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EFFECTS OF MATHEMATICS PRE-TEACHING ON SENIOR SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY IN ILORIN, NIGERIA

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Abstract

Genetics is a branch of Biology that deals with the study of heredity and variation is considered one of the hard-to-teach and hard-to-learn biological concepts in literature. Conceptual understanding of genetics enhances students' performance in both internal and external examinations. The study, therefore, sought to examine the effects of mathematics pre-teaching on senior school students' achievement in genetics. Specifically, two research questions and corresponding hypotheses were raised and tested in the study. All the hypotheses were tested at 0.05 level of significant. The study adopted a quasi-experimental research design and the samples for the study were drawn from two intact classes that were purposively selected from Ilorin metropolis. Genetics Achievement Test and Mathematics pre-teaching manual served as the response and stimulus instruments respectively. Findings from the study revealed that students exposed to Mathematics pre-teaching instructional strategy achieved significantly better than their counterpart that were taught using the conventional method. Gender also did not have any significant influence on the achievement of male and female students taught using the mathematics pre-teaching strategy. Based on the findings from the study, it was concluded that exposing students to basic mathematical concepts that are relevant to proper understanding of genetics brings about better understanding of genetics and hence, improves their achievement in genetics. It was therefore recommended that teachers could adopt pre-teaching of the mathematical components of genetics before teaching genetics.

Keywords: Mathematics Pre-teaching, Genetics, Achievement, Gender.

Introduction

Biology as a school subject occupies a very unique position in the Nigerian secondary school curriculum. The major aim of the biology curriculum is to provide a biology-related learning experience for students to develop science literacy in order that they can participate actively in a rapidly changing knowledge-based society, prepare for further studies or career in the fields related to life science and become life-long learners in science and technology.

The knowledge of biology in secondary schools is significant by allowing the students to know the major differences that exist among living beings. Such knowledge helps learners to have a better understanding about them and also appreciate the biotic components of the biosphere. Bello, Ahmed, Alabi, Bello, and Bello (2016) submitted that without the knowledge of Biology, epidemic diseases caused by viruses and bacteria such as Lassa fever, Zika fever, Ebola, Bubonic plague and HIV/AIDS could have wiped out humankind. The study of biology also enhanced the growth of some industries such as silk, pearl, fishing, apiculture and so forth. It has also assisted in the production of pest and diseases-resistant varieties of plants and animals, thereby improving agricultural practices (Abimbola, 2017). Therefore, the impact of Biology and its importance on the life of every society and individual globally cannot be overemphasized. Hence, the need to continuously revised the Biology curriculum in line with improved knowledge about living things.

In Nigeria, the latest version of the Biology curriculum according to the Federal Ministry of Education (FME, 2009), consists of four themes, which are: organization of life; organisms at work; organisms and their environment; and, continuity of life. Genetics, a topic in Biology, is subsumed under theme four (4) “continuity of life”. It is a branch of biology concerned with the study of inheritance, characters and related phenomena (Abimbola, 2017).

Genetics is one of the fields of Biology which basically deals with the study of genes, genetic variation, and heredity in living organisms. The knowledge of genetics enables students to learn about genes and their mode of transmission from generation to generation. Such knowledge helps students to understand problems of genetic nature rather than relying on superstition and other mystical explanations. Also, students learn accurate scientific ways of explaining the genetic defects that may be found in their families and communities (Paul, 2018).

Despite the importance of Genetics, it is one of the most difficult Biology topics to teach and to learn by teachers and students alike in many parts of the world (Chifwa, 2015). It is noted that students have a lot of misconceptions about genetic terminologies which act as barriers to the understanding the topic. Also, the concept of genetics has many interrelated ideas and facts. Thus, for students to achieve a meaningful understanding of genetics they must actually relate the ideas and facts that make up the concept while teachers endeavor to use relevant teaching methods (Paul, 2018).

Adelana (2018) posited that lack of practical activities, lack of learning resources, discouragement from the teachers, students' negative attitudes, schedule of the topic in the curriculum, unfriendly teachers' teaching methods, among others contributed immensely to students learning difficulties in genetics. Poor mathematical knowledge and too many terminologies are also some factors that influence students' understanding of genetics (Haambokoma, 2007). It is therefore pertinent that students have adequate understanding of basic mathematical concepts such as probability for them to achieve significantly in genetics.

The functional role of mathematics in teaching genetics is enormous, hence the need to pre-expose the students to basic mathematical concepts that are relevant to genetics. Mathematics Pre-teaching of genetics refers to an act of pre-teaching of the mathematics aspect of genetics earlier before the actual teaching of the main content of genetics to students. This strategy provides students prerequisite knowledge that would assist them to understand the concepts perceived difficult to comprehend. Pre-teaching, according to Autism (2017), involves teaching students' concepts or skills prior to a lesson. It requires explaining new vocabulary or new mathematical concepts prior to actual teaching.

Busari (2014) researched into the effects of pre-teaching the mathematics component of genetics on senior school students' genetics achievement. The study was carried out in Oyo State, Nigeria and adopted the quasi-experimental, non-randomized, non-equivalent, pre-test, post-test control group design. One hundred and seventy-six (176) biology students from four secondary schools were purposively selected for the study. Data were collected and analyzed using descriptive statistics; mean standard deviation and mean gain score was used to answer research questions. The t-test and Analysis of Covariance (ANCOVA) were used to test the hypotheses. The findings of the study revealed that students that were pre-taught the mathematics component of genetics achieved significantly better than those that were not pre-taught the mathematics components of genetics.

In another study, Badmus, Akanmu, and Akanbi (2015) carried out research on the predictive effects of mathematical concepts pre-teaching on physics students' performance in Ilorin. The study was an experimental type of quasi-experimental design. A total of 62 students drawn from intact classes of two purposively selected schools were used. The data collected was analyzed using t-Test and Analyses of Variance. The result shows that, the students who were exposed to the pre-teaching of mathematical concepts performed significantly better than their counterparts in the control group. Kurumeh, Igyu, and Mohammed (2013) investigated the correlation that existed between senior school students' mathematics achievement and their achievements in Chemistry, Physics, and Biology in WASSCE. The study emphasized the importance of mathematics to science and that mathematics achievement can be used to predict the achievement of students in other science subjects. The ex-post facto research design was used to carrying out the study. The study consists of four hundred and eighty students selected from six secondary schools in Makurdi Local Government Area of Benue State. The result of the study indicated that a significant relationship existed between Mathematics and each of Chemistry, Physics, and Biology at 0.05 level of significance.

Aside the instructional strategy utilised by the teachers, students' factors such as students' gender and their study habit could also influence their achievement in genetics. Gender issues in educational research have been very controversial. This is because the conclusion of researchers on the influence of gender on students' academic performance and achievement differs. One of the millennium development goals (MDGs) is gender equality. Many studies have established that no significant difference exists between male and female students' achievement in sciences. For instance, findings from the works of Ahmed, Shittu, Yahaya and Dada (2021); Ikitde and Edet (2013); and Oludipe (2012) revealed that there was no statistically significant difference in the achievements of male and female students in sciences. Meanwhile, Jibrin and Zayum (2012); Odagboyi (2015) observed that male students achieved significantly better than their female counterparts. Based on the fact that there has not been any consensus on researchers' findings on the influence of gender on students' achievement in science in general and biology in particular, this study considers gender as a variable of interest.

Purpose of the Study

The main purpose of the study was to examine the effect of mathematics pre-teaching on senior secondary school students' achievement in genetics aspect of biology

Ilorin, Nigeria. Specifically, the study sought to investigate the

1. Effect of mathematics pre-teaching on senior secondary school students' achievement in genetics aspect of biology.
2. Difference in the achievement of male and female students' when taught genetics with mathematics pre-teaching of genetics aspect of biology.

Research Questions

1. What effect does the use of mathematics pre-teaching strategy have on senior school students' achievement in genetics aspect of biology?
2. Do male and female senior school students achieved differently when taught genetics aspect of biology using the mathematics pre-teaching instructional strategy?

Research Hypotheses

H_{01}: There is no statistically significant difference in the achievement of students taught genetics aspect of biology using mathematics pre-teaching instructional strategy and those taught with the conventional strategy.

H_{02}: There is no statistically significant difference in the achievement of male and female students taught genetics aspect of biology using pre-teaching mathematics strategy.

Methods

This study is a quasi-experimental research design of the pre-test, post-test control group design adopting the 2 x 2 factorial design. The 2 x 2 represents the instructional strategies and gender at two levels respectively. The instructional strategies which are mathematics pre-teaching and conventional strategies were the independent variables while the students' achievement in genetics aspect of biology was the dependent variable. Students' gender served as the moderating variables used in the study.

The sample for the study were all senior school students offering biology from which a sample of 122 made up of 70 and 52 for the control and Mathematics Pre-teaching group respectively. The samples were purposively drawn from two intact classes within two co-educational schools within Ilorin metropolis. The researchers ensured that all ethical issues were taken into consideration and adhered to in the course of the study.

Results

Research Question 1: What effect does mathematics pre-teaching strategy have on senior school students' achievement in genetics aspect of biology?

Table 1 reveals the achievement of Biology students taught genetics aspect of biology in the experimental and control groups. The pre-test means scores of students taught genetics aspect of biology using mathematics pre-teaching and control groups were (19.96 and 18.56) respectively, while the post-test mean scores were (39.19 and 37.56) respectively. The mean gain scores for experimental and control groups were (19.23 and 19.00), respectively. It is apparent that there was a marginal difference between the mean gain scores of the experimental and control groups with the group taught using mathematics pre-teaching having a higher mean gain score and a mean gain score difference of 0.23 in favour of the experimental group.

Table 1: Mean Gain Difference of Students taught with Mathematics pre-teaching and Conventional (Control) Strategies

Group	No. of Respondents	Pre-test		Post-test		Mean Gain
	N	Mean	SD	Mean	SD	Mean Gain
Control	70	18.56	5.57	37.56	6.03	19.00
Mathematics Pre-teaching	52	19.96	9.27	39.19	9.36	19.23

$H0_1$: There is no statistically significant difference in the achievement of students taught genetics aspect of biology using mathematics pre-teaching of genetics and those taught without using mathematics pre-teaching of genetics aspect of biology.

The result of the t-test analysis presented in Table 2 indicates that the t-value ($t_{(120)}$=-0.99; $p<0.05$) was significant because the *p*-value 0.03 is less than 0.05 alpha level. This suggested that there was a significant difference between the achievements of students taught genetics aspect of biology using the mathematics pre-teaching strategy and the control group with the result being in favour of mathematics pre-teaching strategy group and it provided the answer to the research question one. Hence, hypothesis 1 was rejected. This implies that the pre-teaching of mathematics components of genetics improves students' achievement in genetics.

Table 2: *The t-test Results of Significant Difference between the Achievement of* pre-teaching strategy *and Control Groups*

Group	N	Mean	SD	Df	T	Sig.	Remark
Control	70	37.56	6.03				
				120	-.99	.03	Significant
Experimental 2	52	39.19	9.36				

$p<0.05$

Research Question 2: Do male and female students achieve differently when taught genetics aspect of biology using mathematics pre-teaching strategy?

Table 3 reveals the achievement of male and female students taught genetics aspect of biology using mathematics pre-teaching strategy. The mean score for male students was 41.59 while the female students had 42.21. It is apparent that the mean score of female students was higher than that of the male students with a marginal mean score difference of 0.62 in favour of the female students.

Table 3: *Mean Scores of Male and Female Students' Achievement in Genetics using Mathematics Pre-teaching strategy*

Treatment	Gender	N	Mean	SD
Mathematics Pre-teaching	Male	22	41.59	8.57
	Female	28	42.21	8.68

$H0_2$: There is no statistically significant difference in the achievement of male and female students' taught genetics aspect of biology using mathematics pre-teaching strategy.

The result of the *t*-test analysis presented in Table 4 indicates that the *t*-value ($t_{(48)}$=0.25; p>0.05) was not significant because the p-value 0.80 is greater than 0.05 alpha level. This suggested that there was no significant difference between the achievements of male and female students taught genetics using mathematics pre-teaching strategy and it provided the answer to research question two. Hence, hypothesis 2 was not rejected. This means that students, irrespective of their gender achieve, significantly when taught using mathematics pre-teaching strategy.

Table 4: *The t-test Results of Significant Difference between the Achievement of Male and Female Students* in *mathematics pre-teaching of genetics Group*

Treatment	Gender	N	Mean	SD	df	T	Sig.	Remark
Mathematics Pre-teaching	Male	22	41.59	8.57				
					48	-.25	.80	NS
	Female	28	42.21	8.68				

p>0.05

Discussion

Findings from this study revealed that students taught genetics using mathematics pre-teaching strategy achieved better than those that were taught genetics using the conventional strategy. Perhaps, the Mathematics aspects of genetics have been simplified before the main lesson was presented which probably helped the students to understand the content effortlessly and meaningfully. It also implies that the use of mathematics pre-teaching strategy serves as the foundation on which the new information that is the content of genetics was built, Therefore, the use of mathematics pre-teaching strategy was able to simplify the mathematical aspect of genetics which students perceived difficult to comprehend, thereby making the understanding of genetics easy. Their understanding was glaring in the improved performance of the group exposed to it. This, therefore, implies that mathematics pre-teaching strategy had enriched the students' understanding of genetics and consequently improved their achievement. This is in agreement with the results of Busari (2014), and Badmus *et al.* (2015) where the researchers in their separate findings affirmed that students' prior deep understanding of mathematics can influence their performance in other science subjects.

It was also revealed from the findings that there was no significant difference in the achievement of male and female students taught genetics using mathematics pre-teaching strategy. Arguably, both male and female students were taught the same tasks, and the content of genetics does not contain gender bias statements and activities. Thus, both male and female students were exposed to the same experience when taught using mathematics pre-teaching strategy. This finding is in agreement with the finding of Ikitde and Edet (2013). Their study showed that gender has no significant effect on students' achievement when taught Biology using guided-inquiry demonstration and lecture

teaching strategy. This outcome is in support of the finding of Busari (2014) who also reported that gender had no significant difference when students were taught genetics using mathematics pre-teaching as an instructional strategy. Conversely, the finding is not in support of the finding of Jibrin *et al*. (2012) whose result indicated that male students taught genetics using concept mapping as an instructional method performed better than their female counterparts. Also, against the result of Odagboyi (2015) which shows that there was a significant difference between the mean score in favour of male students, and this indicated that male students benefited most from the jigsaw method of instruction when compared with their female students' counterpart.

Conclusions

The study examined the effects of mathematics pre-teaching on senior school students' achievement in genetics and based on the findings from the study, it was concluded that exposing students to basic mathematical concepts that are relevant to proper understanding of genetics brings about better understanding of genetics and hence, improves their achievement in genetics. It was also concluded that mathematics pre-teaching as an instructional strategy is not gender bias and as such is favourable in bringing about conceptual change among students of both genders.

Recommendations

The study recommended that:

1. Biology teachers should collaborate with the mathematics teachers in their schools to pre-teach relevant mathematical concepts to their students that will serve as advance organizers that would assist in enhancing the performance of students in genetics and other hard-to-teach and hard-to-learn biological concepts like ecology.
2. Biology teachers can also employ the use of the instructional strategy in a mixed gender classroom since the strategy is not gender sensitive and would help both male and female members of the class in achieving better understanding of genetics.

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