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Effect of Concept-Mapping Strategy on Academic Performance and Retention in Genetics among Secondary Biology Students in Katagum Zonal Education, Bauchi State- Nigeria

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Abstract

The study investigated the effect of concept-mapping strategy on academic performance and retention in Genetics among secondary school Biology students in Katagum Zonal Education, Bauchi State-Nigeria. The study adopted Quasi-experimental design specifically, pre-test post-test non-equivalent control group design. The population of the study comprised a total number of 7,707 SS2 Biology students from 50 public secondary schools in Katagum Zonal Education. Multistage sampling techniques were used to select a sample of 103 Biology students from two co-educational schools. Genetics Performance Test (GPT) was the instrument used for data collection which was validated by experts. The reliability coefficient of the instrument was 0.88 determined using Pearson Product Moment Correlation statistics. Four research questions and four null hypotheses guided the study. Research questions were answered using Mean and Standard Deviation statistics. The null hypotheses were tested at 0.05 level of significance using Independent Samples t-test. The findings revealed that students who were exposed to concept-mapping strategy performed and retained significantly better than those who were exposed to lecture method. The finding also revealed that male and female students in the experimental group do not

significantly differ in their academic performance and retention abilities. Based on the findings of this study, it was recommended among others that, Biology teachers should frequently employ the use concept-mapping strategy in teaching abstract concepts in Biology like Genetics to promote students' academic performance. Government at all levels should train teachers by organizing seminars, conferences and workshops on learning how to teach using concept-mapping strategy.

Keywords: Concept-Mapping Strategy, Academic Performance, Secondary School, Biology, Genetics.

Introduction

Science is a discipline that deals with the systematic study of nature and natural things. It is a body of knowledge that is based on observation and experimentation. According to Daagu, Madugu, Daagu, Kumam and Egahi (2021), science is a study of nature and natural phenomenon in order to discover their principles and laws. Science is the study of our environment through which people can develop both the mind of inquiry, discipline and logical power of thought (Abiodun & Victoria, 2013). The important of science to the development of any nation cannot be overemphasized. Usman (2021) posited that science and technical education are foundations for sustainable national development as they protect human societies from ignorance, illiteracy, disease and poverty. Omiko (2015) noted that the use of science, technology and productivity are often to describe the level of development of a nation. Adeniran, Ochu and Atoo (2018) supported Omiko's view by noting that, it is largely acknowledged that, the survival of a nation's scientifically and technologically is scientific literacy, which can only be achieve through science education.

Biology is a branch of science that deals with the study of life. It is concerned with the study of the structure and function of living organisms. According to Ibrahim (2018), Biology as one of integral part of science is defined as the study of life and evolution of organisms and their structures, functions, processes, and interactions with each other and with their environments. The importance of Biology in science and other science related disciplines cannot be overemphasized. Thus, Martins-Omole, Yusuf and Guga (2016) stated that Biology occupies a unique position in the school curriculum; this is because Biology is central to many sciences related courses such as Medicine, Pharmacy, Agriculture, Nursing, Biochemistry, Dentistry, Microbiology, Laboratory Technology and all other related courses. This means that any

student wishing to study any of the courses mentioned must pass Biology at credit level at least. Similarly, Agaba (2013) asserted that Biology education equips learners with the basic knowledge and skills that are essential in the study of medicine, pharmacy, Nursing, Brewing, Microbiology and other related disciplines.

Despite the fact that biology is an important science subject and the roles it plays in medical sciences, many concepts are found to be difficult to understand by the learners due to its nature of heavily loaded curriculum and some abstract terms. According to Fauzi and Mitalistiani (2018), many concepts or topics in biology including water transport in plants, protein synthesis, respiration and photosynthesis, gas exchange, energy, cells, genetics, organs and central nervous system can be perceived as difficulties to learn and understand by students. Agboghoroma and Oyovwi (2015) and Moses, Gospel and Femi (2016) stressed that despite the efforts of both federal and state governments to encourage Biology Education, students' failure in Biology in Senior School Certificate Examinations (SSCE) is still high.

Genetics is defined as the study of the transmission of character or trait from parent to their offspring and the differences that exist among organisms. Genetics as a branch of Biology has been defined by Jaji (2021) as the science of genes, heredity and variation in living organisms. Genetics is a branch of biology that is concerned with the study of variability caused by inherited characteristics (John, Sani, Ranccas & Maskawa, 2018). The knowledge of Genetics helps us to understand how characters or traits are passed from parent to their offspring and from one generation to another generation. It also provides the basis for blood grouping and genotype in marriage counseling. Despite the above importance of Genetics and Biology to human and generally to the development of the nation, poor academic performance of students in Biology and Genetics in particular have remained in the increase on yearly basis.

Over the years, there have been major concerns on the use of appropriate method of teaching science (Biology inclusive) to shift from rote learning to a meaningful learning. Consequently, various teaching-learning strategies which evolve from the learning theories have been developed to improve learning process of students in science. Novak and his research team at Cornell University developed concept-mapping as an instructional strategy to assist students to learn science in the 1972. This was triggered by Ausubel's learning theory proposed in 1968 which states that learning takes place by the assimilation of new concepts and propositions into existing concept and propositional frameworks held by the learner (Woldeamanuel, Abate & Berhane, 2020).

Concept-mapping can be defined as graphical or pictorial representation of knowledge that shows the relationship between and among concepts. Concept-mapping according to Agaba (2013) is a process of organizing information or knowledge in form of maps as two-dimensional diagram that consists of concepts or nodes linked by labeled lines

to show relationships between and among those concepts. However, Schmid and Telaro (2015) defined concept mapping as diagrams indicating concepts and their interrelations in both the vertical and horizontal dimensions. According to Appaw, Owusu, Frimpong and Adjibolosoo (2021), concept-mapping is defined as a two-dimensional hierarchical diagram that illustrates the interconnection between and among individual concepts.

Statement of the Problem

Poor performance in Biology has become a trend in the West African Examination Council

(WAEC) results of Nigerian secondary schools. The Chief examiner's reports (WAEC, 2018 & 2019) pointed out some of the weaknesses observed among Biology candidates that include: poor grasp of genetics, not putting the sign of 'X' for crossing in genetics question, inability to cross genetics questions properly, inability to explain the rationale behind Rhesus positive and negative factors, inability to explain how blood loss by car accident victim could be restored and inability to spell technical terms correctly etc. These observed weaknesses have persistently been in existence for over a decade and the most often are from the area of Genetics.

In addition to these reports, empirical studies such as those of (Agaba, 2013; Martins-Omole et al, 2016; John et al, 2018; Mohammad & Saleh, 2020; Daagu et al, 2021 and Bizimana et al, 2022) have indicated that students still perform poorly in Biology at secondary schools.

Consequent upon this persistent poor academic performance of students in Biology, it has necessitated science educators and other researchers to search for alternative instructional strategies that may enhance academic performance of students in Biology. Various instructional strategies have been developed which include: concept mapping strategy, cooperative learning strategy, mind mapping strategy, cooperative concept mapping strategy to mention but few. But to no avail, all the efforts made were in vain, because many teachers are still using the conventional method of teaching. Against this background, this study is set to examine the effect of Concept-Mapping Strategy on Academic Performance and Retention in Genetics among Secondary Biology Students in Katagum Zonal Education, Bauchi State.

Objectives of the Study

i. To investigate the effect of concept mapping strategy on academic performance among secondary school Biology students taught Genetics using concept-mapping strategy and those taught using lecture method in Katagum Zonal Education, Bauchi State.

ii. To find out the effect of concept mapping strategy on retention among secondary school Biology students taught Genetics using concept-mapping strategy and those taught using lecture method in Katagum Zonal Education, Bauchi State.

Research Questions

i. What is the difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method?
ii. What is the difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method?

Null Hypotheses

Based on the research questions stated, the following null hypotheses were formulated and tested at 0.05 levels of significance:

H_{O1}: There is no significance difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

H_{O2}: There is no significance difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

Methodology

The design of this study is a quasi-experimental design; specifically, the pre-test, post-test non-equivalent control group design. The study consisted of two groups; which are: the experimental group (EG) and the Control group (CG). The intact classes were used to avoid threat of selection bias among the students and to avoid rearranging and re-grouping which could disrupt the normal school settings. The population for this study comprised a total number of 7,707 senior secondary school II (SS2) students consisting of 4282 males and 3423 females offering Biology in 50 public secondary schools of Katagum Zonal Education, Bauchi State. The sample of the study comprised 103 senior secondary II Biology students made up of 66 males and 37 females from 2 randomly selected public co-educational schools in Katagum Zonal Education, Bauchi State. Multistage sampling techniques were employed in this study. Firstly, cluster sampling technique was used to divide Katagum Zonal Education in to seven clusters based on the number of local governments under the zone. Two clusters were randomly selected from the seven clusters. Simple random sampling technique was finally used to select two co-educational schools from the two clusters, one school

from each cluster. The two sampled schools were randomly assigned as experimental and control groups. The experimental group (EG) was taught using concept-mapping strategy and the control group (CG) was taught using lecture method. Genetics Performance Test (GPT) was the instrument used to collect data which was validated by four experts and the reliability coefficient value of 0.88 of the instrument was obtained using Pearson Product-Moment Correlation (PPMC). The instrument has two sections; section A, which contains student's biod-ata and section B, which contains 40 objective questions. The data collected was analyzed using mean, standard deviation and independent sample t-test.

Results and Discussions

H_{O1}: There is no significance difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

Table 1: Summary of Independent Sample t-test of Academic Performance Scores of Students in Experimental and Control Groups

Groups	N	Mean	SD	t	df	P-value	Remark
Experimental	43	26.907	4.84922				
				5.213	101	0.001	*Significant
Control	60	22.1	4.44057				
***Significant at P≤ 0.05**							

Table 1 show that the t-value obtained is 5.213 and P-value of 0.001 is observed at degree of freedom 101. This P-value is less than the alpha value which is 0.05, meaning that there is significance difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method. The observed difference was in favor of experimental group which was exposed to concept-mapping strategy. Therefore, the null hypothesis which states that there is no significance difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method is rejected.

H_{O2}: There is no significance difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

Table 2: Summary of Independent Sample t-test of Retention Scores of Students in Experimental and Control Groups

Groups	N	Mean	SD	t	df	P-value	Remark
Experimental	43	26.5116	4.67196				
				6.377	101	0.001	*Significant
Control	60	20.7667	4.38938				
***Significant at P≤ 0.05**							

Table 2 shows that the t-value obtained is 6.377 and P-value of 0.001 is observed at degree of freedom 101. This P-value is less than the alpha value which is 0.05, meaning that there is a significance difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method. The observed difference is in favor of experimental group which was exposed to concept-mapping strategy. Therefore, the null hypothesis which states that there is no significance difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method is rejected.

Discussion of Findings

From the result obtained, students in the experimental group had a higher mean academic performance score (26.91) than those in the control group (22.10). This different was significant as shown in the result of t-test analysis in Table 1. This means that students taught using concept-mapping strategy have significantly performed better than those taught using lecture method. This finding is in line with the findings of Sakiyo and Waziri (2015), John et al (2018), Woldeamanuel et al (2020) Appaw et al (2021) and Bizimana et al (2022) who found out that concept-mapping strategy significantly enhanced academic performance of students than the conventional method (lecture method). However, this finding is contrary with the finding of Auta (2015) who found that concept mapping strategy has no connection with improving students' academic performance.

The result also revealed that students in the experimental group had a higher mean retention score (26.51) than those in the control group (20.77). This different was significant as shown in the result of t-test analysis in Table 2. This means that students taught using concept-mapping strategy have significantly retained better than those taught using lecture method. This finding is in line with the findings of Oluikpe and Mba (2014); Sule, Garba and Azare (2016); Ajayi and Angura (2017); Adeniran et al (2018) and Yakubu et al (2019) who reported that retention ability was significantly higher in students taught with concept-mapping strategy than those who were taught with conventional method (lecture method). However, this finding is contrary with the finding of Auta (2015) who found that concept mapping strategy do not improve students' retention ability.

Summary

The following findings were revealed based on the results of this study:

1. There is statistically significant difference between the mean academic performance scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

2. There is statistically significant difference between the mean retention scores of secondary school Biology students taught Genetics using concept mapping strategy and those taught using lecture method.

Conclusion

The study investigated the effect of concept-mapping strategy on academic performance and retention in Genetics among secondary schools Biology students in Katagum Zonal Education, Bauchi State. The conclusions were drawn from the findings of the study based on the statistical analysis of the data collected. Therefore, it was concluded that;

Concept-mapping strategy has positive effect on Biology students' academic performance in Genetics. Therefore, academic performance can be enhanced significantly by using concept-mapping strategy.

Students' retention ability of learnt concept in Genetics can be promoted using concept-mapping strategy. Therefore, it can be concluded that better retention of learnt concept can be achieved by using concept-mapping strategy.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Biology teachers should frequently employ the use concept-mapping strategy in teaching abstract concepts in Biology like Genetics to promote students' academic performance.
2. Government at all levels should train teachers by organizing seminars, conferences and workshops on learning how to teach using concept-mapping strategy.
3. The Federal and State Government through the Ministries of Education should ensure proper use of concept-mapping strategy as well as encourage teachers to use the strategy as this research finding revealed that it is more effective in enhancing academic performance and retention ability of students than the lecture method.

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