
EFFECT OF MIND MAPPING TEACHING STRATEGY ON SENIOR SECONDARY STUDENTS' ACHIEVEMENT IN GENETICS IN NASARAWA STATE, NIGERIA

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Abstract

The study investigated the effect of mind mapping teaching strategy on senior secondary students' achievement in genetics in Nasarawa State, Nigeria. Two research questions and two hypotheses guided the study. A quasi-experimental research design involving non randomized control, pre-test and post-test was used. The population of the study was 27,545 students. Multi-stage sampling was used to select two schools which were randomly assigned to experimental and control groups. The study used 100 biology students consisting of 48 males and 52 females. Genetics achievement test (GAT) was used for data collection. The reliability of GAT was determined using Kuder- Richardson

formula ($K-R_{21}$) and the coefficient of 0.96 was established. The data obtained was analyzed to answer the research questions using mean and standard deviation; while ANCOVA was used to test the hypotheses at 0.05 level of significance. Findings of the study revealed that biology students in the experimental group achieved better than those in the control group. It was recommended that genetics should be taught using mind mapping teaching strategy and biology teachers' trainees of in-service and pre-service should be advised to use mind mapping teaching method to teach genetics.

Keywords: Achievement; Genetics Achievement Test (GAT); Mind mapping; Senior Secondary Students.

Introduction

The significance of science and technology to human life in any nation of the world cannot be over emphasized. This is due to the fact that, skills acquired in these disciplines are

acknowledged as a basic foundation that enhances growth, development, wealth creation and eradication of poverty in every society. The fast growing improvement in the application of skills acquired in these disciplines which the

entire world relies on its utilization, enable them to be valuable that any society or country without them stands the risks of being alienated from the global village (Sambo, 2015).

Genetics is the study of heredity and variation in living organisms. The passing on and expression of traits or characters from parents to offspring is termed heredity or inheritance. Heredity or inheritance may give rise to differences among individual organisms, this is term hereditary variations (Odubunmi, 2005; Odaibo, Ugumba, Egbinola, 2007; Latta, 2010; Mader, Umeh, 2011; Nworgu, 2012; Tian, 2014 and Bayers, 2015).

The problems associated with low achievement in genetics were students' lack of interest and inability to retain most genetics concepts learnt, as identified by Nworgu (2012) and Stephen (2014) which according to them, can be traced to both teachers' and students' related problems. These problems include:

- a. Lack of professional skills and competence for teaching some biological concepts.
- b. Lack of pre-requisite knowledge for genetics.
- c. Students' attitude (forbear) towards genetics as a branch of biology.
- d. Biology teachers' persistent use of conventional teaching method.

The WAEC Chief Examiner's Report comments on senior secondary students' attempts on genetics questions for the years 2013 - 2019, categorically stated that many candidates could not state possible genotypes of the father. Conclusively candidates achieved poorly on

questions of genetics. The similar situation occurred in the West Africa French speaking countries which their students sit for WAEC standardized examination and had poor achievement in genetics. WAEC Chief Examiner's Report Comments (2013 - 2019). Subsequently, the West Africa Examination Council (WAEC), Chief Examiner's Report (2013 - 2019) comments on Nigerian students' achievement in genetics were all very poor. Consequently, candidates achieved very low on questions of genetics because many candidates could not state possible genotypes of the blood group of the father as required by the question.

Students' low achievement in genetics has led to students' low enrolment in biotechnology, anatomy, physiology and genetics courses in higher institutions of learning. Many researchers are of the opinion that conventional teaching method promotes rote learning and memorization (Nworgu, 2012). To solve many problems of teaching and learning and with a view to improve students' learning outcomes, it is therefore necessary to find innovative and students' centred methods or strategies of teaching and learning, especially in science subjects (Katcha, 2017). Consequent to this, Santos (2013) suggested that an innovative instructional strategy approach such as mind mapping teaching strategy (MMTS) among others could be employed.

Mind map is considered a diagram used to represent the relationship of words, ideas, tasks and other items connected to and arranged around a central key word or idea (Deshatty & Mokashi, 2013; Jones & Snyder, 2012;

Tanriseven, 2014; Malekyadeh, & Bayat, 2015 and Yunus, 2016). It is thus, an effective tool to aid in studying and organizing information as well as writing. Mind Mapping can also be defined as a visual representation of hierarchical information that includes a central idea surrounded by connected branches of associated topics or central ideas' information (Buzan, 2010). Mind mapping, which was popularized by Tony Buzan, is an effective diagram with the function of organizing ideas and representing words, ideas, or another links that arranged a central point by branches and contains words, phrases colours, and visual images (Yunus and Chien, 2016). Mind mapping involves writing down a central idea and coming out with new and related ideas from the centre. The mind mapping strategy can be used to explore a wide range of topics in writing and also used in every kind of writing such as: narrative, descriptive, recount, persuasive and argumentative (Riswanto and Prandika, 2012). Students can improve their ideas as mind maps work well as an effective visual design that enables students to clearly see the relationship between ideas, and consequently encourages them to group certain ideas together according to their similar characteristics as they proceed (Padang and Gurning, 2014). By mind mapping, one can develop their ability in memorizing, brainstorming, learning as well as creativity (San Risqiya, 2013). A study done by Padang and Gurning (2014) on improving students' achievement in constructing descriptive written text through mind mapping strategy which was conducted among 30 students of class VIII SMP Swasta HKBP Pardamean showed that Mind

Mapping Strategy improved the students' achievement in writing and also help the teacher in their lessons of teaching writing. This improvement not only resulted in the increment of the mean of students' score, but also greatly enhancing the students' enthusiasm, motivation and expression in writing.

Saed and AL-Omari (2014) conducted research works on the effectiveness of a proposed program based on a mind mapping strategy in developing the writing achievement of eleventh grade EFL students in Jordan which involved 91 female students of the first semester of the academic year 2013/2014 at Sands National Academy, Amman Second Directorate of Education which has shown that students who used mind mapping strategy to organize and summarize information in their draft of writing produced more transformations of ideas in their summaries than the students who did not use this strategy. Mind mapping gives students the opportunity to solidify their ideas before writing. The students' ability to transfer meaning to write summaries improved significantly; they were able to write more complete and well-organized summaries.

Warsidi, Arafah, Makka and Firmansyah (2015) also found out in their study that students' writing ability can be improved through the collaboration of mind mapping and organizational pattern. The items improved that in students writing were contents, organizations, vocabularies and language use. Hence, the use of collaboration of mind mapping and organizational pattern builds the students' positive attitudes because it can motivate and

help them to write an essay. According to Jones (2012), mind maps allow students to create visual image to enhance their learning thus, it can be used as a metacognitive tool that allows them to establish meaningful connections between various ideas.

Naqbi (2011) in a study on “The Use of Mind Mapping to Develop Writing Skills in UAE Schools” which used a classroom-based action research to retrieve data from a group of female 11, English as a Foreign Language (EFL) learners between sixteen and seventeen years old in the school of United Arab Emirates (UAE) found that, mind mapping strategy is a powerful tool that helps students in organizing and developing their ideas and thoughts. The author further asserts that, mind mapping technique is also an effective tool to develop students’ cognition skills and help them in doing assessment or reflection. The students’ skills at generating ideas and evaluating them quickly are enhanced. They were able to recall and retrieve their prior knowledge about different topics which is beneficial for designing mind maps. Therefore, it could be said that mind mapping have a positive impact on students’ cognition skills and information retrieval skills. The researcher concluded that mind mapping technique is an appropriate tool to help students in planning their writing as the approach encourages students to gain an in-depth understanding of the writing topics (Naqbi, 2011).

Jones (2012) revealed in a study on “The Effects of Mind Mapping Activities on Students’ Motivation” which was conducted among 40

undergraduate students who studied an educational psychology course at a U.S. University that, mind mapping activities empowered, and motivated students. Students perceived mind mapping as an entertaining and interesting approach which would greatly enhance their learning as well. Some students preferred individual mind mapping while some preferred group mind mapping. The researchers suggested that instructors should give students freedom to choose their favourite mapping activity options. By allowing students to choose whether to complete the map on their own or with a group in class or out of class would lead to greater engagement as the students are taking charge of their own learning.

Statement of the Problem

The low achievement of students in genetics has been blamed on the teachers’ persistent use of the conventional method of teaching, abstract nature of genetics and inability of teachers to relate structure to function. The implication of the students’ low achievement in genetics is that, Nigeria would hardly become a genetically engineered Nation like other Nations of the world because genetics is about humans and other species of organisms thriving on the planet Earth and beyond. The country as a matter of fact, may lack geneticist manpower to man geneticist centres in the faculties of biological sciences or faculties of life sciences as the case may be in some universities and faculties of medical sciences. Medical institutions like public specialists hospitals, general hospitals, specialized Bio-Medical public and private laboratories and private hospitals leaving quarks

to practice in the fields of medicine thereby exposing many human lives to danger or early termination of their lives.

To ameliorate the problem of students' low achievement in genetics, there is need to shift from the conventional method of teaching to more efficacious method of teaching. It is against this background that the research sought and investigated the effect of mind mapping teaching strategy (MMTS), which hopefully would produce more effective result on senior secondary students' achievement in genetics, in Nasarawa State, Nigeria.

Objectives of the Study

The objective of the study was to investigate the effect of mind mapping teaching strategy on senior secondary students' achievement in genetics in Nasarawa State, Nigeria. The specific objectives of this study are to:

- i. Determine the effect of mind mapping teaching strategy on students' achievement in genetics.
- ii. Examine the effect of mind mapping teaching strategy on male and female students' achievement in genetics.

Research Questions

The following research questions guided the study.

- i. What are the mean achievement scores of biology students taught Genetics using mind mapping teaching strategy and those taught using conventional teaching method?
- ii. What are the mean achievement scores of male and female biology students taught

genetics using mind mapping teaching strategy?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

- H₀₁.** There is no significant difference in the mean achievement scores of biology students taught Genetics using mind mapping teaching strategy and those taught using conventional method of teaching.
- H₀₂.** There is no significant difference in the mean achievement scores of male and female biology students taught Genetics using mind mapping teaching strategy.

Methodology

This study used quasi-experimental research design involving non randomized pre-test, post-test, control group. The groups were non-equivalent in that two intact SSIII biology classes were used in two different schools. One was taught using mind mapping teaching strategy, (experimental group) while the other was taught using conventional teaching method (control group). However to establish the groups entry behaviour, a pre-test was given to the two groups. The pre-test scores were analysed to ascertain the level of similarity of the two groups. After the pre-test, treatment was given to the two groups and subsequently post-test was administered after the treatment. The intervention employed was the mind mapping teaching strategy.

The population for this study was 27,545 SSIII biology students consisting of 15,540 male and 12,005 female drawn from 288 co-educational public Senior Secondary Schools in Nasarawa State. The sample used for the study was 100 SSIII biology students having 52 female and 48 male. The study used multi-stage sampling technique to choose the sample, because stratification was applied on more than one variable at a time in several stages of the research study. Afterwards, a throw of a flip of a coin was made to obtain a strata that has 2 schools. Thus, strata A₁, with 2 schools was drawn. However, a throw of a flip of a coin was further made to obtain which of the 2 schools drawn was to be randomly assigned experimental and control group. Hence, Government Science Secondary School Lafia was assigned experimental group while Government Senior Secondary School Lafia East was assigned control group respectively. The two groups were pre-tested using the developed and validated instrument and different group of similar students outside the sampled schools were pre-tested to ascertain the

reliability of the instrument. However, the experimental and control groups pre-tested with the instrument of the study was meant for the purpose of establishing the groups' entry behaviours. The scores obtained was analysed to ascertain the level of similarity of the two groups. After the pre-test, treatment was given to the two groups and subsequently post-test was administered after the treatment.

The instrument used for this study was Genetics Achievement Test (GAT) whose content areas include: transmission and expression of characteristics in organisms; chromosomes the basis of heredity; probability in genetics; application of the principles of genetics and explanation of genetics terms. This instrument was validated by 2 senior lecturers in the Department of Science, Technology and Mathematics Education (STME) and 1 expert in Department measurement and evaluation department to ensure that it adequately and consistently match the purpose for which it was designed with a validity index of 0.86 while the instrument was trial tested and yielded reliability coefficient of 0.96.

Results

Research Question One

What are the mean achievement scores of biology students taught genetics using mind mapping teaching strategy and those taught using conventional teaching method?. The data generated for answering this research question are presented in Table 1.

Table 1: Mean and Standard Deviation of Achievement Scores of Biology Students Taught Genetics Using Mind Mapping Teaching Strategy and those Taught Using Conventional Teaching Method

Groups	Tests	N	Mean	Standard Deviation (SD)	Higher Standard Deviation (HSD)	Mean Gain (MG)
Experimental	Pre-test	52	18.82	4.50	0.53	6.36
	Posttest	52	40.00	9.51	5.31	21.94
Control	Pre-test	48	12.46	3.97		
	Posttest	48	18.06	4.20		

Table 1 shows the mean achievement scores of the experimental group pre-test and post-test were 18.82 and 40.00 while that of the control group pre-test and post-test were 12.46 and 18.06. This shows that biology students taught genetics using mind mapping has higher pre-test and post-test standard deviations of 0.53 and 5.31 respectively than their counterparts taught using conventional teaching method. While

biology students taught using mind mapping teaching strategy obtained higher pre-test and post-test mean gain scores of 6.36 and 21.94 respectively than their conventional teaching method counterparts. However, standard deviations of the mind mapping (experimental group)'s pre-test and post-test were 4.50 and 9.51 while that of the conventional (control group)'s were 3.97 and 4.20.

Hypothesis one

There is no significant difference in the mean achievement scores of biology students taught genetics using mind mapping teaching strategy and those taught using conventional teaching method.

The results of data generated and tested are presented in Table 2.

Table 2: Results of ANCOVA on the Mean Achievement of Biology Students Taught Genetics Using Mind Mapping Teaching Strategy and Conventional Teaching Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12417.752 ^a	2	6208.876	122.531	.000
Intercept	3177.481	1	3177.481	62.707	.000
Pre-Test	383.662	1	383.662	7.572	.007
Group	5720.404	1	5720.404	112.891	.000
Error	4915.158	97	50.672		
Total	101607.000	100			
Corrected Total	17332.910	99			

a. R Squared = .716 (Adjusted R Squared = .711)

From Table 2, at the group level, the P significant value of 0.000 is less than P significant value of 112. 891 at 0.05 level of significance ($P < 0.05$). Based on these results, the null hypothesis is not retained. This implies that there was a significant difference in the mean achievement scores of biology students taught genetics using

Research Question Two

What are the mean achievement scores of male and female biology students taught genetics using mind mapping teaching strategy?

The data generated for answering this research question are presented in Table 3.

Table 3: Mean and Standard Deviation of Achievement Scores of Male and Female Biology Students Taught Genetics Using Mind Mapping Teaching Strategy

Groups	Tests	N	Mean	Standard Deviation (SD)	Higher Standard Deviation (HSD)	Mean Gain (MG)
Male	Pre-test	48	17.04	5.34	0.38	2.69
	Posttest	48	31.00	13.08		3.79
Female	Pre-test	52	14.35	4.96		
	Posttest	52	27.21	13.24	0.16	

Table 3 shows the pre-test and post-test mean achievement scores of male biology students were 17.04 and 31.00 while that of the female biology students were 14.35 and 27.21 respectively. The standard deviations of male biology students' pre-test and post-test scores were 5.34 and 13.08 while the standard deviations of female biology students' pre-test

mind mapping teaching strategy than those taught using conventional teaching method at 0.05 level of significance with 95% confidence interval for the difference. Those taught using mind mapping teaching strategy obtained higher scores than those taught using the conventional teaching method.

and post-test scores were 4.96 and 13.24. Thus, female biology students has higher post-test standard deviations of 0.16 than their male counterparts while the male has higher pre-test standard deviation of 0.38 than their female counterparts respectively. This shows that male biology students have higher pre-test and post-test mean gain scores of 2.69 and 3.79 than their female counterparts.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female biology students taught Genetics using mind mapping teaching strategy.

The results of data generated and tested are presented in Table 4.

Table 4: Results of ANCOVA on the Mean Achievement of Male and Female Biology Students Taught Genetics Using Mind Mapping Teaching Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6701.602 ^a	2	3350.801	30.573	.000
Intercept	198.295	1	198.295	1.809	.182
Pre-Test	6343.365	1	6343.365	57.877	.000
Gender	4.253	1	4.253	.039	.844
Error	10631.308	97	109.601		
Total	101607.000	100			
Corrected Total	17332.910	99			

a. R Squared = .387 (Adjusted R Squared = .374)

From Table 4, at the gender level, the P significant value of 0.844 is greater than P significant value of 0.039 at 0.05 level of significance ($P > 0.05$). Thus, the null hypothesis is retained. This implies that there was no significant difference in the mean achievement scores of male and female students taught genetics using mind mapping teaching strategy at 0.05 level of significance. Thus, both male and female biology students in the experimental group achieved equally. As such it goes to show that the use of mind mapping teaching strategy is not sex dependent.

Discussion of Findings

The Finding in respect of research question one indicates that, biology students taught genetics in the experimental group achieved significantly

in their mean achievement scores as against the biology students taught genetics in the control group. This finding agrees with those of Nworgu (2012); Stephen (2014); Uzoechi, Gimba (2015); and Katcha (2017) opined that innovative teaching strategy such as mind mapping improves students' achievement than the conventional teaching method. (Buzan, 2010; Jones, Ruth, Snyder, 2012; Andrea, Adodo, 2013; Tanriseven, 2014; Malekyadeh, Bayat, 2015; and Yunus, 2016) also reported that mind mapping teaching strategy is effective in improving students' conceptual scientific skills. The reason for this outcome might be that mind mapping teaching strategy helps in improving the quality of teaching and students' innovative conceptual scientific skills thus leading to better achievement of biology students in genetics. The finding also shows that male biology students in the experimental group's mean

achievement scores was better than that of their female counterpart. This finding disagrees with those of Baram-Tsabari and Yarden (2008), Adodo (2013) who reported that female biology students' in genetics class achieved better than their male counterpart. However, this finding is in agreement with the finding of Stephen (2014), and Katcha (2017) who reported that there was no difference in the mean achievement scores of both male and female biology students taught genetics using mind mapping teaching strategy as one of the co-operative teaching strategy employed in teaching genetics. The reason for this inclusive achievement might be that both male and female students indicated a higher level of commitment which aided the enhancement of their understanding using mind mapping teaching strategy in genetics.

Conclusion

The study investigated the effect of mind mapping teaching strategy on senior secondary students' achievement in genetics in Nasarawa State, Nigeria. The findings of this study revealed that mind mapping teaching strategy is more effective in improving students' achievement in genetics than the conventional teaching method. The educational implication of this is that biology teachers approach in teaching genetics using conventional teaching method might probably be responsible for the persistent or poor students' achievement in genetics.

Recommendations

The following recommendations were made.

1. Curriculum experts should stipulate that Genetics should be taught using mind mapping teaching strategy.
2. Seminars and workshops should be mounted to guide biology teachers on how to use mind mapping teaching strategy to teach genetics in secondary schools.

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