Effects of Mind-Mapping Teaching Approach on Senior Secondary School Biology Students' Interest in Ecological Concepts, Niger State, Nigeria.

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ABSTRACT

This study investigated the effects of Mind Mapping Teaching Approach (MMTA) on Senior Secondary School Biology Students' Interest in Ecological Concepts in Niger State, Nigeria. Two (2) research questions and two (2) research hypotheses were formulated for the study. The study adopted the pretest posttest control quasi experimental design. A sample of hundred (100) students of Senior Secondary School two (SSII) from two (2) SS schools of intact classes in Bida Metropolis were used for the study. The students were randomly assigned to experimental and control Groups (50 students) each in the two intact classes. The instruments used for data collection was the Ecological Concepts Interest Scale (ECIS) which was developed by the researcher and validated by experts. ECIS was used to determine the interest of the students. The test items were all subjected to face and content validity. The instrument was pilot-tested to ascertain the internal consistency and the reliability coefficient of 0.75 was obtained for ECIS respondents using Statistical Package for Social Sciences (SPSS) 20.00 versions. The research hypotheses were tested using Analysis of Covariance (ANCOVA) to test the hypotheses formulated at 0.05 level of significance. The result revealed that MMTA improved the interest of students in ecological concepts than CTM. The study revealed no significant differences between the mean interest scores of male and female students taught with MMTA. MMTA also improved both male and female students' interest in biology. Based on these findings, it was recommended among others that workshops/seminars should be organized by school authorities to update teachers' knowledge on applications of MMTA in teaching biology concepts and other science concepts.

Introduction

The teaching and learning of Biology is faced with numerous challenges in Nigeria. Several researches have affirmed that remarkable problems that have tended to inhibit educational provision especially in Nigeria over the years is lack of human and material resources. In general, the major problems affecting the school system in Nigeria are poor management and control of teacher education programs, teacher training and retraining, the selection and organization of curriculum content, curriculum implementation and evaluation, the development, distribution and use of teaching materials, classroom sizes, laboratory equipment, overloaded syllabus and the relevance of the curriculum to the needs of society. The direct impact of using chalk-talk method of teaching the learners often leads to lack of understanding of abstract concepts and this might cause poor achievement and low enrolment of students in science subjects (Katcha & Babagana, 2012).

The abstract concepts in Senior Secondary (SS) Biology which have been perceived as difficult concepts include genetics, evolution, ecology, homeostasis, taxonomy, central

nervous system, biology practical amongst others. The WAEC and NECO Chief Examiner's Report on SSCE with specific reference to students' performance in Biology over the years have shown that students performed below expectations in ecological topics which are considered to be difficult by both teachers and students (Gambari, Yaki, Gana & Ughovwa, 2014). Ecology aspect of Senior Secondary School (SS) Biology is a very wide area and with increasing interest in environmental problems, it constitutes a challenge on students' efforts in learning and passing required examinations. Any effort that will make SS Biology students enjoy learning and performing very well in ecology will have a positive effect on students' overall performance in SS Biology, (Adodo, 2013). The persistent use of conventional method makes students passive rather than active learners. It does not promote meaningful learning and long–term retention of some abstract concepts in biology (Ahmed & Abimbola, 2011; Umar, 2011).

Efforts have been made by various researchers and science educators to come up with instructional strategies that will promote effective teaching and learning of biology concepts, increase and speed up their conceptual understanding. These instructional strategies have been used to enhance students' achievement and knowledge retention, yet the performance of students in Biology has been dwindling over the years (Adodo, 2013, WAEC & NECO, 2017). Thus, there is need for more efforts that will improve students' performance in SSCE biology. Therefore, it is necessary to examine other methods of teaching science in order to get a suitable strategy that would lead to effective teaching and learning of biology among the students, hence, the necessity for mind mapping instructional strategy in teaching and learning sciences.

One of the promising approaches, according to Sprenger (2012) and Ajaja (2013), involves mind-mapping instructional strategies supported in visual, verbal and written formats of diagrammatic/graphic presentations supplemented with pictures, animations, texts and narration. According to Buzan and Buzan (2010), the mind map is defined as "an expression of radiant thinking" and is therefore a function of the human mind. It is a powerful graphic technique which provides a universal key to unlocking the potential of the brain". The mind map has four essential characteristics. The subject attention is crystallized in a central image. The main themes of the subject radiate from the central image as branches. Branches comprise a key image or key word printed on an associated line. Topics of lesser importance are also presented as branches attached to higher level branches. The branches form a connected nodal structure.

The use of mind-mapping can be assisted with "the adoption of colors, images, codes and multi- dimensional approaches to help human memory, so that one could concentrate the mind on the central part, which is, the crucial subject" (Parikh, 2016). Mind-mapping is one of the cooperative learning strategies and it is a graphic structure containing nodes that are interlinked by labeled lines, directed arcs (Jacobs-Lawson & Hershey, 2002). According to

them these maps can be used as a knowledge representation tool to reflect relationships that exist between concepts that reside within an individual's long-term memory. It is "a creativity and productivity enhancing technique that can improve the learning and efficiency of individual and organizations" (Onyishi, 2009). As mind maps function like our mind on the principle of radiant thinking (Onyishi, 2009), they allow the user to connect each new thought to the one that have come before. In mind maps also the user is able to record a great deal of information on one page, and to show relationships among various concepts and ideas (Mento, Martinelli and Jonnes, 2009). Mind maps are used to form, visualize, conceive and classify thought in education fields, organizational activities and problem-solving and decision-making processes (Riswanto, 2012 & Shodeinde, 2013).

Teaching lessons with mind-mapping involves classroom discussion, practical, demonstration, cognitive and mind-mapping activities. During such lessons the procedure is either from specific to general ideas or from general to specific ideas. This can therefore hopefully makes learning of concepts of ecology easier and thereby improves students' performance in SS biology. In mind maps, learning is made more effective by connecting the main concept to other concepts by means of various symbols and images so as to facilitate recall of all connections (Onyishi, 2013 & Parikh, 2016).

Interest is a subjective feeling of concentration or curiosity over something (Harbor-Peters, 2001). It is the preference for particular types of activities, that is, tendency to seek out and participate in certain activities (Idris, 2014). Relating interest to this study, it is the motivation of students to like ecology concepts through the use of MMTA instructional package in teaching and learning process. One is likely to do well in a discipline of interest. The poor achievement in biology, especially, the genetics and ecology (WAEC, 2004 - 2017), as persistently reported by WAEC chief examiners was due to lack of qualified biology teachers and poor methods of teaching, may be an indicative of lack of interest by students. When students lack interest in learning, attention would not take place.

Gender is also one of the factors influencing students' achievement in biology at senior secondary school levels. Researches have been conducted in the areas of gender-related differences in the academic achievement of students in different areas. Some studies revealed that girls scored significantly higher than boys in science- related subjects (Ezeliora, 2007). Contrary to this, Onose (2007) & Shodeinde (2013) in their studies revealed that male students are academically superior to their female counterparts in sciences. While some studies revealed that there was no significant difference in the performance of boys and girls when taught History, Social Studies and Biology. Adbkhalick, (2008) & Evrekli, (2010); respectively using mind mapping instructional strategies, contradictive evidences in interest and academic achievement due to gender had resulted in the need to verify how mind mapping instructional strategies can influence students' interest by gender in biology (ecology).

Studies showed that when a constructivist approach such as Mind mapping is adopted, it proved to be effective tools for facilitating learning Buzan, 2010; Akinoglu & Yasar 2007; Gambari, Yaki, Gana & Ughovwa 2014). Mind mapping includes the various processes used to sense, encode, store, decode and use information, ideas and concepts in education. Mind maps are used to conceive and classify thoughts and experiences in the world of educational fields. Therefore this study would investigate the effect of (MMTA) on students' interest in Senior Secondary School Biology students in Ecological concepts.

Statement of the Problem

The performance of secondary school students in science subjects and most especially biology has been dwindling and quite unsatisfactory over the years in Nigeria. The external examination bodies such as the West African Examination Council (WAEC) and the National Examination Council (NECO) have repeatedly reported the poor performance of students in biology. The picture emerging from research reports, Chief Examiners' reports and WAEC and NECO SSCE results (2004-2017) show that the students have difficulty in understanding some concepts like ecology, evolution, cell division, genetics and taxonomy. Researches revealed that instructions are unproductive and as such, students find many topics difficult to understand (Koroka & Ezenwa, 2009). These concepts are not always properly taught by teachers (Abu, 2000 & WAEC, 2013). Despite the numerous efforts of educationists to bring about effective performance of students in biology, evidence continues to show that little achievement has been made in students' performance in Biology at SSCE. Thus, there are gaps between efforts of researchers and teachers at improving students' achievement in Biology and specifically in topics like evolution, genetics, ecology, taxonomy and so on. On this basis, this study is centered on the investigation of effect of mind-mapping teaching approach on Senior Secondary School Biology Students' interest in ecological concepts.

Purpose of the Study

The purpose of this study was to investigate empirically the effects of mind-mapping teaching approach on Senior Secondary School Biology Students' interest, in ecological concepts. Specifically, the objectives of the study were to;

1. Determine the effect of MMTA on the interest of biology students in ecological concepts in Senior Secondary Schools, Niger State.
2. Find out if there would be any gender difference in biology students' interest in ecological concepts when taught using MMTA.

Research Questions

The following research questions guided the study:

1. What are the interest mean scores of students taught ecology using MMTA and those taught with TCM?
2. What is the difference in the interest mean scores of male and female students taught ecology using MMTA?

Hypotheses

The following null hypotheses were formulated and tested at probability level of 0.05:

HO1. There is no significant difference in the mean interest scores of students taught ecology using MMTA and those taught with TCM.

HO2. There is no significant difference in the mean interest scores of male and female students taught ecology using MMTA.

Methodology

This study adopted the quasi-experimental research design. Specifically the design was a pre-test, post-test control group design. In effect, 2 groups of intact classes were used, the experimental and control groups. The experimental group was given treatment while the control group was denied treatment but taught the same concepts using Teachers' Conventional Method (TCM) of teaching. Pre-test which was the same with post-test was given to ascertain equivalence between the 2 groups. After treatment the 2 groups were served with posttest. The study maintained the regular class periods. The target population consisted of all SSII Biology students in Public schools in Niger State, Nigeria. There were 149,371SS students in Niger State Public Schools. The sample for study consisted of SSII biology students from schools in one of the Zone 'A' Educational Inspectorate Division of Niger State Ministry of Education. Two co-educational Schools were randomly sampled. Purposive sampling was used to select two (2) schools in the state. Simple random sampling technique (hat-draw method) was used to assign the two selected schools into the two groups (experimental and control) using the toss of a coin. One intact class each was randomly selected (hat-draw method) from the various arms of Senior Secondary two (SS II) in the already selected two schools. Thus, using simple random sampling "lucky dip" one of the arms in each of experimental and control schools were selected for the study. The sample size for the study were 100 students, 50 students from each school, using simple random sampling to obtain 27 males and 23 females. Two (2) instruments were developed by the researcher which was used for data collection. The instruments were Ecological Concepts Interest Scale (ECIS) and Mind Mapping Teaching Package (MMTP): The ECIS was used to determine any interest change in the experimental and control groups after treatment and or teaching respectively. The (ECIS) was a 20-item likert types scale designed and was administered on both groups to assess students' interest in ecology concepts. The ECIS was

scored on a 4 numerical values of 4, 3, 2 and 1 point basis such as Strongly Agree (SA) Agree (A) Disagree (DA) and Strongly Disagree (SD) respectively. The MMTP was developed by the researcher for treatment. The package was made up of flow chart for lessons involving Mind-Mapping Teaching Approach (MMTA) application, and lesson notes that was used for treatment group only. The students were taught one double lesson period (80 minutes) per week for 5 weeks and the contents of the lessons were the same for both experimental and control groups. The instrument was subjected to critical appraisal by a team of experts in science education Copies of ECIS and MMTP were sent to the experts in education and biology teachers. In order to ascertain the reliability of test items on ECIS a pilot-test was conducted. Intact class of 40 students offering Biology at Government Secondary School Paiko, in Niger State was pilot tested. The SSII class was made up of 25 boys and 15 girls. Scores from the tests were used to determine the internal consistency of ECIS using Cronbach Alpha coefficient reliability scale. The results of the pilot-test for ECIS was 'r' value of 0.75 Cronbach Alpha.

The first week of the study was used for familiarity with school environment, teachers and students. Also pre-test was conducted to ascertain initial knowledge and equivalence of the study subjects. The students were drilled on how to draw and use mind-mapping for learning. The second week through to sixth week were used for treatment, the experimental group was given treatment which was denied to the control group. The treatment contained teaching ecology concepts using mind mapping teaching approach. The control group was on the other hand taught the same topics using the teachers' conventional method of teaching. At the end of the treatment; posttest was administered on seventh week of study by the researcher. Raw scores obtained from ECIS served as the data used for answering the research questions and testing the stated hypotheses. The research questions were answered using descriptive statistics of mean and standard deviation. The t-test statistic was used for comparison between the pretest scores of the experimental and control groups to determine their entry behaviour and, analysis of co-Variance (ANCOVA) was employed to test hypotheses 1-2. The hypotheses were tested at 0.05 level of significance.

Data Analysis and Results

The processed data for the study were presented under the following sub-headings namely: Demographic data, answering research questions and testing the hypotheses. The following tables indicate the percentages and number of respondents.

Table 1: Distribution of Respondents by Group & Gender

Groups	No of Respondents	Percentage	Male	Female	Percentage
Experimental	50	50	27	23	55
Control	50	50	27	23	45
Total	100	100%	54	46	100

Table 1 shows that fifty respondents representing 50.0% were in the experimental group while fifty respondents representing 50.0% of the sample were in the control group. The total sample of the study was hundred. Result of this analysis showed that respondents in both the experimental and control groups were equal. It also shows that twenty seven respondents representing fifty five (55.0%) were male students while twenty three respondents representing 45.0% of the sample were female students, respectively. The total sample of the study was hundred. Result of this analysis showed that male respondents were in the majority.

Data Analysis and Results

Pre-test result of the experimental and control groups

Table 2: t-test Analysis of Pretest Scores for both Experimental and Control Groups

Groups	N	Mean	SD	df	t	p
Control	50	11.40	6.06			
				98	-1.78^{ns}	0.08
Experimental	50	9.44	4.42			

The result in table 2 shows t-test comparison between the mean achievement scores of experimental group and control group in the pretest. The mean scores of control group is 11.40 and standard deviation (SD) 6.064 while the mean scores of experimental group 9.44 and the standard deviation is 4.42 with marginal mean difference of 1.96. This means that there is no significant difference in the scores (t= -1.778, df=98, $p<0.05$) as both groups possessed the same entry knowledge. Hence, the study indicated that, the scores of both control group and experimental group were at the same level before the treatment with Mind Mapping Approach on the teaching of ecological concepts. Thus, it is considered satisfactory for the research work.

Research Question One

What are the interest mean scores of students taught ecology using MMTA and those taught with CTM? To answer this research question, mean and standard deviation were used for the analysis as reported in table 5

Table 3: Mean and Standard Deviation of Interest Scores in the Post test

Groups	N	X	MD	SD
Experimental	50	3.02		1.06
			0.56	
Control	50	2.46		1.00

Results on table 3 indicate that subjects in experimental group had a mean interest score of 3.02 with a standard deviation of 1.06 while those in the control group had mean score of 2.46 with a standard deviation of 1.00. In other words the subjects in the experimental group had higher mean scores than their counterparts in the control group.

Research Question Two

What is the difference in the interest mean scores of male and female students taught ecology using MMTA? To answer this research question, frequency count, standard deviations and Means were used for the analysis as reported in table 4

Table 4: Mean and Standard Deviation of Male and Female Students' Interest Scores

Gender	N	X	MD	SD
Male	27	2.93		1.21
			0.22	
Female	23	3.15		1.08

Results on table 4 indicate that male students had a mean score of 2.93 with a standard deviation of 1.21 while the female students had mean score of 3.15 with a standard deviation of 1.08. In other words, the female students had a slightly higher mean score than their male counterparts.

Testing of Hypotheses

The hypotheses stated in chapter one were tested using Analysis of Covariance (ANCOVA). The result of this study was based on stated null hypotheses in chapter one and tested at 0.05 level of significance.

Null Hypothesis One.

H_{o1}. There is no significant difference in the mean interest scores of students taught ecology using MMTA and those taught with TCM. To test this hypothesis, Analysis of Covariance (ANCOVA) was carried out and the result is presented in Table 5

Table 5: Summary of ANCOVA of Post-test Mean Interest scores by Treatment

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected model	1604.843a	4	193.921	37.098	.001
Intercept	16921.049	1	16921.049	1588.16	.000
Pre-test	40.225	1	40.225	3.81	.443
Treatment	1144.976	1	1144.976	107.199	.000*
Error	1598.264	95	16.823	107.465	.000
Total	80886.000	100			
Corrected total	3202.106	99			

Key: * significant at $p<0.05$

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The result in table 5 reveals that [F (I, 95) =37.098 with p=0.001]. Since P-value is less than 0.05, the treatment becomes significant in determining the students' achievement in the ECIS. This means that there is a significant difference in the mean interest scores between the experimental and the control group in favor of the experimental group. Thus the hypothesis is accepted.

Null Hypothesis Two.

H_{o2}: There is no significant difference in the mean interest scores of male and female students taught ecology using MMTA. To test this hypothesis, Analysis of Covariance (ANCOVA) was carried out and the result is presented in Table 6

Table 6: Summary of ANCOVA of Post-test Mean Interest scores by Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected model	192.273	2	96.136	153.031	.000
Intercept	95.290	1	95.290	151.684	.000
Pre-test	136.512	1	136.512	217.301	.000
Gender	4.099	1	4.099	6.524	.421
Error	130.041	47	.628		
Total	133127.896	50			
Corrected Total	322.314	49			

R Squared = .597 (Adjusted R-Squared = .593)

Table 6 shows that F = 4.099 with P=0.421>0.05, which implies that there was no significant difference in the mean interest scores of male and female students taught ecological concepts using mind mapping approach. The null hypothesis was therefore accepted. In essence, there was no effect of gender on the mean interest scores of secondary school students taught ecological concepts using mind mapping.

Discussion

The results in table 3 shows the posttest mean interest scores of students taught with Mind Mapping Teaching Approach (Experimental Group) is higher than the posttest mean interest scores of students taught with conventional teaching method (Control Group). This is further confirmed by the result in table 5 which indicated that the interest of experimental and control groups differs significantly. The result revealed that treatment using MMTA produced significant difference on students' interest in ecological concepts. Attitudes toward the strategy used were significant and the means differed between groups for research question five. Participants in the mind-mapping group indicated significantly more agreement than the control group. Two significant differences resulted in the interest of the respondents. First, the mind-mapping group indicated significantly more agreement in enjoying the creation of mind-mapping notes for the ecological concepts. This finding is

consistent with Goodnough and Woods (2002), who found in their study that fifth and sixth graders enjoyed the mind-mapping strategy. This difference may indicate that students prefer to learn various instructional strategies for organizing notes. The mind-mapping group indicated significantly agreement to having enough time to create the mind-mapping notes. Al-jarf (2009) indicated that time was a factor in individuals becoming comfortable with use of mind mapping. Results indicated that students were comfortable with the mind-mapping strategy.

The results in table 4 show the posttest mean interest scores of male and female secondary school biology students taught ecological concepts using mind mapping approach. The mean interest scores of the female students taught with mind mapping approach is higher than that of the male students taught with the same mind mapping approach. This indicated that the female students' interest scores differ significantly from the male interest scores. This is further confirmed by the result in table 6 which indicated that treatment using mind mapping approach produced no significant difference on gender. This result agrees with Trevino (2005), who conducted a study to determine effects and interest of mind mapping and outlining on learning life science in the seventh grade. In evaluation of one-week delayed comprehensive posttest results on cellular biology, a significant difference did not exist between genders.

Conclusion

The following conclusions were made based on the findings of this study. The result of this study provides empirical evidence that the use of Mind Mapping Approach enhanced students' interest in ecological concepts more than the use of conventional teaching method. Secondly, students taught with the use of Mind Mapping Approach (experimental group) performed better than their counterpart taught same ecological concepts using the conventional teaching method. There was no significant difference in gender interest of students taught ecological concepts with Mind Mapping Teaching Approach. This implies that gender has no significant effect on interest of students in ecological concepts. Therefore, the use of Mind Mapping Teaching Approach enhanced the teaching and learning of ecological concepts.

Recommendations

The following recommendations were made based on the findings of this study.

1. Since the use of Mind Mapping Teaching Approach enhances achievement, retention and interest of students in biology, the biology teachers should use it as one of the strategies to be employed in classroom teaching and learning.
2. Workshops / Seminars should be organized by the proprietors of schools, for biology teachers to enable them learn how to develop mind mapping and also learn how to use mind mapping in teaching biology especially ecological concepts and other topics in biology.
3. Secondary school teachers should be adequately trained to become Mind Mapping expert.

This will enable them to appreciate and use Mind Mapping Teaching Approach to promote effective teaching and learning. To achieve this, the federal, state, local government, private individuals, organizations and alumni associations should endeavour, as a matter of commitment to provide schools with needed Mind Mapping Approach/Cognitive maps with accompanying software, manpower and routine maintenance.

4. Parents should be encouraged to buy computers with mind mapping software for their children to use at home after normal classes. This will help the students to practice what they have learnt in school and also discourage them from engaging in unnecessary ventures after school hours.

5. Textbook writers should shift emphasis from teacher-centred to learners' centred activities that will promote learning by doing such as the use of mind maps in the teacher's manual/teachers guide.

6. Computer programmers and software developers should develop relevant mind mapping instructional packages for use within the Nigerian school systems.

7. Curriculum developers should embrace and include mind mapping instructional strategies that will bring about improvement in learning, acquisition of critical thinking, problem solving and performance skills in students into the curriculum.

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