ASSESSMENT OF COMPUTER-BASED CONCEPT MAPPING STRATEGIES ON MATHEMATICS PERFORMANCE AND INTEREST OF UPPER BASIC SCHOOLS IN KADUNA STATE, NIGERIA

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Abstract

The study examined the impact of Computer-Based Concept Mapping Strategies on mathematics performance and interest of upper basic schools in kaduna state, Nigeria the purpose of this research work, four objectives, research questions and hypotheses were type of quasi-experimental design used was pre-test, post-test non-equivalent non-randomized and eighty-four (10584) from public junior secondary schools in one hundred and eighty three hundred and eighty eight (288) JSS students from four Junior Secondary Schools in Kaduna metropolis. The study used the multiple-choice objectives tests tagged instrument for this research consists of the treatment instrument "Mathematics Performance Test (MPT)".The instrument was duly validated by experts. The test and re-test score was calculated using the Pearson Product Moment Correlation Coefficient (PPMC) formula. The result showed a reliability coefficient of 0.76. Both descriptive and inferential statistics were used in the analysis of data. The findings of the study showed that spider and flow-chart computer-based concept mapping are efficacious in enhancing students' academic performance and interest in learning Mathematics. Furthermore, the result revealed that computer-based concept mapping is gender-friendly as it is effective for co-educational settings. The study recommends that teachers should be encouraged to use cooperative instructional strategy in teaching mathematics by allowing them attend courses and seminars where such modern teaching methods are discussed and put in practice for effective teaching.

Keywords: Computer-Based Concept Mapping, Strategies Mathematics, Performance, Interest

Introduction

The learning strategies and the integration of suitable technology assist learners to learn mathematics more effectively which leads to the development of meta-cognitive strategies that can enhance meaningful learning (Ayuba, 2017). The information conveying by teacher to the learner can be communicated in two broad ways "passively" and "actively." Distinction between these ways of communicating information to the learners is the role that students and teacher play in the exchange of information. The earlier practices (passive leaning) have received criticism of various kind from cognitivists and constructivist school of thoughts on how effective learn can take place. The latter practice (Actively leaning) is a new trend in education practice which has primary goal of engaging learners in the activities of constructing knowledge using their previous knowledge. Among strategies used to achieve this paradigm shift into active learning strategies is concept mapping.

Concept maps according to Freeman,(2014) are a kind of graphic representation which shows how different concepts relate to each other. They are made up of nodes (concept squares) and links (lines with tags) which are designed to represent knowledge and are used in a wide range of activities to make learning easier. Concept mapping is a strategy that helps learners to organize their cognitive frameworks into more powerful integrated patterns. A concept map is a schematic device used to explicitly represent a number of concepts and their interrelationships. It is a technique that allows students to see the connections between ideas they already have, connect new ideas to knowledge that they already have, and organize ideas in a logical structure. Research work conducted by Chiou (2018) have observed that concept mapped can improve meaningful learning and can help in learning science independently. They added further that CM is a schematic device for representing a set of concept meaning embedded in a hierarchical diagram that illustrates the interconnections between/among concepts. It is consistent with the theories of knowledge representation, constructive learning and meaningful Learning. It is now widely applied in teaching and Learning of sciences. Concept map provide a visual road map showing the pathways a learner can take to construct meaning of concepts and propositions. This strategy can be both learning tool as well as evaluation tool, which encouraged the student to use meaningful model-learning patterns.

More recently, the use of information and computer technology has enabled information mapping to be achieved with far greater ease (Novak & Cañas 2018). A plethora of software tools has been developed to meet various information mapping needs. Computer-based concept mapping instruction (CBCM) is the process by which written and visual information is presented in a logical sequence to a learner through a computer. The student learns by reading the text material presented or by observing the graphic information displayed. Some of the programmes provide audio-visual presentation with options for student to select audio presentation in addition to the visual media. Each segment of text is followed by questions, for student's response. Feedback on response is indicated immediately. CBCM can features interactivities and manipulations none and links. Computer-based concept mapping support individualized learning as it usually involves a dialogue between one student and a computer programme. Students can learn at his own pace and time frame. Computer-based Concept mapping are of different modes. This includes hierarchical mode, system mode, flowchart mode and spider mode. Of all these modes, spider modes and flowchart are commonly used in mathematics instruction (Nesbit & Adesope,2016).

Muhammad and Munawar (2012) carried out a research titled "Effectiveness of Computer-based Concept Mapping in Urdu Language for Secondary School Students' Achievement in Science". This study examined the effectiveness of computer assisted 'instruction (CBCM) on students' achievement in general science as compared with the traditional method of instruction (TMI). The CBCM program comprising interactive tutorials in Urdu language was used for learning by the experimental group. The control group was taught the same content in the classroom by the teacher through textbook based lecture method, which is the traditional method of teaching in public schools in Pakistan. An achievement test assessing knowledge, comprehension and application components of learning was administered to both the groups after a two months long treatment period. The study revealed that experimental group performed better on all the three components of the achievement test as compared to the control group. The CBCM group also scored higher than the TMI group in various content areas of general science. Instead of understanding mathematics concepts, pupils tend to view mathematics as a piece of information. As a result, new concepts are not assimilated into their long-term memory (Chile, 2010, Davies, 2010). There is need to use some innovative teaching methods (such as spider mode concept and flow-chat mode concept) to see

the effect of the two concept modes for the performance in mathematics students. CBCM Instructional Strategy has been extensively used as a teaching, learning, and evaluating tool in different disciplines.

Liu, Chen, and Chang, (2010) conducted a study on "Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension." The results indicated that the computer-assisted Concept Mapping learning strategy enhanced learners' use of other English reading strategies–listing, enforcing, and reviewing. Vural, O. F. (2010) conducted research on the "Effectiveness of concept maps in learning from a computer-based instructional video resource." The findings discovered that there is no significant differences in the achievements of students who used either learner-generated concept maps or expert-generated concept maps. Asan (2007) conducted an investigation on "Concept Mapping in Science Class: A Case Study of Fifth Standard Students." The results concluded that concept mapping has an evident impact on student achievement in science. Royer, and Royer, (2004) conducted research on "Comparing hand-drawn and Computer Generated Concept Mapping." The findings revealed that the group using the computer created more complex maps than the group that used paper or pencil. This difference was significant. Riley and Ahlberg, (2004) conducted a study on "Investigating the use of ICT-based Concept Mapping Techniques on Creativity in Literacy Tasks." The findings revealed that ICT-based Concept Mapping enhances learning. Hang, Sung and Chen (2001) conducted a study on Learning through computer-based concept mapping with scaffolding aid." The results revealed that both the two computer-based groups achieved more than the group using paper and pencil.

Statement of the Problem

Mathematics knowledge is prerequisite knowledge for chemistry, physics and biology at all levels of science education. Therefore, poor interest in the mathematics at the foundational level may negatively affect the poor performance of the students. There is no subject in our school today that has attracted attention of stakeholders like mathematics due to unsatisfactory academic performance in the subject (Ibrahim, Jibrina & Deba 2015; Igwe & Daniel, 2015). This is made obvious in the West Africa Examination Councils (WAEC, 2018 to 2020) result analysis in mathematics of some selected secondary schools in Nigeria. The result analysis shows, those that scored credit (A1-C6) in mathematics are less than 40% (WAEC Chief Examiners Report, 2018). This scenario of unsatisfactory academic performance made WAEC Chief Examiner Report, (2018) suggested that mathematics teachers should teach the subject both theoretically and practically with examples. Computer-based Concept mapping is of the strategies of engaging learners practically and theoretically in mathematics learning. This strategy is rarely used in our school because the teachers are satisfied with didactic method of teaching mathematics. This didactic method does not engage pupil's prior knowledge actively (Cristòfol, 2016). The present study is designed to look at whether compare effect of two modes of computer-based concept mappings strategy will have on the academic achievement of junior secondary school and interest in learning mathematics through concept mapping as a contribution towards the development of knowledge and learning of mathematics in Kaduna state, Nigeria.

Research Questions

In view of the above, the following research questions were formulated to guide the conduct of the study.

1. What is the difference between academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of computer based concept mapping strategies in junior secondary schools in Kaduna State?

2. What is the difference in Spider Mode and flowchart computer-based concept mapping group's interest in CBCP as learning tools for mathematics in Kaduna State?

3. What is the difference in male and female JSS students' performance scores in mathematics when taught mathematics using flow-chat concept mapping strategy in junior secondary schools in Kaduna State?

4. What is the difference in male and female JSSII students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary schools in Kaduna State?

Research Hypotheses

The following null hypotheses were postulated for this study:

1. There is no significant difference between academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of computer based concept mapping strategies in junior secondary schools in Kaduna State;

2. There is no significant difference in spider mode and flow-chart computer-based concept mapping groups interest in junior secondary schools in Kaduna State;

3. There is no significant difference in male and female JSS2 students' performance scores in mathematics when taught using flow-chart concept mapping strategy in junior secondary schools in Kaduna State;

4. There is no significant difference in the male and female jss2 students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary school in Kaduna State.

Methodology

The study used quasi-experimental design. The specific type of quasi-experimental design used in this study is pre-test, post-test non-equivalent nonrandomized comparison groups design. The study has two treatment groups; each group received one mode of computer-based concept mapping. This design is suitable for intact groups as it does not disrupt the existing research setting (Dimitrov & Rumrill, 2003). Quasi experimental is sensitive to internal validity problems due to interaction between such factors as selection and maturation, selection and history, and selection and pretesting, but was statistically controlled (Yusuf, 2016). The population of this study compromises of ten thousand, five and eight four (10584) JSSII students of public of public junior secondary school in 183 public secondary school of Kaduna metropolis. The sample size for this study is 288 JSS students from four Junior Secondary Schools in Kaduna State, Nigeria. The sample size is made up of four intact classes of JSSII Students. The school "A" is having an intact class of 78 students, School "B" is having an intact class of 68 students, School "C" is having an intact class of 75 students while school "D" is having an intact class of 67 students. The study used purposive sampling technique. The sampling of schools to participate in the study is based on schools that have adequate functional computer facilities that served an intact class of 67-70 students when grouped into groups of 3-5members. The research also choose stream "A" of JSS II because they are all students who do not have any subject similar to mathematics unlike science students. Purposive sampling technique is technique where the researcher includes cases or participants in the sample because they believe that they warrant inclusion (Taherdoost, 2016).

The study used the multiple-choice objectives tests tagged instrument for this research consists of the

treatment instrument "Mathematics Performance Test (MPT)". The experimental group were given a pre-test to ensure homogeneity. Reliability of the instrument was ascertained based on the results of a pilot study to determine the internal consistency and stability of the items in the instrument. The test and re-test score was calculated using the Pearson Product Moment Correlation Coefficient (PPMC) formular. The result showed a reliability coefficient of 0.76.This shows that the instrument is reliable and can be used for study.   The method used for data collection involves the use of: Pre-test, Treatment, and Post-test. i. Pre-test: the pre-test was at the initial stage administered to Experimental groups before the treatment. The researcher conduct the experiments and also administered the measurement instrument (treatment instrument) to the students. The two groups (experimental group l which was used of flow-chat mode and group2 use of spider mode) was subjected to the MPT as pre-test. ii. Treatment: The treatment for all the groups lasted for eight (8) weeks. After the test of homogeneity. The experimental group was expos to CBCM.

The students in the experimental group will be expose to the CBCM format under teacher's supervision long enough for them to be familiar with the navigation buttons and use the package independently. In addition, they were encouraged to take enough notes that could be useful for them in the post-test. The topics for the instruction were extracted from the Mathematics syllabus for the JSS II at the time of the study. They were taught using conventional classroom format. The classroom contained a chalkboard, chalk, textbook and charts which were used for the instruction. iii. Post-test: After the treatment, the two groups were exposed to the MPT as post-test. This is to ensure homogeneity in the lessons which ensured that measurements for the homogeneity are without any bias. Both descriptive and inferential statistics were used in the analysis of data. The bio data of the respondents were analyzed using frequencies and percentage while the descriptive statistics of mean and standard deviation were used to answer the research questions earlier stated in chapter one of this study, followed by detailed interpretation. For the four null hypotheses, inferential statistics of the t-test were used to test each of them at $p=<0.05(5\%)$ level of significance.

Results

The study used the multiple-choice objectives tests tagged instrument for this research consists of the treatment instrument "Mathematics Performance Test (MPT)". The experimental group were given a pre-test to ensure homogeneity.

Hypothesis One: There is no significant difference between academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of concept mapping strategies in junior secondary schools in Kaduna State;

Table 1; Comparison between the academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of concept mapping strategies

Group	N	Mean	SD	Df	t-value	Sig (2 tail)
Spider model	146	68.17	8.08			
				286	12.38	0.214
Flowchart model	142	51.76	11.54			

Results of two samples t-test on Table 1 shows that there is statistically significant difference between the mean academic performance scores of JSS II students taught mathematics using flow-chat mode and those

taught using Spider-mode of concept mapping strategies in junior secondary schools in Kaduna State, Nigeria. This is due to the fact that the calculated p value of 0.214 (2-tailed) is found to be greater than the 0.05alpha level of significance while the t-calculated value of 12.38 is greater than the t-critical value of 1.96, at Df 286.Their calculated post-tests mean academic performance scores were 68.17 and 51.76 for spider model instructional strategy and flowchart instructional model respectively. Consequently the null hypothesis which states that there is no significant difference between academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of concept mapping strategies in junior secondary schools in Kaduna State is hereby rejected.

Hypothesis Two: There is no significant difference in spider and flow-chart computer-based concept mapping groups interest in CBCP as learning tools for mathematics in Kaduna State;

Table 2: Comparison between the spider and flow chart computer-based concept mapping groups interest in CBCP as learnings tools for mathematics

Gender	N	Mean	SD	Df	t-value	Sig (2 tail)
Male	146	57.64	13.02			
				286	15.28	0.177
Female	142	36.89	8.89			

Results of two samples t-test on Table 2 shows that there is statistically significant difference in spider and flow-chart computer-based concept mapping interest in CBCP as learning tools for mathematics in Kaduna State, Nigeria. It showed that significant differences existed in the mean interest scores of students taught mathematics using spider instructional strategy and those taught using flow-chart computer-based concept mapping (CBCP) as learning tools for mathematics in Kaduna State, Nigeria. This is due to the fact that the calculated p value of 0.177 (2-tailed) is found to be less than the 0.05 alpha level of significance while the t-calculated value of 15.28 is greater than the t-critical value of 1.96,at Df 286.Their calculated post-tests mean motivation scores were 57.64 and 33.68for experimental and control groups respectively. Consequently the null hypothesis which states that there is no significant difference in spider and flow-chart computer-based concept mapping groups interest in CBCP as learning tools for mathematics in Kaduna State, Nigeria is hereby rejected.

Hypothesis Three: There is no significant difference in male and female JSSII students 'performance scores in mathematics when taught mathematics using flow-chart concept mapping strategy in junior secondary schools in Kaduna State, Nigeria.

Table 3: Comparison between the male and female JSSI students' performance scores in mathematics when taught mathematics using flow- chart concept mapping

Gender	N	Mean	SD	Df	t-value	Sig (2 tail)
Male	89	77.37	10.08			
				140	0.49	0.63
Female	53	60.78	11.54			

Results of two samples t-test on Table 3 shows that there is no statistically significant difference in male and female JSSII students' academic performance scores in mathematics when taught mathematics using flow-chart concept mapping strategy in junior secondary schools in Kaduna State, Nigeria. This is due to the fact that the calculated p value of 0.879 (2-tailed) is found to be higher than the 0.05 alpha level of

significance while the t-calculated value of 1.09 is found to be less than the t-critical value of 1.96, at Df 140. Their calculated posttests mean academic performance scores were 67.37 and 50.78 for male and female students respectively. Consequently the null hypothesis which states that there is no significant between male and female JSSII students' performance scores in mathematics when taught mathematics using flow-chart concept mapping strategy in junior secondary schools in Kaduna State, Nigeria is retained.

Hypothesis Four: There is no significant difference in male and female JSS2 students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary school in Kaduna State, Nigeria

Table 4: Comparison between the results of motivation tests for the Control and Experimental Groups in relation to Gender

Gender	N	Mean	SD	Df	t-value	Sig (2 tail)
Male	89	77.37	10.08			
				140	0.49	0.63
Female	53	60.78	11.54			

Results of two samples t-test on Table 4 shows that there is no statistically no significant difference in male and female JSS2 students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary school in Kaduna State, Nigeria. This is due to the fact that the calculated p value of 0.63(2-tailled) is found to be higher than the 0.05 alpha level of significance while the t-calculated value of 0.49 is less than the t-critical value of 1.96, at Df 140.Their calculated post-tests mean academic performance scores were 77.3 and 60.78 for male and female students respectively. Consequently the null hypothesis which states that there is no significant difference in male and female JSS2 students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary school in Kaduna State, Nigeria is retained.

Discussions
The finding of this study reveals that there is statistically significant difference between the mean academic performance scores of JSS II students taught mathematics using flow-chat mode and those taught using Spider-mode of concept mapping strategies in junior secondary schools in Kaduna State, Nigeria. (Nesbit & Adesope, 2016). Muhammad and Munawar (2012) carried out a research titled "Effectiveness of Computer-based Concept Mapping in Urdu Language for Secondary School Students' Achievement in Science". This study examined the effectiveness of computer assisted 'instruction (CBCM) on students' achievement in general science as compared with the traditional method of instruction (TMI). As a result, new concepts are not assimilated into their long-term memory (Chile, 2010, Davies, 2010).There is need to use some innovative teaching methods (such as spider mode concept and flow-chat mode concept) to see the effect of the two concept modes for the performance in mathematics students.

Similarly the finding also shows that there is statistically significant difference in spider and flow-chart computer-based concept mapping interest in CBCP as learning tools for mathematics in Kaduna State, Nigeria. It showed that significant differences existed in the mean interest scores of students taught mathematics using spider instructional strategy and those taught using flow-chart computer-based concept mapping (CBCP) as learning tools for mathematics in Kaduna State, Nigeria. (Nesbit,& Adesope,2016).

Muhammad and Munawar (2012) carried out a research titled "Effectiveness of Computer-based Concept Mapping in Urdu Language for Secondary School Students' Achievement in Science". This study examined the effectiveness of computer assisted 'instruction (CBCM) on students' achievement in general science as compared with the traditional method of instruction (TMI).

Succinctly the study also shows that there is statistically significant difference in spider and flow-chart computer-based concept mapping interest in CBCP as learning tools for mathematics in Kaduna State, Nigeria. It showed that significant differences existed in the mean interest scores of students taught mathematics using spider instructional strategy and those taught using flow-chart computer-based concept mapping (CBCP) as learning tools for mathematics in Kaduna State, Nigeria.

Finally the study reveals that there is no statistically no significant difference in male and female JSS2 students' performance scores in mathematics when taught mathematics using spider mode concept mapping strategy in junior secondary school in Kaduna State, Nigeria. This is in line with Research work conducted by Chiou (2018) have observed that concept mapped can improve meaningful learning and can help in learning science independently. They added further that CM is a schematic device for representing a set of concept meaning embedded in a hierarchical diagram that illustrates the interconnections between/among concepts. It is consistent with the theories of knowledge representation, constructive learning and meaningful Learning. It is now widely applied in teaching and Learning of sciences. As a result, new concepts are not assimilated into their long-term memory (Chile, 2010, Davies, 2010).There is need to use some innovative teaching methods (such as spider mode concept and flow-chat mode concept) to see the effect of the two concept modes for the performance in mathematics students. CBCM Instructional Strategy has been extensively used as a teaching, learning, and evaluating tool in different disciplines. Liu, Chen, and Chang, (2010) conducted a study on "Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension." The results indicated that the computer-assisted Concept Mapping learning strategy enhanced learners' use of other English reading strategies–listing, enforcing, and reviewing. Vural (2010) conducted research on the "Effectiveness of concept maps in learning from a computer-based instructional video resource." The findings discovered that there is no significant differences in the achievements of students who used either learner-generated concept maps or expert-generated concept maps. Asan (2007) conducted an investigation on "Concept Mapping in Science Class: A Case Study of Fifth Standard Students." The results concluded that concept mapping has an evident impact on student achievement in science. Royer and Royer (2004) conducted research on "Comparing hand-drawn and Computer Generated Concept Mapping." The findings revealed that the group using the computer created more complex maps than the group that used paper or pencil. This difference was significant. Riley, N. R., and Ahlberg, M. (2004) conducted a study on "Investigating the use of ICT-based Concept Mapping Techniques on Creativity in Literacy Tasks." The findings revealed that ICT-based Concept Mapping enhances learning. Hang, Sung and Chen (2001) conducted a study on Learning through computer-based concept mapping with scaffolding aid." The results revealed that both the two computer-based groups achieved more than the group using paper and pencil.

Conclusion
The study discovered that spider and flow-chart computer-based concept mapping are efficacious in enhancing students' academic performance and interest in learning Mathematics in Kaduna State, Nigeria. It also indicated that computer-based concept mapping is gender-friendly as it is effective for co-

educational settings.

Recommendations

Based on the findings of the study it was recommended that

1. Educational technologists, psychologists and mathematics should be encouraged to use Computer-Based Concept Mapping Strategies on mathematics performance and interest of upper basic schools in Kaduna state, Nigeria

2. Workshop, seminar and conferences should be organized on Computer-Based Concept Mapping Strategies on mathematics performance and interest of upper basic schools in Kaduna state, Nigeria

3. Educational technologists, psychologists and mathematics should be encouraged to use Computer-Based Concept Mapping Strategies on mathematics performance and interest of upper basic schools in respective of gender differences

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