EFFECT OF CONCEPT MAPPING AND STANDARDIZED-BASED TESTING ON SCIENCE STUDENTS' ACADEMIC ACHIEVEMENT IN SENIOR SECONDARY SCHOOLS IN IMO STATE, NIGERIA

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Abstract
The study examined the Effects of Concept Mapping and Standardized-Based Testing on Science Students' Academic achievement in Senior Secondary Schools in Imo state. Two research questions and two null-hypotheses were formulated to guide the study. The research design adopted was the quasi-experimental non-randomized pretest and post-test control group. The population for the study comprised all the 5,763 Senior Secondary School Two (SS II) Science students in all the Secondary Schools within Ehime Mbano Local Government Area of Imo State. The sample size comprised 120 Science students which made up of 58 experimental and 62 control groups. Purposive sampling technique was used to select two secondary schools out the fifteen Secondary Schools. The research instrument was Agricultural Science, Biology and Physics Standardized Test (ASBPST) adapted from NECO past questions. The instruments were validated by experts in Measurement and Evaluation, Department of Science Education, Michael Okpara University of Agriculture, Umudike, to establish its validity and test re-test method was used to establish the reliability of the instrument which yielded a reliability index of 0.74 calculated using the Kuder-Richardson Formular 20. Mean and standard deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used for testing the hypotheses at a significance level of 0.05. The findings revealed that science students taught Biology, Physics and Agricultural Science with concept mapping and assessed using standardized based testing performed better than their counterpart taught without concept mapping but assessed using standardized based

testing, that concept mapping and standardized-based testing has relative effect on male and female students achievement in science subjects. Based on the findings, it was recommended that teachers should inculcate the idea of using various concept mapping whenever Biology, Physics and Agricultural Science topics are being taught in the classroom.

Keywords: *Concept Mapping, Standardized-Based Testing, Science, Achievement*

Introduction

Education is an avenue of training and learning, especially in schools or colleges, to improve knowledge and develop skills. The ultimate purpose of education is to empower an individual to excel in a chosen field of endeavor or career, and to be able to positively impact his/her environment. On the contrary, the end results of the processes of education have failed to maintain a high degree of academic distinction and excellence amongst learners and recipients of education in institutions of learning as of these days, more specifically science subjects (Assefa, 2018). Science has been regarded as the bedrock of modern-day technological breakthroughs. Nowadays, countries all over the world, especially the developing ones like Nigeria, are striving hard to develop technologically and scientifically, since the world is turning scientific and all proper functioning of lives depend greatly on science. According to Ogunleye (2012), science is a dynamic human activity concerned with understanding the workings of the world. This understanding helps man to know more about the universe. Without the applications of science, it would have been difficult for man to explore the other planets of the universe. Science comprises the basic disciplines such as Physics, Chemistry, Mathematics and Biology in addition to Agricultural Science. However, the present study focused on Biology, Physics and Agricultural Science.

Biology appears to be the most popular science subject at Secondary School level. This is partly because most art students consider Biology easier when compared to Physics and Chemistry. Biology is the science which deals with the study of the life of animals and plants alongside their interactions with their environment (Michael, 2018). Biology plays an important role in all aspects of human life. It is a prerequisite subject in the fields of medicine, agriculture, biochemistry and even extends to the field of geology and mining. Due to its indispensability, much emphasis has been placed on its instruction especially at the secondary school level (Umuoke & Nwafor, 2014). This is to ensure full realization of the objectives of the Biology syllabus as stated in the National Policy on Education (Federal Republic of Nigeria, FRN, 2013).

Physics is a branch of science concerned with the nature and properties of matter and energy. The subject matter of Physics includes mechanics, heat, light and other radiation, sound, electricity, magnetism and the structure of atoms. Al-Zoubi and Younes, (2015) noted that Physics is a pure science subject which deals with matter, energy and the relationship between them. By that, students need to understand and learnt physics to become the future engineers, technologists, scientists and so on. Techniques of teaching and testing students play a vital role in their comprehension and assimilation of physics as a subject.

Agriculture is the science of making use of land to raise plants and animals. It is the basic source of human sustenance on the planet earth. Agriculture is the production of food, feed, fibre and other goods by the systematic growing and harvesting of plants and animals (Ihechu, 2019). Agriculture is at the heart of our daily life, vital to the economy and society. Agricultural sector plays a strategic role in the process of economic development of a country. It has already made a significant contribution to the economic prosperity of advanced countries and its role in the economic development of less developed countries especially Nigeria is of importance. The economic growth and development of Nigeria depends heavily on the foundation of Agriculture Science and Technology (Ihechu, 2019). Many instructional strategies have been reported by many researchers to enhance the academic achievement of science students. They include: use of analogy, concept mapping, computer assisted instruction, among others (Anidu, 2015). However, there is seemingly no clear-cut evidence on the effects of concept mapping teaching strategy and standardized based testing on the academic achievement of science students.

In learning to construct a concept map, it is important to begin with a domain of knowledge that is very familiar to the person constructing the map. It is also important to define the area of knowledge to be mapped, and this is done best by preparing an appropriate focus question, or a question that will be answered by the knowledge that is mapped. Usually focus questions that require explanation, rather than simple description or classification, lead to better concept maps. Recall that concepts are constructed to code regularities in events or in objects. Generally speaking, focus questions that call for more event explanations require deeper, more meaningful thinking than those that describe object characteristics (Derbentseva et al, 2006).

A concept map is a graphical representation of knowledge that is composed of concepts and the relationships among them. Among the many techniques

available, concept mapping as an effective tool for organizing new information and integrating it with the existing knowledge can provide learners with opportunities to learn and construct knowledge (Ojima, 2016). Various studies on concept mapping have revealed that this technique has prominent roles in a variety of instructional settings and is widely implemented in classroom instruction which leads to more comprehensive learning of technical skills (Ojima, 2016). This maybe implemented and achievement using standardized tests. A standardized test, such as the West African Examinations Council and National Examinations Council Achievement Test Series, are carefully designed for consistency of format, content, and administration procedure. The reliability of a standardized test is verified by statistical evidence gathered by the test publisher during national examinations in which representative groups of students take the test under standardized conditions. By aligning a standardized test with the instructional standards that it is intended to measure, a test publisher can ascertain one facet of the test's validity. Finally, analysis of the student population enables a test publisher to design a fair test that accounts for the population's diversity and the special needs of individual students. The highest quality standardized tests are produced and used in compliance with accepted guidelines found in the Standards for Educational and Psychological Testing (published jointly by the American Research Association, the American Psychological Association, and the National Council on Measurement in Education).

As suggested by Owolabi (2019), the standardized-based testing is the scientific process of organizing, administrating, scoring and reporting of a standard test items. While standard test items are test items with all the necessary psychometric properties of a good test. School-based standard testing aims to provide uniform, rapid measurement of some kind of mental capability that is related to education. Derbentseva, Safayeni and Cañas (2006) revealed that there are significant difference in the performance of students exposed with standardized test and teacher made testing after exposed with cooperative learning strategy. The distinguishing features of a standard test are uniform administration and some form of calibration. Before routine use, standard tests or component items will be tried out with groups intended to represent populations of test- takers (Maganga, 2016).

Gender difference plays a significant role in the performance of science students as most of the female students dislike calculations (Ojima, 2016). A method of teaching should be adopted to help the students (males &females) understand science very well. This study focused on the assumption that

concept mapping and standardized-based testing influences the students' learning in a specify subject matters. Concept mapping serve as a teaching strategy in teaching science subjects, and standardized-based testing as a method of assessing the students' performance in selected science subjects like Biology, Physics and Agricultural Science.

Many students find it difficult to study Biology, Physics and Agricultural Science because they see the subjects as being complicated and scientific. Those students who eventually study the subjects in secondary schools and colleges do not perform well in the West African Examination Council (WAEC), National Examination Council (NECO) as well as National Business and Technical Examinations Board (NABTEB) (Akanbi, 2018). There are many factors that may influence the performance of students in Biology, Physics and Agricultural Science and others. Some of which are peer group influence, teacher's methods of teaching, motivation, the lack of standardized based testing, psychometric properties of the test, lack of availability of Human and material resources and so on. However, there are divergent scholarly propositions on effect of gender on academic achievement of students in Biology, Physics and Agricultural Science. Based on the foregoing, the researchers considered it necessary to examine the effect of concept Mapping and Standardized-based testing on science students' academic performance in some selected Senior Secondary Schools in Ehime Mbano Local Government Area of Imo State and also explorer the inconsistence findings on the effects of gender on the achievement in Biology, Physics and Agricultural Science.

The following research questions guided the study:

1. What is the difference in the mean achievement scores of students taught Biology, Physics and Agricultural Science with concept mapping and lecture method, assessed using standardized based testing?
2. What are the mean achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing?

The following null hypotheses at a level of significance of 0.05 guided the study:

1. There is no significant difference in the mean achievement scores of students taught Biology, Physics and Agricultural Science with concept mapping and lecture method, assessed using standardized based testing.

2. There is no significant difference in the mean achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing.

Method

The research design adopted was the quasi-experimental non-randomized pretest and post test control group design. The type of quasi experimental design used was the non-equivalent pretest and posttest control group which involves two groups. The population for the study comprised all the 5,763 Senior Secondary School Two (SS II) Science students in all the Secondary Schools within Ehime Mbano Local Government Area of Imo State. The sample size comprised 120 Science students which made up of 58 experimental and 62 control groups. Purposive sampling technique was used to select two out the fifteen Secondary Schools. Two intact classes were used. The instrument for data collection were Agricultural Science, Biology and Physics Standardized Test (ASBPST) adapted from NECO past questions. The ASBPST is a-60 multiple choice item which comprised 20 items each from Agricultural Science, Biology and Physics. Each has four options. The instrument covers the content areas of the topic selected for the study. The instrument was subjected for face and content validation by two experts in Measurement and Evaluation, Department of Science Education, Michael Okpara University of Agriculture, Umudike, to establish its validity and test re-test method was used to establish the reliability of the instrument which yielded a reliability index of 0.74 calculated using the Kuder-Richardson 20 Formular.

The consent of the schools' principals in the selected public secondary schools was obtained in order to permit the use of the school with regards to information, students, classroom, and teachers for the study. The teachers of the different schools were trained on the concept and procedure of the research. The study was carried out within the periods of lessons in the school time table, and based on the contents of the lesson so as not to distort the school time table. The duration of the experiments was six (6) weeks in all the groups. At the commencement of the research experiment, the pretest ASBPST was administered to all the students in the two groups. This was done with the help of the subject teachers. The scores of the students were collected for use after the experiment. After the pretest, teaching was implemented with the experimental groups using concept mapping instructional package and control group using lecture method. This teaching was done by the subject teachers who were trained on how to use concept mapping instructional strategy. After

the teaching of the groups, a post - test (Post-ASBPST) was administered to the students in each group and their scores were obtained.

The scores generated from the pre-test and post-test administered to the science students of the two secondary schools were used for the data analysis. Mean and standard deviation were used to answer the research questions while the analysis of covariance (ANCOVA) was used for testing the hypotheses at a significance level of 0.05. Since the research involved pre-test and post-test of intact classes, the statistical technique adopted for testing the hypotheses (ANCOVA) enable the researcher to adjust initial group differences (Non-equivalence).

Results

Table 1: Mean Difference in the Men Achievement Scores of Students taught Biology, Physics and Agricultural Science with Concept Mapping and Lecture Method, Assessed Using Standardized Based Testing

Groups Method	N	Pre-test Mean	SD	Post-test Mean	SD	Mean effect
Concept mapping	58	41.55	5.45	52.95	6.28	11.40
Lecture Method	62	41.10	5.41	41.85	5.47	0.75
Mean difference		0.45	0.04	11.1	0.81	

Table 1 indicated that the pre-test mean score for students in concept mapping and lecture method groups were 41.55 and 41.10 with standard deviation 5.45 and 5.41 respectively, indicating that both of the students have relatively equal academic achievement in Biology, Physics and Agricultural Science before treatment. However, the post-test scores of students in concept mapping and lecture method groups were 52. 95 and 41.85 respectively with standard deviation of 6.28 and 5.47 respectively. The mean effect score for concept mapping group was11.40 while that for lecture method group was 0.75 with the mean difference of 11.1 at post test. This implies that concept mapping has more effects on science students' academic achievement when assessed with standardized based testing.

Table 2: Analysis of Covariance (ANCOVA) for the Difference in the Men Achievement scores of Students taught Biology, Physics and Agricultural Science with Concept Mapping and Lecture Method, assessed using Standardized Based Testing.

Source of variation	Sum of Squares	Df	Mean Square	F	p-value
Corrected Model	2384.571[a]	3	794.857	30.691	.000
Intercept	5847.633	1	5847.633	225.786	.000
Pretest	380.993	1	380.993	14.711	.015
Group	1016.757	1	912.674	35.240	.000
Error	3030.183	117	25.899		
Total	10275.566	120			
Corrected Total	5414.754	119			

Result of data analysis in Table 2 shows that F calculated value (35.240). Since this p - value (0.000) is less than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis which states that there is no significant difference in the men achievement scores of students taught Biology, Physics and Agricultural Science with concept mapping and lecture method, assessed using standardized based testing is therefore rejected. Hence, there was a significant difference in the men achievement scores of students taught Biology, Physics and Agricultural Science with concept mapping and lecture method, assessed using standardized based testing.

Table 3: Mean achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing

Groups Method	N	Pre-test		Post-test		Mean
		Mean	SD	Mean	SD	Effect
Male	30	41.63	5.45	49.26	6.02	7.62
Female	28	41.10	5.41	48.85	5.47	7.75
Mean difference		0.53		0.41		

Result in Table 3 indicated that the pre-test mean achievement score of male and female students taught using concept mapping and assessed with standardized-based testing were 41.63 and 41.10 with standard deviation of 5.45 and 5.41 respectively and mean difference of 0.5 at pre-test. This indicated that both male and female students were relatively at the same

achievement before treatment. However, the post-test performance mean scores for male and female were 49.26 and 48.85 respectively with standard deviation of 6.02 and 5.47 respectively with mean difference of 0.41. The mean effect score for male was 7.62 while that for 7.75 was 0.75 indicated that concept mapping and standardized-based testing has relative effect on male and female students achievement in science subjects.

Table 4 : Analysis of Covariance (ANCOVA) for the Achievement Scores of Male and Female Students Taught Biology, Physics and Agricultural Science with Concept Mapping and Assessed with Standardized-Based Testing

Source of variation	Sum of Squares	Df	Mean Square	F	P-value
Corrected Model	450.024[a]	1	450.024	4.575	.049
Intercept	671.064	1	671.064	6.823	.033
Pretest	592.023	1	592.023	6.019	.045
Gender	316.510	1	316.510	3.218	.072
Error	5507.959	56	98.356		
Total	14175.112	58			
Corrected Total	7087.556	57			

The analysis in Table 4 revealed the F calculated value of (3.218) and P-value .072. Since this p-value is greater than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis which states that there is no significant difference in the men achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing is thereby retain. It implies that there is no significant difference in the men achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing.

Discussion

The findings revealed that science students taught Biology, Physics and Agricultural Science with concept mapping and assessed using standardized based testing performed better than their counterpart taught without concept mapping but assessed using standardized based testing at posttest. This is an indication that the use of concept mapping in teaching science subjects improved students' achievement than teaching without concept mapping. It also implies that concept mapping has more effects on science students'

academic achievement when assessed with standardized based testing. In addition, analysis of covariance was used to test the first hypothesis on Table 2, found that there was a significant difference in the men achievement scores of students taught Biology, Physics and Agricultural Science with concept mapping and lecture method, assessed using standardized based testing. This finding is similar with the view of Ojima (2016) who noted that concept mapping as an effective tool for organizing new information and integrating it with the existing knowledge can provide learners with opportunities to learn and construct knowledge.

The findings revealed that male and female students assessed with standardized-based testing have positive effect on their academic performance. This was revealed in the pre-test scores before the treatment, the score is poor compare to the post-test scores which was based on standardized testing. It also implies that concept mapping and standardized-based testing has relative effect on male and female students' achievement in science subjects. Also hypothesis four elaborated that both male and female science students were positively affected by standardized-based testing without significant differences between their academic performances. Hence, there is no significant difference in the men achievement scores of male and female students taught Biology, Physics and Agricultural Science with concept mapping and assessed with standardized-based testing. This finding is in agreement with the finding of Derbentseva, Safayeni and Cañas (2006) who revealed that there was significant difference in the performance of students exposed with standardized test and teacher made testing after exposed with cooperative learning strategy.

Conclusion

The study investigated the effect of concept mapping and standardized-based testing on science students' academic achievement in senior secondary schools in Ehime Mbano Local Government Area. Based on the findings, the researchers concluded that the use of concept mapping is more effective in improving the academic achievement of science students in secondary schools. Irrespective of gender, the use of concept mapping and standardized-based testing showed significant improvement in the academic achievement of science students in the secondary schools. The researchers as well concluded that there was no significant difference in the mean score of male and female science students. However, the results showed that the use of concept mapping and standardized-based testing are viable in teaching and assessing strategy for teaching science subjects in secondary schools.

Recommendations

Based on the findings and conclusion of this study, the following recommendations were made:

1. Government should organize regular workshop in order to promote the production and usage of concept mapping in Nigerian secondary schools.

2. Teachers should inculcate the idea of using various concept mapping whenever Biology, Physics and Agricultural Science topics are being taught in the classroom.

3. Government should incorporate the use of standardized-based testing for assessing various concepts in Biology, Physics and Agricultural Science in secondary schools curriculum.

4. Science teachers in secondary schools should adopt standardized-based testing as way of removing gender related differences in classroom teaching.

5. Students should also be encouraged to produce concept mapping as this will help in coming closer to the understanding of the concept of Biology, Physics and Agricultural Science as this will make learning science subjects more concrete.

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