

## EFFECT OF PROJECT-BASED LEARNING ON COMPUTER SCIENCE EDUCATION STUDENTS' ACADEMIC ACHIEVEMENT IN COMPUTER NETWORKING IN TERTIARY INSTITUTIONS IN BAYELSA STATE

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**Abstract:** The study investigated the effect of project-based learning on computer science education students' academic achievement in computer networking in tertiary institutions in Bayelsa State. Two research questions guided the study while three hypotheses were tested at .05 level of significance. Quasi experimental design was adopted for the study. The population comprised 136 second year students. There was no sampling because the population was manageable. The instrument for data collection was Computer Networking Achievement Test (CNAT). The instrument was validated by three research experts and the internal consistency of .80 was determined using Kuder-Richardson Formula (K-R<sub>20</sub>). The experiment involved the use of project-based learning to teach computer networking and it lasted for four weeks. Mean and standard deviation scores were used in answering the research questions while Analysis of Covariance (ANCOVA) was used in testing the hypotheses. The findings of the study revealed that the use of project-based learning enhances students' academic achievement in computer networking more than the lecture method. There was an improved academic achievement among the male than their female counterparts in the experimental group when taught with project-based learning. Based on the findings, the study recommended that Tertiary institutions in Bayelsa State should consider integrating project-based learning into the teaching of learning of computer networking.

**Keywords:** Project-Based Learning, Computer Networking, Academic Achievement, Gender, Computer Science Education

### Introduction

Computer science education is an academic and practical discipline that involves teaching and learning the principles and practices of designing, building, and using computer systems. Koli & Knobelsdorf (2016), defined computer science education as the process of acquiring knowledge and skills related to the principles and practices of computing. It covers a wide range of topics, including programming, data analysis, computer architecture, artificial intelligence, and software engineering. Computer science education may take place at various educational levels, from primary schools to universities and beyond (Cyril, 2015). Computer science education provides the

theoretical and practical knowledge necessary to understand, design, and optimize computer networks (Denning & Tedre, 2019). Okechukwu & Ukeh (2022), stated that computer science education has led to the development of various digital tools and platforms that can be used for teaching and learning. Computer science education has become an integral part of modern education, influencing both the methods of teaching and the tools available for educators and students. Consequently, the current mode of learning computer science education in Nigerian education has been found to be mostly based on lecture method.

Lecture method is a traditional and widely used instructional approach in education where an instructor imparts information or knowledge to a group of students through spoken communication (Nilson, 2016). It typically involves the instructor presenting information, concepts, or ideas to the students in a structured manner, often using verbal communication, visual aids, and sometimes interactive elements. Ukeh et al. (2020) pointed out that the actions of lecturers in the classroom play a vital role in shaping students' learning capabilities. Research findings of Eze, Okeke & Ukeh (2020), Nwanekezi & Kalu (2012), established that lecture method has contributed to poor levels of academic achievement in science related courses like computer networking.

Computer networking is the practice of connecting and interconnecting multiple computing devices, such as computers, servers, routers, switches, and other devices, to facilitate data communication and resource sharing. This interconnected system of devices enables the exchange of information and resources, including files, applications, and services, among users and systems within a network. Computer networking plays a crucial role in modern communication, allowing individuals, organizations, and even global systems to share data and collaborate efficiently. Computer networking can enhance and extend the traditional lecture method in education by providing opportunities for remote learning, interactivity, collaborative learning, and access to a wealth of resources (Smith, 2020). These connections demonstrate how technology has influenced and enriched the lecture method in the modern educational landscape. While lectures are a valuable part of teaching computer networking, they are typically not the sole method of instruction. However, it becomes necessary to conduct an experiment to test the concepts behind the project-based learning.

Project-Based Learning (PBL) is an instructional approach that centers on organizing learning experiences around real-world, multifaceted projects or problems. According to Stoller in Tamimi (2020), PBL is a multifaceted idea that extends beyond the mere integration of projects into the curriculum, as noted by experts in education who emphasize its broader implications for student learning and development. 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 nurtures students' inquisitiveness and fosters their grasp of fundamental scientific concepts, empowering them to tackle challenges and develop into informed, responsible members of society equipped with scientific knowledge (Krajcik & Czerniak, 2018).

Furthermore, in PBL, students engage in hands-on, collaborative activities that require them to investigate and solve complex questions, often within the context of a particular subject or topic. This method emphasizes critical thinking, problem-solving, creativity, communication skills, and the application of knowledge in practical situations, fostering a deeper understanding of the subject matter and promoting lifelong learning (Yanan and Lei, 2022). PBL encourages students to take an active role in their education and helps them develop skills and knowledge through active participation and inquiry. A study conducted by Yanan and Lei (2022) showed that project-based learning exhibited a positive impact on students' academic achievement in science related courses like chemistry. This can positively impact their academic achievement.

Academic achievement refers to the successful completion or accomplishment of educational goals and objectives within an academic setting, such as schools, colleges, and universities.

Academic achievement according to Ikwuka & 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, according to Ademola (2013), is an indicator of a student's progress in completing particular activities in a subject or field of study after a learning experience. Omeje (2023), conducted a similar study and found that students that were taught electrochemical cells with project-based learning recorded higher academic achievement than those taught with expository method. Another study by Wekesa & Ongunya (2016), revealed that project based learning technique enabled students to improve in academic achievement as well as developing positive attitude towards classification of organisms.

While the studies mentioned above focused on the effectiveness of the PBL in the context of teaching chemistry and biology, it is important to recognize that computer networking, like chemistry and biology, is a complex and intricate course that requires a deep understanding and effective teaching methods. Therefore, the findings of these studies may have implications for computer networking as well notwithstanding of the students' gender.

Gender is a multifaceted concept that encompasses a range of social, cultural, and individual aspects related to identity, roles, and expectations. It is distinct from biological sex, which is based on physiological and genetic characteristics. Gender is a societal creation that delineates the roles, behaviours, qualities, and emotional traits associated with females and males (Ojo, 2015). The issue of gender and its effect on students' academic achievement particularly in computer networking remains unresolved. While some researchers like Ukeh, et al. (2020), Ukeh

and Nwankwo (2023) and Omeje (2023), suggested that male students outperformed their female counterparts in science related courses, others argued that achievement is influenced by various factors like socio-economic background and teaching methods, rather than being solely dependent on gender. Consequently, the matter of gender's role in students' achievement in computer networking requires further investigation especially in tertiary institutions.

Tertiary institutions are not left out in this. There exists a growing concern regarding the academic achievement of computer science education students in computer networking based on their last result as observed by the researchers. Despite efforts to improve the educational outcomes in state, many students continue to struggle with understanding the concepts taught in computer networking. This has led to a decline in academic achievement and an increased rate of students dropping out or failing the course. Unfortunately, the lecture teaching method employed in computer science education classrooms may not adequately cater to the diverse learning needs and abilities of the students. It is based on the above discourse that the present study investigated the effect of project-based learning on Computer Science Education students' academic achievement in computer networking in tertiary institutions in Bayelsa State.

### **Statement of the Problem**

The poor academic achievement of computer science education students in Bayelsa State, particularly in the field of computer networking, has become a hurdle for educational effectiveness. Computer networking is a critical field in the domain of computer science education, and its importance cannot be overstated in today's interconnected world. Tertiary institutions play a pivotal role in equipping students with the knowledge and skills needed to excel in this field.

Stakeholders in tertiary education have linked this underachievement to the way computer networking is currently taught. The predominant teaching method among lecturers involves lectures with textbooks as the primary instructional resource. Recognizing the necessity for a more effective teaching approach, there is a call for a shift in the style of lecture delivery. One suggested alternative is project-based learning. Project-based learning (PBL) has emerged as a popular pedagogical approach, which emphasizes hands-on, experiential learning. Furthermore, numerous research studies have identified gender as a significant factor influencing academic success. 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 Computer Science Education students' academic achievement in computer networking in tertiary institutions in Bayelsa State. Specifically, the study investigated:

1. the mean achievement scores and standard deviations of students taught computer networking with project-based learning and those taught using lecture method in both pre-test and post-test;
2. The mean achievement scores and standard deviations of male and female students taught computer networking with project-based learning.

### **Research Questions**

The following research questions guided the study:

1. What are the mean achievement scores and standard deviations of students taught computer networking with project-based learning and those taught using lecture method in both pre-test and post-test?
2. What are the mean achievement scores and standard deviations of male and female students taught computer networking with project-based learning?

### **Hypotheses**

The following hypotheses guided the study and they were tested at alpha level of .05:

**H01:** There is no significant difference between the mean achievement scores and standard deviations of students taught computer networking with project-based learning and those taught the same topic using lecture method in both pre-test and post-test.

**H02:** There is no significant difference between the mean achievement scores and standard deviations of male and female students taught computer networking with project-based learning.

**H03:** There is no significant interaction effect of gender and methods on students' academic achievement in computer networking.

### **Research Method**

The study employed a quasi-experimental design, which, as defined by Nworgu (2015), is characterized by the inability to randomly assign subjects to both experimental and control groups. The study included 136 second-year students, with 74 in the experimental group (41 males and 33 females) and 62 in the control group. Since the population size was small, there was no need for sampling. The data collection instrument used was the Computer Networking Achievement Test (CNAT), which was validated by three research experts, and its internal consistency was determined to be .80 using the Kuder-Richardson Formula (K-R20). The experiment involved implementing project-based learning to teach computer networking, which spanned four weeks. The Computer Science Education lecturers in the experimental group received training on using this approach and developed a lecture plan focused on computer networking topics. In contrast, the lecturers in the control group were not provided with specific guidance and continued with their usual lecture method. This instructional intervention also took place over four weeks,

following the standard lecture schedule, with one week dedicated to each topic. To answer the research questions, mean and standard deviation were used, and the Analysis of Covariance (ANCOVA) was applied to test the null hypotheses at alpha level of 0.05. ANCOVA was chosen because the study used intact classes, and initial differences between groups could not be controlled. The null hypothesis was rejected if the probability value was less than or equal to the

significance level of .05 ( $P \leq .05$ ) and not rejected if the probability value was greater ( $P > .05$ ).

**Data Analysis and Results**

**Research Question 1:** What are the mean achievement scores and standard deviations of students taught computer networking with project-based learning and those taught using lecture method in both pre-test and post-test?

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

| Groups            | Number | Pre-test           |                        | Post-test          |                        |            |
|-------------------|--------|--------------------|------------------------|--------------------|------------------------|------------|
|                   |        | Mean ( $\bar{x}$ ) | Standard Deviation (s) | Mean ( $\bar{x}$ ) | Standard Deviation (s) | Mean Gain  |
| Experimental      | 74     | 36.49              | 4.56                   | 40.09              | 5.11                   | 3.60       |
| Control           | 62     | 35.44              | 4.01                   | 38.59              | 4.89                   | 3.15       |
| <b>Mean Diff.</b> |        |                    |                        |                    |                        | <b>.45</b> |

Table 1 illustrates that students who received instruction in computer networking through project-based learning exhibited pre-CNAT and post-CNAT scores of 36.49 and 40.09, respectively, along with standard deviations of 4.56 and 5.11. In contrast, students taught using the lecture method displayed pre-CNAT and post-CNAT scores of 35.44 and 38.59, accompanied by standard deviations of 4.01 and 4.89. The experimental group exhibited a mean gain of 3.60, while the control group had a mean gain of 3.15, resulting in a mean difference of 0.45. 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 computer networking with project-based learning outperformed those instructed 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 computer networking with project-based learning?

**Table 2: Mean achievement scores and standard deviations of male and female students taught web development with electronic interactive board**

| Groups            | Number | Pre-test           |                        | Post-test          |                        |            |
|-------------------|--------|--------------------|------------------------|--------------------|------------------------|------------|
|                   |        | Mean ( $\bar{x}$ ) | Standard Deviation (s) | Mean ( $\bar{x}$ ) | Standard Deviation (s) | Mean Gain  |
| Male              | 41     | 35.65              | 3.95                   | 39.91              | 4.85                   | 4.26       |
| Female            | 33     | 34.11              | 3.86                   | 37.59              | 4.14                   | 3.48       |
| <b>Mean Diff.</b> |        |                    |                        |                    |                        | <b>.78</b> |

Table 2 illustrates that when male students were instructed in computer networking through project-based learning, their pre-test and post-test on CNAT scores were 35.65 and 39.91, respectively, with standard deviations of 3.95 and 4.85, correspondingly. Conversely, female students, who received the same instruction, had pre-CNAT and post-CNAT scores of 34.11 and 37.59, along with standard deviations of 3.86 and 4.14, respectively. The data in Table 2 demonstrates 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 4.26 for males compared to a 3.48 gain for females. This results in a mean difference of

.78 in favour of male students. In conclusion, the findings suggest that male students, when taught computer networking with project-based learning, outperformed their female counterparts in terms of academic achievement.

**Hypotheses**

**Ho1:** There is no significant difference between the mean achievement scores and standard deviations of students taught computer networking with 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 students taught computer networking using project-based learning and those taught using lecture method**

| <b>Dependent Variable: ACHIEVEMENT</b> |                         |     |             |       |      |
|--|-------------------------|-----|-------------|-------|------|
| Source                                 | Type III Sum of Squares | df  | Mean Square | F     | Sig. |
| Corrected Model                        | 109.10                  | 2   | 54.55       | 10.11 | .00  |
| Intercept                              | 98.69                   | 1   | 98.69       | 18.92 | .00  |
| GROUP                                  | 19.87                   | 1   | 19.87       | 9.66  | .00  |
| Error                                  | 3825.7                  | 134 | 28.55       |       |      |
| Total                                  | 4053.36                 | 136 |             |       |      |
| Corrected Total                        | 4944.89                 | 135 |             |       |      |

Table 3 shows that the calculated F value of 9.66 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 computer networking using project-

based learning and those taught using lecture method.

**Ho2:** There is no significant difference between the mean achievement scores and standard deviations of male and female students taught computer networking with project-based learning.

**Table 4: Analysis of Covariance on the mean achievement scores of male and female students taught computer networking using project-based learning**

| Source          | Type III Sum of Squares | df | Mean Square | F     | Sig. | Decision |
|-----------------|-------------------------|----|-------------|-------|------|----------|
| Corrected Model | 129.7                   | 2  | 64.85       | 9.11  | .00  | Rejected |
| Intercept       | 73.64                   | 1  | 73.64       | 8.56  | .00  |          |
| Pretest         | 43.09                   | 1  | 43.09       |       |      |          |
| Gender          | 64.64                   | 1  | 64.64       | 9.56  | .00  |          |
| Error           | 1580.40                 | 72 | 21.95       | 10.05 | .01  |          |
| Total           | 1891.47                 | 74 |             |       |      |          |
| Corrected Total | 1863.98                 | 73 |             |       |      |          |

Table 4 shows that the calculated F value is 9.56 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 is a significant difference between the mean scores of

male and female students taught computer networking using project-based learning.

**H03:** There is no significant interaction effect of gender and methods on students’ academic achievement in computer networking.

**Table 5: Analysis of Covariance on the interaction effect of gender and methods on students’ achievement in web development**

| Source          | Type III Sum of Squares | df  | Mean Square | F     | Sig. | Decision |
|-----------------|-------------------------|-----|-------------|-------|------|----------|
| Corrected Model | 109.78                  | 2   | 54.89       | 9.53  | .00  |          |
| Intercept       | 101.44                  | 1   | 101.44      | 9.56  | .00  |          |
| Methods*Gender  | 104.78                  | 1   | 104.78      | 14.73 | .01  | Rejected |
| Error           | 3871.26                 | 134 | 28.89       |       |      |          |
| Total           | 4187.26                 | 136 |             |       |      |          |
| Corrected Total | 4018.09                 | 135 |             |       |      |          |

Table 5 shows that the calculated F value is 14.73 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 is a significant interaction effect between methods and gender in students’ academic achievement scores.

The finding of the study showed that male students, when taught computer networking with project-based learning, outperformed their female counterparts in terms of academic achievement. 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. The hypothesis tested showed that there is a significant interaction effect between methods and gender in students’ academic achievement scores.

**Discussion of Findings**

**Conclusion**

The finding of the study showed that students taught computer networking with project-based learning outperformed those instructed using the lecture method in terms of academic achievement. The finding of the study is in line 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. Further finding showed that the hypothesis tested showed that there was a significant difference between the mean scores of male and female students taught computer networking using project-based learning.

The findings of this research emphasized the potential of project-based learning (PBL) as a powerful tool for enhancing the academic achievement and overall preparedness of computer science education students in computer networking. As technology continues to advance, the adoption of innovative and practical teaching methods like PBL becomes increasingly crucial in preparing students for the ever-evolving demands of the digital age.

## Recommendations

Based on the findings, the following recommendations were proffered:

1. Tertiary institutions in Bayelsa State should leverage the success of project-based learning in computer networking, ultimately providing students with a more engaging and effective learning experience that better prepares them for careers in the field.
2. Tertiary education stakeholders should provide diversity and inclusion training for lecturers to create a more inclusive and equitable learning environment.

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