



Scaffolding and Cooperative Instructional Strategies on Academic Performance in Genetics of Secondary School Students in Ojo Local Government Area of Lagos State, Nigeria

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Abstract

This study determined the effect of scaffolding and cooperative instructional strategies on academic performance in genetics of secondary school students in Ojo Local Government Area of Lagos State, Nigeria. The researcher adopted a pre-test, post test, quasiexperimental, non-equivalent control group design. A sample of two hundred and forty (240) Senior Secondary two (SS II) students was drawn from two co-educational secondary schools in Ojo Local Government Area of Lagos State, Nigeria. Three research questions and three null hypotheses guided the study. Genetics Achievement Test (GAT) and a checklist were used in the collection of data. GAT had a reliability coefficient of 0.81 through the use of split-half reliability. Descriptive statistics was used to answer the research questions, while inferential statistics - the Analysis of Variance (ANOVA) was used to test the hypotheses at 0.05 alpha level. The results showed that there was a significant effect of treatment on the academic performance of students taught the concepts of genetics ($F(2, 232) = 20.94, p = .000, \eta^2 = .153$). However, there was no significant effect of gender on the academic performance of students taught the concepts of genetics ($F(1, 232) = 3.268, p = .072, \eta^2 = .014$). Finally, there was no significant interaction effect of treatment and gender on the academic performance of students ($F(2, 232) = 2.772, p = .065, \eta^2 = .023$). Based on the result obtained, it was therefore recommended that teachers should be encouraged to use scaffolding instructional strategy to teach genetics in secondary schools.

Keywords: Scaffolding instructional strategy, cooperative instructional strategy, academic performance, genetics, SS II students, gender.

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INTRODUCTION

National development depends on Science, Technology, Engineering and Mathematics (STEM) education because *it* is the bedrock of technological advancement. Science education prepares learners with appropriate skills, abilities and competencies that would lead to social, mental and physical development. Achieving these plausible objectives therefore, calls for proactive teaching methods and strategies by teachers. Many researchers agree that the conventional lecture method does not help students construct their own understanding. Igboanugo (2013) reported that cooperative learning is more efficacious in capturing students' interest than conventional teaching methods. He stressed further that the uninspiring teaching methods adopted by science teachers lead not only to low achievement in the science but also incapacitates students from developing required skills necessary for creative thinking (Igboanugo, 2013; Kolawole, 2007; Oke, 2005). The poor performance of students has also been blamed on a number of variables which include teaching strategies (Guirguis & Pankowski, 2017), students' factors and attitude (Mensah & Kuranchie, 2013), inadequate learning resources (Yara & Otieno, 2010), gender (Nnamani & Oyibe, 2016), and students' study habits (Ayodele & Adebisi, 2013; Etobro & Fabinu, 2017; Obasoro & Ayodele, 2012).

Among the students' factors that affect academic performance is gender. Gender is one of students' variables of considerable discourse in literature. For a long time, gender was listed by researchers as one of the factors that influenced the academic achievement of the child (Abubakar & Oguguo, 2011; Gupta, Sharma & Gupta, 2012). Consequently, there has been controversy on whether or not gender really affects academic achievement. Some researchers believed that male students often out-perform their female counterparts in most subject areas, while others have a contrary view (Jabor, Machtmes, Kungu, Buntat & Nordin, 2011; Maliki, Ngban & Ibu, 2009). Abubakar and Bada (2012) emphasized that the gap that once existed between genders is fast closing. This suggests that females are getting more exposure to educational activities more than ever.

Teaching methods and strategies are among the teacher factors that affect students' academic performance. Teaching methods and strategies include lecture, discussion, demonstration, fieldtrip among others. Lecture method of instruction is teacher-centred and is profitable in verbal presentation of ideas, concepts, generalizations and facts that need to be covered within a short period in a large class size. It appears that most often biology teachers present biology as knowledge to be memorized through their long lectures, large notes and assignments which are meant to keep the learners busy without positive impact on their cognition and affection. In this instructional strategy, learners are passive listeners; learn by rote and memorization of facts leading to perhaps poor retention and poor academic achievement. The demerits of conventional lecture methods of instruction may have led researchers to seek alternative methods and strategies that may be learner-centred. Some teaching methods and strategies have been proved more efficacious in the teaching of abstract and difficult topics in different science subjects than the conventional lecture method. Such strategies include dramatization, scaffolding, concept mapping, collaborative and cooperative and guided inquiry, among others. Consequently, studies have been carried out using innovative instructional strategies such as guided inquiry and demonstration method (Irinoye, Ayodele, Adetunji & Awodele, 2015; guided inquiry and collaborative strategy (Obomanu, Nwanekezi & Ekineh, 2014); lecturing, concept mapping, cooperative learning (Ajaja, 2013); scaffolding strategy (Alake & Ogunseemi, 2013) and cooperative learning strategy (Ajaja & Eravwoke, 2010).

Nnorom (2015) stresses that Biology education is an integral part of Science, Technology, Engineering and Mathematics (STEM) education. It appears that most often biology teachers present biology as knowledge to be memorized through their long lectures,

large notes and assignments which are meant to keep the learners busy without positive impact on their cognition and affection. There is need for Biology teachers to adopt appropriate instructional methods and strategies that are student-centred rather than teacher-centred. It becomes imperative for teachers to employ strategies that are student-centred which would arouse students' interest, develop their inquiry skills and enhance students' positive attitude. The thrust of this study therefore focused on scaffolding instructional strategy as well as cooperative instructional strategy.

Scaffolding as an instructional strategy according to Reiser (2004) is a process by which a teacher, an instructor or a more knowledgeable peer assists a learner, altering the learning task so the learner can solve problems or accomplish tasks that would ordinarily be impossible for him to learn from the experience. Alake & Ogunseemi, (2013) citing Verhagen & Collis (1996) and Sawyer (2006), further described scaffolding as a temporary support made available for students' learning until the students can perform independently of that support. Instructional scaffolding could also be thought of as the strategy that a teacher uses to help learners bridge a cognitive gap or process in their learning to a level they were previously unable to accomplish (Owenvbiugie & Iyoha, 2017). In scaffolding instructional strategy, supports needed in the development of learners' cognitive, psychomotor and social skills may include resources, a compelling task, templates and guidance. Such skills may include modeling behaviours, coaching and prompting, thinking out loud, dialogue with questions and answers, planned and spontaneous discussions, as well as other interactive planning or structural assistance to help the learner bridge a cognitive gap.

Cooperative learning is a dynamic learner-centred approach that enhances students learning in the cognitive, psychomotor and affective domains. Eziyi, Mumuni and Nwanekezi (2016) stated that in a cooperative instructional approach, learners of diversified ability levels explore the socio-cultural significance of human movement by working together in small structured heterogeneous groups with the sole aim of completing tasks. In such heterogeneous groups individual member of a group takes responsible not only what is been taught but at the same time assisting members of the group to learn what is taught in order to achieve the set goals. In cooperative instructional approach, the success of the group is anchored on the performance of the entire group rather than on the performance of individual learners in the group. With cooperative instructional approach, the different tasks learners are exposed to; enhances learners understanding of each other's abilities, interests and needs. The various tasks encourage learners to take responsibility for their learning, thus imbibing the basic cooperative values and attitudes they require in relating with their fellow learners within and outside the classroom. It further promotes the communication of pre-social behaviour, encouraging high thought processes and fostering concept understanding and achievement (Ajaja, 2013). In cooperative instructional approach, learners are actively engaged in the instructional process, imbibe appropriate models of social behaviour as well as improving their critical thinking, problem solving and reasoning skills.

There is dearth in literature on the combined effects of scaffolding and cooperative learning instructional strategies in teaching genetics. The concept of genetics is a difficult concept for students (Etobro & Fabinu, 2017). There is therefore, the need to employ innovative instructional strategies in teaching genetics. The study examined the effects of scaffolding and cooperative strategies on SS II students' academic performance in conceptual understanding of genetics in Ojo Local Government Area of Lagos State, Nigeria. The study specifically:

- Determined the effects of scaffolding and cooperative instructional strategies on SS II students' academic performance in genetics;

- Compared the performance of male and female SS II students in genetics after been exposed to scaffolding instructional, cooperative instructional and conventional lecture strategies; and,
- Assessed the interactive effect of treatment and gender on the performance of SS II students in concepts of genetics.

The research questions that guided the study include:

- What is the effect of scaffolding instructional, cooperative instructional and conventional lecture strategies on the performance of SSII students in genetics?
- What is the influence of gender on the performance of SSII students in genetics using scaffolding instructional, cooperative instructional and conventional lecture strategies?
- What is the interactive influence of treatment and gender on the performance of SS II students in genetics using scaffolding instructional, cooperative instructional and conventional lecture strategies?

The null hypotheses formulated to guide the study include:

- There is no significant effect of treatment (scaffolding instructional, cooperative instructional and conventional lecture strategies) on SS II students' academic performance in genetics.
- There is no significant effect of gender on SS II students' academic performance in genetics.
- There is no significant interaction effect of treatment and gender on SS II students' academic performance in genetics.

METHODOLOGY

This study was a 3x2 factorial pre-test, post-test, control group, experimental design that involved a treatment group and a control group. The design consisted of three treatment groups (scaffolding instructional, cooperative instructional and conventional lecture groups) and two levels of gender (male and female). Multistage sampling technique was employed in the study. Education District V was selected by balloting from the six Education Districts in Lagos State. Six senior secondary schools were purposively sampled from Ojo local government area of Education District V of Lagos State. Schools were purposively selected – schools that had presented students for Senior Secondary Certificate Examination (SSCE) for fifteen years with well-equipped biology laboratories. Adopting simple random sampling technique by balloting, six schools were sampled. The six schools were assigned to three groups consisting of two experimental groups and a control group; two schools were assigned to each group. Treatments administered included two experimental conditions – scaffolding instructional strategy and cooperative instructional strategy and a control group where students were taught using conventional lecture method. A sample of forty students from each of the six sampled schools was randomly selected employing systematic probability sampling technique resulting to 240 students.

Instrumentation

School Based Checklist (SBC) and Genetics Achievement Test (GAT) developed by the researcher were used in data collection. The School Based Checklist (SBC) was administered

to Biology teachers. It focused on the teacher's teaching experience, qualification, number of times the school had presented students for the SSCE and availability of biology laboratories. GAT was made up of 40 multiple choice objective test items generated from subtopics in genetics such as Cell Division, Mitosis, Meiosis, Chromosomes and DNA Structure. In order to establish the psychometric properties of the test, it was administered on 50 students that were not part of the study. Using split-half reliability method a reliability index of 0.84 was obtained. A pre-test was administered on the sampled 240 students before exposing them to the treatments. The sampled students were randomly assigned to treatment groups by simple random sampling by balloting. The six teachers that were purposively selected for the study were trained on the skills of scaffolding instructional, cooperative instructional and the conventional lecture strategies. Two teachers were trained to adopt each of the treatment strategies. The treatment lasted for four weeks. After the treatment a post-test was administered on the students.

RESULTS

Question 1: What is the influence of scaffolding instructional, cooperative instructional and conventional lecture strategies on SS II students' academic performance in genetics?

Table 1: Descriptive Statistics of the influence of scaffolding instructional, cooperative instructional and conventional lecture strategies on SS II students' academic performance in genetics

Group	N	Pre test		Post test		Difference	
		Mean	SD	Mean	SD	Mean	SD
Scaffolding Strategy	80	11.4	7.24	20.65	7.99	9.25	0.75
Cooperative Strategy	80	11.65	8.63	20.55	7.95	8.9	-0.68
Conventional Method	80	6.14	8.65	9.88	12.89	3.74	3.74

Table 1 shows that students taught with scaffolding instructional strategy had the highest mean difference of 9.25 with a standard deviation of .75, followed by those taught with cooperative instructional strategy with mean difference of 8.90 and standard deviation of -0.68, while the students in the conventional lecture group had the least mean difference of 4.24 and standard deviation of 3.74.

Question 2: What is the influence of gender on the academic performance of SS II students in genetics using scaffolding instructional, cooperative instructional and conventional lecture strategies?

Table 2: Descriptive Statistics of the influence of gender on performance of SS II students in genetics

Gender	N	Pre test		Post test		Difference	
		Mean	SD	Mean	SD	Mean	SD
Male	131	10.7	7.87	17.2	9.65	6.5	1.78
Female	109	10.4	7.09	19.04	8.97	8.64	1.88
Mean		10.56	7.52	18.03	9.38	7.46	1.86

Table 2 reveals that female students with mean difference of 8.64 and a standard deviation of 1.88, performed better than their male counterparts with a mean difference of 6.50 and standard deviation of 1.78.

Question 3: What is the interactive effect of treatment and gender on SS II students' academic performance in genetics using scaffolding instructional, cooperative instructional and conventional lecture strategies?

Table 3: Descriptive Statistics of the interactive effects of treatment and gender on SS II students' academic performance in genetics

Group	Male			Female		
	N	Mean	SD	N	Mean	SD
Scaffolding Strategy	33	21.15	8.43	47	20.35	7.81
Cooperative Strategy	54	18.52	7.2	26	24.77	7.9
Conventional Method	44	12.61	11.37	36	13.22	7.84
Average	*131	**17.2	9.65	*109	**19.04	8.97

* Total male and female respondents

** Average of the respondents' achievement mean scores

Table 3 shows that female students who were taught with cooperative instructional strategy had the highest mean of 24.77 and standard deviation of 7.9, followed by male students taught with scaffolding instructional strategy with a mean of 21.15 and standard deviation of 8.43. Female students in the scaffolding instructional strategy group had a mean and standard deviation of 20.35 and 7.81 respectively, while male students in the cooperative instructional strategy respectively had a mean and standard deviation of 18.52 and 7.2. Furthermore, female and male students in the conventional lecture group had means of 13.22 and 12.61 respectively.

Testing of Hypotheses

Hypothesis 1: There will be no significant effect of treatment (scaffolding instructional, cooperative instructional and conventional lecture strategies) on SS II students' academic performance in genetics.

Table 4a: ANCOVA Table of the effect of treatment and gender on SS II students' academic performance in genetics

Source	SS	df	MS	F	Sig.	η^2
Corrected Model	4138.823 ^a	6	689.804	9.534	.001	.198
Intercept	20946.958	1	20946.958	289.509	.001	.555
Pre_Test	253.456	1	253.456	3.503	.063	.015
Gender	236.425	1	236.425	3.268	.072	.014
Treatment	3030.553	2	1515.277	20.943	.001	.153
Gender * Treatment	401.192	2	200.596	2.772	.065	.023
Error	16785.972	232	72.353			
Total	98613.000	240				
Corrected Total	20924.795	238				

Table 4a reveals that there is significant effect of treatment (scaffolding instructional, cooperative instructional and conventional lecture strategies) on SS II students' academic performance in genetics ($F_{(2, 232)} = 20.94, p = .001, \eta^2 = .153$). The implication of this is that since p-value (.001) of the F-ratio was significant, the null hypothesis which states that there will be no significant effect of treatment (scaffolding instructional, cooperative instructional and conventional lecture strategies) on SS II students' academic performance in genetics was rejected. The partial Eta squared estimated indicates that the treatment accounted for 15.3% of the variance observed in the post-test on the students' academic performance. To

determine the sources of the difference among the groups, Scheffe's Post-Hoc comparison analysis was performed.

Table 4b: Scheffe's Post-Hoc Pair-wise Comparison of scaffolding instructional, cooperative instructional and conventional lecture strategies

(I)	(J)	(I-J)	Std. Error	Sig.
Scaffolding	Cooperative	0.1335	1.356	1.00
	Conventional	7.7960*	1.356	.001
Cooperative	Scaffolding	-0.1335	1.356	1.00
	Conventional	7.6625*	1.352	.001
Conventional	Scaffolding	-7.7960*	1.356	.001
	Cooperative	-7.6625*	1.352	.001

The significant main effect shown in table 4a was as a result of significant difference in the teaching strategies as shown in table 4b between scaffolding instructional strategy and conventional lecture method groups ($p = .001$) with a mean difference of 7.8, cooperative instructional strategy and conventional lecture method groups ($p = .001$) with a mean difference of 7.7. Furthermore, there was a difference between scaffolding instructional strategy and cooperative instructional strategy.

Hypothesis 2: There is no significant gender effect on SS II students' academic performance in genetics.

Table 4a shows that there was no significant gender effect on SS II students' academic performance in genetics ($F_{(1, 232)} = 3.268$, $p = .072$, $\eta^2 = .014$). This implies that since p-value (.072) of the F-ratio was not significant, the null hypothesis which states that there is no significant gender effect on SS II students' academic performance in genetics was not rejected. Gender accounted for 1.4% of the total variance in the model.

Hypothesis 3: There is no significant two-way interaction effect of treatment and gender on SS II students' academic performance in genetics.

Table 4a reveals that there was no significant two-way interaction effect of treatment and gender on SS II students' academic performance in genetics ($F_{(2, 232)} = 2.772$, $p = .065$, $\eta^2 = .023$). The implication is that since p-value (.072) of the F-ratio was not significant, the null hypothesis which states that there is no significant two-way effect of treatment and gender on SS II students' academic performance in genetics was not rejected. Gender accounted for 2.3% of the total variance in the model.

DISCUSSION

Results showed that there was significant effect of treatment (scaffolding instructional, cooperative instructional and conventional lecture strategies) on SS II students' academic performance in genetics. Students in the scaffolding instructional group had the highest mean score, followed by those in the cooperative instructional group, while the students in the conventional lecture group had the least mean score. The implication of this is that scaffolding instructional strategy has the more positive effect in enhancing understanding of the concept of genetics and in enhancing students' academic performance than the conventional method. The finding of this study is in agreement with those of Owenbiugie and Iyoha (2017), Omiko (2015) and Alake and Ogunseemi (2013) who reported that

students exposed to scaffolding strategy performed better than those who were in the traditional method group.

The study also revealed that cooperative instructional strategy was better than conventional lecture method. The finding of this study also is in consonant with Nnorom (2015) and Muraya and Kimamo (2011) who stressed that students exposed to cooperative instructional strategy outperformed those taught with conventional lecture method. Furthermore, Ajaja (2013); Nwagbo and Okoro (2012); Odagboyi, Otuka and Uzochi (2015); and Igboanugo and Njoku (2015) found that cooperative instructional strategy is more effective in the teaching of science than lecture method just as this study also observed.

Result in this study revealed that there was no significant gender effect on SS II students' academic performance in genetics. This finding is in agreement with Adeyemi (2008); Cirila (2003); Muraya and Kimamo (2011); Nwagbo and Chikelu (2011); and Wachanga and Mwangi (2004) who found no significant gender differences when exposed to treatment groups. The finding was however not in agreement with that of Kolawole (2008) who reported significant gender difference in academic achievement.

Finally, there was no significant interaction effect of treatment and gender on SS II students' academic performance in genetics. This result agrees with (Ajaja 2013) Nwagbo and Chikelu (2011) and Iloputaife (2001) who reported in their studies that there was no significant interaction effect between teaching strategies and gender. The implication is that teaching strategies and the gender of students do not jointly influence academic performance in genetics. The implication of this therefore is that the observed significant differences in academic performance in genetics among students taught with scaffolding instructional, cooperative instructional and conventional lecture strategies may not be linked to gender but to the instructional strategies adopted in this study and other extraneous variables not considered in this study.

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