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Using Concept Maps For Facilitating Critical Reasoning And Recall Amongst Electrical Technology Students

Okworo, Gibson Samuel (Ph.D)
Department of Educational Technology and Library Science
Faculty of Education
University of Uyo, Uyo
Akwa Ibom State, Nigeria
gibsonokworo62@gmail.com

Caleb, E.E[1]
Department of Vocational Education
Faculty of Education,
University of Uyo, Uyo
Akwa Ibom State Nigeria
ezekielemmanuel.voc.lect@uniuyo.edu.ng

Touitou, Tina C.
Department of Mass Communication
Babcock University, Ilishan – Remo, Ogun State

***Abstract*—This study investigated the effect of concept map instructional strategies on performance and retention amongst electrical installation students in Technical Colleges of Akwa Ibom state, Nigeria. A quasi-experimental design using the pre-test, post-test control group method was employed for the study. The population is 435 students comprising all Electrical Installation and maintenance Senior Technical Two (ST. II) students in the six public Technical Colleges in Akwa Ibom State. The sample consists of 105 Senior Technical II Electrical Installation and Maintenance work students in two intact classes drawn from two selected Technical Colleges in Akwa Ibom state. Data for the study was collected using the researcher developed instrument called "Electrical Troubleshooting Practical Checklist" (ETPC). Scores for retention were obtained by administering the test again to the same sets of students after two weeks. Mean and Standard deviation was used to answer the research questions while Analysis of Covariance was used to test the null hypothesis 1 at .05 alpha level and t-test used to test null hypothesis 2 at .05 alpha level. The findings reveal that the use of concept mapping instructional strategy can aid the retention of taught materials. It was recommended amongst others that Technical College teachers should consider using a hybrid model of Concept mapping-Demonstration method during instruction in Technical Practical Courses.**

Keywords—Concept Mapping, Technology, Cognitive and Critical Reasoning

Introduction

The goals of any good instruction in Technical Education goes beyond just assisting students to grapple with subject matter, but to facilitate the acquisition of soft skills as well as technical skills. Technical Education and industrial technology students, whose strength has always been on the use of technical skills, now, also need to focus on developing soft skills such as critical thinking and problem solving skills, which will enable them to be adaptable to changes in technology and job descriptions. Science and technological education training programmes have seen the adoption of instructional methods in classrooms that mirrors the new global industrial environment. These instructional methods develop both the technical (hard) skills and non-technical (soft) skills demanded by industries for adaptation. One of such methods that can be used to develop critical thinking skills as well as technical skills is the use of concept maps.

Ebenezer and Conner (1998), state that a concept map is a schematic device for representing a set of interrelated, interconnected conceptual meaning. They further go on to say that it is a semantic network showing the relationships among concepts in a hierarchical fashion. Concepts and ideas are linked with phrases that illustrate the relationships among them.

Similar to an outline or a flowchart, a concept map is a way of representing or organizing knowledge. However, a concept map goes beyond the typical outline, in that, concept maps show relationships between ideas/concepts, including bi-directional relationships. Usually, a concept map is divided into nodes and links. According to Anderson-Inman and Zeitz, (1994), nodes (often circles) represent various concepts; and links (lines) represent the relationships (propositions) between concepts. Words are used to label the links in order to explicitly depict relationships.

The theoretical framework for concept mapping is given by Ausubel's learning theory. Ausubel believes that learning of new knowledge relies on what is already known. That is, construction of knowledge begins with observation and recognition of events and objects through concepts already known. Students learn by constructing a network of concepts and adding to them. According to Ausubel in Ioana, Silvia and Cristina (2011), the most important single factor influencing learning is what the learner already knows. Thus, meaningful learning results when a person consciously and explicitly ties new knowledge to relevant concepts they already possess. Ausubel suggests that when meaningful learning occurs, it produces a series of changes within ones entire cognitive structure, modifying existing concepts and forming new linkages between concepts.

Concept-mapping has been identified as creating a stimulating learning environment which facilitates critical thinking, by encouraging students to connect new knowledge to their prior learning as well as providing students opportunity to gain further, wide and varied knowledge of a number of concepts in a short period of time. Consequently, because knowledge is stored hierarchically, it becomes easy for recall. It follows that concept map instructional strategy can aid retention and enhance academic performance of students.

According to Mary (2010), concept-mapping is an integral teaching method to facilitate critical thinking. Concept-mapping encourages meaningful understanding by helping students to organize and connect the information they already know about a subject with the new knowledge. The understanding according to Akinsanya and Williams (2004) is brought about by the student's ability to meaningfully connect, link and integrate new ideas, thoughts, concepts and statements to their existing body of knowledge. The students are able to link and cross-link the concepts and describe their relationship. They then see the 'bigger picture' of the phenomenon. Through concept-mapping, the teacher can determine the intellectual growth of students and also diagnose their misunderstanding through misdirected links or wrong connections. The student's conceptual knowledge is illustrated well through concept-mapping. In a concept map, each word or phrase is connected to another and linked back to the original idea, word or phrase. They are a way to develop logical thinking and study skills, by revealing connections and helping students see how individual ideas form a larger whole. Thus concepts maps aid the teacher in assessment.

Concept learning is an active process that is fundamental to understanding science concepts, principles, rules, hypotheses, and theories. It is the responsibility of the Technical College teacher to organize learning experiences in a way that will facilitate student learning. As students are introduced to new concepts in electricity, electronics, mechanical technology and building technologies, they embark on a cognitive process of constructing meaning and making sense by consciously or subconsciously integrating these new ideas with their existing knowledge. This is best facilitated by Concept Maps. In the view of Safdar (2010), if teachers learn how to construct concept maps and use them for planning and assessing lessons, they will be able to teach students better how to make concept maps to organize their thoughts and ideas. Technical Education teachers can use concept maps to determine the nature of students' existing ideas, and make evident the key concepts to be learned and suggest linkages between the new information to be learned and what the student already knows. To sum up, Concept maps can be used for; knowledge construction; learning; assessment, where it can be used as a pre-post assessment of what students' prior knowledge and what they have learned; evaluation (to evaluate how students organize their knowledge); record of understanding and misconceptions and Instruction (Markham and Mintzes, 1994).

Beyond knowledge construction, concept maps can be used to outline the processes and techniques involved in production and can aid in the acquisition of practical technical skills. Each word or phrase linked/connected to another word or phrase can be used to describe activities to be carried out by the students. The nodes and links can also be used to show what activities should come first and what activity should follow next. It can also be used to describe the process and link one process to another in the skills acquisition process. This can help the students acquire skills even in the absence of the teacher, because, a detailed concept map is more or less a do-it-yourself approach and students, following the map, can actually develop practical skills by themselves. Beyond acquiring skills, the concept map learning process also develops critical thinking and problem solving skills, analytical and initiative taking skills which are embedded in the process of reading and interpreting maps.

Statement of the Problem

Concept mapping requires the learner to operate at all six levels; knowledge, comprehension, application, analysis, evaluation, and creation (synthesis) of Bloom's educational objectives of cognitive domain. The question then is: Will concept mapping, used in the classroom as an instructional method, affect the information searching of students and by extension influence academic performance positively? Will it help students in their search for relevant knowledge and acquisition of skills in Technical/Industrial Education? Will concept mapping aid recall and retention among Technical Education students?

Objectives of the Study

The main purpose of this study was to determine the effect of concept mapping instructional strategy on academic performance of students. Specifically, the study sought to

1. Determine the Mean academic performance score of students in electrical troubleshooting when taught with concept maps as against those taught with demonstration method.
2. To ascertain the mean retention scores of students' in electrical troubleshooting when taught using concept mapping and demonstration instructional methods.

Null Hypothesis

The following null hypotheses were tested at .05 alpha level

H_{o1}: There is no significant difference in the mean scores of students' academic performance in electrical troubleshooting when taught using concept mapping and demonstration instructional methods.

H_{o2}: There is no significant difference in the mean retention scores of students' in electrical troubleshooting when taught using concept mapping and demonstration instructional methods.

Research Method

A quasi-experimental design using the pre-test, post-test control group method was employed for the study. This design was deemed appropriate since the study involved students in Senior Technical Two (ST II) using two intact classes in electrical installation work and in two independent groups. The population is 435 students. The population of the study comprised all Electrical Installation and maintenance Senior Technical Two (ST. II) students in the six public Technical Colleges in Akwa Ibom State. The sample consists of 105 Senior Technical II Electrical Installation and Maintenance work students in two intact classes drawn from two selected Technical Colleges in Akwa Ibom state. Random sampling technique was used to select the two schools from six Technical Colleges in the study area. The two schools were randomly assigned to treatment and control schools. Data for the study was collected using the researcher developed instrument called "Electrical Troubleshooting Practical Checklist" (ETPC). Scores for retention were obtained by administering the test again to the same sets of students after two weeks. Mean and Standard deviation was used to answer the research questions while Analysis of Covariance was used to test the null hypothesis 1 at .05 alpha level and t-test used to test null hypothesis 2 at .05 alpha level.

Null Hypothesis 1

There is no significant difference in the mean scores of students' academic performance in electrical troubleshooting when taught using concept mapping and demonstration instructional methods.

Table 1: Summary of Result for Significant Test of Students' Academic Performance in Electrical Troubleshooting

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Pretest (covariate)	7027.542	1	7027.542	97.072	.000
Explained	726.344	1	726.344	10.033	.002
Main Effect (Teaching Methods)	443.706	1	443.706	6.129*	.015
Residual	7384.280	103	72.395		
Total	345988.000	105			

*= significant at P < .05 alpha level.

Table 1 shows the Covariance Analysis of students' academic performance scores in electrical troubleshooting when taught using concept mapping and demonstration instructional methods. The table indicates that the calculated F-value is 6.129 with the significant of F at .015 at P≤.05. Therefore the null hypothesis stating that there is no significant difference in the mean scores of students' academic performance in electrical troubleshooting when taught using concept mapping and demonstration instructional methods is rejected. This implies that, there is significant difference between the mean scores of students' academic performance in electrical troubleshooting when taught using concept mapping and demonstration instructional methods, with those taught with concept maps performing better than those taught with demonstration method.

Null Hypothesis 2

There is no significant difference in the mean retention scores of students' in electrical troubleshooting when taught using concept mapping and demonstration instructional methods.

Table 2: Summary Of Significant Test For Retention Scores Of Students In Electrical Troubleshooting When Taught Using Concept Mapping And Demonstration Instructional Methods.

Teaching methods	n	Mean	Std. Dev.	df	tcal	Sig.of t	Decision
Concept Mapping	59	61.24	6.20	103	4.455	0.001	*
Demonstration	61	48.65	19.07				

*=significant at p≤.05.

Table 2 shows the summary of the t-test of significance for retention scores of students taught with Concept Mapping and Demonstration Instructional Methods. The result shows that students taught with concept mapping had higher Mean performance scores than students taught with demonstration method. Table 2 further reveals that the significance of p is 0.001, this is less than the alpha level of .05. Since p≤.05, the null hypothesis is rejected. Thus, there is a significant difference in the mean retention scores of students' in electrical troubleshooting when taught using concept mapping and demonstration instructional methods, with the students taught using concept mapping retaining more taught material than those taught with demonstration.

Discussion of Findings

The findings of this study has shows that students taught electrical trouble shooting using concept mapping performed significantly better when tested as against those taught using demonstration. This could be because electrical troubleshooting will require students to think and explore different ways of rectifying a malfunction unlike straight tasks where little or no thinking maybe required. Troubleshooting requires students to draw from previous knowledge, use problem solving skills as well as creative skills. A concept mapping learning environment encompasses these skills and it thus becomes easy for students to develop these skills during instruction using concept mapping. This findings is in line with Kehinde (2013), which found that a careful integration of concept mapping instructional strategy in the classroom helps students perform complex tasks as routine tasks as it helps them through the cognitive process of problem solving.

The study also found a significant difference in the mean retention scores of students' in electrical troubleshooting when taught using concept mapping and demonstration instructional methods, with the students taught using concept mapping retaining more taught material than those taught with demonstration. This could be as a result of the fact that information stored in schema is easy to retrieve. This findings is supported by the findings of Haynie (2003), Savage and Sterry (2003) which concurred that the important element of retention is comprehension because the easier the material followed the easier it is to recall that material. The scholars asserted that a teacher who wants his or her students to remember what is taught could work hard to invest it with all the strategies for enhancing comprehension and mastery of skills. This is in line with the findings of Ebenezer and Conner (1998), which opined that concept formation provides learners with an opportunity to explore ideas by making connections and seeing relationships between items of information.

Conclusion

From the findings of the study, it is established that the use of concept mapping instructional strategy can aid the retention of taught materials. Also, concept maps if developed properly and applied in Technical Colleges, can be used to develop technical skills even in the absence of the teacher.

Recommendations

1. Technical College teachers should consider using a hybrid model of Concept mapping-Demonstration method during instruction in Technical Practical Courses.
2. Technical College teachers should explore the use of concept maps in teaching the theoretical aspects of instruction as materials taught can be easily remembered by students in diagrammatical/pictorial forms.

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