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Effect of Gagne's-Nine-Events-of-Instruction on Academic Performance in Genetics among Biology Students in Kumbotso Zonal Education Directorate, Kano State, Nigeria

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Abstract

The study investigated the effect of Gagne's Nine Events of Instruction on academic performance in genetics among students in some selected secondary school students in Kumbotso Zonal Education Directorate, Kano State. The research employed a quasi-experimental control group design with pretest and posttest measures. The population consisted of 9,617 (males and females) students from 33 secondary schools. From the population, ten (10) schools were selected using simple random technique and were given a pretest out of which four schools (two males and two females) were found to be equivalent in their performances based on the pretest result. One intact class from each school was randomly selected using simple random sampling technique which gave rise to four intact classes with a sample size of 196 participants. Genetic Performance Test (GPT) was used to collect data with reliability coefficient of 0.92. Descriptive statistics were used to analyze research questions, while ANCOVA and t-test were used to analyze the null hypotheses. Findings of the study revealed a significant difference in performance between students taught using Gagne's Nine Events of Instruction and those taught using traditional methods in favour of the experimental group. Based on the findings, it was recommended among others that schools should adopt and implement Gagne's instructional model in teaching science subjects as it enhances academic performance among students.

Keywords: Gagne's Nine Events, Performance, Genetics, Instructional Design, Kumbotso Zonal Education Directorate

Introduction

Science Education is crucial for empowering individuals with knowledge and skills to tackle real-world challenges, foster innovation, advance societal progress and this took a central place in the curricula of schools at all levels. According to Smith (2023), the overarching goal of science education is to

empower learners to gain knowledge, skills, and attitudes essential for their future endeavors. Science education unlocks the wonders of the universe and helps to understand and improve our lives.

In this era of technological innovations, speedy progress and advancement, the improvement of science education is becoming the dire need of the nations. Science Education is considered to be a tool for developing scientific attitude among the students and help the learners to think like scientist. According to Marzano (2017), teaching strategy is the most critical factor in determining learning outcomes. Science Education encompasses a broad range of disciplines and teaching approaches. There are many branches of Biology such as Biochemistry, Physiology, Ecology, Genetics and Molecular biology that have made Biology a central focus in most human activities including problems like food scarcity, pollution, population, radiation, disease, health, hygiene, family life, management and conservation of natural resources as well as biotechnology and ethics.

The objectives of teaching Biology as a science subject are based on practical and experiment as are contained in the National Policy on Education (FRN, 2013). Also, included among others are to equip learners with meaningful and relevant knowledge of Biology, adequate laboratory, instructional material and field skills. It is only through utilization of Biology laboratory equipment and other instructional materials that the above objectives and goals can be achieved. A recent observation regarding the significance of Biology as a science subject and the concerning trend in grades achieved by candidates in the West African Examination Council (WAEC), particularly in Biology examinations, as highlighted by Adekunle, Ahmed and Yusuf (2023). According to the recent data from the West African Examination Council (WAEC) and the National Examination Council (NECO), a significant portion of candidates who took the West African Senior Secondary School Examination (WASSCE) between 2018 and 2022 failed to achieve a credit level in Biology. Specifically, the WAEC Zonal Coordinator noted that 57% of the candidates fell below the credit threshold, aligning with the findings from the Registrar and Chief Executive of NECO, who reported a failure rate of 55.83% among candidates registered for science subjects.

The efforts to address poor academic performance in Biology among Nigerian secondary school students have been extensive. Scholars and professional bodies like the Science Teachers Association of Nigeria (STAN) have long

been engaged in developing innovative teaching strategies. Also, Scholars such as Rilwani, Akahomen and Gbakeji (2022) and Adeola (2023), encompassed various elements including class size, laboratory resources, instructional methods, textbook quality, guidance and counselling services, teachers' academic qualifications and attributes, students characteristics, peer influence, parental support, home environment, and school infrastructure, among other factors. This underscores the significance of instructional design in fostering improved academic outcomes, as outlined by Gagne's nine events of instruction.

Genetics as a branch of biology that studies genes, heredity, and variation in living organisms encompasses a wide range of topics, including the structure and function of genes, genetic inheritance, genetic disorders, and the role of genetics in evolution and biotechnology (Kumar, Abdel-Ghany & Chelmanska-Aoyaya, 2019). A fundamental concept in genetics is DNA, or deoxyribonucleic acid, which contains the instructions for building and maintaining an organism. Genes are segments of DNA that encode specific traits, such as eye color or susceptibility to certain diseases.

Gender issue according to Miller and Jones (2024) has become a prominent topic in today's academic discourse. Gender is a specially constructed phenomenon that is brought about as society ascribes different roles, duties, behaviors, and mannerisms to the two sexes, The concept 'gender' could be discussed in terms of masculinity or feminist observed in an individual. UNICEF. (2021) agreed that gender bias is very prevalent in Africa and particularly Nigeria. It argued that in Nigerian, harder tasks are assign to males while females are given the relatively easy and less demanding tasks.

Gagne (1974) defined nine events of instruction as an instructional design that aims to help, develop and deliver a class lesson. These instructional events according to Gagne, (1977) should satisfy or provide the necessary conditions for learning and serve as the basis for designing instruction and selecting appropriate media. The nine events of instruction according to University of Florida (2018) are: 1) gaining attention, 2) informing the learner of the objective, 3) stimulating recall of prior knowledge, 4) presenting the stimulus, 5) providing learning guidance, 6) eliciting the performance, 7) providing feedback about performance correctness, 8) assessing performance, and 9) enhancing retention and transfer. By the end of this overall process, Johnson & Smith, (2024) claimed that students would be able to draw upon what they had

learned in a way that permits them to apply their knowledge to new situations. Al-Shammari (2020) reviewed a number of studies that attempted to validate nine events of instruction developed according to Gagne's principles and found that these events of instruction have a significant relationship with learners' performance and confidence. Lee, Kim & Park (2023) noted that students taught using Gagne's nine events of instruction tend to achieve significantly higher academic achievement compared to those that do not use these events of instruction. In the same vain Wang, Lui & Zhang, (2023) reported that Gagne's nine events of instruction have been instrumental in enhancing the academic achievement of senior secondary school chemistry students while simultaneously reducing their anxiety levels. Therefore, the implementation of Gagne's instructional events can bolster students' academic confidence, leading to more effective learning outcomes.

Statement of the Problem

Academic performance in science subjects, particularly Biology, among senior secondary students is a growing concern for educators and stakeholders. Recent assessments reveal that students are struggling with genetic concepts in Biology, demonstrating low academic confidence and consistently performing below credit level in examinations such as WAEC (2020) and NECO (2022).

Several factors contribute to this issue, including inadequate instructional design and delivery methods as identified by Gagne (1985), insufficient understanding of cognitive and affective learning domains (Bloom, 1984), ineffective teaching strategies, and a lack of student engagement and motivation (Garcia et al., 2024). The alarming trend of poor academic performance in genetics is evident, with reports indicating significant difficulties among students in applying conceptual knowledge to practical problems in the subject. This is further supported by the WAEC Examiner's Report highlighting the general poor performance in Biology, particularly regarding Genetics and Molecular Biology (WAEC, 2020):

Objectives of the Study

The objectives of this study are to:

1. determine the difference in the mean performance scores of students taught genetic concept using Gagne's nine events of instruction and the those taught using conventional method.

2. find out the effect of Gagne's nine events of instruction on performance between male and female students in genetics.

Research Questions

This study will seek answers to the following research questions:

1. What is the difference in the mean performance scores of students taught Genetic concept using Gagne's nine events of instruction and those taught using conventional method?

2. What is the difference in the mean academic performance scores of male and female students taught Genetic concept using Gagne's nine events of instruction?

Hypotheses

The following null hypotheses are formulated and tested at 0.05 level of significance

i. There is no significant difference in the mean performance scores of students taught Genetics using Gagne's nine events of instruction and those taught using conventional method.

ii. There is no significant difference in the mean performance scores of male and female students taught Genetics using Gagne's nine events of instruction.

Methodology

The study adopted quasi – experimental non-randomised control group design involving the use of pretest and posttest as the participants in the experimental and control groups were not randomly assigned. The study used four schools (two experimental and two control) because all the schools in the study area are single sex schools and there is objective on gender. The population for the study consisted of nine thousand six hundred and seventeen (9,617) senior secondary students from Thirty-three (33) public schools of Kumbotso Zonal Education Directorate, Kano State (KSSSSMB, 2023). From this number, 5,815 (60.5%) were female and 3802 (39.5%) were male. The students were typically between 15-18 years old and in their second year of senior secondary school. A total of 196 students were selected to participate in the study,

comprising the sample size for the research. Simple random sampling using balloting was employed to select ten (10) schools (5 male schools and 5 female schools) from a total of 33 in the population. This method ensured that each school had an equal chance of being selected, making the sampling process fair and unbiased. The selected ten (10) schools were pretested and the pretest scores were subjected to statistical analysis using ANOVA and later to Scheffes' test. Based on the results, four (4) schools (two male and two female schools), with similar pretest scores were selected so as to ensure homogeneity among the groups. From the four (4) schools, one intact class of SSII was selected per school using simple random sampling technique, resulting in a total of four (4) intact classes for the study, with 196 students in total (104 males and 94 females). The schools selected were then randomly assigned into two experimental and two control groups,

The Genetics Performance Test **(**GPT) was adapted from the past questions papers of WAEC, NECO and Biology Text Books, consisting of thirty (30) items with multiple choice of letters A-D. GPT used for the pretest and Post-test in order to measure the level of performance of SSII Biology students. Mean and standard deviation was used to answer the research questions while

independent sample t-test were used to test null hypotheses at 0.05 level of significance.

Results

Research Question 1: What is the difference in the mean performance scores of students taught Genetic concept using Gagne's nine events of instruction and those taught using conventional method?

Table 1: Means and Standard Deviations of the Experimental and Control Groups

Group	N	Mean	Df	Std. Deviation	M.D
Experimental	93	60.25		4.28	17.12
Control	103	43.13		4.21	
Total	196		194		

The post test scores of the experimental and control groups were analysed and presented in Table1. The result in Table 1 shows the mean performance scores of the Experimental Group (EG) that were taught using Gagne's nine event of instruction and that of the Control Group (CG) taught using conventional method. The Experimental Group has a mean of 60.25 with a standard deviation of 4.28 while the Control Group (CG) has a mean of 43.13 with a

standard deviation of 4.21. The raw (mean) difference between the experimental and the control group is 17.12.

Research Question2. What is the difference in the mean performance scores of male and female students taught Genetic concept using Gagne's nine events of instruction?

Table 2: Posttest Mean Performance Scores of Male and Female Students in the Experimental Groups

Experimental	N	Mean	Df	Std. Deviation	M.D
Male	48	60.00		3.99	0.51
Female	45	60.51		4.60	
Total	93		91		

The result in Table 2 shows the posttest mean performance scores of male and female students in the experimental group. Male students in the experimental group has posttest mean score of 60.00 with a standard deviation of 3.99, while female students in the same group has posttest mean score of 60.51, with a standard deviation of 4.60. The mean difference between the experimental and the control group is 0.51.

Hypotheses Testing

H_{01}: There is no significant difference in the mean performance scores of students taught Genetics using Gagne's nine events of instruction and those taught using conventional method.

Table 3: Analysis of Covariance (ANCOVA) of the Mean Performance Scores for the Experimental and Control Groups

Dependent Variable: POSTTEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Remarks
Corrected Model	14404.382[a]	2	7202.191	402.900	.000	.807	Ho_1 is Rejected
Intercept	40936.277	1	40936.277	2290.031	.000	.922	
TREATMENT	13712.875	1	13712.875	767.117	.000	.799	
PRETEST	16.741	1	16.741	.937	.334	.005	
Error	3450.041	193	17.876				
Total	531841.000	196					
Corrected Total	17854.423	195					

a. R Squared = .807 (Adjusted R Squared = .805)
Significant at $\alpha \leq 0.05$ level

The result in Table 3 shows the Analysis of Covariance of the mean performance scores for the Experimental Group and the Control Group. It tests the effect of the treatment (Gagne's Nine Events and Conventional

method) on the students Post test scores while controlling for their Pretest scores. The results show that the treatment effect is highly significant at a p-value of 0.000 which is less than the alpha level of 0.05, indicating a significant difference in the posttest between the groups, but controlled by the ANCOVA, allowing for a clearer interpretation of the treatment effects on the posttest scores. This suggests that the experimental group taught genetics concepts using Gagne's nine events of instruction achieved significantly higher than the control group taught the same concept using conventional method. Thus, the null hypothesis is rejected.

H_{02}: There is no significant difference in the mean performance scores of male and female students taught Genetics using Gagne's nine events of instruction.

Table 4: t-test Analysis of Mean Performance Scores of the Male and Female Students in the Experimental Groups

Group	Gender	N	Mean	Std.Dev.	df	t-value	p-value	Remarks
Experimental	Male	48	59.75	4.35	91	-1.08	0.285	Ho2 is not Rejected
	Female	45	60.73	4.46		-1.07		
Total		93						

Significant at $\alpha \leq 0.05$ level

The result in Table 4 shows an independent sample t-test analysis of the Mean performance Scores of Male and Female students in the experimental group. From the table, the p-value of 0.285 which is greater than 0.05 alpha level of significance suggests that there is no significant difference in mean performance scores between male and female students in the Experimental Group. This result indicates that the mean performance is similar across gender in this group. Therefore, the null hypothesis is retained.

Discussion of the Results

The study has established that there is a significant difference in the mean performance scores of students taught Genetic concept using Gagne's nine events of instruction and those taught using conventional method in favour of the experimental group. This finding is in agreement with the finding of Sabiru (2013) who studied the effects of using Gagne's learning hierarchy on Chemistry students' academic achievement and anxiety level in Balancing Chemical Equations among Secondary Schools students in Katsina Metropolis

and found out that students taught using Gagne's learning hierarchy recorded high academic achievement than those taught using conventional method. The anxiety level of students taught using Gagne's learning hierarchy tended to be low when compared with students taught using conventional method. The finding of this study is in contrast with that of Prima and Sinnadurai (2018) who investigated the relationship between Gagne's nine event of instruction on anxiety and academic performance among engineering students using quasi experiment. Their finding showed that there was no significant correlation of high-level anxiety and low academic performance among engineering students. The effectiveness of the Gagne's nine events of instruction stems from its structured, engaging, and adaptive nature, which lead to better academic performance and reduced anxiety in many educational contexts.

The study has also established that there is no significant difference in the mean performance scores of male and female students taught Genetic concept using Gagne's nine events of instruction. This finding is in agreement with the finding of Manjale (2017) who evaluated Secondary School teachers' application of the Gagne's nine events of instruction in classroom sessions in Musoma- Tanzania. The finding of the study established that the higher the age group and the academic performance level, the higher the perception of students on teachers' application of nine events of instruction. Also, In addition, Auwalu, Mohd, and Muhammad (2019) investigated the academic achievement in Biology with Suggested Solutions in Selected Secondary Schools in Kano State, Nigeria. Their finding revealed that there is no significant different between male and female students. In contrast Al-Momani and Al-Hajri (2017), they studied Gender Difference in Learning Outcomes using Gagne's Nine Events of Instruction. The results of the study indicated that male students had significantly higher performance than their male counterparts. The instructional strategy provides an equitable learning environment that supports the academic performance of both genders equally.

Conclusion

Based on the findings, several conclusions can be drawn regarding the effectiveness of Gagne's nine events of instruction in enhancing academic performance and confidence among students learning genetics concepts. Firstly, when properly implemented, Gagne's instructional model significantly improves the performance of students, as evidenced by the first hypothesis, which shows that those in the experimental group achieved notably higher

mean performance scores compared to their peers taught through the traditional Conventional method. Furthermore, this instructional approach benefits both male and female students equally, as indicated by the second hypothesis; both gender in the experimental group exhibited significantly higher performance scores with only slight variations between them, suggesting that Gagne's model is gender-friendly.

Recommendations

Based on the outcome of the study, the following recommendations are made, that:

1. Teachers of Senior Secondary Schools should adopt and implement Gagne's instructional model in teaching science subjects as it enhance academic performance among students.

2. NERDC as a Curriculum planner should examine the effectiveness of Gagne's nine events and consider their suitability for teaching science concepts since it has the potential of bringing about meaningful learning and improving academic performance

3. The Science Teachers Association of Nigeria, STAN, could train teachers in the adoption of Gagne's nine events of instruction in their capacity building workshop for teachers.

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