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EFFECTS OF SIMULATION STRATEGY ON SENIOR SECONDARY TWO STUDENTS' ACHIEVEMENT IN CELL BIOLOGY IN JOS NORTH LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA

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ABSTRACT

This study examined the effect of Simulation Strategy on the academic achievement of Senior Secondary II students in Cell Biology in Jos North Local Government Area, Plateau State, Nigeria. The study targeted a population of 2,985 SS II students, with a sample of 71 students divided into two groups: an experimental group, which was taught through Cell Biology, and a control group, which received instruction via the traditional lecture method. A quasi-experimental design with a non-equivalent control group pre-test-post-test approach was employed, using the Cell Biology Achievement Test (CBAT), a researcher-developed instrument with a reliability coefficient of 0.78. The study aimed to address three research questions and test three hypotheses at a significance level of 0.05. Data were analyzed using mean and standard deviation for the research questions, while an independent t-test was used to test the hypotheses. The findings showed that at the post-test stage students in the experimental group had higher mean achievement scores compared to those in the control group. A significant difference was found between the pre-test and post-test scores of the experimental group in the Cell Biology Achievement Test (CBAT). Lastly, at post-test, the mean achievement scores of male and female students in the experimental group were equal. Based on the findings, it was concluded that the simulation strategy can be utilize to enhance students' achievement in Cell Biology. The study therefore, recommended among others that Biology teachers should incorporate Simulation Strategy into their instructional practices. This method promotes active learning and enhances students' understanding of complex biological concepts.

Keywords: Achievement, Cell Biology, Simulation Strategy

INTRODUCTION

Education is a cornerstone of personal and societal development, equipping individuals with the necessary knowledge, skills, and values to navigate life's challenges and opportunities. It fosters economic growth, promotes political stability, and facilitates scientific and technological advancements that drive societal progress. According to the National Policy on Education (FRN, 2014), education in Nigeria is viewed as an instrument for national development, particularly through its focus on science and technology. Science education plays a significant role in fostering innovation and problem-solving skills, which are essential for addressing the complex challenges of modern society (Kalogiannakis, Papadakis & Zourmpakis, 2021). It is through science education that learners acquire the ability to apply theoretical knowledge to real-world situations, making it an indispensable element of any nation's developmental agenda. Disciplines within the realm of science, like biology, not only contribute significantly to a nation's development but also play a significant role in its very existence (Umar, 2023).

Biology is a core science subject in the Nigerian secondary school curriculum that explores the mechanisms of life, encompassing cellular processes, genetic inheritance, ecological interactions, and biodiversity conservation (Udofia, Ijeoma & Chukwuemeka-Nworu, 2021). These concepts form the foundation for careers in medicine, agriculture, biotechnology, and environmental science. According to the Federal Republic of Nigeria (FRN, 2014), Biology is crucial for students aspiring to contribute to these fields. Among the key topics in Biology, cell biology is particularly significant, as it underpins growth, reproduction, and genetic stability in living organisms (Sunchu

& Cabernard, 2020). Mastery of this topic is essential for understanding the broader principles of biology and their applications in solving real-world problems.

Despite its importance students' performance in Biology has been persistently low (WAEC Chief Examiners' Reports, 2023). These report highlighted that candidates' overall performance in Biology showed no significant improvement compared to previous years. The report also noted that students faced challenges in answering questions related to genetics. Additionally, factors such as ineffective teaching methods in biology classrooms, a shortage of qualified teachers, and the abstract and complex nature of certain biology concepts (Nguyen, Nguyen & Dang, 2024). Poor achievement in Biology not only limits students' academic prospects but also hampers their opportunities for careers in science-related fields. This has necessitated the exploration of innovative instructional strategies that enhance students' understanding and engagement with complex biological concepts. Research has shown that simulation strategies, which employ interactive models and virtual environments, are effective in improving student motivation and academic achievement in science education (Akhigbe & Ogufere, 2020; Koomson, Safo-Adu & Antwi, 2020).

Simulation strategies provide students with a hands-on, experiential approach to learning, allowing them to visualize and interact with abstract concepts in a controlled environment. These strategies are particularly effective in teaching complex topics where direct observation of processes like mitosis and meiosis is challenging (Egara, Eseadi & Nzeadibe, 2022). This method not only enhances academic achievement but also fosters critical thinking and problem-solving skills among both genders. The role of gender in academic achievement has also been a subject of interest in educational research. While studies have shown that gender-related disparities in academic performance often arise from traditional teaching methods and societal stereotypes, inclusive teaching strategies like simulations have been found to minimize these disparities (Musimenta, Adyanga & Sekiwu, 2020; Saadat, Alam & Rehman, 2022). Such strategies promote equity and cater to diverse learning needs, ensuring that all students, regardless of gender, have equal opportunities to succeed. In light of these considerations, this study examines the effects of simulation strategy on Senior Secondary Two students' motivation and achievement in cell division in Jos North, Plateau State, Nigeria.

RESEARCH QUESTIONS

1. What difference exists between the post-test mean scores of the control and the treatment group after exposing the experimental group to simulation strategy?
2. What difference exists between the pre-test and post-test mean scores of the experimental group before and after the exposure to simulation strategy?
3. What difference exists between the post-test scores mean of the male and female students in the experimental group after exposure to simulation strategy?

HYPOTHESES

1. There is no significant difference between the post-test scores of the control and experimental group after exposure of the experimental group to simulation strategy.
2. There is no significant difference between the pre-test and post-test scores of the experimental group after exposure to simulation strategy.
3. There is no significant difference between the post-test scores of the male and female students in the treatment group after exposure to simulation strategy.

METHOD

The study adopted a non-equivalent control group pretest-posttest quasi-experimental design, suitable for situations where random assignment of subjects was impractical. The research focused on Senior Secondary II Biology students in Jos North, Plateau State, with a sample of 71 students from two public secondary schools, selected using a stratified random sampling method. The experimental group received instruction through Simulation strategy, while the control group

followed the conventional lecture method. The Cell Biology Achievement Test (CBAT), a 20-item multiple-choice instrument aligned with the curriculum, served as the data collection tool, administered as both pre-test and post-test to measure student performance. The instrument was validated by three experts from the university of Jos (two from Biology Education unit of the Department of Science and Technology Education and one from Research, Measurement and Evaluation unit of the Department of Educational Foundations. The instrument was pilot tested using Kuder Richardson (K-R21) which yielded a coefficient of 0.78. Simulation strategy was used to teach the experimental group for eight weeks while the lecture method was used to teach the control group the concepts of Cell Biology. Data analysis was conducted using SPSS Version 24, with means computed to answer research questions and paired t-tests employed to test hypotheses. Calculated t-values were compared to table values to accept or reject null hypotheses.

RESULTS

Research Question One

What difference exists between the post-test mean scores of the control and the treatment group after exposing the experimental group to Simulation Strategy?

Table 1: The Mean and Standard Deviation scores of the post-test mean scores of the Control and Experimental Groups

Group	N	Mean(x)	SD
Control	**37**	**50.5405**	**7.0498**
Experimental	**34**	**63.0882**	**12.674**

The data presented in Table 1 reveals the comparison between the post-test mean scores of the control and experimental groups after exposing the experimental group to the Simulation Strategy. The experimental group, achieved a mean score of 63.0882 with a standard deviation of 12.674, while the control group, had a lower mean score of 50.5405 and a standard deviation of 7.0498.

Research Question Two

What difference exists between the pre-test and post-test mean scores of the experimental group before and after the exposure to Simulation Strategy?

Table 2: The Mean and Standard Deviation of the pre-test and post-test scores of the Experimental Group

Test	N	Mean (X)	SD
Pre-test	**34**	**46.625**	**11.950**
Post- test	**34**	**61.429**	**13.254**

Table 2 reveals the mean scores and standard deviations of the experimental group before and after exposure to the Simulation Strategy. The pre-test mean score for the experimental group was 46.625 with a standard deviation of 11.950. After the intervention, the post-test mean score significantly improved to 61.429, with a standard deviation of 13.254.

Research Question Three

What difference exists between the post-test scores mean of the male and female students in the experimental group after exposure to Simulation Strategy?

Table 3: The Mean and Standard deviation of the post-test scores of the male and female students in the experimental group.

Gender	N	Mean (x)	SD
Male	**16**	**63.125**	**13.276**
Female	**18**	**63.056**	**12.502**

Table 3 reveals very minimal difference in the post-test mean scores between the male and female students. The male students, with a sample size of 16, achieved a post-test mean score of 63.125 and a standard deviation of 13.276, while the female students, consisting of 18 individuals, achieved a nearly identical mean score of 63.056 with a standard deviation of 12.502.

Hypothesis One ($H0_1$)

There is no significant difference between the post-test scores of the control and experimental group after exposure of the experimental group to Simulation Strategy.

Table 4: t-test results of Sample Analysis for post-test mean differences of Experimental and Control Groups in CBAT

Group	N	Mean (x)	SD	t-cal	Df	P-value	Decision
Control	37	50.5405	7.0498	-5.210	69	0.000	Reject $H0_1$
Experimental	34	63.0882	12.674				

P<0.05

Table 4 shows that the control group achieved a mean score of 50.5405 with a standard deviation of 7.0498, while the experimental group, with 34 students, achieved a significantly higher mean score of 63.0882 and a standard deviation of 12.674. The calculated t-value was -5.210 with 69 degrees of freedom and a p-value of 0.000. Since the p-value is less than 0.05, the null hypothesis (H02) is rejected, indicating a significant difference in the post-test scores between the control and experimental groups.

Hypothesis Three ($H0_2$)

There is no significant difference between the pre-test and post-test scores of the experimental group after exposure to Simulation Strategy.

Table 5: t-test Result of Sample Analysis of pre-test and post-test scores of the Experimental Group in Cell Biology Achievement Test (CBAT).

Test	N	Mean(x)	SD	t-cal	Df	P-value	Decision
Pre-test	34	46.625	11.950	-4.806	66	0.000	Reject $H0_2$
Post-test	34	61.429	13.254				

P<0.05

Table 5 shows that the pre-test mean score is 46.625 with a standard deviation of 11.950, while the post-test scores show a significant increase, with a mean score of 61.429 and a standard deviation of 13.254. The calculated t-value is -4.806, with 66 degrees of freedom, and a p-value of 0.000. Since the p-value is significantly less than 0.05, the null hypothesis (H03) is rejected.

Hypothesis Three ($H0_3$)

There is no significant difference between the post-test scores of the male and female students in the treatment group after exposure to Simulation Strategy.

Table 6: t-test Result of Sample Analysis of post-test scores of the male and female students in the Experimental Group.

Gender	N	Mean(x)	SD	t-cal	df	P-value	Decision
Male	16	63.125	13.276	- 0.16	32	0.988	Accept HO_3
Female	18	63.056	12.502				

P< 0.05

Table 6 show that the male students achieved a mean score of 63.125 with a standard deviation of 13.276, while the female students had a nearly identical mean score of 63.056 and a standard deviation of 12.502. The calculated t-value was -0.16, with 32 degrees of freedom, and the p-value was 0.988. Since the p-value is greater than 0.05, the null hypothesis (H04) is accepted, indicating that there is no significant difference between the post-test scores of male and female students in the experimental group.

DISCUSSION OF FINDINGS

The findings of this study revealed that the Simulation Strategy was effective in improving the academic achievement of SS2 students in Biology. For instance, students in the experimental group, who were taught using the Simulation Strategy, scored significantly higher than those in the control group who received conventional instruction. This improvement can be attributed to the hands-on and interactive nature of the Simulation Strategy, which enhanced students' understanding of Cell Biology concept and encouraged active participation in the learning process. The results indicated that there was a significant difference in the post-test mean scores between the experimental and control groups, leading to the rejection of the null hypothesis. This finding aligns with previous studies by Akhigbe and Ogufere (2020) and Awodun and Oyenyi (2018), which demonstrated the positive impact of simulation on students' academic performance.

Furthermore, the study also showed a significant improvement in the pre-test and post-test mean scores of the experimental group, indicating the effectiveness of the Simulation Strategy in enhancing students' performance over time. The observed improvement supports the rejection of the null hypothesis and corroborates findings from similar studies by Egara, Nzeadibe and Okeke (2018), which reported significant academic gains with practical teaching strategies.

With regard to gender differences, the study found no significant variation in the post-test mean scores of male and female students in the experimental group. This indicates that the Simulation Strategy was equally effective for both genders, as evidenced by the minimal difference in their mean scores. This finding supports the null hypothesis and aligns with studies by Manju (2020) and Muhammad and Suleiman (2020), which found no gender disparities in academic performance when active teaching methods were used. However, it contrasts with Ojo and Owolabi (2018), who reported higher performance among female students. The results suggest that the Simulation Strategy provides equal opportunities for academic success regardless of gender, reinforcing its potential as an inclusive instructional method.

CONCLUSION

Based on the findings of this study, it is concluded that the Simulation Strategy significantly improves students' academic achievement in Biology. The post-test results demonstrate a clear improvement in the performance of students exposed to this strategy compared to those taught using conventional methods. The use of Simulation not only enhances student engagement but also leads to better understanding and retention of scientific concepts. Moreover, the study found no significant gender differences in achievement, suggesting that the strategy is equally beneficial for both male and female students. Therefore, the Simulation Strategy is a valuable tool for fostering academic success in Biology education.

RECOMMENDATIONS

From the findings of the study, the following recommendations were made:

i. Biology teachers should incorporate virtual teaching strategies, such as the Simulation Strategy, into their instructional practices. This method promotes active learning and enhances students' understanding of complex biological concepts.
ii. Education authorities and school administrators should organize regular training sessions and workshops for Biology teachers to ensure they are well-versed in using practical teaching methods effectively.

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