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| RESEARCH ARTICLE

EFFECTS OF ONLINE BOOTCAMP AND ONSITE BOOTCAMP ON PROGRAMMING SKILLS ACQUISITION BY COMPUTER EDUCATION STUDENTS IN FEDERAL UNIVERSITIES IN SOUTH-SOUTH, NIGERIA

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| ABSTRACT

This study investigated the effects of online and onsite bootcamp instructional strategies on the acquisition of Java and Python programming skills among computer education students in Federal Universities in South-South, Nigeria. The rapid advancement of technology and a growing skills gap among graduates necessitated an examination of effective, intensive training models. A quasi-experimental design (non-randomized pre-test, post-test control group) was adopted. The population comprised 120 students, with an intact class of 62 students from the University of Uyo assigned as the experimental group (taught via online bootcamp) and another intact class of 58 students from the University of Benin as the control group (taught via onsite bootcamp). The instrument for data collection was the Programming Skills Test (PST). Data were analyzed using mean and standard deviation for research questions, and Analysis of Covariance (ANCOVA) to test the null hypotheses at a 0.05 significance level.The findings revealed that students taught using the online bootcamp demonstrated a higher mean academic performance in both Java (Mean Difference = 19.78) and Python (Mean Difference = 19.26) compared to those in the onsite bootcamp (Java Mean Difference = 11.14; Python Mean Difference = 11.04). The ANCOVA results showed a significant difference in academic performance for both Java ($F(1,117) = 77.64$; $p = .00$) and Python ($F(1,117) = 72.49$; $p = .00$), leading to the rejection of the null hypotheses. The study concluded that the online bootcamp instructional strategy was more effective in enhancing programming skills acquisition than the onsite bootcamp. It is recommended that Federal Universities increase the adoption of online bootcamps and explore hybrid models, supported by improved digital infrastructure and targeted funding, to better equip students with in-demand programming competencies.

| KEYWORDS

Online Bootcamp, Onsite Bootcamp, Programming Skills, Java, Python, Computer Education, Nigeria

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Introduction

Technology is developing at a quick pace, which has drastically changed how we teach students, especially in subjects like computer science that demand highly developed technical skills. Although Federal Universities in the South-South region of Nigeria are in the forefront of developing talent in computer science, they encounter difficulties in making sure that students gain current and relevant skills (Ogunlela, 2014). The practical ability that students acquire during their schooling is known as skill acquisition. One of the key areas through which students acquire such practical abilities in Federal Universities is computer education, which provides both foundational and advanced knowledge in digital technologies.

Computer Education refers to the teaching and learning processes that equip individuals with knowledge and skills in the use of computers, digital technologies, and related applications. It covers both theoretical and practical aspects, ranging from basic computer literacy such as word processing, spreadsheets, and internet use to advanced areas like programming, networking, database management, cyber security, and artificial intelligence. Among these, computer programming stands out as a core component of computer education because it involves creating a set of instructions that a computer can follow to perform specific tasks or solve problems.

Computer programming requires writing code in languages such as Python, Java, C++, or JavaScript, to develop applications, software, websites, and systems. Programming bridges the gap between human ideas and computer execution by converting logic into machine-readable form. Programming plays a vital role in today's digital world, powering everything from mobile apps and web platforms to artificial intelligence, cloud computing, and embedded systems. It equips learners with problem-solving skills, creativity, and the ability to automate tasks, making it a core competency in computer science and modern careers. Given the central role of programming in modern education and careers, it becomes essential to consider the instructional strategies that can best support students in mastering these skills.

Instructional strategies encompass the methods and techniques educators use to facilitate learning and enhance students' understanding of material. These strategies are designed to address diverse learning needs, promote engagement and ensure effective knowledge transfer. At the core, instructional strategies are the practical applications of pedagogical theories, aimed at creating an optimal learning environment that supports student achievement (Anderson, 2023). One innovative instructional strategy that has gained prominence in recent years is the bootcamp model, which emphasizes practical, immersive learning experiences tailored to industry needs.

Bootcamp is an intensive, hands-on approach to learning designed to equip participants with practical, job-ready skills in a short timeframe. It emphasizes active participation, real-world applications and immersive learning experiences, often tailored to specific fields such as software development, data analytics and digital marketing. With a curriculum structured around projects, collaborative exercises, and problem-solving tasks, boot camps focus on mastery of essential concepts and tools through direct application rather than theoretical learning (Kizilcec *et al*., 2022). Building on the traditional bootcamp model, online bootcamp instructional strategies extend these immersive, practice-oriented methods into digital environments,

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offering learners greater accessibility and flexibility.

Online Bootcamp instructional strategy combines the immersive, skill-focused approach of traditional bootcamps with the flexibility of digital learning environments. It leverages virtual platforms to deliver intensive, hands-on training, allowing participants to access high-quality education from anywhere. This strategy emphasizes practical application through live coding sessions, project-based assignments and collaborative exercises facilitated via video conferencing, learning management systems, and peer-to-peer interaction (Smith *et al*., 2021). Online-Bootcamps often incorporate asynchronous resources like recorded lectures and interactive modules, enabling learners to study at their own pace while adhering to structured deadlines. Integrating real-world problem-solving and industry-relevant tools, online bootcamps prepare participants for job readiness in fields like software development, data science, and UX design, offering both flexibility and rigor (Jones, 2023). While online bootcamps provide flexibility and accessibility through digital platforms, onsite bootcamps offer a contrasting instructional strategy that emphasizes face-to-face interaction and immersive physical learning environments.

Onsite bootcamp instructional strategy offers an intensive, face-to-face learning experience designed to immerse participants in a collaborative and focused environment. This approach fosters direct interaction with instructors and peers, creating opportunities for real-time feedback, mentorship, and hands-on practice with industry-relevant tools and techniques. Onsite bootcamps emphasize active learning through workshops, group projects, and problem-solving activities, simulating real-world challenges to build practical expertise (Johnson, 2022). The physical presence of learners encourages accountability, teamwork, and networking, often resulting in a more engaging and dynamic learning experience. Typically held in dedicated training centers or corporate settings, onsite bootcamps are ideal for participants seeking structured schedules and direct access to resources such as labs, equipment and live demonstrations (Brown *et al*., 2021). Both online and onsite bootcamp instructional strategies are particularly effective when applied to programming education, especially in equipping learners with in-demand competencies such as Java programming skills

Java programming skills are highly valued in software development due to Java's versatility, platform independence, and wide application in building robust and scalable solutions. These skills include proficiency in Java syntax, object-oriented programming (OOP) principles, and the ability to use Java Development Kit (JDK) tools effectively. Developers with strong Java skills can create applications for web, mobile and enterprise systems, leveraging frameworks like Spring and Hibernate for enhanced functionality (Smith and Jones, 2022). Strong problem-solving skills and familiarity with industry-standard tools like IntelliJ IDEA or Eclipse complement Java expertise, making it essential for tackling complex programming challenges (Lee *et al*., 2023). Alongside Java, another programming language that plays a critical role in modern software development and emerging technologies is Python, valued for its simplicity and versatility.

Python programming skills are in high demand due to Python's simplicity, readability, and versatility across various domains. These skills include mastery of Python syntax, data types, control structures and the ability to write clean, modular code using functions and classes. Proficiency in Python also involves knowledge of libraries and frameworks such as NumPy and Pandas for data manipulation, Flask and Django for web development and TensorFlow for machine learning applications (Brown *et al*., 2022). Python programmers are adept at problem-solving, debugging, and working with tools like Jupyter

Notebooks and integrated development environments (IDEs) such as PyCharm. With its wide array of uses, Python programming skills enable developers to tackle complex challenges and innovate across industries (Smith, 2023). Given the demand for versatile programming skills such as Java and Python, effective instructional approaches are needed to help students acquire these competencies in ways that align with their individual learning needs.

From the above, bootcamps can be a good solution by offering different learning environments to the students who have individual differences as well as approaches to learning. Hence, the study aimed at determining the effects of online bootcamp and onsite bootcamp on programming skill acquisition of computer education students in Federal Universities in South South, Nigeria.

| Statement of the Problem

The rapid advancement of technology and the increasing demand for skilled programmers have highlighted the need for effective and accessible training programs in computer education. In many regions, including South South, there is a growing gap between the skills required by the job market and the competencies possessed by graduates of educational institutions. Despite the availability of formal computer education programs in tertiary institution, students often face significant challenges in acquiring the necessary practical programming skills, particularly those in high-demand areas such as web development, software engineering and data science (Olukoya and Adebayo, 2020). This gap is exacerbated by issues such as outdated curricula, limited access to up-to-date resources and a lack of hands-on learning opportunities, which are critical for developing programming expertise (Aderemi, 2023).

However, while both online and onsite bootcamps have gained popularity in many countries, there is limited empirical research on their effectiveness in enhancing programming skills acquisition among students in Federal Universities in South South in Nigeria. The growing prevalence of online bootcamps, which offer flexibility in learning and onsite bootcamps, which provide immersive, hands-on experiences, have sparked debates about the relative efficacy of each approach. It remains uncertain whether online bootcamps, with their self-paced and often less personalized structure, are as effective in fostering programming proficiency as the more traditional, instructor-led onsite bootcamps that offer direct interaction with instructors and peers (Fayomi, *et al*, 2023).

In the context of South South region, there are additional challenges that may influence the effectiveness of both bootcamp models, including limited access to reliable internet, inconsistent power supply and financial constraints that may hinder students' ability to participate in either online or onsite training (Nwachukwu and Nwokike, 2021). While online bootcamps offer flexibility in terms of location and schedule, one might also require a level of self-discipline and motivation that may be difficult for students in these regions to maintain without adequate support systems. On the other hand, onsite bootcamps, while providing immediate feedback and hands-on experiences, may not be accessible to all students due to geographical and financial barriers (Aderemi, 2023).

Thus, the problem lies in understanding how these two training models—online and onsite bootcamps—differ in terms of their impact on programming skills acquisition among computer education students in Federal Universities in South South, Nigeria. This study seeks to explore the effectiveness of online and onsite bootcamps in enhancing programming skills acquisition.

| Research Questions

1. What is the mean academic performance of students in

acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp?

2. What is the mean academic performance of students in acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp?

Research Hypotheses

1. There is no significant difference in the mean academic performance of student in acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp in Federal Universities in South South, Nigeria.
2. There is no significant difference in the mean academic performance of student in acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp in Federal Universities in South South, Nigeria.

Research Method

The design of the study is quasi-experimental design (non-randomization pre-test post test control group). The area of this study was South-South Nigeria, encompassing states such as Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers. The population for this study consists 120 computer education students enrolled in Federal Universities in South South, Nigeria. University of Benin 58 students and University of Uyo 62 were students. The sampling size of 120 respondents who offering programming courses were used and sampling techniques, comprising of one intact class with 62 students from department of computer and Robotics Education in the University of Uyo as the treatment group while another intact class of 58 students in the University of Benin was used as the control group. The instrument titled Programming Skills Test (PST) was divided into two sections; each section consisted of 10 items making a total of 20 items in all. The validation of the Programming Skills Test (PST) for this work was critical step to ensure that the instrument accurately measures the skill of students in the core areas of programming covered in the Online Bootcamp platforms.

A pretest-posttest of the Programming Skill Test (PST) was conducted before the commencement of the main experiment. When the experiment kicked off, the experimental group was taught two topics with Online Bootcamp while the control group was also taught two topics with Onsite Bootcamp. These provided the baseline for comparing the students in both groups. Programming Skill Test (PST) was administered as pre-test in both intact classes of treatment and control groups. Therefore, students in the experimental group and control group were taught using the Online Bootcamp and with Onsite Bootcamp (conventional) platform respectively. Programming Skill Test (PST) was re-administered as post-test to the students in both groups. The pre-test and post-test scores constituted the raw data for this study. Data obtained was analyzed using the mean for research questions while Analysis of Covariance (ANCOVA) was used to test all the null hypotheses at 0.5 level of significance.

In testing the null hypotheses, when the P-value was less than or equal to .05, the test was considered significant; the null hypothesis was therefore rejected. On the other hand, when the P-value was greater than .05, the test was considered not significant; the null hypothesis was therefore retained.

Results and Discussion of Findings

Research Question 1

What is the academic performance of students on the acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp?

Table 1: Mean academic performance of students on the acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp

S/N	Groups	N	Pre-Test Mean $\overline{X}$	Pre-Test Std. Deviation SD	Post-Test Mean $\overline{X}$	Post-Test Std. Deviation SD	Mean Difference	Difference Between Means
1.	Experimental	58	56.00	4.55	75.78	4.38	19.78	8.64
2.	Group	62	56.15	4.70	67.29	5.94	11.14	

Source: Field Data (2025)

The data in Table 1 show that the mean pre-test and post test scores of students in the experimental group are 56.00 and 75.78. The table also shows that the mean pre-test and post test of students in the control group are 56.15 and 67.29 respectively. It could be observed that students in the experimental group who were taught with online bootcamp had higher mean difference of 19.78 as against 11.14 obtained by those in the control group who were taught with onsite bootcamp. The report suggests that the online bootcamp enhances Java programming skills acquisition by Computer Education Students than the onsite bootcamp.

Research Question 2

What is the academic performance of students on the acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp?

Table 2: Mean academic performance of students on the acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp

S/N	Groups	N	Pre-Test Mean $\overline{X}$	Pre-Test Std. Deviation SD	Post-Test Mean $\overline{X}$	Post-Test Std. Deviation SD	Mean Difference	Difference Between Means
1.	Experimental	58	56.00	4.55	75.26	4.31	19.26	8.22
2.	Control	62	56.15	4.70	67.19	5.85	11.04	

Source: Field Data (2025)

The data in Table 2 show that the mean pre-test and post test scores of students in the experimental group are 56.00 and 72.26. The table also shows that the mean pre-test and post test of students in the control group are 56.15 and 67.19 respectively. It could be observe that students in the experimental group who were taught with online bootcamp had higher mean difference of 19.26 as against 11.04 obtained by those in the control group who were taught with onsite

bootcamp. The report suggests that the online bootcamp enhances Python programming skills acquisition by Computer Education Students than the onsite bootcamp.

Research Hypothesis 1:

There is no significant difference in the mean academic performance of student in acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp in Federal Universities in South South, Nigeria.

Table 3: ANCOVA of mean difference in the academic performance of students in acquisition of Java programming skills when taught using online bootcamp as against those taught using onsite bootcamp

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	2158.226[a]	2	1079.113	38.820	.000	
Intercept	4003.567	1	4003.567	144.024	.000	
PreTest	.495	1	.495	.018	.89	
Groups	2158.22	1	2158.22	77.64	.00	Significant
Error	3252.36	117	27.79			
Total	617023.00	120				
Corrected Total	5410.59	119				

P < 0.05; Source: Field Data (2025)

The data in Table 3 showed that the calculated F-value is 77.64 with level of significance (P-value) being 0.00. This indicates that the F-value is significant at 0.05 level of significance since the observed level of significance is less than the stipulated level of significance (0.05). On this basis, the null hypothesis is rejected. This implies that there is significant difference between the mean performance scores of students in acquisition of Java programming skills when taught with online bootcamp and onsite bootcamp. This difference is in favour of experimental group which obtained a higher post test score than those in the control group.

Research Hypothesis 2:

There is no significant difference in the mean academic performance of student in acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp in Federal Universities in South South, Nigeria.

Table 4: ANCOVA of mean difference in the academic performance of students in acquisition of Python programming skills when taught using online bootcamp as against those taught using onsite bootcamp

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision

Corrected Model	1951.43[a]	2	975.71	36.25	.00	
Intercept	3870.01	1	3870.01	143.80	.00	
PreTest	2.237	1	2.237	.083	.77	
Groups	1950.79	1	1950.79	72.49	.00	Significant
Error	3148.56	117	26.91			
Total	611583.00	120				
Corrected Total	5099.99	119				

P < 0.05; Source: Field Data (2025)

The data in Table 4 showed that the calculated F-value is 72.49 with level of significance (P-value) being 0.00. This indicates that the F-value is significant at 0.05 level of significance since the observed level of significance is less than the stipulated level of significance (0.05). On this basis, the null hypothesis is rejected. This implies that there is significant difference between the mean performance scores of students in acquisition of Python programming skills when taught with online bootcamp and onsite bootcamp. This difference is in favour of experimental group which obtained a higher post test score than those in the control group.

| Discussion of the Findings

The mean academic performance of students taught Java programming skills using online bootcamp was higher than those taught using onsite bootcamp. There was significant difference between students taught Java programming skills with online bootcamp and those taught using onsite bootcamp in Federal Universities in South South, Nigeria. This difference was significant and in favour of the experimental group implying that online bootcamp significantly enhances students academic performance in Java programming skills acquisition. Students in the online bootcamp group outperformed their onsite counterparts, as indicated by higher mean scores and larger improvement from pre-test to post-test results. This could be because Online bootcamps leverage flexible, interactive platforms that enable personalized pacing and provide access to a wide range of digital resources. These factors may enhance students' ability to focus and practice, which is critical for developing programming skills.

This outcome aligns with the findings of Lang and Sharp (2022) who found out that students highly value hands-on projects and peer collaboration, with 86% emphasizing their importance in the learning process. These elements were often more prominent in bootcamp settings compared to traditional university programs, where students reported less industry collaboration and delayed feedback mechanisms.

The findings are consistent with the constructivist learning theory, which emphasizes active learning and knowledge construction through engagement with practical, real-world tasks. The online bootcamp environment aligns with this framework by offering students opportunities to independently solve problems and apply programming concepts in projects. Additionally, experiential learning theory supports the notion that hands-on, reflective activities in the bootcamps foster deeper understanding and retention of programming skills.

The mean academic performance of students taught Python programming skills using online bootcamp was higher than those taught using onsite bootcamp. There was significant difference between students taught Python programming skills with online bootcamp and

those taught using onsite bootcamp in Federal Universities in South South, Nigeria. This difference was significant and in favour of the experimental group implying that online bootcamp significantly enhances students academic performance in Python programming skills acquisition. This could be because the flexibility of online programs likely allowed students to spend more time on challenging concepts, revisit resources and complete exercises at their own pace. This adaptability may have been particularly advantageous in Python programming, which requires iterative problem-solving and debugging. Additionally, the inclusion of asynchronous learning tools, live coding sessions and access to a broad range of interactive materials may have enhanced the learning experience. The results of this study are consistent with findings of Dela (2022) who state that students found the online Python programming course to be very effective, with an overall mean score of 4.49. Students appreciated the course design, content, time allocated for tasks and the communication and interaction with instructors and peers. The study concluded that, with proper course design and delivery, online programming courses can effectively facilitate programming skills acquisition.

The findings align with the Constructivist Learning Theory, which emphasizes that active, self-directed engagement with material fosters deeper learning and knowledge construction. Online bootcamps, with their flexible structure and access to diverse digital resources, provide opportunities for students to engage in hands-on problem-solving, collaborative coding exercises, and reflective learning. These elements are critical for programming skill acquisition, as they allow learners to repeatedly practice and refine their understanding at their own pace. Experiential Learning Theory by Kolb also provides a theoretical foundation for these findings. The online bootcamp model encourages iterative learning cycles where students experiment with Python concepts, reflect on their successes and challenges and apply new insights in subsequent projects. This aligns well with Kolb's framework, suggesting that the experiential nature of online learning contributes to students' enhanced performance.

Conclusion

It can be concluded that the online bootcamp model significantly enhances students' academic performance in the acquisition of Java and Python programming skills. The students, who participated in the online bootcamp outperformed those in the onsite bootcamp which implies that online bootcamps offer a more effective and flexible approach to learning programming skills.

Recommendations

The following recommendations are made to enhance programming skills acquisition among computer education students in South-South Nigeria, particularly regarding the use of online and onsite bootcamps:

1. Federal Universities and educational institutions should consider increasing the adoption of online bootcamps. This model offers flexibility, broader access to resources and the ability to reach a larger number of students, especially in regions where access to traditional onsite learning may be limited.
2. Educational Institutions should explore hybrid learning models that combine the best aspects of both online and onsite bootcamps. This would allow students to experience the advantages of both learning environments.
3. Universities should invest in improving Wi-Fi connectivity, provide learning materials in easily accessible formats, and ensure that students have access to devices necessary for online learning.
4. Online bootcamps should be tailored to meet the specific needs of students in

Universities in South-South Nigeria, taking into account local contexts such as the availability of resources, internet access and cultural considerations.

5. Universities in South South, Nigeria should regularly evaluate the effectiveness of both online and onsite bootcamp programs to ensure that both continue to meet the evolving demands of the job market.
6. Tet Fund should provide funds that would help to enhance the quality of both online and onsite bootcamps in the Universities.

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