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EFFECTS OF PRE-TEACHING THE MATHEMATICS COMPONENT OF GENETICS ON SENIOR SCHOOL STUDENTS' GENETICS ACHIEVEMENT IN OYO STATE, NIGERIA

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ABSTRACT

This study examined the effects of pre-teaching the mathematics component of genetics on senior secondary school students' genetics achievement in Oyo State, Nigeria. It also investigated the influence of gender, school type and scoring levels on their achievement in genetics. A quasi-experimental, non-randomized, non-equivalent, pre-test, post-test, control group design was adopted for the study. One hundred and seventy-six biology students from four secondary schools were purposively selected for the study. The researchers sought the permission of the school authorities of the selected schools and collected the pre-test data. With the help of mathematics teachers from the experimental group, mathematics component of genetics was taught to the students. The items in WASSCE past question on Genetic was administered as pre-test to students from all the selected schools. The instrument was validated, and reliability coefficient of 0.74 at 0.05 level of significance was obtained. Four hypotheses were formulated and tested in the study. Descriptive statistics; mean, standard deviation and mean gain score were used to answer research questions while t-test and Analysis of Covariance (ANCOVA) were used to test the four hypotheses. Findings from the study revealed that students that were pre-taught the mathematics component of genetics achieved better than those that were not, and there was no significant difference in the achievement of male and female students that were pre-taught the mathematics component of genetics; also the low scoring students had the highest mean gain, followed by the medium scoring students while the high scoring students had the lowest mean gain score of 6.40, 4.20 and 3.30 respectively; which means that the low scorers gained more while the high scorers had least gain. Also, the type of school attended by students did not significantly influence their achievement. Based on the findings of this study, it was recommended that; students should have solid knowledge of aspects of mathematics involved in genetics before being exposed to genetics. Genetics teachers should present their lessons in such a way that the connections of mathematics components with genetics concepts will be appreciated. Finally, Ministries of education and science professional associations should organize seminars and workshops to keep biology teachers abreast of the application of mathematics to genetics for instructional delivery to assist the students.

INTRODUCTION

Biology is one of the science subjects in senior secondary schools in Nigeria. According to Abu (2000), students offer biology with the aim of possessing pre-requisite Biology foundation for future career in any of the biological sciences like Botany, Zoology, Medicine, Genetics, Pharmacy, Biotechnology, Laboratory technology, Agriculture and Nursing. According to Nwachukwu and Nwosu (2007) knowledge of Biology enable students to understand the structure and function of different parts of the body, the environment in which they live and how best to conduct themselves therein.

Agbowuro (2008) observed that one of the objectives of Biology teaching is to ensure that students learn biological concepts meaningfully. Biology had witnessed a high level of students' enrolment than any other science subjects in the final year external examinations. However, WASSCE Chief Examiner reports (2009, 2013) indicated that students have been performing poorly in Biology in public examinations for years. Analysis WASSCE result in Oyo state in Biology between 2008 -2012 indicated that about 20% of the candidates presented passed at credit level and about 35% had D7-E8 while 45% had F9.

Biology is the most popular science subject among the senior secondary schools. It was observed that students' performance in Biology for the past few years was not encouraging. WASSCE result analysis (2008-2012) indicated the poor performance of students in Biology. The highest percentage of biology result was recorded in 2010 and 2012 with 20.58% and 20.89%, respectively at credit level and 35% D7 and E8 in 2008 which were far below 50% average. The obtained results do not justify the high students' enrolment in the subject.

Many factors have been identified to be responsible for poor performance in science subjects, Biology inclusive (Ahmed, 2009). These factors include lack of motivation for teachers, poor infrastructural facilities, inadequate textual materials, and attitude of students to learning, lack of teaching skills, competence, experience and inadequate teachers' qualification (Ahmed, 2009, Braimoh & Okediji, 2001, Folaranmi 2002, Umeh 2002). WAEC Chief Examiners' reports for Biology theory indicated that candidates had difficulties in answering questions on genetics in the final examination. (WAEC Chief Examiners' Reports 2004, 2005, 2007, 2009, 2010 and 2012). According to Senior Secondary Education Curriculum (SSEC, 2009), Biology consists of four themes and the themes are:

(i) Organization of life (ii) Organisms at work; (iii) Organisms and their environment; (iv) Continuity of life. Genetics is subsumed under continuity of life. Sarojini (2011) defines genetics as the branch of Biology that deals with the study of heredity and variations in living organisms. Genetics helps human being to know their body composition. It helps in crime detention, marriage counselling, blood transfusion, sex determination and diagnosing diseases. From the aforementioned importance of genetics, students must therefore be given proper understanding of genetic principles.

Genetics happened to be one of the areas identified to be difficult by both teachers and students. The WAEC Chief Examiners' Reports 2004, 2005, 2007, 2009, 2010 and 2012 showed that students have difficulty in genetics related questions. Studies conducted by Abimbola (1998), Umeh (2002), Okebukola (2002) and Okechukwu (2003) showed that both teachers and students find genetics, ecology and evolution difficult to teach and learn. Buseri (2010) contended that to meet up with the rapid scientific progress in technology, teaching requires the presence of well-trained, efficient, knowledgeable and skilful teachers that are versatile in discharging their duties and responsibilities. Based on these reasons and others, this study investigated the effects of pre-teaching the Mathematics component of genetics on students' genetics achievement. It is hoped that this study would generate information that curriculum planners, developers, text book writers and Biology teachers could use to improve the teaching and learning of genetics, and Biology as a whole.

According to Badru (2004), Mathematics is the foundation of Science and Technology. Kurumeh, Igyu and Mohammed (2013) regarded Mathematics as a subject and a field of study which is seen as the language of science. According Maynard (1968), the main mathematics concept needed in genetics is probability.

Dayioglu and Turut-Asik (2004) observed that academic performance is affected by a host of factors. The factors include individual and household characteristics like students' ability,

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motivation quality of school attended and the like. Ogunkola and Bilesanmi-Awoderu (2000) noted that the issue of gender is an important one in science education especially with increasing emphasis on ways of boosting manpower for technological development as well as increasing the enrolment of females in science and technological fields.

Alimi, Ehinola and Alabi (2011) observed that the general opinion of people is that private schools are better in terms of the availability of human and physical facilities and consequently, private school students performed better than public school students. This has made many parents to enrol their children in private secondary schools. Research findings on school types are inconclusive. Ajayi (2006) found out that school type made a difference in students' academic performance while Philias and Wanjobi (2011) observed that the type of school has no influence on the academic performance of students. This calls for the investigation of the influence of prior mathematics knowledge, gender and school type on the students academic achievement.

This study was guided by Ausubel's learning theory on advance organizer. Ausubel (1968) believes that learning of new knowledge depend on what is already known. Ausubel believes also that for individual to learn meaningfully, individual must relate knowledge to relevant knowledge they already know. New knowledge must relate with the learners' knowledge structure. According to Ausubel (1968), to help students to adopt a meaningful learning, teachers should construct and provide advance organizers. Advance organizers facilitate learning and retention of meaningfully learned information in three ways. These are by (i) use of advance organizers as a mechanism to help to link new learning materials with the existing related ideals (ii) as process of learning when difficult and complex material are introduced and (iii) to activate existing schemas and as reminder bring into the working memory of what an individual may not realize is relevant.

PURPOSE OF STUDY

The main purpose of the study was to investigate the effects of pre-teaching the mathematics component of genetics on senior secondary students' genetics achievement in Oyo, Nigeria. The study sought to determine the effects of pre-teaching the mathematics component of genetics on the achievement of senior secondary school students:

- (i) by the teachers.
- (ii) based on students' gender.
- (iii) based on school type.
- (iv) based on students' scoring levels.

Research Questions

The following research questions were raised:

- (i) What are the effects of pre-teaching the mathematics component of genetics on the achievement of senior secondary school students?
- (ii) Does the pre-teaching of the mathematics component of genetics have effect on the achievement of senior school students based on gender?
- (iii) What effects does the pre-teaching of the mathematics component of genetics has on the achievement of senior school students based on school type?
- (iv) How do the effects of pre-teaching the mathematics component of genetics on the achievement of senior school students differ based on students scoring levels?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level significance.

- HO1: There is no significant difference in the achievement of students exposed to the pre-teaching of the mathematics component of genetics and those that were not exposed to the pre-teaching of the mathematics component of genetics.
- HO2: There is no significant difference in the achievement of students exposed to the pre-teaching of the Mathematics component of genetics based on gender.
- HO3: There is no significant difference in the achievement of students exposed to the pre-teaching of the Mathematics component of genetics based on type of schools.
- Ho4: There is no significant difference in the achievement of students exposed to the pre-teaching of the mathematics component of genetics based on their scoring levels.

METHODOLOGY

The target population for this study was all Senior Secondary School Biology students in Oyo State. The study adopted a quasi-experimental research design. A 2x2x2x3 pre-test, post-test control group design was adopted for the study. Senior Secondary II Biology students were non-randomly chosen in four secondary schools from four local government areas in Oyo. The schools were co-educational schools. Two of the schools were public schools while the other two were private schools. One public and one private schools form the experimental group, while the remaining two schools form the control group. The experimental group was pre-taught the mathematics component of genetics while the control group was taught the concept of genetics without the pre-teaching of the mathematics component of genetics. A researcher designed Genetics Achievement Test (GAT) containing forty items multiple choice questions which were adapted from past WASSCE questions form the instrument for the study.

The instrument was validated by Biology lecturers in the field of Science Education and Biology Teachers in some secondary schools for face and content validity. The discrimination power and difficulty index for each question was calculated to determine the validity of the instrument. With the permission of the Principals and Biology Teachers of the selected schools, GAT was administered to groups to obtain the pre-test scores of the students. The experimental group was then taught the mathematics component of genetics by sample school teachers, later genetics was taught to the students in the experimental and control groups. The control groups were not exposed to the pre-teaching of the mathematics component of genetics. The study was for six weeks. The first week was for orientation and pre-test, followed by four weeks of intensive teaching of mathematics component and the sixth week was for the post test. The scores for the two groups were recorded.

The result obtained from the GAT was analysed using descriptive statistics of frequency counts and the percentage to calculate the mean and standard deviation to answer the research questions while hypotheses were tested using t-test and ANCOVA statistical analysis at 0.05 significant level. The results from the two groups were analysed.

RESULTS

The result of the analysis of the mean and standard deviation on the comparison and the equivalence of both the experimental and the control groups showed that the scores of the students in groups were not significant, which indicates their compatibility. The experimental group had a mean score of 20.4 while the control group had a mean score 18.9.

Research Hypothesis one states that there is no significant difference in the achievement of students exposed to the pre-teaching of the mathematics component of genetics and their

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counterparts that were not pre-taught the mathematics component of genetics. The analysis of the result of the t-test indicated that the experimental group exhibited significant difference in the mean scores between pre test and post tests whereas the result of the control group for pre test and post tests indicated no difference in mean scores. This implies that the treatment given to the experimental group yielded a positive result. Thus, the null hypothesis is rejected.

Table 1: The t-test Comparison of Post-test Mean Scores of the Experimental Group and the Control group

Variable	N	Df	X	SD	t-Cal	t-Cri	Remark
Pre-test	93	174	25.9	5.74	4.9	1.96	Significant
Post-test	83		21.7	5.61			

The results of experimental and control groups revealed that pre-teaching of the mathematics component of genetics has positive effect on students' achievement. The mean gain score of the experimental group is 5.5, which is greater than that of the control group of 1.0.

Research Hypothesis two states that: There is no significant difference in the achievement of students exposed to the pre-teaching of the mathematics component of genetics based on gender.

As shown in Table 2, the t-Cal value is less than the t-critical value (t-Cal=0.34, t-critical=1.08, df=91, $\alpha=0.05$). This means that there is no significant difference between the mean score of male and female students in the experimental group. Thus, the null hypothesis was not rejected

Table 2: The t-Test Comparison of Post-test Mean Score of Male and Female Students in the Experimental Group.

Variable	N	Df	X	SD	t-Cal	t-Cri	Remark
Pre-test	52	91	27.3	6.33	0.34	1.08	Not significant
Post-test	41		27.7	5.08			

The analysis of achievement of male and female students using mean, standard deviation and mean gain score of students indicated that sex has no effect on students' academic achievement when pre-taught the mathematics component of genetics. The analysis of the result revealed that male students have mean gain score of 2.2 which is very close to that of female students of 1.7 in the experimental group.

Research Hypothesis three states that: There is no significant difference in the achievement of students exposed to the pre-teaching of the mathematics component of genetics based on types of school.

The result in Table 3 showed that the t-Cal is less than t-critical (t-Cal=0.759, t-critical=1.98, df=91, at $\alpha 0.05$). This implies that there is no significant difference between the achievements of students in the experimental group based on the type of school. Therefore, the null hypothesis is not rejected.

Table 3: The *t*-Test Comparison of Post-test scores of Public and Private School Students in the Experimental Group.

Variable	N	Df	X	SD	t-Cal	t-Cri	Remark
Pre-test	57	91	27.8	4.36	0.759	1.98	Not significant
Post-test	36		28.6	5.29			

The analysis of results of students from public and private schools revealed that school type has no effect on students' achievement when subjected to the same treatment. From the result, students from public schools have mean gain score of 3.30 which is very close to that of students from private schools of 3.60.

Research Hypothesis four states that: There is no significant difference in the achievement of high, medium and low scoring ability students exposed to the pre-teaching of the Mathematics component of genetics.

The result in Table 4 shows the Analysis of Covariance on scoring levels for the Experimental group. The result revealed that there was a significant difference between the pre-test and the post-test mean scores of students pre-taught the mathematics component of genetics based on scoring levels. Since the F ratio value of 26.305 is greater than the significance value of 0.004, therefore, the null hypothesis is rejected.

Table 4: Analysis of Covariance for the Experimental Group Based on Scoring Levels.

Source of Variation	Sum of square	df	mean square	Fcal	sig
Pre-test	96.40	1	96.40	6.195	0.001
Scoring level	911.892	2	455.946	26.305	0.004
2-way interaction	116.88	1	116.88	7.512	0.348
Corrected model	1784.424	3	582.808	47.456	0.246
Residual	1384.841	89	15.560		
Total	3169.263	92			

The analysis of results of high, medium and low scorers using their mean, standard deviation and mean gain scores indicated that there were differences based on scoring levels. The analysis revealed that the high scoring students had the lowest mean gain score followed by the medium scoring students and lastly low scoring students having the highest mean gain score 3.30, 4.20 and 6.40, respectively. The Analysis of Covariance on scoring levels for the experimental group indicated that there was a significant difference between the pre-test and post-test mean scores of students in the experimental group. Thus, the null hypothesis is rejected.

SUMMARY OF MAJOR FINDINGS

1. There was a significant difference in the achievement of students that were pre-taught the mathematics component of genetics and those that were not pre-taught the mathematics components. Those that were pre-taught mathematics component of genetics performed better than those that were not pre-taught the mathematics component of genetics. The

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- experimental and control groups exhibited difference in the mean gain scores of 5.5 and 1.0, respectively
2. There was no significant difference in the achievement of male and female students that were pre-taught the mathematics component of genetics. Male students had the mean gain score 2.2 which is very close to that of female students 1.7.
 3. There was no significant difference in the achievement of students from private and those from public schools that were pre-taught the mathematics component of genetics. Students from private school had mean gain score 3.60 that is very close to the mean gain score of students from public school of 3.30.
 4. There was a significant difference in the genetics achievement of the experimental groups and the control groups based on their scoring levels. The achievement of high, medium and low scoring ability students before and after the treatment, each of the groups benefitted from the treatment. The high, medium and low scoring students had mean gain scores 3.30, 4.20 and 6.40, respectively.

DISCUSSION

The main focus of this study was to examine the effects of pre-teaching the mathematics component of genetics on senior school students' genetics achievement. The findings indicated that the students that were pre-taught the mathematics component of genetics performed better than their counterpart that were not pre-taught the mathematics component of genetics. This finding corroborated the findings of Okereke (2006) and Shihusa and Keraro(2009) on the same issue

The findings revealed that there was no significant difference in the achievement of male and female students that were pre-taught the mathematics component of genetics. This agreed with the findings of Nwachukwu and Nwosu (2007). The findings also revealed that, there was no significant difference in the achievement of students that were pre-taught the mathematics component of genetics based on school type. This is in line with Alimi, Ehinola and Alabi (2011). However, there was a significant difference in the achievement of high, medium and low scoring ability students on genetics when pre-taught the mathematics component of genetics. This finding agreed with the findings of Yusuf (2006) and Amosa (2012). Pre-teaching of mathematics component of genetics was most useful for the low scoring students than the medium scoring students and high scoring students in that order.

CONCLUSION

From the result of this study, the achievement of the experimental group in the post-test was identified to be probably dependent on the students having some degree of mathematics knowledge. Gender of the students did not affect the teaching and learning of genetics. Male and female students that were not pre-taught the mathematics component of genetics performed about the same. Also, the type of schools attended by students did not affect their academic achievement. Students in public school performed equally with those in private school since they were all subjected to the same treatment. However, the scoring levels of students have effect on their academic achievement on genetics when pre-taught the mathematics component of genetics.

RECOMMENDATIONS

The following recommendations are made based on the findings:

1. Students should have knowledge of mathematic component of the genetics before being introduced to genetics topic.
2. Teachers should present their lessons to connection mathematics component with genetics concepts.
3. Ministries of education should organize seminars and workshops to keep biology teachers abreast of the application of mathematics for instructional delivery.
4. Since gender did not affect students' achievement in genetics, biology teachers should put equal effort on both male and female students.
4. students of both private and public schools should be given equal attention in the learning of genetic.
4. Once low scoring ability students are identified, their individual levels of understanding should be encouraged by arousing their interest in mathematics and mathematics-related subjects.

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