Volume: 1, Issue: 4
Page: 11-24
YEAR: 2021

ISSN: 2184-9692 (Online), 2184-9706 (Print)
EURO GLOBAL CONTEMPORARY STUDIES JOURNAL (EGCSJ.COM)

Effect of Instructional Simulation Strategy On Students' Academic Performance in Biology in Ondo State Secondary Schools

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Abstract

This study investigated the effect of Instructional Simulation (INS) strategy on students' academic performance in Biology in Ondo state secondary schools. This study adopted a pre-test, post-test, control group quasi experimental design in which two groups (one experimental group and one control group) were involved. The population of the study comprised all S.S.S. 2 students offering Biology in all the public secondary schools in Ondo State, Nigeria. The sample consisted of class intact size (students offering Biology) drawn from 4 public secondary schools in Ondo State. The sample was selected using multistage sampling procedure. Biology Achievement Test (BAT) was used to collect relevant data for this study. The face and content validity of the instruments were ensured by experts in Tests and Measurement and Biology Education. The reliability of the instrument was established using internal consistency method which yielded reliability co-efficient of 0.81 for BAT. The study was carried out in three phases namely pre-treatment, treatment and post treatment Stage**.** The data collected for this study were analyzed using descriptive and inferential statistics. The findings of this study revealed that the use of Instructional Simulation strategy enhanced better performance of students in Biology than the conventional method. It was also revealed that Instructional Simulation strategy is not gender biased. It was recommended among others that Biology teachers should be given adequate orientation through in-service training to update their knowledge in the use of Instructional Simulation strategy in teaching.

E.G.C.S.J
Accepted 25 October 2021
Published 30 October 2021
DOI: 10.5281/zenodo.5771557

Keywords: Instructional Simulation, Academic Performance, Biology,

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Introduction

One of the objectives of Science Education is to develop students' interest in Science subjects. Biology, in particular is central to many of the scientific fields of human endeavours and its teaching should be given a serious attention. Biology is the science which studies living things and concerns itself with the study of the structure, behaviour, distribution, the origin of plants and animals and their relationship with their environments. The study of Biology helps in the appreciation and enjoyment of nature and life. In addition, it prepares students for professional careers in such fields, as, medicine, bio-technology, agriculture and pharmacy. This implies that Biology is an important science subject needed for higher education in virtually all the science related professions, such as, Medicine, Pharmacy, Agriculture, Engineering, Food and Nutrition. Hence, Biology occupies a unique position in the Secondary School Education Curriculum.

It has been observed that Biology is a preferred science subject among senior secondary school students because it has less mathematical calculations unlike Physics and Chemistry. Therefore, Biology often has a higher enrolment figure of students in external examinations, such as, the West African Senior School Certificate Examination (WASSCE) and National Examination Council Senior Certificate Examination (NECO SSCE) more than Physics and Chemistry. It is also a popular subject for prospective medical, engineering and agricultural students.

The performance of Nigerian students in the subject at the secondary school remains not encouraging (Opara, 2016). Reports have shown that the Senior Secondary School Biology results in WASSCE and NECO SSCE in the last ten years (2010-2019) in Nigeria were generally not encouraging. For instance, WAEC Chief Examiner Report (2016) showed that only 25.62%, 34.10%, 36.02%, 48.81%, 43.19% and 49.66% of the students who sat for Biology examinations obtained credit passes and above in 2010, 2011, 2012, 2013, 2014 and 2015 respectively. The Report, which covered a period of ten years (2010 - 2019), clearly showed that the percentage of candidates that passed Biology at credit level and above in Ondo State was below 39%.

One of the major contributory factors for this under-achievement in Biology examination by students is linked to the use of conventional method in the teaching of secondary school Biology. This conventional method of teaching has been reported to dwell more on the transmission of knowledge in a manner that emphasizes memorization and has been criticized as a poor method of teaching Biology and other science subjects because it involves unidirectional flow of information/knowledge from the teacher to the students (Robert, 2011).

The quest to curtail the shortcomings of the conventional method used in teaching and learning of Biology led to the discovery of other innovative teaching methods, such as, the inquiry method, instructional simulation, blended learning, concept mappings, simulations and games, spaced-learning, problem based learning among others (Opara, 2011). These innovative methods are considered as effective teaching methods that can improve students' performance and interest in Biology.

Simulation is conceived as a representation of the behaviour or characteristics of a system through the use of another outlet especially a computer programme designed for the purpose (Krulik, 2010). Simulation is a tool that facilitates learning through representation and practice in a repeatable, focused environment (Awodun 2010). Simulation means imitation of situation or process. Simulation is otherwise known as 'the act of pretending or

deception'. Simulation involves the use of model- a simplified version of reality which reduces the complexity of a real-life situation, taking from reality only those essential features of the learning objectives (Awodun, 2010).

It can mean making replicas or representations of machines for demonstration or analysis of problems but clearly illustrates real life or hypothetical situations. Simulation is used with the aid of computer to simplify real life situation and this could aid to manage the class, support reluctant learners, stimulate gifted children and ease administration.

Simulation helps students to identify and understand factors which control the system and or predict the future behaviour of a system. It can also bring into the classroom situation, aspects of the world or universe that are too expensive, dangerous, abstract, difficult or too slow or too fast in occurrence to be comprehended. The use of simulations in the teaching and learning of Biology could help the understanding of abstract and difficult concepts by allowing students to develop their own understanding. Umoke and Nwafor (2014) observed that the use of simulations to teach science gives positive results over time and permits the learner to manipulate variables or parameters and then observe the consequences of their actions.

Instructional simulation includes instructional elements that help a learner explore, navigate or obtain more information about that system or environment that cannot generally be acquired from mere experimentation. Instructional simulations combine visual and interactive learning experiences, promotes application of knowledge, and provides a simplified representation of real world systems (Eskrootchi & Oskrochi, 2010).

Simulation could be in form of role plays, games, computer programmes that encourage students to become active participants in Biology classroom. Simulation can be inferior, substitute, imitating an original or a display of not real behaviours. Instructional simulation in teaching and learning of Biology helps understanding of abstract and difficult concepts by allowing the students to experiment on the variables that form the concept. Instructional simulation helps students to develop their own understanding of Biology concepts.

The integration of instructional simulation in Biology classrooms can provide an effective learning environment for students to enhance their Biology skills by engaging them with "real world" conditions to make the abstract concepts concrete and clear. In this way students could have a meaningful and retentive learning and they will be much more ready for their future education life such as university education or their professional life. The instructional simulation environment provides a platform to apply the knowledge in a given situation and their interactions results in the discovery of new knowledge that will help cognitive domain development and the accumulation of knowledge (Shama, 2011).

Therefore, the present study investigates the effect of Instructional Simulation (INS) strategy on students' academic performance in Biology in Ondo state secondary schools.

The study specifically examined:

i. the student's performance before and after exposure to Instructional Simulation (INS) strategy in Biology;
ii. difference between the performance of students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method;
iii. difference between the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy; and

iv. difference in male and female students' academic performance after being exposed to Instructional Simulation (INS) and the conventional method.

Research Questions

The following research questions were raised to guide the study:

1. What is the student's performance before and after exposure to Instructional Simulation (INS) strategy in Biology?
2. What are the performances of male and female students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method

Research Hypotheses

The following null hypotheses were generated for this study.

1. There is no significant difference between the performance of students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method.
2. There is no significant difference between the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy.
3. There is no significant difference in male and female students' academic performance after being exposed to Instructional Simulation (INS) strategy and the conventional method.

Literature Review

Biology plays a vital role in the field of biochemistry, medicine, physiology, ecology, genetics, and molecular biology and, as such, biology has been made a central focus in most human activities including being a solution to the problem of food scarcity, health, hygiene, family life, poverty eradication, management and conservation of natural resources, biotechnology, ethics, various social vices and as well lack of appropriate infrastructural materials.

Biology is one of the science subjects that senior secondary students offer in senior secondary certificate examinations in Nigeria (FRN, 2013). Interestingly, it is a popular subject among students and its popular nature among other science subjects has made it a distinct choice for all students (Lawal, 2011). Biology is a very important science subject and a requirement for further studies of other science related professional courses such as medicine, agriculture, pharmacy, biotechnology, genetic engineering, etc. Biology is the key to economic, intellectual, sociological, human resource development and well-being of any society. It is of importance in many ways for both individual and societal development as seen in biotechnology and genetic engineering (Lawal, 2011). Based on these assertions on the importance of biology, there is need for it to be properly taught in the secondary schools to improve students' achievement in the subject.

The word simulation comes from Latin word 'similis' meaning 'like', that is, to act like, to resemble, or to pretend to be. Additionally, the format of simulations ranges from computerized games to elaborate, role-playing scenarios (Moore, 2009). Simulations give students the chance to apply theory, develop critical skills, and provide a welcome relief from the everyday tasks of reading and preparing for classes (Awodun, 2010).

An additional benefit of simulation is the introduction of an aspect of realism into the students' experience. Simulation is an educational tool where students learn through the application of theory and decision-making to a simulated real-world business scenario. The use of simulation techniques where students are allowed to project themselves into new classroom roles helps to improve classroom dialogue, active participation and transfer of learning.

According to Awodun (2010), simulations can be classified as follows:

1. *Physical Simulation:* Here the physical object is presented on a screen and the students learn about it.
2. *Process Simulations:* Processes that are not visible can be demonstrated using simulation.
3. *Procedural Simulations:* Here procedures are followed in order to understand sequence of events.
4. *Situational Simulations:* This has to do with attitudinal and behavioural changes of people. The students use this simulation to explore the effects of different approaches to a problem.

According to Awodun (2010), simulation has three types namely:

1. *Life Simulation:* This shows human behaviour in real life.
2. *Virtual Simulations:* Simulation occurs in a computer controlled setting. For example a pilot flying air craft but is controlled from the control room.
3. *Constructive Simulations:* This does not involve humans or equipment but by proper sequencing of events.

The use of simulation techniques in instruction at different levels has been reported to be of high motivational value by researchers (Chauham, 2009). This is one of the most distinctive features of simulation which makes it acceptable at all levels of teaching because if any teaching technique succeeds in creating motivation in learners all other problems may be drastically reduced (Chauham, 2009). The use of simulation techniques where students are allowed to project themselves into new classroom roles helps to improve classroom dialogue, active participation and transfer of learning (Watson in Awodun, 2010).

Balleck (2012) reported that the use of active learning in the form of simulations, student presentations, and problem-solving situations will better prepare students to understand. Although researches have stated the positive effect that the use of active learning through simulation techniques has upon knowledge acquisition (Rising, 2009), professionals involved in education at all levels are still struggling to make sure that this acquisition, introducing active methodologies in the classroom, turns into understanding and retention so that formal instruction becomes a precursor to life-long learning (Crostom in Yusuf, 2010).

Instructional simulation is therefore a program of instruction presented by means of a computer or computer systems. Most recent, some computer software integrates features that encourage activities beyond the simple drill-and-practice, such as simulations, graphing and even modeling (Benson, 2011; Barot, 2009; Yusuf, 2010). Instructional simulation is central in the field of Educational Technology as it makes use of computers and software applications to teach concepts or skills.

Computer as instructional material has made a significant contribution to a wide range of group-learning activities. They can, for example, be used to manage or structure a group-learning process, by guiding the group through a simulation exercise of some sort. This can provide a vehicle through or with which a group of learners interact, and gain access to information, investigate simulated situations, which can lead to creativity. Learners in groups thus, do not only benefit from feedback they receive from the computer, but also from the feedback they receive from one another.

Instructional simulations combine visual and interactive learning experiences, promotes application of knowledge, and provides a simplified representation of real world systems (Eskrootchi & Oskrochi, 2010). Instructional simulation is used with the aid of

computer to simplify real life situation (simulation) and this will aid to manage the class, support reluctant learners, stimulate gifted children and ease administration. Simulation employs selected aspects of a real-life situation.

Instructional simulation can be applied to Biology by providing real life settings for the application of biological concepts. Instructional simulation in teaching and learning of Biology helps the understanding of abstract and difficult concepts by allowing the students to experiment on the variables that form the concept. Instructional simulation helps students to develop their own understanding of Biology concepts.

It appears that the integration of instructional simulation in Biology classrooms can provide an effective learning environment for students to enhance their Biology skills by engaging them with "real world" conditions to make the abstract concepts concrete and clear. In this way students could have a meaningful and retentive learning and they will be much more ready for their future education life. The instructional simulation environment provides a platform to apply the knowledge in a given situation and their interactions results in the discovery of new knowledge that will help in cognitive domain development and the accumulation of knowledge (Shamai, 2011).

Some studies have shown a real impact of instructional simulation on students' achievement. Umoke and Nwafor's (2014) summary of result revealed that simulated instructional approach fostered higher achievement in biology than the conventional approach while Akinsola (2007) concluded that the teachers' use of stimulating teaching methods would go a long way in sustaining and motivating students interest in learning Mathematics. Ezeudu and Ezinwanne (2013) showed that simulation increased students' achievement in Chemistry more than the conventional method.

Brown and Liedholm (2002) surveyed students in a matched pair of multimedia and conventional concept of biological course taught by the same teacher. They reported that exam scores, after taking into account differences in student characteristics, were approximately 6% higher for the conventional format than for the multimedia format. They attributed the relatively better performance in the conventional classes to the benefit of in-person teacher-student interactions, and attributed the relatively poorer performance of the students in the online class to the lack of self-discipline necessary for successful independent learning in the online environment.

Fuchs and Woessman (2004) used international data from the Programme for International Student Assessment (PISA). They showed that while the bivariate correlation between the availability of instructional simulation and students' performance was strongly and significantly positive, the correlation became small and insignificant when other student environment characteristics were taken into consideration.

Gambari (2010) pointed out that instructional simulation presented information in a non-linear style, allowing students to explore new information via browsing and cross-referencing activities. Secondly, instructional simulation teaching supports active learning processes emphasized by constructivist theory. Thirdly, instructional simulation education has enhanced understanding through improved visualization and finally, the convenience, it could be used any time, at any place".

Nkweke, Dirisu, and Umesi (2012) in their research opined that, effective and efficient use of instructional simulation in teaching and learning offers both audio and visual messages or information and these appeals to sense of sight and hearing, simultaneously. Students feel a sense of reality in what they learn and a lot of frustrating situations can be avoided if

teachers use relevant synchronized simulation during instructional development, among other efforts (Hoska, 2009).

Computer simulations can significantly affect and improve attitude of students towards Biology and be effectively used as instructional method in Biology classroom (Nireti, Morenike & Joyce, 2014). Computer simulations brings about students' interest and involvement in the learning process, foster retention of information and offers opportunities for affective and behavioural learning (Guy & Lownes-Jackson, 2015).

Methodology

This study adopted a pre-test, post-test, control group quasi experimental design in which two groups (one experimental group and one control group) were involved. The population of the study comprised all S.S.S. 2 students offering Biology in all the public secondary schools in Ondo State, Nigeria. The sample consisted of class intact size (students offering Biology) drawn from 4 public secondary schools in Ondo State. The sample was selected using multistage sampling procedure.

Biology Achievement Test (BAT) was used to collect relevant data for this study. BAT was self-designed by the researcher and measured students' academic performance in Biology. It consisted of sections A and B. Section A sought for the bio-data of the respondents while Section B consisted of 40 objectives items with four options.

The face and content validity of the instruments were ensured by experts in Tests and Measurement and Biology Education. The reliability of the instrument was established using internal consistency method which yielded reliability co-efficient of 0.81 for BAT. The study was carried out in three phases namely pre-treatment, treatment and post treatment Stage**.** The data collected for this study were analyzed using descriptive and inferential statistics. The research questions were answered using means and standard deviation. All the hypotheses were tested using t-test. All the hypotheses were tested at 0.05 level of significance.

Results

Research Question 1: What is the student's performance before and after exposure to Instructional Simulation (INS) strategy in Biology?

Table 1: Mean and standard deviation of pre-test and post-test scores of students exposed to INS and conventional methods

Strategies	**Test**	**N**	**Mean**	**S.D**	**Mean Diff.**
INS	Pre Test	74	12.28	0.91	**20.38**
	Post Test		32.66	1.67	
Conventional	Pre Test	77	12.22	0.90	**11.65**
	Post Test		23.87	1.66	
Total		**151**			

From Table 1, it is shown that the mean difference in students' performance in Biology between pre-test and post-test scores for INS method is 20.38 and conventional method is 11.65. It appears that the use of Instructional Simulation (INS) and conventional methods influences students' performance in Biology with INS method being the more effective method in the teaching of Biology. The graphical representation below further shows the more effective method in the teaching of Biology.

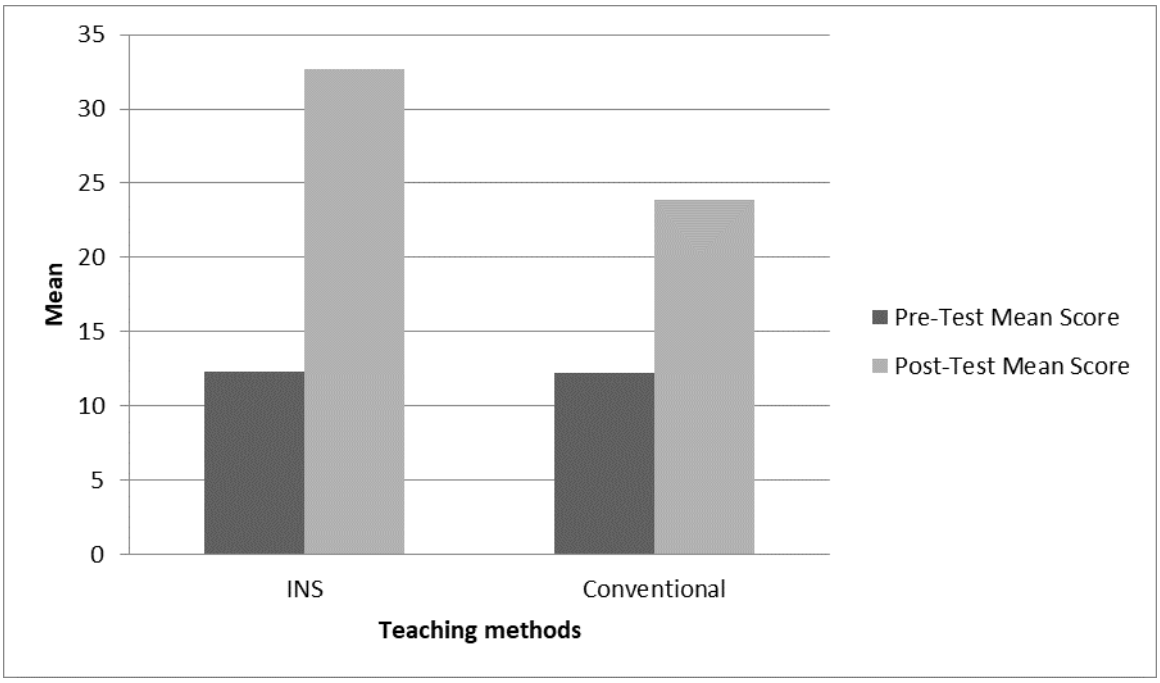

Figure i: Pre-test and Post-test mean scores of students exposed to INS and conventional methods

Research Question 2: What are the performances of male and female students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method?

Table 2: Mean and standard deviation of performances of male and female students exposed to INS strategy and conventional method

Strategies	Gender	N	Mean	S.D	Mean Diff.
INS	Male	36	32.56	1.75	**0.20**
	Female	38	32.76	1.62	
Conventional	Male	41	24.46	1.52	**1.27**
	Female	36	23.19	1.56	
Total		**151**			

From Table 2, it is shown that the gender difference in students' performance in Biology for INS method is 0.20 in favour of female students and conventional method is 1.27 in favour of male students. The graphical representation below further shows the gender difference in performance.

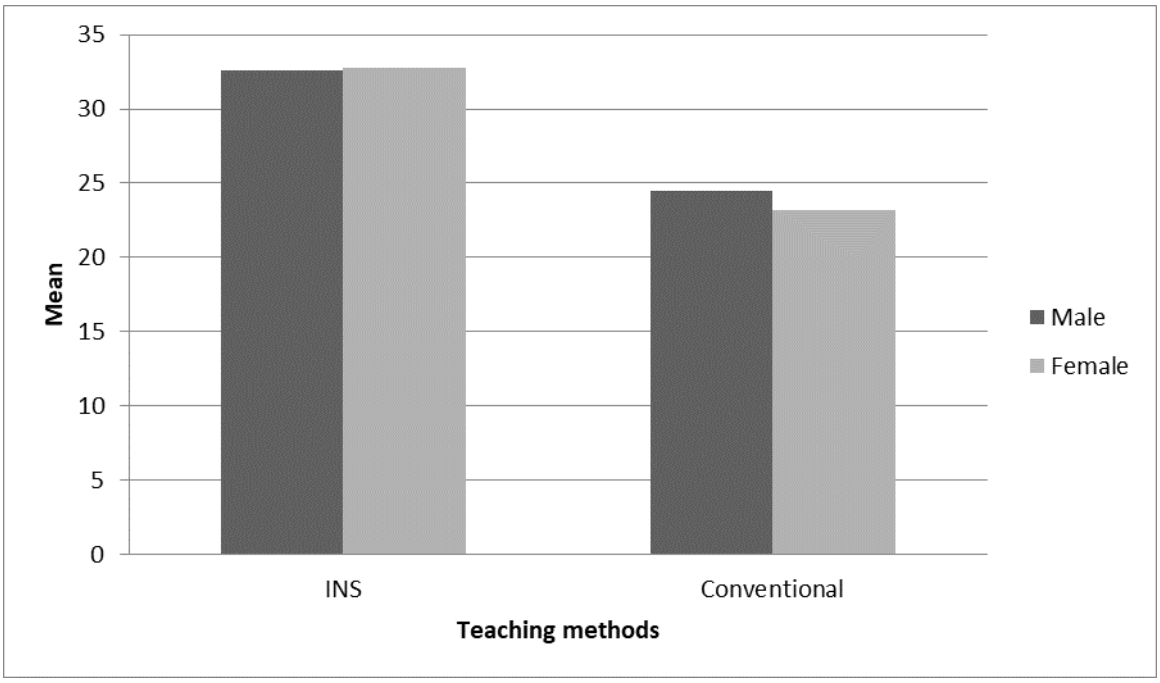

Figure ii: Gender difference in performance of students exposed to INS and conventional methods

Testing of Hypotheses

Hypothesis 1: There is no significant difference between the performance of students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method

Table 3: t-test analysis for difference between the performance of students in Biology exposed to INS and Conventional method

Variations	N	Mean	SD	df	t_{cal}	P
Instructional Simulation	74	32.66	1.67	149	32.428*	0.000
Conventional Method	77	23.87	1.66			

*P<0.05

Table 3 shows that the t-cal value of 32.428 is significant at 0.05 level of significance because the p-value (0.000) <0.05. This implies that null hypothesis is rejected. Hence, there is significant difference between the performance of students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method in favour of students exposed to Instructional Simulation (INS) strategy.

Hypothesis 2: There is no significant difference between the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy.

Table 5: t-test analysis for difference in the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy

Variations	N	Mean	SD	Df	t_{cal}	P
Pre-test	74	12.28	0.91	146	91.905*	0.000
Post-test	74	32.66	1.67			

*P<0.05

Table 5 shows that the t-cal value of 91.905 is significant because the P value (0.000) < 0.05. This implies that null hypothesis is rejected. Hence, there is significant difference

between the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy. The mean score showed a significant difference of 20.38.

Hypothesis 3: There is no significant difference in male and female students' academic performance after being exposed to Instructional Simulation (INS) strategy and the conventional method.

Table 6: t-test analysis for gender difference in academic performance of students exposed to Instructional Simulation (INS)

Variations	N	Mean	SD	Df	t_{cal}	P
Male	36	32.56	1.75	72	0.531	0.597
Female	38	32.76	1.62			

P>0.05

Table 6 shows that the t-cal value of 0.531 is not significant because the P value (0.597) > 0.05. This implies that null hypothesis is not rejected. Hence, there is no significant gender difference in academic performance of students exposed to Instructional Simulation (INS).

Table 7: t-test analysis for gender difference in academic performance of students exposed to conventional method

Variations	N	Mean	SD	Df	t_{cal}	P
Male	41	24.46	1.52	75	3.608*	0.001
Female	36	23.19	1.56			

*P<0.05

Table 7 shows that the t-cal value of 3.608 is significant because the P value (0.001) < 0.05. This implies that null hypothesis is rejected. Hence, there is significant gender difference in academic performance of students exposed to conventional method. The mean score showed a significant difference of 1.27 in favour of male students.

Discussion

The findings of the study revealed that there was significant difference between the performance of students in Biology exposed to Instructional Simulation (INS) strategy and the conventional method in favour of students exposed to Instructional Simulation (INS) strategy. The study likewise revealed that there was significant difference between the pre-test and post-test mean score of students exposed to Instructional Simulation (INS) strategy. Computer simulations can significantly affect and improve performance of students towards Biology and be effectively used as instructional method in Biology classroom (Nireti, Morenike &Joyce, 2014). Simulation is used with the aid of computer to simplify real life situation (simulation) and this helped to manage the class, support reluctant learners, stimulate gifted children and ease administration. Computer simulations brings about students' interest and involvement in the learning process, foster retention of information and offers opportunities for affective and behavioral learning (Guy & Lownes-Jackson, 2015).

It was however revealed that there was no significant gender difference in academic performance mean scores of students exposed to Instructional Simulation (INS). Dauda (2015) and Adoke (2015), on the effect of instructional simulation technique on students' academic performance and attitude found that instructional simulation technique was more effective in comparison to other teaching techniques of teaching and not gender biased. The finding of this study is quite interesting in the sense that there was no interaction and no cause to separate biology instruction along gender lines. The finding is also in line with that of

Maduagwuna (2012), Fayombo et al (2012) and Olariwaju (2007). These studies reveal no interaction between method and gender on students mean achievement scores. This is an indication that simulation approach is not only efficacious but also cost effective in science classrooms.

Conclusion

Based on the findings of this study, it could be concluded that, the use of Instructional Simulation strategy enhanced better performance of students in Biology than the conventional method. In addition, Instructional Simulation strategy is not gender biased.

Recommendations

Based on the findings of this study, the following recommendations were made.

1. The use of Instructional Simulation strategy should be encouraged in Biology class in secondary schools so as to enhance better academic performance of students in Biology.
2. Biology teachers should be given adequate orientation through in-service training to update their knowledge in the use of Instructional Simulation strategy in teaching.

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Cite this article:

Author(s), AKINWUMI, Ibukun Omolara, Prof. S.O. Adodo, (2021). "Effect of Instructional Simulation Strategy On Students' Academic Performance in Biology in Ondo State Secondary Schools". **Name of the Journal:** Euro Global Contemporary Studies Journal, (EGCSJ.COM), P, 11- 24. **DOI**: http://doi.org/10.5281/zenodo.5771557 , Issue: 4, Vol.: 1, Article: 2, Month: October, Year: 2021. Retrieved from https://www.egcsj.com/all-issues/

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