# TEACHING STRATEGIES AND STUDENTS' LEARNING OUTCOMES IN BASIC SCIENCE AND TECHNOLOGY IN THE EKET LOCAL GOVERNMENT AREA, NIGERIA

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**ABSTRACT**

*This study investigated the effect of teaching strategies and students' learning outcomes in basic science and technology in the EKET Local Government Area of Akwa Ibom State. 2 research questions and 2 hypotheses were used for the study. The study was designed using the pretest-posttest quasi-experimental design. 1663 Junior Secondary Two (JS2) students in the 10 public secondary schools formed the population. A sample size of 131 JS2 students from three purposely sampled 3 intact classes was used for the study. A purposive sampling technique was used to select the 3 schools. The instrument for data collection was the Basic Science and Technology Achievement Test (BSTAT). The reliability of the instrument was determined using the Kuder-Richardson formula (K-R20) and was found to be 0.81. The data obtained was analyzed using mean, standard deviation, and ANCOVA. The findings of the study revealed significant differences in the mean achievement scores of Basic Science and Technology students taught the concept of living and non-living things using computer simulation, tutorials, and flipped classroom strategies. However, while no significant difference was found between computer simulation and tutorial strategies, both*

*computer simulation and tutorial teaching strategies showed significantly higher achievement compared to flipped classroom strategies. Also, teaching strategies did not influence students' gender. Based on the findings it was recommended among others that students should be made to use the opportunities these strategies provide to better their understanding of concepts and improve their digital skills, which are essential for academic success and future endeavors.*

**KEYWORDS**
*Teaching Strategies, Computer simulation, Tutorial, Flipped classroom, Students' Learning Outcome, Basic Science and Technology*

## INTRODUCTION

Nigeria aspires to position itself amid the foremost scientifically and technologically progressive countries in the global arena. This aspiration is closely linked to the myriad contributions that science and technology make to human development. Babayemi (2014) describes science and technology as the arrowhead that determines the direction and dimension of national development. It has long been posited that the wealth, power, and impact of any nation are predominantly contingent upon its ability to harness science and technology for sustainable progress. For any country, particularly Nigeria, to attain scientific and technological progress, it is crucial to establish a robust foundational scientific education for its citizens from an early age (Enemarie, 2016). This necessity arises from the fact that children embark on career exploration at a remarkably young age. The foundational education of science and technology commences with primary education and continues through Junior Secondary Schools (JSS) as Basic Science and Basic Technology (Balaraba, 2016).

Basic Science and Technology (BST), recognized as a crucial subject, is imparted during the foundational (primary and Junior Secondary) educational level, serving as the cornerstone upon which the core scientific disciplines such as Biology, Chemistry, and Physics during senior secondary education are established. BST curriculum at the Junior Secondary School is designed to furnish students with specific scientific process skills, including: observing, organizing collected information, generalizing based on gathered data, predicting as a consequence of generalization, and constructing experiments with controls where necessary to verify predictions (Federal Republic of Nigeria, FRN, 2014). It is anticipated that by educating children in BST in the foundational classes, every Nigerian child will acquire the essential knowledge and comprehension of the principles of science and technology, alongside the innovations occurring within their environment. This premise aligns with the aims of BST instruction during Upper Basic Education, which seeks to cultivate individuals adept at effectively navigating the contemporary scientific and technological landscape and contributing to national advancement (FRN, 2014).

BST serves as a foundational framework that imparts the most requisite pieces of training in scientific and technological competencies to address the evolving demands of society. The fundamental knowledge gained through BST at the upper basic level acts as a catalyst for the transformation of the world via significant advancements across a multitude of fields, including information and communication technology, medicine, engineering, electronics, and aeronautics, among others (Chima, 2021). The content and process of science and technology have undergone significant evolution due to the advent of Information and Communication Technology (ICT). Itighise and Thomas (2022) contended that emerges of Information and Communication Technology (ICT) is one essential building blocks of contemporary society. Consequently, the utilization of technology functions as a propellant for development and innovation within the educational system. It offers unique opportunities to foster growth and enhance innovation by facilitating more productive interactions between individuals and institutions within the global economy and the broader world.

Itighise and Wordu (2016) emphasized the implementation of pedagogical methodologies utilizing Information and Communication Technology (ICT) which entails facilitating effective learning through the utilization of computers (Eden, Etiubon, Ekong, Sampson, and Umoetuk, 2023c) along with other informational technologies (Eden, Lambert & Mbuk, 2024) as supportive learning instruments. Akpan and Itighise (2019) posit that the utilization of ICT tools brings the learning experience in closer proximity to the learners and simplifies the teaching process for educators. As the world is moving toward paperless, workspaces, classroom interaction requires at least some level of interaction with computers (Eden et al., 2023c). Unfortunately, the main stakeholders in education are teachers (lecturers included) who do not use computers to teach (Itighise and Babayemi, 2018). The advent of computers and the internet has provided access to an almost boundless array of resources applicable to the learning environment (Eden, Akpan & Umanah, 2023). Consequently, the learning process increasingly necessitates proficiency in accessing, locating, extracting, evaluating, organizing, and presenting digital information using digital devices and skills.

In today's educational setting, the effective utilization of computer applications and digital resources (Eden, Lambert & Mbuk, 2024; Eden et al., 2023c) fosters a closer alignment of learning with the needs of students and facilitates a more straightforward teaching experience for instructors (Eden et al., 2023c). Nonetheless, despite the myriad advantages associated with computer applications in educational contexts, particularly in foundational science subjects such as Basic Science and Technology, student performance in this domain remains suboptimal. Evidence from Basic Education Certificate Examinations (BECE) results over recent years indicates that

students' learning outcomes in BST have been inadequate, with a significant proportion of successful students attributed to incidences of malpractice within educational institutions, as reported by the Chief Examiners for the Basic Education Certificate Examination (National Examination Council (NECO), 2022).

Academic achievement is regarded as a paramount component of the instructional experience, as it fundamentally influences the outcomes of the entire instructional process (Uko & Uko, 2024). The observed deficiencies in achievement have been linked to various factors, including challenges associated with digital practices and the professional application of diverse computer tools by educators, the incapacity of instructors to leverage various software applications in their teaching methodologies, insufficient digital operating skills, the scarcity of computer/software specialists, and the persistent reliance on traditional classroom environments that do not necessitate the integration of digital tools (Eden et al., 2024) for teaching and learning purposes. These factors collectively contribute to the unsatisfactory achievement levels in basic science.

A plethora of studies have offered valuable perspectives on the relationship between computer software applications and academic performance (Eden et al., 2024; Eden et al., 2023a&b; Youssef, Dahmani & Ragni, 2022; Murtafi, Hidayanto, & Setyo, 2019). For instance, Osuafor and Onoh (2021) investigate the effects of computer-based tutorials and drill-and-practice techniques on the academic achievements of secondary school students in computer studies. Additionally, Lasisi, Oti, Arowolo, Agbeyenku, and Ojoko (2021) examine the impact of innovative computer simulation instruction on students' academic performance in understanding difficult topics within the field of science. However, their inquiry did not explicitly aim to assess the application of digital packages such as computer simulations, tutorials, and flipped classrooms in enhancing students' academic success. Consequently, it is imperative at this juncture to identify the factors that cause the non-application of digital packages in the classroom and adopt a suitable pedagogy in teaching. This rationale underpins the present study, which is thus conducted to address the existing gaps by providing a more thorough examination of the roles of computer simulation, tutorials, and flipped classrooms in enhancing student's learning outcomes in secondary education.

The pedagogical approach of computer simulation constitutes an instructional strategy embedded in a computer program that leads to the creation of animated, interactive, game-like environments and connects real-life phenomena to science concepts (Lasisi, Oti, Arowolo, Agbeyenku & Ojoko, 2021). It is a method that exemplifies the dynamic behavior of a system by a hypothesized mathematical model, which is subsequently transformed into discrete algorithms for execution on computational devices (Seoane, Greca, and Arriassecq, 2020). The design of computer simulation aims to augment the

learning experience by visualizing and engaging with active representations of natural events. Computer simulations permit students to form and discover circumstances that could not be witnessed originally. Olorukooba, Sani & Kazeem (2016) observed that it is meant to repeat trials immediately and quickly change variables. Widiyatmoko (2018) argued that computer simulation can transfer dynamic information more precisely and help students to envisage several occurrences.

Computer tutorial teaching is a strategy that employs computational tools for educational purposes, facilitating an interactive engagement between learners and technology, thereby promoting comprehensive understanding and mastery of particular concepts, in stark contrast to conventional instructional methodologies (Etiubon, Etiubon & Akpan, 2021). The propensity for computer-based tutorials is witnessing an expeditious expansion, consequently providing educators with augmented opportunities for collaboration with learners. Increase in curiosity and consciousness among learners who engage with available educational tutorials and software that facilitates various learning methodologies. Students are granted the capability to structure and manage their learning pathways, as well as to discern essential skills and resources necessary for the attainment of educational goals. Ampuch, Hiranrat, Pimbaotham, and Singnam (2014) posited that adopting computer tutorials markedly improves student motivation, as it serves a pivotal function in furnishing timely feedback, including responses such as 'correct', 'incorrect', 'ok', 'no', and 'try again' to the learners. The constructive feedback provided to students serves as a pivotal mechanism that facilitates the rectification of any misconceptions or erroneous understandings about the inappropriate knowledge that they may have previously acquired, thereby enhancing their overall educational experience. This particular methodology, which integrates computer-based tutorials, endeavors to transition students away from the conventional and often monotonous lecture-based forms of instruction towards a more dynamic and innovative learning paradigm that actively engages them in the process. Such an approach is not only effective in traditional settings but is also highly relevant within the framework of the flipped classroom teaching strategy, which has garnered considerable attention in contemporary educational discourse.

## LITERATURE REVIEW

The flipped classroom teaching strategy, as conceptualized within the realm of pedagogical methodologies, represents a distinctive approach to blended learning that fundamentally changes conventional classroom setting through the delivery of the learning materials, frequently using virtual platforms, outside of the physical classroom setting (Gambari, Bello, Agboola, & Adeoye, 2016). In a comprehensive analysis conducted by Itighise and Umanah (2019), it was concluded that this innovative teaching strategy allows students to first familiarize themselves with the

core content at home, subsequently enabling them to engage in practical applications of that knowledge during in-person school sessions. This pedagogical reversal stands in stark contrast to the traditional educational practice where new material is typically introduced during class time, followed by homework assignments that students are expected to complete autonomously at home (Umoetuk and Akpan, 2024). The researchers further elucidate that within the flipped classroom framework, students are often encouraged to watch pre-recorded instructional videos at home, equipping them with both questions and a foundational understanding as they arrive at school to undertake their homework. This educational methodology can be characterized as one that fosters interactive group learning activities within the classroom while simultaneously allowing for direct, individualized computer-based instruction to be accessed externally, thus promoting greater student engagement and participation in the learning process.

Umoetuk and Akpan (2024) also elaborated on the flipped classroom teaching strategy, describing it as a combination of various pedagogical approaches that effectively merge the advantages and social interaction opportunities presented within the classroom environment with the technological advancements facilitated by online learning platforms. Efiuvwere and Fomsi (2019) assert that this particular approach significantly enhances student learning outcomes and bolsters essential social skills. Furthermore, the flipped classroom is known to actively encourage students to assume the role of active learners, in contrast to being passive recipients of information, thereby transforming the teacher's responsibility from merely dispensing information into becoming facilitators and architects of engaging learning activities.

Gender is another crucial variable that warrants consideration in this study. It is a socio-cultural construct that delineates certain characteristics and duties that are ascribed to individuals based on their identification as male or female within society. Numerous studies have established connections between gender-related issues and students' performance in various academic tasks, although these investigations have often yielded inconclusive results. The occurrence of gender disparity is understood as the systemic relationship of inequality that persists between males and females, which is particularly pronounced within the educational domain. A plethora of inconsistent findings have emerged regarding gender differences and their impact on academic performance (Eden et al., 2023; Eden et al., 2023a&b; Enemarie, Ogbeba & Ajayi, 2019; Babayemi and Ahmad, 2019; Babayemi, Ahmed, Yisau, & Babalola, 2016; Umanah & Sunday, 2022; Ugwuanyi, 2016). For example, Voyer and Voyer (2014) identified that male students achieved superior performance compared to their female counterparts in interactive physics, while Gambari, Folade, and Adegbenro (2014) ascertained that female students excelled over males when employing science process skills as their instructional approach. Nonetheless, in a divergent analysis,

Umanah and Akpan (2024) determined that gender did not exert a significant influence on the academic accomplishments of students. In light of the ambiguous nature of certain results, this study sought to systematically examine the influence of students' gender on academic achievement specifically when instructed on the concept of living organisms, with an emphasis on the pedagogical strategies employed and the resultant learning outcomes in Basic Science and Technology within the Eket Local Government Area, Akwa Ibom State.

Utilizing computer applications and digital platforms facilitates a closer engagement between learners and the educational content, thereby rendering the pedagogical process more efficient and accessible for educators. Nonetheless, despite the numerous advantages associated with the incorporation of computer applications within the educational paradigm, particularly in foundational science disciplines such as BST. The learning outcomes of learners within this domain continue to be suboptimal. Evidence derived from the results of the Basic Education Certificate Examinations (BECE) spanning from 2020 to 2023 indicates a persistent inadequacy in the performance of students in BST, showing a notable proportion of successful candidates attributed to incidences of malpractice within educational institutions (NECO Chief Examiners' reports on Basic Education Certificate Examination, 2023). The lackluster achievement can be ascribed to various factors, including the challenges associated with digital practices, the insufficient expertise in employing diverse computer tools by educators, and the teachers' inability to effectively utilize various software applications in their instructional methodologies, compounded by a deficiency in both digital operational skills and the availability of computer/software specialists, as well as a shortfall in technological apparatus necessary for skills development, among other contributory elements. While considerable emphasis has been directed toward the qualifications of teachers and the lack of student commitment to their academic pursuits due to distractions that impede learning, scant attention has been afforded to the efficacy of a computer-based learning environment. This learning environment, which includes virtual, online, remote, and blended modalities that facilitate equitable access to high-quality educational resources and technologies, and foster a connection between students and technological devices within the classroom, has been largely overlooked by both educators and researchers. The pertinent inquiry at this juncture is whether the implementation of computer simulations, tutorials, and flipped classroom methodologies enhances the learning outcomes of learners in BST. Furthermore, the BST curriculum currently lacks provisions for the incorporation of computer-based pedagogical approaches, thereby engendering a gap in utilization that subsequently contributes to subpar student performance in this subject area. Several investigations have been conducted regarding the application of various computer-based strategies in isolation; however, based on the information available to the researchers, a lack of research focusing on the interplay between specific teaching

strategies (namely computer simulation, tutorials, and flipped classrooms) and student learning outcomes in BST exist within Eket Local Government Area. Consequently, there exists a pronounced necessity for the present investigation to address this gap.

## RESEARCH OBJECTIVES

1. Ascertain the mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorial, and flipped classroom.
2. Ascertain the difference in mean achievement scores of male and female BST students taught the concept of living and non-living things.

## RESEARCH QUESTIONS

1. What are the mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorial, and flipped classroom?
2. What is the difference in the mean achievement scores of male and female BST students taught the concept of living and non-living things?

## RESEARCH HYPOTHESES

1. There is no significant difference in the mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorials, and flipped classroom teaching strategies.
2. There is no significant difference in the mean achievement scores of male and female BST students.

## RESEARCH METHODOLOGY

Quasi-experimental design of pretest-posttest control group design was used. Eket Local Government Area was used as the area of study. The population study consisted of 1663 Junior Secondary Two (JS2) BST students from ten (10) public secondary schools in the study area. The sample of the study consisted of 131 (55 males and 76 females) selected from 3 coeducational schools. A purposive sampling technique was employed in selecting 3 schools in the study area. The three schools were assigned experimental Groups 1, 2, and control groups. “Basic Science and Technology Achievement Test (BSTAT)” was the instrument used for data collection. The BSTAT is a 50-item, 4 multiple-choice (A-D) test on the concept of "Living and Non-Living Things". The instrument was vetted by two (2) Integrated Science Education lecturers and an expert in measurement and evaluation in the Department of Science Education at Akwa Ibom State University for validation. The instrument was trial tested using a sample of 30 Junior Secondary Two (JS2) BST students. The scores were analyzed using the Kuder-Richardson formula (K-R20) and a reliability coefficient of 0.81 was obtained. Data obtained was coded and analysis was done using mean and standard deviation to answer research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 probability level of significance.

## DATA ANALYSIS AND RESULTS

**Research Question One**: What is the difference in the mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorial, and flipped classroom?

**Table 1:** ***Mean and standard deviation of mean achievement scores of students on pretest-posttest based on teaching strategies***

| Teaching Strategies | N | Pretest | | Posttest | | Mean Difference |
|---|---|---|---|---|---|---|
| | | Mean | Sd | Mean | Sd | |
| Computer Simulation | 43 | 28.09 | 8.54 | 64.88 | 13.30 | (1.6)(5.05) |
| Computer Tutorial | 40 | 28.15 | 9.39 | 63.28 | 16.59 | (-1.68)(3.45) |
| Flipped Classroom | 48 | 28.79 | 7.88 | 59.83 | 13.69 | (-5.05)(-3.45) |

The result in Table 1 reveals that the pretest mean scores of students taught the concept of living and non-living things using computer simulation, tutorial, and flipped classroom are 28.09, 28.15, and 28.79 with standard deviations of 8.54, 9.39, and 7.88 respectively. The posttest mean scores accordingly were 64.88, 63.28, and 59.83 with their standard deviation scores of 13.30, 16.59, and 13.69 respectively. Furthermore, the mean difference scores show that the computer simulation group had a mean difference of 1.6 and 5.05 against those in the computer tutorial and flipped classroom while those in the computer tutorial group had a mean difference of -1.68 and 3.45 against those in the computer simulation and flipped classroom and those in flipped classroom group had the mean difference of -5.05 and -3.45 against those in computer tutorial and computer simulation. This result implies that students in the computer simulation group had higher mean achievement scores and mean differences than those in the computer tutorial and flipped classroom.

**Research Question Two**: What is the difference in the mean achievement scores of male and female BST students taught the concept of living and non-living things?

**Table 2:** ***Mean and standard deviation of mean achievement scores between male and female students on pretest-posttest scores based on teaching strategies***

| Gender | N | Pretest | | Posttest | | Mean difference |
|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | |
| Male | 55 | 28.4 | 7.61 | 58.2 | 16.4 | -1.0 |
| Female | 76 | 28.3 | 9.17 | 59.2 | 15.5 | |

Table 2 shows the result of the pretest and posttest mean achievement scores of males and females in all the groups taught living and non-living things concepts. The result reveals that the pretest score of males was 28.4 while the pretest of the female

counterparts was 28.3. The posttest result revealed that the mean achievement scores (58.2) of males were less than the posttest mean achievement scores (59.2) for females. This was observed with a remarkable mean difference of -1.0 indicating that the female gender in all groups achieved academically better than the male gender in all groups.

**Hypothesis One:** There is no significant difference in mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorials, and flipped classroom teaching strategies.

**Table 3:** ***Analysis of Covariance (ANCOVA) on the difference in mean achievement scores of BST students taught the concept of living and non-living things using computer simulation, tutorial, and flipped classroom***

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 5633.933[a] | 3 | 1877.978 | 8.850 | .000 |
| Intercept | 36642.059 | 1 | 36642.059 | 172.667 | .000 |
| PreBSTAT | 17.046 | 1 | 17.046 | .080 | .777 |
| Teaching Strategies | 5632.337 | 2 | 2816.168 | 13.270* | .000 |
| Error | 26951.014 | 127 | 212.213 | | |
| Total | 490959.000 | 131 | | | |
| Corrected Total | 32584.947 | 130 | | | |

a. R Squared = .173 (Adjusted R Squared = .153); *p<.05

Table 3 presents findings derived from the Analysis of Covariance (ANCOVA) regarding the disparities in mean achievement scores among BST students instructed on the concept of living and non-living things through the utilization of computer simulation, tutorials, and flipped classroom teaching strategies. Findings indicate a statistically significant difference in mean achievement scores of BST students instructed via computer simulation, tutorial, and flipped classroom teaching strategies $\{(F_{2,\ 127}) = 13.27,\ p = 0.000.\}$. Therefore, the null hypothesis is dismissed at a significance level of 0.05.

**Hypothesis Two:** There is no significant difference in the mean achievement scores of male and female BST students.

**Table 4:** ***Result of Analysis of Covariance (ANCOVA) on the difference in mean achievement scores of male and female BST students based on teaching strategies***

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 94.506[a] | 2 | 47.253 | .186 | .830 |
| Intercept | 36870.263 | 1 | 36870.263 | 145.255 | .000 |
| PreBSTAT | 1.771 | 1 | 1.771 | .007 | .934 |
| Gender | 92.910 | 1 | 92.910 | .366* | .546 |
| Error | 32490.440 | 128 | 253.832 | | |
| Total | 490959.000 | 131 | | | |
| Corrected Total | 32584.947 | 130 | | | |

R Squared = .003 (Adjusted R Squared =.013); *p>.05

Table 4 presents the findings from the Analysis of Covariance (ANCOVA) concerning the difference in the mean achievement scores of male and female students enrolled in BST across all three strategies. The result showed computed p-value (.546) associated with gender exceeds the threshold of 0.05, {($F_{1, 128}$) = .366, p=.546}. This suggests that there is no statistically significant difference in the mean achievement scores between males and females in BST. Consequently, this second null hypothesis is upheld at the 0.05 level of significance.

## DISCUSSION

The investigation of the outcomes concerning disparity in mean achievement scores among BST students instructed in living and non-living things concepts through utilizing computer simulation, tutorial, and flipped classroom pedagogical strategies indicated that students within the computer simulation cohort exhibited superior achievement levels compared to those receiving instruction via computer tutorials, while the latter group outperformed those engaged in the flipped classroom approach. The observed superiority in achievement associated with the utilization of computer simulations can be attributed to the integrative characteristics of such simulations, which synthesize visual and interactive pedagogical approaches, promote the practical application of learned knowledge, and provide an efficient representation of real-world phenomena. Findings obtained from the ANCOVA analysis highlighted a statistically significant difference in mean achievement scores among students of BST who were instructed on the concepts of living and non-living entities through the employment of computer simulation, tutorial, and flipped classroom teaching strategies.

The results of the research indicated a statistically significant variance in the mean achievement scores of students enrolled in BST who were instructed on living and non-living entities through the utilization of computer simulation and flipped classroom pedagogical strategies. Moreover, a discernible discrepancy in mean achievement scores was identified between BST students who were educated on the principles of living and non-living things via computer tutorials and those who participated in the flipped classroom instructional format. These findings corroborate the investigation conducted by Omoedu, Adolphus, and Agbigo (2022), which concluded that learners who were taught utilizing the computer simulation methodology demonstrated superior performance when compared to their counterparts who received instruction through conventional lecture formats. Furthermore, these results are in agreement with the assertions made by Ojo (2020), who argued that the computer simulation instructional approach significantly enhanced students' performance in basic science.

The evaluation of the results on the difference in mean achievement scores between males and females instructed in living and non-living things concepts by using computer simulation, tutorial, and flipped classroom teaching strategies revealed that the computer simulation group performed academically superior compared to those in computer tutorial and flipped classroom groups, while those in the computer tutorial outperformed those in the flipped classroom based on gender. Findings gleaned from ANCOVA analysis indicated the absence of a statistically significant difference in the mean achievement scores between males and females in the concepts of living and non-living things through computer simulation, tutorials, and flipped classroom teaching modalities. This lack of significant difference is attributed to the dynamic engagement of both males and females throughout the treatment. This outcome supports the assertions made by Enderly and Leanne (2016), who discovered that gender does not constitute a significant determinant of students' achievement in science, positing that males and females can achieve comparably when afforded equal opportunities alongside appropriate teaching and learning processes. This notion is further corroborated by Umanah and Sunday (2022) and Eden et al. (2023a, b, and c), who indicated that males/females exerted no significant influence on students' achievement and that the observed interaction was not significant.

The implementation of computer simulation and computer tutorials has been shown to facilitate superior student learning outcomes in BST compared to the flipped classroom model. This finding implies that the learning outcome in BST is significantly influenced by the teaching strategies employed. There exists no discernible gender disparity in the academic achievements of males and females when utilizing computer simulation, computer tutorials, and the flipped classroom approach. Consequently, it can be asserted that computer simulation and computer tutorials

represent profoundly effective pedagogical strategies that promote meaningful engagements that improve students' learning outcomes despite gender variations. Thus, teaching strategies exert a substantial impact on students' academic achievement in BST. These findings thus underscore the critical role of teaching strategies in shaping students' academic outcomes while simultaneously affirming their inclusivity across genders.

## RECOMMENDATIONS

1. Students should be made to use the opportunities these strategies provide to better their understanding of concepts and improve their digital skills, which are essential for academic success and future endeavors.
2. Teachers should adopt technology-based teaching strategies such as computer simulation, and tutorials for effective teaching of concepts in BST.
3. Educational planners should help provide computer software packages and equipment in schools for the teaching and learning process in other to bring about effective lesson delivery.
4. Curriculum planners/developers should pay more attention to curriculum design by integrating strategies such as the curriculum more computer and technological-based to improve the delivery of science content.
5. The government and the Ministry of Education should provide funds for the provision of equipment and other computer devices in schools to enhance teaching and learning.

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