EFFECTS OF TWO DIFFERENT INSTRUCTIONAL APPROACHES ON ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL BIOLOGY STUDENTS IN GOMBE STATE, NIGERIA.

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Abstract
The study investigated the effects of instructional approaches (Concept Mapping and Mathematical approach) on academic achievement of senior secondary school Biology students in Gombe Metropolis. Quasi-experimental, non-equivalent control group design was adopted. The population was all senior secondary two (SS2) Biology Students in Gombe metropolis. The sample was two hundred and twenty four (224) SS2 Biology students derived from three senior secondary schools using purposive and simple random sampling technique (Balloting), Genetic achievement test (GAT) was used as an instrument for data collection. The test-retest reliability coefficient of the instrument was 0.77. The results revealed that the treatment had significant effects on students' academic achievement ($F(2,222) = 76.23$, $0.00 p<0.05$). It was also found that gender had no significant main effect on student's academic achievement ($F(1,223) = 1.07$, $0.11 p>0.05$). There was also no significant interaction effect of gender and treatment on students' academic achievement ($F(2,223) = 1.26$, $0.23 p>0.05$). Post hoc test revealed that Mathematics approach group had highest academic achievement in Genetics, followed by concept mapping group and lastly the lecture teaching method group. It was recommended that seminars be organized for Biology teachers to be fully and adequately trained on how to use Mathematical and Concept mapping approaches in teaching secondary school Biology concepts most especially Genetics.

Keywords:
Mathematic Approach, Concept Mapping, and Genetics Achievement Test.

Introduction

Biology is a science of life. It studies the biosphere. Genetics is the study of heredity and variation among organisms of the same species. The study of heredity and variation is of great importance to human being in terms of improving the quality of plants such as high yielding varieties, control and prevention of genetic diseases, and plants and animal breeding (Sakiyo and Muhammad, 2017). Not only that, the

importance of genetics to other disciplines such as Medicine, Agriculture, Floriculture, Horticulture, Genetic Engineering and Biotechnology cannot be over emphasized. This is an indication that genetics is also a panacea for sustainable development in science, technology and industrialization in Nigeria. This is in agreement with the National Policy on Education (Federal Republic of Nigeria, (FRN, 2014), which stresses functional education for all so that learners may fit into the society and the world. This can be achieved through meaningful learning of genetics in Biology using innovative students centered approaches for effective learning and development of science process skills and not just a recall of facts of the Biology subjects. However, in recent years, Biology results most especially in secondary schools certificate examination (SSCE) are very low (WAEC chief examiners' report 2017, 2018 & 2019). Not only that, a genetic achievement test administered to some students in some selected schools in Gombe Local Government area, revealed a very poor performance. Gombe State is one of the North East States affected by the Boko Haram insurgency. The insurgency affected students' enrolment as well as the safety of the school environment. Gombe State recorded 57.5 % failure rate in 2018 and 54.7% in 2019 in WAEC (MOE, Gombe State). Despite the investment in education in the state by the past civilian administrations, the low performance of students in Biology continued. These low performance may be attributed to teaching methods adopted by Biology teachers, poor teacher quality, poor working conditions, student teacher ratio, and inadequate instructional facilities in schools. In support of this, Sakiyo (2018) observed that students' low performance in Biology is partly due to teachers being ignorant or running away from activity oriented teaching methods that are more effective such as concept mapping, science technology and society, constructivist teaching methods etc. concept mapping is an innovative approach in Biology teaching which allows students to be in charge of their learning by relating concepts under the guidance of the Biology teacher. It is a schematic or diagrammatic representation of concepts that are related to one another. It helps students to develop knowledge, acquire skills during teaching learning process. Chibabi and Umoru (2018) states that concept mapping is a reform in science education which emphasizes a shift from rote learning of science concepts to relating concepts to make meaningful learning. Danjuma (2017) stressed that the elements that characterized concept mapping are problem orientation and interdisciplinary approach which promote meaningful learning.Research have shown that when students are taught Biology with concept mapping they achieved better than those who were taught using lecture methods. Concept mapping is an instructional approach based on Ausubel assimilation theory of cognitive learning. It is based on the idea that new concepts are given meaning through assimilation into existing concepts prepositional framework (Chinwe & Chikelu 2017). The Mathematical approach involves three mathematical concepts applied in teaching genetics. The concepts are Line Graph

and Scatter Plot. Each of these was used in teaching specific content of genetics to senior secondary schools two students. Line graph and scatter plot were used to teach monohybrid inheritance. Histograms were used to teach both phenotypic and genotypic ratios. Mathematical approach is also a student-centered teaching approach which enables learners take charge of their learning process through connecting new ideas to previous knowledge, on the basis of materials or activities presented to them. The implication is that biological/genetic concepts that are perceived abstract can be seen as concrete when students are actively involved. Many studies on the effects of concept mapping on students' academic achievement revealed that students had higher achievement scores than those who were taught using lecture teaching methods.

Lecture method is a one - way flow of communication from the teacher to students. This method is teacher-centered where the teacher is the reservoir of knowledge while the students remain passive listeners or be taking notes. (Sakiyo & Muhammad 2018). Large volumes of information are presented to the learners in a limited time that may be the reason why teachers embrace lecture teaching method. Lecture teaching method can also be used to teach large classes and the teacher may ask a few questions or no question in the teaching-learning process. Adamu (2017) stated that lecture method may not require the use of instructional materials or resources. This means that students are denied the opportunity of developing manipulative and science process skills, collaborative study and active participation. The issue of gender and gender disparity permeates all aspects of human endeavors (Sakiyo & Muhammad, 2018). The consequences of gender disparity cut across social, economic, political and educational development especially in the area of Science, Agriculture, and Technology. Aisha (2016) identified some reasons for gender disparity in science education to include cost of education, early marriage, influence of peer group, and poor self-concept. Gender differences may be a factor responsible for low academic achievement in Biology. According to Nwagbo (2016), women's low representation and achievement in Biology can be attributed to low enrolment of women in science education. However, Muhammad and Mary (2017) found no significant difference in students achievement based on gender. Sakiyo and Muhammad (2018) suggested that gender difference can be eliminated when teachers use student-centered teaching approaches such as concept mapping, cooperative learning, Science, Technology and Society, problem solving, concept symbols, cartoons and flip strategy. In view of this, it becomes necessary to determine the effects of Mathematical Approach and Concept Mapping on senior secondary school students' academic achievement in Gombe metropolis. One research question and three null hypotheses guided the study.

1. What are the pre-test and post-test mean achievement score differences of students taught some genetic concepts with Mathematical and Concept Mapping and Lecture Teaching Methods?

The null hypotheses were stated and tested at 0.05 alpha level of significance

H_o1: There is no significant main effect of treatment on students' academic achievement.

H_o2: There is no significant main effect of gender on students' academic achievement in genetics when taught using Mathematical Approach, Concept Mapping and Lecture Teaching Method.

H_o3: There is no significant interaction effect of gender and treatment on the academic achievement of senior secondary school students in Biology.

Methodology

The research design for this study was quasi-experimental design involving non-equivalent pretest post test control group with 3×2 functional matrix for matching variables. The population of the study consisted of all senior secondary school three Biology students in Gombe metropolis in 2018/2019 academic session. Three schools were selected through purposive and simple random sampling techniques because these schools are not co-educational and had Biology teachers with at least five (5) years teaching experience. The instrument used for data collection was Genetic Achievement Test (GAT) based on the topics treated (Mendelian genetics: Monohybrid inheritance, Backcross, Testcross, Codominance and Blood Group Genotype, determination of Paternity).

GAT had 25 multiple choice questions. The instrument was content and face validated by Science Education and Biology experts. The instrument was pilot tested in Government Day Secondary School Alkaleri, Alkaleri Local Government Area of Bauchi State. The reliability of the instrument was determined using test-retest reliability method and a reliability coefficient of 0.77 was obtained for the instrument. The subjects used for the study were SS2 Biology students in three intact classes in the three selected schools. A total of 71 students were in experimental group 1, 87 students were in group 2 and 66 students were in control the group. The three groups were taught genetics using Mathematical Approach, Concept Mapping and LTM respectively. Mathematical Approach in this study is a student-centered innovative teaching approach in which the teacher directs students to use the line graphs to teach monohybrid cross (Backcross, testcross, codominance and sex determination) and use histogram to teach phenotypic and genotypic ratios in monohybrid inheritance under the guidance of the teacher.

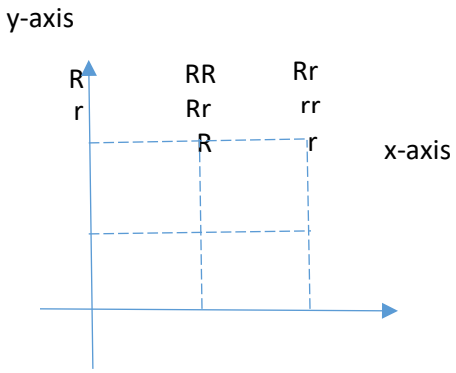

Fig 1. A line graph showing monohybrid cross of two heterogeneous red flowered pea plant. Concept mapping enhanced with the use of Punnet square in this study is also a student centred oriented teaching approach in which the teacher directs students to use the Punnet square diagram to teach monohybrid inheritance under

PARENTAL PHENOTYPE	RED FLOWER	RED FLOWER PLANT
PEA PLANT	PEA PLANT	PARENTAL GENOTYPE

GAMATE	Rr	Rr	R	R	r	r

the guidance of the teacher.

PARENTAL GENOTYPE	Rr	×	Rr			
GAMATE	R	r		R	r	

nce using Punnet S e

PARENTAL PHENOTYPE	RED FLOWER	×	RED FLOWER PLANT
	PEA PLANT	×	PEA PLANT

Lecture method in this study involves one way communication pattern in which the teacher was the dominant figure and students' participation virtually low, rather they listen, asked questions and took notes.

Three research assistants were hired for three weeks on the use of the instructional guides and lesson plans provided by the researchers. They are the regular Biology teachers in their respective schools. The treatment lasted for four weeks. Data were collected and analyzed using mean and standard deviation to answer the research question and analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 alpha level.

Results

Research Question 1: What are the pre-test and post-test mean score difference of students taught genetics with Mathematical Approach, Concept Mapping and LTM?

Table 1: pre-test and post-test mean scores of academic achievement of students in Biology who were taught genetics with MA, CM and LTM.

Teaching Method	Pre-test N	Pre-test Mean($\bar{x}$)	Pre-test S.D	Post-test N	Post-test Mean($\bar{x}$)	Post-test S.D	Mean difference
MA	71	18.93	2.78	71	34.12	3.06	15.19
CM	87	18.95	2.61	87	30.05	3.34	11.1
LTM	66	16.62	2.45	66	17.85	2.71	1.23
Total	224	18.33	2.61	224	21.64	3.20	3.31

Source: Field work, 2019.

The result of the descriptive analysis in table 1 revealed that mathematical approach group had a pre-test mean score of 18.93 with standard deviation of 2.78. The post-test of mathematical approach group had the highest mean score of 34.12 with a standard deviation of 3.06 which gives a mean difference of 15.19. The concept mapping group had a pre-test mean score of 18.95 with standard deviation of 2.61 and post-test mean score of 30.05 with a standard deviation of 3.34 which gives a mean difference of 11.1. The Lecture Method group had a pre-test mean score of 16.62 with a standard deviation of 2.45 and post-test mean score of 17.85 with a standard deviation of 2.71 which gives a mean difference of 1.23. This shows that students taught genetics with mathematical approach and concept mapping perform better than those taught with lecture teaching method.

Ho1: There is no significant main effect of treatment on students' academic achievement in genetics when taught using mathematical approach, concept mapping and lecture teaching method.

Table 2: ANCOVA summary of students' academic achievement when taught genetics with MA, CM and LTM.

Source	Type II Sum of squares	Df	Mean square	F	Sig.
Corrected model	$777.21_{(a)}$	5	155.44	8.03	.00
Intercept	86223.68	1	86223.68	.45	.00
Teaching approach	736.95	2	368.48	19.03^{*}	.00
Gender	13.24	1	13.24	.69	.31
Gender*teaching approach	19.03	2	9.52	.49	.51
Error	2002.72	218	9.19	.81	.29
Total	89772.83	224			
Corrected Total	2805.38	213			

Source: Field work, 2019

Tables 2 shows that there is significant difference between MA, CM and LTM at 0.05 level of significance (F (2,213) = 19.03, 0.00 $p<0.05$), therefore Ho1 was rejected. This result shows that the effect of teaching approach was significant, hence; experimental groups achieved higher scores thus improving students' academic achievement in genetics better than the control group.

Ho2: There is no significant main effect of gender on students' academic achievement in genetics when taught using MA, CM and LTM.

Table 2 shows that there was no significant main effect of gender when taught genetics using MA, CM and LTM at 0.05 level of significance (F (2, 213) = 0.69, 0.31 $p>0.05$), therefore, Ho_2 was retained. This result shows that there was no significant gender difference at 0.05 level of significance when taught genetics with MA, CM and LTM.

Ho3: There is no significant interaction effect of gender and teaching approaches on the academic achievement of senior secondary school students in genetics.

Table 2 shows that there is no significant interaction effect of gender and teaching approaches on academic achievement of students in genetics at 0.05 level of significance (F (2, 213) =0.49, 0.51 $p>0.05$), therefore Ho_3 was also retained. This result shows that there is no significant interaction effect of gender and teaching approaches on students' academic achievement in genetics.

A scheffe post hoc analysis was done to identify the groups that brought about the significant difference.

Table 3: Scheffe Multiple comparison of teaching approaches (Post Hoc Analysis).

Teaching approaches	Teaching approaches	Mean Df.	Std. error	Sig.
MA	CMA	+4.07	.41	.00*
	LTM	+16.27	.39	.00*
CM	MA	-4.07	.41	.00*
	LTM	+12.2	.39	.00*
LTM	MA	-16.27	.41	.27
	CM	-12.20	.39	.11

*The mean difference is significant at 0.05 alpha level.

Table 3 indicated that the MA was significantly better than CM and LTM (+4.07 α +6.27). CM was significantly better than LTM with (+4.2). There was significant difference between the two teaching approaches and LTM (+6.27 & +4.2). This shows that the MA group brought about the significant difference.

Discussion of Findings

The objective of this study was to investigate the effects of Mathematical Approach and Concept Mapping on Senior Secondary School Biology students' academic achievement in Biology. The results of the study showed that Biology students had higher academic achievement when genetics was taught using Mathematical approach and Concept Mapping than when taught the same using LTM. This is in line with the findings of some researchers that Mathematical approach improves genetics learning (Danjuma, 2017). This implies that the use of the line graph in monohybrid crosses by the students in learning activities and their active involvement had improved the relative effectiveness of the Mathematical approach more than the LTM which is a teacher-centered method. Mathematical approach facilitated higher academic achievement than the LTM. This finding agrees with that of Mari (2012) who found that students had higher academic achievement scores in Mathematical approach than their counterparts in the control group. The M.A groups brought out the highest effect because of the use of Line Graph and Histogram to find answers to genetic questions raised by phenotypic and genotypic ratios of inheritance.

The study also found that gender significantly had not affected students' academic achievement and there was no significant interaction of gender and teaching approaches on students' academic achievement in genetics. This finding agreed with the findings of Muhammad and Mary (2016) who examined the effects of Science, Technology and Society and constructivist teaching strategies on academic achievement and retention and found that there were no gender differences in the genetics achievement test scores. However, this result contradicts the findings of (Mari, 2012) who revealed that gender had significant main effect

on students' academic achievement and retention when taught genetics using inquiry teaching methods.

Conclusion

Based on the findings of this study, it was concluded that the use of M.A enhanced students' academic achievement in genetics. There was no significant main effect of gender on students' academic achievement and also there was no significant interaction effect of gender and teaching approaches on students' academic achievement. This means that the two approaches are gender friendly teaching approaches.

Recommendations

The following recommendations are hereby made:

1. Biology teachers should be trained and encouraged to use innovative students-centered teaching approaches such as the Mathematical approach to facilitate Biology teaching.
2. Symposium and workshops should be organized by the federal and state ministries of education on the application of Mathematical approaches for Biology teachers to improve students' academic achievement and retention.
3. The Biology teacher education curriculum should re-emphasise on Mathematical approaches to teaching genetics.

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