

Influence of Selected Variables on Students' Academic Performance in Genetics and Their Implications for Effective Application of Stem Education

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Abstract

A comparative *ex-post facto* study was conducted to investigate factors that could influence the performance of students in Genetics. The sample for this study was drawn from 200 Level students in the Departments of Biochemistry, Biological Sciences and Microbiology, Federal University Wukari, Taraba State, Nigeria. Simple random sampling was used to select 100 students from the 150 in the class. A 12-item structured questionnaire was used to obtain data on students' attitude towards Genetics, mode of admission, gender and school type while the instrument titled 'Genetics Concepts Achievement Test' (GCAT), which comprised 40 multiple option questions, was used to measure the students' performance in genetics. The first null hypothesis was tested using percentages while the remaining hypotheses were tested with Independent Sample T-test. The data collected was subjected to descriptive statistics using the SPSS version 17.0 software and the results were coded and tabulated. Findings from results indicate that students had a generally positive attitude towards Genetics. The t-test analysis revealed a significant difference ($P=0.05$) for type of school attended and a non-significant difference for students' gender and mode of entry into the university. This study is of great significance to teachers and policy makers since the current trend is towards the improvement of students' academic performances in STEM courses so as to fast-track national development. To bridge the gap between the day and boarding schools, these researchers recommend the provision of adequate teaching resources for all schools as these play vital roles in the enhancement of students' academic performance.

Keywords: academic performance, genetics, STEM education, gender, mode of entry, type of school

INTRODUCTION

The role of science in improving lives and advancing national developments has led to increasing efforts towards enthroning STEM education in societies. Currently, contemporary schools are probing resources to improve teaching, provide enjoyable and practical-based learning with lasting impressions on the students as well as preparing them for the rigours of higher learning. Science Technology Engineering and Mathematics (STEM) courses, experts say, have proven to be crucial to the technological advancement of nations and biology is a key component of STEM education. Biology - a multidisciplinary science that studies the nature of organisms, their interaction with other organisms and their environment – has as its core the field of genetics. Klug *et al.*, (2006) defined genetics as the biology of hereditary and variation. Hereditary or inheritance focuses on the transmission of characteristics from one generation to another, hence similarities while variation dwells on the causes of differences among individuals. Genetics, therefore attempts to explain the mechanism of two constants that are found in the universe – similarities and differences. According to Klug *et al.*, (2006), the knowledge of Genetics is essential to the understanding of such disparate disciplines like molecular biology, cell biology, evolution,

physiology, ecology, systematics and even behavior. Current applications of genetics concepts in STEM encompass engineering, biotechnology, transgenic organisms, gene therapy, crop and animal breeding, and medicine and has added value to the wellbeing of humans. For these reasons, the study of genetics has been viewed as *sine qua non* for STEM education thereby necessitating its inclusion in the curricula of secondary schools, colleges of Education, polytechnics and Universities (Akunnubi *et al.*, 2012). Indeed, Genetics has been widely recognized as the conceptual foundation for the understanding of Biology itself (Deadman and Kelly, 1978).

Wabuke (2013) reiterated that attitudes and perceptions- which could be positive or negative- are acquired bias towards certain facets of our environment. Research findings have shown that both lecturers/teachers and students have a negative perception of some concepts as being difficult to teach and learn. Abimbola (1998) investigated the content areas of Biology which teachers find important but difficult to teach and the reasons for their negative perceptions and revealed that some teachers find the concepts of Genetics too complex to understand. Earlier, Soyibo (1988a) researching into instructional difficulties in O'Level Genetics,

reported that the teaching of Genetics (and Ecology) have been neglected in most secondary schools in Nigeria. In his conclusion, he decried the nonchalant attitudes of all the parties (especially the teachers) towards the teaching of Genetics concepts which has translated into students' poor performance not only in Genetics aspects but the whole biology paper. Samikwo (2013) in his study showed that students with positive attitudes towards a subject performed better in examinations in that subject. He stressed the need for the use of teaching/learning resources by teachers to motivate the students. Owiti (2000) further confirmed the positive correlation between students' attitude and their academic performance when he stated that attitudes of students impact on their achievement and that achievement also affects their attitude.

Skryabina (2000) attributed the poor performances of students in answering questions relating to genetics to the abstractness, complexity, sophistication of the concepts, short or no allocation of hours for genetics practical. Soyibo (1988b) listed the causes of students' performance in genetics to include lack of teacher's motivation, lack of practicals in Genetics, variation of genetic concepts in various textbooks among many others. In another study, Ndirangu (2000) attributed the poor performance to lack of creativity, interest, confidence and self-drive towards the sciences. He decried the lack of practical approach to the teaching of science subjects and concepts, stating this as the cause of the poor mastery of essential skills and concepts in sciences. Kirima (2000) cited in Samikwo (2013) blamed teachers for students' poor performance in science, adding that teachers lack qualification, innovation and mastery of basic scientific concepts.

Currently a lot of attention is being focused on academic performance of students. Joe *et al.*, (2014) stated that academic performance is useful in ascertaining the capabilities of the students from which inferences can be made on their inherent abilities. They added that factors that impact on learning can also impact on the academic performance of students. Akinnubi *et al.*, (2012) reported that the gender of the students does influence their performance in genetics with the female having a better inclination and performance in the subject while Yusuf and Adigun (2010) argued to the contrary. Evrora (2009) investigating the relationship between mode of entry and performance among degree students found out that there is no relationship between mode of entry into the university and students academic performance. Singh (2010) stated that academic performance, as measured by testing, is one of the important aspects of a well composed learning objective. Joe *et al.*, (2014) maintained that academic performance is used in establishing the ability of students in retaining,

remembering and communicating acquired knowledge. They further reported that the Unified Tertiary Matriculation Examination (UTME) and the Direct Entry (DE) are two of the modes through which students gain admission into Universities in Nigeria. Apantaku (2003) reported that students admitted through the pre-degree or preliminary programs performed better than those admitted through the UTME. Ajayi (1999) argued that the type of school attended by students had an influence on their academic performance whereas Yusuf and Adigun (2010) maintained that school type had no significant influence on the students' academic performance.

STATEMENT OF THE PROBLEM

In recent times, as in the past, the difficulties of certain concepts and students' performance have continued to be some of the subsisting issues in the teaching and learning process. A review of the West African Examination Council (WAEC) Chief Examiners Report in Biology for the May/June and November/December Examinations in the last decade yields an insight into the direness of the situation. Remarks such as "students' poor understanding of certain genetics terms", "non-familiarities with concepts of genetics", "poor performance on questions related to Genetics" are among many others used by the WAEC Chief Examiner's in-charge of Biology to describe the weakness of students in Biology examinations (WAEC 2009 - 2013). The perennially poor and fluctuating performance of students in Biology is a recurrent theme in the same document. Failures in Biology, nay Genetics, means a general shortage of manpower in related fields like Medicine, Agriculture, Industry (Samikwo, 2013) and education. This picture is even more depressing when viewed against the backdrop that Biology is the third most registered for subject (after English Language and Mathematics) in the May/June WAEC examinations (WAEC, 2009 - 2013).

JUSTIFICATION

The importance of genetics, especially in an increasingly populous and complex world like ours, has been reported by many authors. Such reports indicate that the application of genetics span such diverse areas like crop and animal improvement, drug development, gene therapy, crime detection and medicine among many others (Klug *et al.*, 20006). In spite of these reported benefits of genetics, there has been increasing public outcry by students, parents, teachers and policy planners about the down turn in the performance of students in STEM related subjects (Yusuf and Adigun, 2010). This trend, if not immediately reversed, portends doom not only to our nation but also the world at large. It is against this backdrop that the present researchers conceived and conducted this study to investigate if the attitude,

gender, mode of entry and type of school attended by the student are implicated in students' performance.

PURPOSE OF THE STUDY

This study aimed at looking into whether certain reported factors influence the academic performance of students in Genetics aspects of Biology. This was done through the investigation of the performance of 200 Level students in a Genetics Concepts Achievement Test (GCAT) so as to further elucidate if there are significant differences in the performance of students based on their gender, mode of entry and type of secondary schools attended.

LIMITATIONS OF THE STUDY

The scope of the present study was limited to a few variables that could impact on students' academic performance in genetics. For this reason, other variables that could also impact on the academic performance of the students were ignored. Furthermore, this research was confined to the small sample of 200 Level Biochemistry, Biological Sciences and Microbiology students in the university. The interpretations of the result from this study were therefore based on the variables investigated and the researchers had neither bias nor power over the views and the performance of the students. In spite of these constraints, this study still provided a context for investigating and analyzing the influence of the selected variables on the academic performance of the students in genetics.

RESEARCH QUESTIONS

- I. Do students have a positive attitude towards genetics
- II. Does the gender of the students have a significant influence on their performance in genetics
- III. Does the students' mode of entry into the university have a significant influence on their performance in genetics
- IV. Does the type of school attended by students have a significant influence on their performance in genetics

RESEARCH HYPOTHESIS

The following hypotheses have been formulated to guide this study.

1. Students do not have a positive attitude to genetics
2. There is no significant difference between the mean achievement scores of female students and male students in genetics.
3. There is no significant difference between the mean achievement scores of students in Genetics who were admitted into the University through UTME and those admitted through Direct Entry.
4. There is no significant difference between the mean achievement scores of students

who attended day schools and those who attended boarding schools.

METHODOLOGY

This study was carried out among the 200 Levels students of Federal University, Wukari, Taraba State. The Federal University Wukari, is one of the nine (9) Federal Universities created by the Jonathan-led administration in 2011. A survey design was adopted for this study where a 12-item structured questionnaire and Genetics Concepts Achievement Test (GCAT) were used as the instruments of data collection. An ex post facto method was adopted for the study of the effects of four (4) independent variables (gender, mode of entry, school type and attitude towards Biology) on the dependent variable (students' performance in the GCAT). The GCAT comprised 40 standardised multiple choice test items extracted from past WAEC questions in Biology which covered diverse aspects of genetics. Each question was allotted one (1) mark making a total of 40 marks for all the questions. Burd (2012) outlined the advantages of the multiple choice test format to include objectivity, wide coverage, independence on proficiency in language, higher reliability than essay questions and easy scoring. The study population comprised of one hundred and fifty (150) 200 level students of Departments of Biochemistry, Biological Sciences and Microbiology. A sample of 100 students representing 66.7% of the students was sampled using simple random sampling. Due consideration was not given to equal representation of both sexes. The content and construct validity of the instrument was ensured through the use of reliable tools by experts in the measurement and by adapting the questionnaire items from Samikwo (2013) and the GCAT from WAEC questions. Data was collected and the first null hypothesis was tested using percentages while the remaining hypotheses were tested with Independent Sample T-test. Kpolovie (2011) affirmed that the Independent Sample T-test is the most suitable statistical tool for analysing and comparing the means of two separate groups. The data collected was analyzed using descriptive statistics with the SPSS version 12 software and the results were coded and tabulated.

CHARACTERISTICS OF THE STUDY SAMPLE

In this study, 66% of the respondents were males while 34% were females, 73% of the students gained entrance into the university through UTME while 27% got admission into the university through direct entry. Furthermore, 58% of the respondents had attended day secondary schools while 42% attended boarding secondary schools.

RESULTS

The results are presented sequentially based on the research questions and hypotheses. The instrument

captured data on the distribution of students by gender, mode of entry into the university and the type of secondary school they attended before gaining entrance into the university.

Research Questions 1: *What is the attitude of students towards genetics?*

The students were asked to respond to statements that would indicate their attitude toward Genetics as shown in table 1 below.

Table 1: Percentage Response of Students on their attitude towards genetics

S/NO	STATEMENTS	AGREED (%)	DISAGREED (%)	UNDECIDED (%)
1	I like genetics very much	88	12	0
2	I like genetics because of the guidance of my secondary school Biology teacher	46	54	0
3	I am frightened when I think of Genetics	12	84	4
4	I understand the concepts of Genetics quite easily	58	36	6
5	I was not taught Genetics at all in my secondary school	20	79	1
6	Learning Genetics is an enjoyable experience	93	7	0
7	Genetics is tedious and not fun to study	10	85	5
8	The study of Genetics is sure to prepare me for my future career	90	10	0
9	I will take a Genetics related degree at a higher level of education	54	45	1
10	My secondary school teacher always backed his lessons in Genetics with practicals	76	23	1
11	Genetics is a very important aspect of the Biology curriculum	97	3	0
12	The Biology Teacher covered the syllabus in Genetics before final exams.	67	33	0

Data obtained from the questionnaire, indicate that the student sampled had a generally positive perception of genetics. Nearly all the student (97%) agreed that Genetics is an important aspect of Biology while 90% also agreed that the study of genetics is sure to prepare them for their career. Furthermore, 93% of the respondents agreed that genetics is an enjoyable experience while only 10% agreed that genetics is tedious and not fun. Even though 85% of the students agreed that they liked genetics, only 46% of the students agreed that their secondary school Biology teacher contributed to their liking of Genetics. Although 58% of the respondents

agreed that the concepts of genetics are easy to understand, 36% of the respondents disagreed with this proposition while 6% were undecided. Only 12% of the student agreed that they were frightened when thinking of genetics while a large number (84%) disagreed with this stance. Although 20% of the students agreed that they were not taught genetics at all in their secondary school, 76% and 67% agreed that their teachers conducted practicals and covered the syllabus respectively

Hypothesis 2: *There is no significant difference between the mean achievement scores of female students and male students in genetics.*

Table 2: A t-test analysis of the influence of gender on students' academic performance in Genetics.

GENDER		N	Mean	Std. Deviation	df	Sig.	T	Sig. (2-tailed)	Decision (H ₀)
SCORES	Male	66	22.2879	5.16427	98	.149	.890*	.376	Accepted
	Female	34	21.2647	5.96611					

* = Significant at 0.05

Table 2 shows that the mean scores (22.28) of the male students in the GCAT scores was higher than that of the female students (21.21). Data from Table 2

above also shows that since the Sig. Value .376 is greater than 0.05, then there is no significant difference (P<0.05) between the male and female students in the GCAT. This shows that the performance of both the male and female students in genetics is the same. This is in contrast to the works

of Akinnubi *et al.*, 2012 who reported that gender has influence on the performance of students in genetics. They remarked that female students usually have a better and quicker understanding of the concepts of Genetics than the male ones.

Hypothesis 3: *There is no significant difference between the mean achievement scores of students in Genetics who were admitted into the University through UTME and those admitted through Direct Entry.*

Table 3: A t-test analysis of the influence of mode of entry on students' academic performance in Genetics.

	MODE OF ENTRY	N	Mean	Std. Deviation	Df	Sig.	T	Sig. (2-tailed)	Decision (H ₀)
SCORES	UTME	73	22.5753	5.35132	98	.934	1.947*	.054	Accepted
	DE	27	20.2222	5.40892			1.937	.059	

* = Significant at 0.05

Table 3 indicates that the mean scores in the GCAT among the UTME and DE students were 22.5753 % and 20.2222 % respectively. The t-test analysis of the influence of mode of entry on the students' performances in Genetics revealed that there was no significant difference in the performance between the students who were admitted through UTME and those admitted through DE although the UTME

students had a collectively higher average score than the DE students. Since the Sig. Value .054 is greater than 0.05, there is no significant difference (P<0.05) between the UTME and DE students in the GCAT and the null hypothesis is rejected.

Hypothesis 4: *There is no significant difference between the mean achievement scores of students who attended day schools and those who attended boarding schools.*

Table 4: A t-test analysis of the influence of school type attended on students' academic performance in Genetics.

	SCHOOL TYPE	N	Mean	Std. Deviation	df	Sig.	t	Sig. (2-tailed)	Decision (H ₀)
SCORES	Day	58	21.0000	5.65685	98	.367	-2.063*	.042	Rejected
	Boarding	42	23.2381	4.90301			-2.111	.037	

* = Significant at 0.05

Table 4 shows the mean scores of GCAT of the students from the two school types. Students from boarding schools had a mean score of 23.2381 which was higher than the mean score of 21.0000 obtained by the day students in the GCAT. This table also shows that since the Sig. Value is .042 is less than 0.05, there is a significant difference (P<0.05) between the Day and Boarding students in the GCAT.

DISCUSSION

Findings from this study indicate that students have a generally positive attitude to genetics. This is in consonance with the findings of Samikwo (2013) but contradict the findings of Soyibo (1988), Abimbola (1998) and Skryabina (2000) who reported students' negative attitude towards genetics. The reason for the contradictory findings with reference to students' attitude may have been due to the fact that students who have a good attitude towards genetics also do better in Biology and ultimately gain admission into biology-related courses in the university as in the present case and vice versa. Although the response of the students on most of the items indicate that genetics topics are easier to study, understand and that good performance in examinations is attainable if the teaching of Genetics is supported with appropriate resources, the negative perception of

teachers by the students with regards to guidance in genetics could have serious deleterious effects. For one, since a positive attitude is an acquired essential ingredient to a good academic performance, teachers are therefore duty bound to inculcate and reinforce in the students positive attitude towards the subject. Teachers also need to mentor and guide their students so as to stoke their interest in complex subjects areas, like genetics since it is a basic science subject required by many science-based students to prepare them for their future careers. The findings from this study also indicate that, although many teachers are making efforts to back up their lesson with practicals and also cover the syllabus before examinations, a few of these teachers still need to do more.

The findings on the influence of gender on students' academic performance indicate that students' gender has no significant influence on their performance in genetics. The present finding supports that of Yusuf and Adigun (2010) who discounted the effect of gender on students' academic performance while it contradicts that of Akinnubi *et al.*, (2012) who reported that the females have a better inclination to and performance in the genetics. This might be attributed to the fact that admission into the university involves criteria which hold no bias on the gender of the students to be admitted. The finding from this study implies that whether a student is male

or female does not make a difference in his or her performance in the subject. This supports the call for more female students to take up courses such as genetic engineering that are traditionally known as 'male courses'. It also reinforces the call for equal chances in STEM areas for both male and female students.

The findings on the influence of mode of entry on academic performance reveal that this variable had no significant influence on students' performance in genetics even though the UTME students had a higher mean. This implies that whether a student entered the university through UTME or DE does not make a significant difference in his or her performance in genetics. This finding contradicts those of Apantaku (2003) and Joe *et al.*, (2014) who had earlier reported that students admitted through other modes performed better than those admitted through UTME, hence the mode of entry into the university had a significant influence on students' academic performance. This contradiction could have been due to the fact that both UTME and DE students were expected to have passed their O level Biology before admission. More students should be encouraged to enter Nigerian colleges and polytechnics as these institutions also provide mid to high level professionals for STEM areas. However, the lower mean performance by DE students as compared to UTME reinforces the call for government to recruit more genetics specialist teachers for the colleges of education and polytechnics.

The findings on the influence of school type on academic performance reveal that this variable had significant influence on students' performance in genetics. The implication of this finding is that whether a student attended a day or boarding secondary school had a significant difference in his or her performance in genetics. This finding is in agreement with the findings of Ajayi (1999) but contradicts the finding of Apantaku (2003). This significant difference could have been due to the facts that students in boarding schools have a regimented life where enough time is given for daily preparatory classes. Furthermore, most of these boarding schools are equipped with good labs and other facilities. This leads us to call for government and other well-meaning individuals and groups to establish schools that are well equipped so that students can have a fulfilled experience studying science and so that more students can be prepared for careers in STEM disciplines.

THE WAY FORWARD

This study has shown that students have a positive attitude towards genetics. It also revealed that while the students' gender and mode of entry into the university do not significantly influence the

performance of these students in genetics, the type of secondary school they attended does. These findings have far reaching consequences due to the applications of genetic concepts in diverse areas of science and technology. The importance of Genetics cannot therefore be overlooked because of its current applications in diagnosing and treating diseases, development of novel drugs, bringing criminals to justice, improving our food supply among many areas of STEM. For this reason these researchers recommend that:

1. Adequate teaching resources should be provided for all schools so as to bridge the gap between the day and boarding schools as these play vital roles in the enhancement of students' academic performance.
2. Teachers and career counselors in school settings should mentor and guide students so that these students can attain high academic performance in science subjects including genetics.
3. Experts in Genetics should be enlisted to help build more vibrant, dynamic and practicable curriculum that will make teaching more enjoyable to students. Biology is basically a practical subjects, thus every topics in Genetics must be accompanied with relevant and easy to understand practicals.
4. Experts should also train teachers from both the secondary schools and universities on the concepts and practical application of Genetics to our everyday life.

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