

EFFECT OF PROJECT-BASED LEARNING ON SENIOR SECONDARY STUDENTS' ACADEMIC ACHIEVEMENT IN PROGRAMMING LANGUAGE IN ENUGU EDUCATION ZONE

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ABSTRACT

This study investigated the effect of project-based learning on senior secondary students' academic achievement in programming in Enugu Education zone of Enugu State. Two research questions guided the study while three hypotheses were tested at .05 alpha level. The study adopted quasi-experimental research design of pre-test post-test non-equivalent. The target population consisted of 2411 SS II students. The sample size was 286 SS 2 students and it was drawn using purposive random sampling technique. It comprised 155 SS 2 students in experimental group (64 male and 91 female SS II students) and 131 SS II students in control group in the 2023/2024 session. A teacher-made test called "Programming Language Achievement Test (PLAT)" was used as the data collection instrument. The validity of the PLAT was established through face and content validation, while its reliability was tested on a group of 20 students in public senior secondary schools in Nsukka Education zone. Kuder-Richardson 20 (K-20) formula was used to estimate the reliability of the instrument and a reliability index of .81 was obtained. The research process involved administering the PLAT as a pre-test to both the experimental and control groups before implementing the project-based learning treatment. The research questions were answered using mean and standard deviation, while analysis of covariance (ANCOVA) was used to test the hypotheses. The findings of the study showed that students taught programming language using project-based learning in the experimental group outperformed those used lecture method in the control group, as evidenced by their higher mean achievement scores in the post-test. Furthermore, male students in the experimental group achieved higher scores than their female counterparts in the post-test. Based on these findings, the study recommended that Enugu State government should adequately train and support teachers in using project-based learning approach effectively for teaching programming language.

Keywords: Effect, Project-Based Learning, Academic Achievement, Programming.

Introduction

Programming refers to the process of designing and building executable computer programs to accomplish a specific task or solve a particular problem. It involves creating a set of instructions that a computer can understand and execute, typically using a programming language. Programming is a fundamental aspect of computer science and plays a crucial role in various fields, including software development, artificial intelligence, data science, and more (Sebesta, 2015). A programming language is a formal system designed to instruct a computer. It consists of a set of rules and symbols that define the syntax and semantics of the language. According to Sebesta (2015), the choice of a programming language depends on

factors like the project requirements, performance, ease of learning, community support, and available libraries and frameworks. Programming languages are essential tools for software development, enabling humans to harness the capabilities of computers to solve problems, innovate, and build a wide range of applications that impact various aspects of our daily lives.

Furthermore, recognizing computer programming as a crucial skill that enriches problem-solving abilities, logical reasoning, and analytical thinking, there is a growing understanding of its potential impact on secondary school academic achievement in programming language. The positive reception of its integration across various educational levels suggests that incorporating programming into secondary education may contribute to improved academic outcomes (Annamalai & Salam, 2017). Meyerovich and Rabkin (2013), highlighted the widespread popularity of programming languages like Java, C, and C#. Teaching programming logic and skills poses challenges for educators, prompting a reconsideration of teaching methods. Research indicates that numerous students face deficiencies in problem-solving and computational thinking abilities (Papadopoulos & Tegos, 2012), recognized as crucial competencies in the 21st century (Marques & Marques, 2012). However, the current mode of learning programming language in Nigerian education has been found to be mostly based on lecture method.

Lecture method is a traditional teaching approach where an instructor delivers information to a large group of students. In this method, the instructor typically speaks or presents information for an extended period, while students listen and take notes. It is a one-way communication process where the primary goal is to transfer knowledge from the instructor to the students (Nilson, 2016). Ukeh et al. (2020), pointed out that the actions of teachers in the classroom play a vital role in shaping students' learning capabilities. Research findings of Ukeh and Nwankwo (2023), Okechukwu and Ukeh (2022), established that lecture method has contributed to poor levels of academic achievement in science related topics like programming language. However, in the dynamic landscape of education, the quest for effective teaching methodologies that enhance students' academic performance and foster a deeper understanding of complex subjects is ever-evolving. The effectiveness of teaching methods employed by instructors can influence how well students grasp programming concepts. Interactive and hands-on approaches tend to be more effective in teaching programming. Among these innovative approaches, Omeje (2023) stated that Project-Based Learning (PBL) stands out as a pedagogical strategy that immerses students in real-world problem-solving scenarios, encouraging active engagement and critical thinking.

Project-based learning (PBL) is a teaching and learning approach that centers on the completion of a significant project. Instead of traditional classroom instruction, where students may passively receive information, PBL encourages active engagement, critical thinking, collaboration, and problem-solving. PBL can be viewed as an approach that helps students acquire essential abilities like communication and critical thinking, while also incorporating technology (Larmer, 2018). Project-based learning cultivates students' curiosity and enhances their understanding of core scientific principles, enabling them to address challenges and evolve into knowledgeable, accountable contributors to society, armed with a solid foundation in scientific knowledge (Krajcik & Czerniak, 2018). Independent studies conducted by Yanan and Lei (2022), Omeje (2023), showed that project-based learning exhibited a positive impact on students' academic achievement in science related subjects.

Academic achievement refers to the level of success that a student attains in their educational endeavors. It typically involves the demonstration of knowledge, skills, and competencies across various subjects or academic areas. Academic achievement according to Ikwuka and Samuel (2017), is referred to as the extent to which a learner, educator, or organisation has met their educational goals, and it is generally assessed by tests or continuous evaluation. Academic achievement is often measured through assessments, examinations, grades, and other indicators that assess a student's understanding of the material taught in a specific educational context. The annual release of Senior Secondary Certificate Examination (SSCE) results by the West African Examination Council (WAEC) brings attention to the prevalent issue of subpar academic achievement among secondary school students across different subjects and topics, including programming language (as indicated by the WAEC Chief Examiner in 2022).

In a study conducted by Omeje (2023), it was discovered that students who were taught using project-based learning achieved higher academic success compared to those taught through the lecture method. Similarly, Wekesa and Ongunya (2016) found that the implementation of project-based learning not only enhanced students' academic achievement but also fostered a positive attitude of students. While these studies primarily explored the effectiveness of project-based learning in the realms of chemistry and biology, it is crucial to acknowledge that programming language, similar to these subjects, is a complex and intricate topic demanding a profound comprehension and effective teaching strategies. Consequently, the outcomes of these investigations may bear significance for programming language, irrespective of the students' gender.

Gender refers to the social, cultural, and psychological attributes and roles associated with being male or female in a given society. Gender is a societal creation that delineates the roles, behaviours, qualities, and emotional traits associated with females and males (Ojo, 2015). The question of how gender influences students' academic performance, especially in the field of computer networking, remains unsettled. While studies by Ukeh, et al. (2020), Ukeh and Nwankwo (2023), and Omeje (2023) propose that male students tend to excel over their female counterparts in science-related subjects, opposing viewpoints suggest that achievement is shaped by factors such as socio-economic background and teaching methodologies, rather than being solely determined by gender. Consequently, there is a need for additional research to delve deeper into the role of gender in students' academic success in the context of programming language. Therefore, this study investigated the effect of project-based learning on senior secondary students' academic achievement in programming language in Enugu Education zone of Enugu State.

Statement of the Problem

In recent years, there has been a growing emphasis on innovative teaching methodologies to enhance students' learning experiences and academic achievements. Within the context of senior secondary education in Enugu Education Zone, the effective teaching of programming language is crucial for preparing students for the demands of the rapidly evolving technological landscape. One such teaching approach that has gained attention is Project-Based Learning (PBL), a student-centered pedagogical strategy that emphasizes hands-on, real-world projects. Despite the potential benefits associated with Project-Based Learning,

there is a paucity of research specifically examining its effect on the academic achievement of senior secondary students in programming language in Enugu Education Zone. The current teaching practices may not be adequately engaging students or providing them with the practical skills and problem-solving abilities necessary for success in programming. Furthermore, many studies have identified gender as a significant factor influencing academic achievement. This analysis takes gender into consideration when exploring its implications.

Purpose of the Study

The purpose of the study was to investigate the effect of project-based learning on senior secondary students' academic achievement in programming language in Enugu Education zone of Enugu State. Specifically, the study investigated:

1. the mean achievement scores and standard deviations of students taught programming language with project-based learning (Experimental group) and those taught using lecture method (Control group) in both pre-test and post-test;
2. the mean achievement scores and standard deviations of male and female students taught programming language with project-based learning (Experimental group).

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores and standard deviations of students taught programming language with project-based learning (Experimental group) and those taught using lecture method (Control group) in both pre-test and post-test?
2. What are the mean achievement scores and standard deviations of male and female students taught programming language with project-based learning (Experimental group)?

Hypotheses

The following hypotheses guided the study and they were tested at 0.05 level of significance:

Ho₁: There is no significant difference between the mean achievement scores and standard deviations of SS II students taught programming language using project-based learning and those taught the same topic using lecture method in both pre-test and post-test.

Ho₂: There is no significant difference between the mean achievement scores and standard deviations of male and female SS II students taught programming language with project-based learning.

Ho₃: There is no significant interaction effect of gender and method (project-based learning) on students' academic achievement in programming language.

Research Method

The study adopted quasi-experimental research design of pre-test post-test non-equivalent. Quasi-experimental research design is defined as one which random assignment of subjects to experiment and control groups is not possible (Nworgu, 2015). The target population consisted of 2411 SS II students. The sample size was 286 SS II students and it was drawn using purposive random sampling technique. It comprised 155 SS II students in experimental group (64 male and 91 female SS II students) and 131 SS II students in control group in the 2023/2024 session. A teacher-made test called "Programming Language Achievement Test (PLAT)" was used as the data collection instrument. The validity of the PLAT was established

through face and content validation, while its reliability was tested on a group of 20 students in public senior secondary schools in Nsukka Education zone. Kuder-Richardson 20 (K-20) formula was used to estimate the reliability of the instrument and a reliability index of .81 was obtained. A two-week training session was organized within the schools by the researchers for the regular computer studies teachers. The research process involved administering the PLAT as a pre-test to both the experimental and control groups before implementing the project-based learning treatment. The research questions were answered using mean and standard deviation, while analysis of covariance (ANCOVA) was used to test the hypotheses.

Data Analysis and Results

Research Question 1: What are the mean achievement scores and standard deviations of students taught programming language with project-based learning (Experimental group) and those taught using lecture method (Control group) in both pre-test and post-test?

Table 1: Mean achievement scores and standard deviations of students taught programming language using project-based learning and those taught using lecture method

Groups	Number	Pre-test		Post-test		Mean Gain
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Experimental	155	31.58	4.98	38.45	5.89	6.87
Control	131	30.09	4.21	35.88	4.93	5.79
Mean Diff.						1.08

Table 1 illustrates that students taught programming language using project-based learning exhibited pre-PLAT and post-PLAT scores of 31.58 and 38.45, respectively, along with standard deviations of 4.98 and 5.89. In contrast, students in control group taught using the lecture method displayed pre-PLAT and post-PLAT scores of 30.09 and 35.88, accompanied by standard deviations of 4.21 and 4.93. The experimental group exhibited a mean gain of 6.87, while the control group had a mean gain of 5.79, resulting in a mean difference of 1.08. This disparity reflects the difference in mean achievement scores between the experimental and control groups. The analysis indicates that learning indeed occurred, as both groups achieved higher mean scores in both the pretests and posttests. However, students taught programming language with project-based learning outperformed those taught using the lecture method in terms of academic achievement.

Research Question 2: What are the mean achievement scores and standard deviations of male and female students taught programming language with project-based learning (Experimental group)?

Table 2: Mean achievement scores and standard deviations of male and female students taught programming language using project-based learning

Groups	Number	Pre-test		Post-test		Mean Gain
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Male	64	34.78	4.93	40.63	5.61	5.85
Female	91	34.44	4.89	39.93	5.74	5.49
Mean Diff.						.36

Table 2 shows that when male students were taught in programming language using project-based learning, their pre-test and post-test on PLAT scores were 34.78 and 40.63, respectively, with standard deviations of 4.93 and 5.61, correspondingly. Conversely, female students, who received the same instruction, had pre-PLAT and post-PLAT scores of 34.44 and 39.93, along with standard deviations of 4.89 and 5.74, respectively. The data in Table 2 shows that male students achieved a higher mean score than their female peers in project-based learning, as indicated by a gain in mean score of 5.85 for males compared to a 5.49 gain for females. This results in a mean difference of .36 in favour of male students. In conclusion, the findings suggest that male students, when taught programming language with project-based learning, outperformed their female counterparts in terms of academic achievement.

Hypotheses

Ho: There is no significant difference between the mean achievement scores and standard deviations of SS II students taught programming language using project-based learning and those taught the same topic using lecture method in both pre-test and post-test.

Table 3: Analysis of Covariance on the mean achievement scores of SS II students taught programming language using project-based learning and those taught using lecture method

Tests of Between-Subjects Effects					
Dependent Variable: ACHIEVEMENT					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	78.99 ^a	1	78.99 ^a	7.09	.000
Intercept	289.09	1	289.09	11.08	.000
GROUP	111.41	1	111.41	8.91	.000
Error	8750.04	284	30.81		
Total	9229.53	286			
Corrected Total	8967.83	284			

Table 3 shows that the calculated F value of 8.91 is significant at .00 which is less than the .05 significant level set for the study. Thus, the null hypothesis is rejected. This implies that a significant difference exists between the mean scores of students taught programming language using project-based learning and those taught using lecture method.

H₀₂: There is no significant difference between the mean achievement scores and standard deviations of male and female SS II students taught programming language with project-based learning.

Table 4: Analysis of Covariance on the mean achievement scores of male and female SS II students taught programming language using project-based learning

Tests of Between-Subjects Effects					
Dependent Variable: ACHIEVEMENT					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14.48	1	14.48	2.98	.001
Intercept	244.43	1	244.43	12.44	.000
GENDER	9.84	1	9.84	11.50	.001
Error	1891.08	153	12.36		
Total	2159.08	155			
Corrected Total	2091.43	154			

shows that the calculated F value is 11.50 which is found to be significant at .00. Since this significant level (.00) is less than the .05 significant level set for the study, the null hypothesis is, accordingly, rejected. This means that there was a significant difference between the mean scores of male and female students taught programming language using project-based learning.

H₀₃: There is no significant interaction effect of gender and methods (project-based learning and lecture method) on students' academic achievement in programming language.

Table 5: Analysis of Covariance on the interaction effect of gender and methods (project-based learning and lecture method) on SS II students' achievement in programming language

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	118.22	2	59.11	8.44	.00	
Intercept	107.09	1	107.09	8.81	.00	
Methods*Gender	101.43	1	101.43	18.78	.01	Rejected
Error	6662.64	284	23.46			
Total	6989.64	286				
Corrected Total	5811.46	284				

Table 5 shows that the calculated F value is 18.78 which is found to be significant at .01. Since this significant level (.01) is less than the .05 significant level set for the study, the null hypothesis is, accordingly, rejected. This means that there was a significant interaction effect between methods and gender in students' academic achievement scores in programming language.

Discussion of Findings

The finding of the study showed that students taught programming language with project-based learning outperformed those taught using the lecture method in terms of academic achievement. Further finding shows that a significant difference exists between the mean scores of students taught programming language using project-based learning and those taught using lecture method. The finding that students in the project-based learning group outperformed their counterparts in terms of academic achievement suggests that the hands-on and practical nature of project-based learning has a positive impact on learning outcomes. Instead of solely relying on lectures, students in the project-based learning approach likely had the opportunity to apply theoretical concepts in real-world scenarios, enhancing their academic achievement. The finding is in accordance with Wekesa & Ongunya (2016) and Omeje (2023), who conducted independent studies and found that students that were taught with project-based learning recorded higher academic achievement than those taught with lecture method.

The finding of the study showed that male students, when taught programming language with project-based learning, outperformed their female counterparts in terms of academic achievement. Further study showed that there was a significant difference between the mean scores of male and female students taught programming language using project-based learning. There was a significant interaction effect between methods and gender in students' academic achievement scores in programming language. The observed difference in academic performance between male and female students could be attributed to various factors. It's important to note that these findings do not imply inherent gender-based differences in programming ability but may be influenced by a combination of educational, social, and environmental factors. Possible contributing factors could include variations in prior exposure to programming concepts, individual learning styles, and socio-cultural influences. The finding of the study is in line with Omeje (2023), who posited that male students exposed to project-based learning outperformed their female counterparts.

Conclusion

This study shed light on the significant effect of project-based learning on senior secondary students' academic achievement in programming language in Enugu Education Zone. The evidence overwhelmingly supports the assertion that students exposed to project-based learning surpassed their counterparts taught through the lecture method, showcasing the effectiveness of this innovative pedagogical approach in enhancing learning outcomes. Furthermore, the study brought to the forefront an interesting dimension, revealing a gender-based disparity in academic achievement. Specifically, it was found that male students, when engaged in programming language education through project-based learning, demonstrated higher academic performance compared to their female counterparts. While the reasons behind this discrepancy warrant further investigation, it highlights the importance of considering gender-specific instructional strategies and support mechanisms to ensure equitable learning opportunities for all students.

Recommendations

Based on the findings, the following recommendations were proffered:

1. Enugu State government through the state Ministry of Education should encourage collaborative projects where students work in teams. This not only fosters teamwork

and communication skills but also exposes students to different perspectives and approaches in solving problems.

2. Principals should encourage teachers to adopt teaching approaches that are inherently gender-neutral. Emphasize collaborative and cooperative learning strategies that engage all students, irrespective of gender, fostering an environment that nurtures diverse talents.

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