNOLOGIES REQUIRED BY TEACHERS FOR TRAINING ELECTRONICS STUDENTS IN PROBLEM-SOLVING IN HIGHER INSTITUTION IN NIGER STATE, NIGERIA

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Abstract: *The aim of the study was to determine the techniques and technologies that the teacher need for training electronics students in problem solving. Two research question and two null hypotheses guided the study. The study employed cross-sectional survey design. Random Sampling was employed to select 40 respondents consist of 30 electronics students and 10 electronics teachers in higher institution of learning in Niger State. The instrument used for data collection was questionnaire. Data collected was analyzed using mean for research questions and t-test for hypotheses. Emerging findings revealed 15 techniques and 10 technologies in problem solving. Among the techniques include; create cooperative learning group, analyze problems, teach electronics symbolic operations that often associates electronics problems, select suitable electronics operations that correctly translate a problem, use electronics operations to represent electronics problems, generate possible approaches that a represented electronics problem can be solve whereas technologies are; create computer based interactive learning environment, employ interactive training and learning tool such as interactive white board, use electronics instructional software with electronics symbols, use computer based software that provide dynamic models in interactive media that offer visualization and analytic tools, employ innovative software with inquiry and thinker tools that allows students to perform electronics exercises in group and compare results with exercises carried out by student's self amongst others. It was recommended that for effective training in problem solving schools should adapt these techniques and technologies since they promote learning environment that support group cooperative learning which is a core requirement for problem-solving.*

Keywords: *Electronics, Higher institution, Problem solving, problem, Teaching techniques and technology*

1. INTRODUCTION

Nigeria been a developing country that hope to attain economic and technology advancement, has over the years taken steps towards the attainment of this vision. One of these steps was the introduction of subjects that are relevant in fostering the needed technological development into her education system. One of such subjects is Electronics. Electronics is a science or branch of physics that deals with the emission, behavior, effects and movement of electronics in vacuums, gases and semiconductors with associated devices using such electrons (Merriam-Webster, 2008). It is a branch of science that deal with the study of the flow and control of electrons, and the study of their behavior and effects in vacuums, gases and semiconductors and with devices using such electronics (Electronicsandyou.com, 2013). Virdi

(2018) defined electronics as the study of the flow of charge through various materials and devices such as semiconductors, resistors, inductors, capacitors, nanostructures.

The role electronics plays in our everyday life can never be over emphasized. Today, with the advent of mobile telecommunication and information communication technology, equipment such as phones and computers has made electronics to have become part and parcel of our everyday lives. Computers and internet for instance provides various innovations in the economy and technology via the use of electronics components which is today useful for the processing of normal academic works, business, family, personal schedules and functions. Because of the significance role electronics play in our everyday lives particularly in the manufacture of modern machines, equipment and materials, in Nigeria electronics studies has been fused into the education system and offered as; integration of fields of study at the elementary school, trade at technical college, subject at secondary schools while it is offered as a course at the higher institution.

Higher institution refers to the type of education which is offered after secondary education that its operation is overseen by the State or Federal Ministry of Education (FRN, 2004 and Jaja, 2013). In Nigeria categories of higher institutions exist namely; Colleges of Education, Polytechnics, Monotechnics and Universities (Federal Ministry of Education, 2003). As a foundational course needed for understanding the manufacturing/operation of modern equipment and the technologies associated with computers, teaching electronics with its dynamism requires a problem solving approach (Khairiyah, Phang & Helmi, 2013).

Problem solving is simply defined as thinking that is directed towards providing solution to a specific problem (Yahya, 2017). Carson (2007) defined it as the means by which an individual uses previously acquired knowledge, understanding and skills to satisfy the demands of an unfamiliar situation by synthesizing what is learnt and applying it to a new and different situation. Problem-solving is the act of defining a problem, determining the cause of the problem, identifying, prioritizing and selecting alternatives for a solution and implementing the solution (Maheshwari, 2017). From these definitions, it implies that problem solving entails the deployment of previously learnt knowledge by an individual towards solving a present confronting or existing problem that he or she is not familiar with. Teaching students problem solving has enormous importance amongst which are; it develop in the student creative, persistence and proactive mindset, it prepares students for real life situation in the real world, it produce self-confidence and self-esteem students, it teach students to make decision independently (Bethany & Laura, 2016). In training electronics students to develop thinking skills to solving confronting problems in problem solving involves certain procedures.

Procedures in problem solving are the steps involve in solving a problem (Yahya, 2017). These procedures provided by Bethany and Laura (2016), Yahya (2017) and Eva (2017) are: (i) identification of the problem; this requires that you understand the nature of the problem after which possible ways which the problem can be solved is proffered, (ii) problem definition and representation is the next step; after identifying existing problem, the problem is then defined and represented in a format that will enable you to understand the problem and develop approach to solving the problem, (iii) formulation of strategy; after the problem is effective defined and represented, a plan of how to solve the problem is strategized. Several strategies to solving problems in electronics are available amongst which is task analysis which involves breaking down complex problem into manageable element. Other strategies are divergent and convergent thinking and problem synthesis (Yahya, 2017), (iv) organization of information; once the strategy to approaching the problem is derived, the available information is organized to enable easy implementation of the strategy, (v) allocation of resources; at this stage everything that one

need to use to aid in the deployment of planned strategy in order to effectively confront a problem is employed. Some of the resources concern the person's capacity to deal with the problem (such as reasoning, skill, planning), (vi) solution implementation; all the preparations made concerning proffering solution to the problem is put into action at this stage. Effective problem solvers inspect the solution processes in order to ensure that they are not deviating from the end point and (vii) evaluating the solution which is the final step. This is analysis stage that enables the problem solver to carefully assess the entire procedure in order to establish whether the solution arrived at is right. And if otherwise, adjustment is required by reviewing the procedures so as to factor areas that need correction. When these procedures are carefully followed solution is provided to a problem.

A problem is a situation which is experienced by a person as different from the situation which the person ideally would like to be in (Yahya, 2017). Cambridge Academic Content Dictionary (2018) defined problem as a question or something that causes difficulty that needed to be answered. Electronics problem from the foregoing could be seen as a situation in electronics that needed to be answered. A problem is answered or solved by a sequence of actions that reduce the different between the initial situation and the goal. In training electronics students, sequence of actions that reduces the difference between initial situation and the goal using procedures involving problem solving employs certain techniques and technologies.

Techniques and technologies in problem solving are two discrete terms use to describe the strategies and media or material the teachers use to enhance effective communication in problem solving. Techniques describe the strategies or possible plan of approach which the electronics teacher employs in training electronics students. Techniques refers to the procedures, processes or systems of communication that a teacher uses to achieve effective teaching and learning (Westwood, 2008) whereas technologies describe materials and associate instructional resources which the electronics teacher adopt to enhance effective training (Juran, 2018). The importance of technique and technologies employed in problem solving can never be over emphasized in the sense that the strategy, plan of approach and associated materials adopted by an individual can either mar or ease the solution to a problem irrespective of the nature of the problem. Some of the techniques employed in electronics training include; understanding the problem and employing teaching aids that will possibly help in solving the problem, working out a plan of action reflecting reasoning activities on how to approach the task, breaking a complex problem into smaller easily digestible unit, involve library research across different domain, seek support when need be, think carefully about the consequences of the support, queue the outcome of the support into your plan of action in order to ensure that the final decision is yours, carryout your plan of action, inspect the action plan steps and do a careful analysis to establish if the solution reached solved the problem (Yahya, 2017; Juran, 2018 & Eva, 2017).

Today, evolution in information communication technology has made electronics problems to become part of our everyday life as such it is important that the electronics students is train to be responsible for their personal life learning by making decisions independently. To make effective independent decision and be relevant in the present day technology world, electronics student has to be vast in problem solving. As such in training electronics student in problem solving, it is important that the teacher deploy appropriate techniques and technologies.

Notwithstanding the demand to producing self-confidence, creative and proactive mindset and prepared students to take up electronics problems in the present day technology world, available evidence such as Kennedy (2009) lamented that the individuals who are expected to contribute to the solution of electronic problems in our present society are gradually disappearing due to lack of adequate problem solving skills. This situation therefore questions the adequacy of

the strategies and technologies employed by the teacher for training electronics students in problem solving. Therefore, it becomes imperative to determine the techniques and technologies required by teachers for training electronics students in problem solving particularly at higher institutions.

1.1 Objectives of the Study

1) To determine the techniques required by teachers for training electronics students in Problem-Solving.
2) To determine the technologies required by teachers for training electronics students in Problem-Solving.

1.2 Research Questions

1) What are the techniques required by teachers for training electronics students in Problem-Solving?
2) What are the technologies required by teachers for training electronics students in Problem-Solving?

1.3 Hypotheses

The following hypothesis was tested at 0.05 level of significance;

HO_1: There is no significance difference between the mean response of students and teachers on the techniques required by teachers for training electronics students in Problem-Solving.

HO_2: There is no significance difference between the mean response of students and teachers on the technologies required by teachers for training electronics students in Problem-Solving

2. METHODOLOGY

The research design adopted for the study was Cross-sectional survey design. The study was conducted in Niger State. The sample for the study was drawn from the two technology education based Higher Institutions offering electronics (Federal University of Technology, Minna and College of Education, Minna). Using Random Sampling, 10 Electrical/Electronic teachers (5 from each school) and 30 Electrical/Electronic students (15 from each school) were randomly sampled for the study. Thus a total of 40 respondents were randomly administered questionnaire. The instrument that was used for the collection of data was a twenty five (25) structured items questionnaire consisting of 15 question items on techniques required by teachers for training electronics students in Problem-Solving and 10 question items on technologies required by teachers for training electronics students in Problem-Solving. A Four Point Rating Scale with the following response scale: Strongly Required (SR) = 4, Required (R) = 3, Strongly Not Required (SNR) = 2, Not Required (NR) = 1 was employed as response options. Data collected were analyzed using mean statistics for research questions and t-test for hypotheses. For determining which item is required or not required a cutoff mean of 2.50 interpreted in relative to the 4-point rating scale is set as decision rule.

3. RESULTS

Table 1: Mean and Standard Deviation on Techniques Required for Training Electronics Students in Problem Solving

S/N	Techniques Required for Training in Problem Solving	$\bar{X}_1$	SD_1	$\bar{X}_2$	SD_2	$\bar{X}_t$	Decision
1	Create cooperative learning group	3.93	0.25	3.90	0.32	3.93	Required
2	Encouraging students to solve electronics problems in smaller group	3.67	0.48	3.50	0.53	3.62	Required
3	Analyze identified problems	3.70	0.47	3.80	0.42	3.72	Required
4	Teach electronics symbolic operations that often associates electronics problems	4.00	0.00	3.20	0.92	3.80	Required
5	Select suitable electronics operations that correctly translate or represent a problem	3.33	0.48	3.00	0.94	3.25	Required
6	Use electronics operations to represent electronics problems	3.33	0.55	3.50	0.53	3.37	Required
7	Generate possible approaches that a represented electronics problem can be solved	3.37	0.62	3.90	0.32	3.50	Required
8	Select the more simplified possible solution approaches to a problem	2.67	1.23	3.40	0.51	2.85	Required
9	Use the selected possible solution approaches to solve identified problem(s)	3.00	1.43	3.40	0.52	3.10	Required
10	Weigh the competing risk of the different generated options used in solving a problem	3.03	0.81	3.70	0.48	3.20	Required
11	Determine the solution approach that generated minimized risk	3.67	0.47	2.70	0.68	3.43	Required
12	Employ the solution approach with the minimized risk to resolve the problem	2.67	1.26	3.70	0.48	2.93	Required
13	Evaluate each step of the solution process	3.97	0.18	3.40	0.69	3.83	Required
14	Discussed steps adapted in solving the problem among (cooperative) learning groups	3.77	0.57	3.90	0.32	3.80	Required
15	Adopt the solution approach that led to the solution of the problem with minimized risk in similar situations.	3.33	0.45	3.30	0.82	3.33	Required
	Grand Mean	**3.43**	**0.62**	**3.47**	**0.57**	**3.44**	

Result analysis of students and teachers responses on techniques required for training electronics students in problem solving showed that the respondents agreed with all the items as techniques required for training electronics students in problem solving since all the items average mean rating is above cutoff mean of 2.50. Among the list of items, number 1, 13, 4, 14, 3 and 2 have the highest mean which are 3.93, 3.83, 3.80, 3.80, 3.72 and 3.62 respectively.

Table 2: Mean and Standard Deviation on Technologies Required for Training Electronics Students in Problem Solving

S/N	Technologies Required for Teaching in Problem Solving	$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	$\overline{X}_t$	Decision
1	Create computer based interactive learning environment	3.60	0.62	3.56	0.53	3.59	Required
2	Employ interactive training and learning tool such as interactive white board, flipped classroom.	3.97	0.18	3.60	0.52	3.88	Required
3	Use electronics instructional software with electronics symbolic, pictorial and mathematical expressions	3.80	0.48	3.90	0.32	3.83	Required
4	Use electronics graphing programmes	3.93	0.37	3.60	0.67	3.85	Required
5	Use removable electronics storage devices	3.87	0.43	3.50	0.53	3.78	Required
6	Use electronics mathematical supposers for making and checking conjectures	3.33	0.47	3.00	0.47	3.25	Required
7	Use computer based software that provide dynamic models in interactive media that offer visualization and electronics analytic tools	3.50	0.78	3.70	0.48	3.55	Required
8	Employ innovative software with inquiry and thinker tools that allows electronics students to perform variety of electronics exercises in group and compare results with exercises carried out by student's self.	3.83	0.46	3.50	0.53	3.75	Required
9	Use computer software tools that pose problems, give feedback, structure and support dialogue among electronics students and their teachers.	3.67	0.48	3.10	0.32	3.53	Required
10	Use answering machines such that can guide students on personal needs outside normal classroom setting.	3.43	0.82	3.00	0.47	3.33	Required
	Grand Mean	**3.69**	**0.51**	**3.45**	**0.48**	**3.63**	

Result of Table 2 indicate that the respondents agreed with the items listed as technologies required for training electronics students in problem solving since the average mean rating of all items are above cutting mean of 2.50. As contained in the table, the items mean range between 3.88 to 3.25. Thus, is an indication that the respondents agree with all the items.

Table 3: t-test Analysis of Techniques Required for Training Electronics Students in Problem Solving

Group	N	Mean Difference	Standard Error Difference	t-calc.	df.	t-table	Decision
Students	30	-0.87	2.91	-0.31	38	2.01	H_0: Not Sign.
Teachers	10	-0.87	2.75				

Result of the t-test analysis of the responses of teachers and students regarding techniques required for training electronics students in problem solving contained in Table 3 indicate that t-calculated (-0.31) is less than t-critical (2.01) at 0.05 level of significance df38. The null hypothesis is therefore accepted thus, there is no significance difference in the mean response of the respondents as regards techniques required for training electronics students in problem solving.

Table 4: t-test Analysis of Technologies Required for Training Electronics Students in Problem Solving

Group	N	Mean Difference	Standard Error Difference	t-calc.	df.	t-table	Decision
Students	30	2.83	1.53	1.85	38	2.01	H_0: Not Sign.
Teachers	10	2.83	1.50				

Result of table 4 presents the t-test analysis of technologies required for training electronics students in problem solving. From the table, t-calculated (5) is less than t-table (2.01) value at 0.05, level of significance df38. The null hypothesis is therefore accepted thus, there is no significance difference in the mean response of the respondents regarding technologies required for training electronics students in problem solving.

4. RESULTS AND DISCUSSION

Findings of the study contained in Table 1 are the techniques required for training electronics students in problem solving. As revealed the respondents agreed with the 15 items as techniques for training electronics students in problem solving. The identified problem solving techniques as revealed in the findings are; create cooperative learning group, encouraging students to solve electronics problems in smaller group, analyze identified problems, teach electronics symbolic operations that often associates electronics problems, select suitable electronics operations that correctly translate or represent a problem, use electronics operations to represent electronics problems, generate possible approaches that a represented electronics problem can be solved, select the more simplified possible solution approaches to a problem, use the selected possible solution approaches to solve identified problem(s), weigh the competing risk of the different generated options used in solving a problem, determine the solution approach that generated minimized risk, employ the solution approach with the minimized risk to resolve the problem, evaluate each step of the solution process, discussed steps adapted in solving the problem among

(cooperative) learning groups and adopt the solution approach that led to the solution of the problem with minimized risk in similar situations. Techniques use in teaching varies depending on the teaching methodology employed. As regard Problem solving, there are procedures or steps involved and these procedures determine the techniques.

Emerging finding on techniques required for training electronics students in problem solving follows the processes and procedures identified by Bethany and Laura (2016), Yahya (2017) and Eva (2017) that are involved in problem solving which include; problem identification, definition of the problem, formulation of possible strategies in which the problem can be solved after the problem has been represented with symbolic operations and assessment of the entire procedure adopted to solve a problem. Buttressing on the outcome of this finding, t-test analysis presented in Table 3 showed a no significance difference in the mean response between the teachers and students on techniques required for training electronics students in problem solving. This is affirmation that both teachers and students unanimously agreed with outcome of this finding as techniques required for training electronics students in problem solving.

Table 2 present finding on technologies required for training electronics students in problem solving. The result as contained in the table shows that technologies needed for training electronics students are; create computer based interactive learning environment, employ interactive training and learning tool such as interactive white board, flipped classroom, use electronics instructional software with electronics symbolic, pictorial and mathematical expressions, use electronics graphing programmes, use removable electronics storage devices, use electronics mathematical supposers for making and checking conjectures, use computer based software that provide dynamic models in interactive media that offer visualization and electronics analytic tools, employ innovative software with inquiry and thinker tools that allows electronics students to perform variety of electronics exercises in group and compare results with exercises carried out by student's self, use computer software tools that pose problems, give feedback, structure and support dialogue among electronics students and their teachers and use answering machines such that can guide students on personal needs outside normal classroom setting. These emerging results supports the views of Yahya (2017), Juran (2018) and Eva (2017) that fore mostly advocate for having group learning environment such that will allow students work cooperatively, assess their work progress, compare individual work progress with other groups with or without the physical presence of the teacher.

With computers, cooperative learning group can be created such that using interactive white board different groups can be attended by a teacher. Also with teaching-learning media tools such as computer software with inquiry and thinker tools, computer software tools that pose problems, give feedback provides that platform that allow students in cooperative group perform variety of exercises, compare results with exercises carried out by individuals or groups and also dialogue among groups with a view of agreeing on solutions approach that best resolve a problem given problem with minimize risk which should be considered to form basis for solving future related problems. In addition, the t-test analysis contained in Table 3 that revealed a no significance difference on technologies required for training electronics students in problem solving affirmed that the opinion of both teachers and students does not differ significantly on technologies required for training electronics students in problem solving.

5. CONCLUSION

Emerging results from the study provides techniques and technologies to be employed in training electronics students in using problem solving approach to solving electronics problems. The identified techniques and technologies basically established that for effective students training in problem solving, learning environment that supports cooperative group learning

should be provided and also students should be provided with technologies that gives them the opportunity to evaluate their peers' (among cooperative group) proposed solutions in classroom so as to enable them determine among alternatives the solution approach that best solved a problem with minimized risk. It is therefore recommended that for training in problem solving to be effective, school authorities should adapt the techniques and technologies which the study identified since these techniques and technologies promotes learning environment that support group cooperative learning and also gives students opportunities to evaluate their work progress among groups which is the fundamental requirement in problem solving.

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