IMPACT OF GENDER ON STUDENTS' INTEREST AND ACHIEVEMENT IN BIOLOGY IN TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT

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Abstract

The study examined the impact of gender on students' interest and achievement in biology in a technology-enhanced learning environment (TELE). Two research questions and two null hypotheses guided the study. The study employed a quasi-experimental research design. The population of the study consisted of 191 first-year students (43 males, 148 females) of Biology Education in five federal universities in Southeast Nigeria. The sample consisted of 172 first-year students (38 males, 134 females) from three federal universities in the population of the study. Intact classes were used for the study. The treatment and test instruments were an Instructional Computer Animation Package, a Biology Achievement Test (BAT), and a Biology Interest Scale (BIS). The instruments were validated and trial-tested. Reliability coefficients of 0.8 and 0.70 were established for BAT and BIS respectively. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance. The result revealed that TELE had a significant positive effect on both male and female students' interest and achievement in biology. However, male students had statistically higher interest than female students while female students had higher achievement mean scores than male students. The difference was not statistically significant. Based on the findings, it was recommended that TELE be adopted by lecturers in teaching abstract and complex processes in biology. The researchers recommended that further research work be carried out on the effectiveness of TELE on undergraduate students' interest and achievement in other complex science processes.

Keywords: Gender, interest, achievement, biology, technology-enhanced learning environment.

Introduction

Biology is an important basic subject of modern life sciences. It is a subject in senior secondary schools and a basic course for undergraduate students in science education in Nigeria (National Commission for Colleges of Education (NCCE), 2012). The goals and objectives of a biology curriculum are to: 1. prepare students to acquire adequate laboratory and field skills in Biology; 2. have meaningful and relevant knowledge in Biology; 3. possess the ability to apply scientific knowledge to everyday life in matters of personal/community health and agriculture, and 4. acquire reasonable and functional scientific attitudes (National Policy on Education, 2014). Essentially, the overall aim of biology education in tertiary institutions in Nigeria is to equip students with a solid foundation in biological sciences and prepare them for future academic and professional pursuits in the field of biology. The study of biology is important for the obvious reasons. Biology is essential for scientific literacy and understanding of metabolic processes (Ndirika & Anidu, 2020). This implies that it provides students with a wealth of knowledge on the molecular and scientific basis of life.

The study of biology enables students to gain a meaningful understanding of the cellular basis for healthy growth and diseased conditions. This agrees with Lukow's (2021) assertion that many cellular diseases, (for example cancer disease) that are of global concern are basically a result of uncontrolled or unchecked biological processes in the body. To fight the menace of cancer and other deadly diseases, an intense study into some biological processes is required. Research and studies in biology have enhanced diagnoses, treatments, and cures of diseases (Lukow (2021) It has enabled biologists working in animal, plant, and medical sciences to be able to develop new vaccines, more effective

medicines, and plant species with improved qualities. Despite the importance of biology education, many students tend to have a poor interest in the subject due to several factors including poor teaching methods. However, scholars have noted that a learning environment with innovative technologies can build students' intrinsic motivation and interest, and help them achieve higher levels of academic success (Odunukwe, 2019). In other words, a technology-enhanced learning environment is believed to have a potential tool for making learning more inspiring and effective but this could differ for both girls and boys. Gender plays a role with regard to technology-enhanced learning.

Gender is a significant factor when learning involves technological tools. Several researchers affirmed that gender is a significant factor in technology acceptance and use in teaching and learning environments (Josiah, 2017; Gracia & Aria, 2011; Enochsson, 2010). Empirical evidence revealed cognitive differences between male and female students in various subjects and fields (Cowards, Crooks, Flores & Dao, 2012). However, traditional and popular belief is that males tend to learn more in a TELE than females since they are more inclined to the use of computers. This perception of technology as a masculine domain can create an unconscious barrier for females, hindering their full engagement and participation in TELE. Modern belief has it that girls may be more motivated in their learning when TELE is employed. Indeed, gender participation in TELE is controversial (Wang & Hung, 2022) although the general assertion is in favor of males more than females. For instance, Onuorah et al (2020) found a statistically significant gender gap in the mean achievement scores of male and female students in favor of male students. Contrarily, Nasrudin, Setiawan & SanjayaIt (2017) reported that girls performed significantly

better than boys in academic content. The implication is that female students are just as comfortable as male students using technology for learning. They appear to prefer multi-modal instruction in TELE than the male students. Other studies reported no significant gender difference in students' achievement (Demir. 2022) when learning took place using TELE. While studies on the influence of gender on technology-enhanced learning exist, there remain very few, especially on the influence of gender on TELE among undergraduate students' interest in biology in Nigerian universities. Thus, this research aims to fill the gap.

Statement of the Problem

The study of biology has remained an important impetus for the survival of life on Earth. However, the learning of biology has been a challenge to students in Nigeria. Evidence has shown that undergraduate students' interest and achievement in biology appear unsatisfactory over the years. Previous studies attributed the ugly situation to a lot of factors including the use of traditional learning environments and media to teach biology. Hence, the need to employ TELE in the teaching and learning of biology in Nigeria. However, there is conflicting evidence on the influence of gender on students' achievement in biology when using TELE. There is also a dearth of literature on the influence of gender on undergraduate students' interest in biology in a technology-enhanced learning environment. Thus, this research examined the influence of gender on undergraduate students' interest and achievement in biology in a technology-enhanced learning environment in Nigeria.

Objectives of the Study

The main aim of this study was to examine the impact of gender on

undergraduate students' interest and achievement in biology in a technology-enhanced learning environment. Specifically, the study examined:

- The effect of gender on students' interest in biology when learning takes place in a TELE.
- The effect of gender on students' achievement in biology when learning takes place in a TELE.

Research Questions

- What is the effect of gender on the mean interest scores of students in biology when taught in a TELE?
- What is the effect of gender on the mean achievement scores of students in biology when taught in a TELE?

Research hypotheses

Ho_1: There is no significant difference in the mean interest scores of male and female students in biology.

Ho_2 There is no significant difference in the mean achievement scores of male and female students in biology.

Research Methodology

The research design was quasi-experimental, specifically pretest, and post-test design. The population of the study consisted of 191 first-year undergraduate students (43 males, 148 females) of Biology Education in the five federal universities in South-East Nigeria. The sample consisted of 172 first-year students (38 males, 134 females) of biology education drawn from three federal universities in the population of the study. Three federal universities offering degree programmes in education were purposively sampled for the study. The treatment instrument was an instructional computer animation package. Instruments used for data collection were a

Biology Achievement Test (BAT) and a Biology Interest Scale (BIS). The instruments were validated by experts and trial tested on students with homologous characteristics with the sample. A reliability coefficient of 0.8 and 0.70 was established for BAT and BIS respectively using the Kuder Richardson (KR-20) formula and Cronbach alpha method. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance.

Interest and Achievement: Conceptual Review

Interest is one of the variables associated with teaching and learning. It can be defined as a display of a positive attitude towards an object or situation. Chikendu (2018), refers to interest as a person's enjoyment of an activity or situation. Thus, interest in biology can be viewed as a positive disposition or likening to the learning of biology. However, several studies have reported poor students' interest in biology over the years (Abdulrahman et al, 2022; Etobru, 2017) and a lot of factors have been attributed to this. Some of these factors include poor teaching strategies and methods which rely heavily on lectures and note memorization, making learning less engaging and uninteresting (Raiyegbemi, Osokoya, Taiwo, Adu, Nsofor, Adeniran & Ajani, 2020). Students' perception of some complex processes in biology is difficult (Okoro & Oluwasegun, 2020). Also, the use of traditional media in teaching biological processes is a factor (Gambari et al, 2014). Other factors such as curriculum limitations, social influences, peer attitudes, and societal perceptions contribute to students' poor interest in biology. For example, if biology is viewed as less prestigious or exciting compared to other subjects, students may be less interested in it.

Interest has been noted to significantly impact achievement in any subject. Kusmaryati and Amertaningrum (2017) noted that interest serves as a motivational factor in learning which tends to drive achievement. When students' interest in biology is enhanced, they are more likely to become actively engaged in the learning process and ultimately perform well in class. Interest, therefore, forecasts a measure of educational success, including future course-taking and achievements as well. Achievement is an important learning outcome in education. It is a measure of the academic standing of a student at the end of an instructional task. Achievement can be defined as students' performance outcomes after completing a definite or particular task. This definition concurs with that of Herrera et al (2020) who defined achievement as the final grades of students in school subjects. Achievement in biology can therefore be stated as the extent to which a student attained educational goals in biology when measured, tested, or assessed on a pre-determined scale. Achievement in biology can be expressed in terms of scores from various assessments in biology curriculum content, including classroom tests and external examinations.

There are several reports of students' poor achievement in biology. The worrisome situation was observed in both secondary and tertiary institutions (Raiyegbemi et al, 2020; Ali, Toriman & Gasim, 2014; Lebata & Mudau, 2014). Several reasons were also attributed to that. Some researchers argue that biological processes are naturally abstract and complex making it difficult for most students to understand and perform well in biology (Chukwuemeka & Dorgu, 2019). Other studies attributed the poor achievement to factors such as poor teaching methods (Mamalanga, & Awelani, 2014), non-use and unavailability of modern instructional facilities and resources (Daworiye, 2015), and, poor teacher competency and

motivation (Agboghoroma & Oyovwi, 2015). Other possible factors may include students' background and physiological variables. The problem of students' low interest and poor achievement in biology has been of great concern to educators. This has prompted studies on learning environments enhanced with innovative technologies that can facilitate deep learning of complex and dynamic concepts in biology and other sciences.

Technology-enhanced Learning Environment (TELE): An Overview.

Technology-Enhanced Learning Environment (TELE) is a learning environment that ensures student access to technological tools during instruction. It is a learning environment that promotes the use of instructional televisions, computers, and other multimedia technologies during teaching and learning activities. Awad and Kasaji (2018) described TELE as any teaching or learning environment that utilizes computers as the main feature of intervention to present learning materials to students and enhance learning. According to Sharma (2017), TELE is an interactive environment that uses technology to present instructional material to learners and monitor the learning that takes place. In order words, TELE involves interaction between a learner and a designed instruction within a technological tool. It has become one of the most powerful tools in education for presenting multimedia materials to learners (Mansor, Zakaria, Rashid, Arifin, AbdRahim, Zakaria & AbdRazak, 2020). TELE provides an enabling environment that facilitates deep learning of complex and dynamic concepts in science using multiple media formats.

Technology-Enhanced Learning Environment (TELE) plays a crucial role in transforming learning by creating more accessible, engaging, and personalized learning experiences. It caters to the different learning styles and needs of students and facilitates the development of critical skills in

today's digital world (Odunukwe, 2024). TELE contributes to the learning process in several essential ways: it enables personalized learning that is adapted to each student's strengths and weaknesses, it makes learning more engaging and visually stimulating, it enables students to build critical soft skills essential for future careers, essential digital literacy skills needed for a technology-driven future. TELE provides students with access to academic resources that may not be available locally. It encourages students to be self-directed and independent in their learning. However, in a technology-enhanced learning environment, individual students may present differing dispositions to the use of technology in learning. Such disposition may be influenced by the student's gender. Consequently, gender is a factor when TELE is employed in the teaching and learning process.

RESULTS

Research Question 1

- What is the effect of gender on the mean interest scores of students in biology when taught in a TELE?

Table 1: Mean Interest Rating Scores and Standard Deviation of Students Based on Gender

GENDER	N	PRETEST INTEREST		POST-TEST INTEREST		ADJUSTED MEAN
		X	SD	X	SD	X
Male	38	52.29	3.21	57.08	5.98	57.05
Female	134	51.56	4.04	54.78	5.29	54.79

Table 1 showed that the pretest interest mean score and standard

deviation of male students were 52.29, and 3.21. Post-test interest mean score and standard deviation were 57.08, and 5.98, adjusted mean was 57.05. While the pretest interest mean score and standard deviation of female students were 51.56, and 4.04. Post-test interest mean score and standard deviation were 54.78, and 5.29, the adjusted mean was 54.79. This shows that male students had higher interest than female students in biology when taught in a technology-enhanced learning environment (TELE).

Research Question 2

- What is the effect of gender on the mean achievement scores of students in biology when taught using TELE?

Table 2: Mean Achievement Score and Standard Deviation of Students Based on Gender

GENDER	*N*	*PRETEST ACHIEVEMENT*		*POST-TEST ACHIEVEMENT*		*ADJUSTED MEAN*
		X	SD	X	SD	X
Male	38	39.42	12.57	46.89	17.12	49.80
Female	134	43.72	13.68	54.68	15.95	53.86

Table 2 shows that the pretest achievement mean score and standard deviation of male students were 39.42 and 12.57. Post-test achievement mean score and standard deviation were 46.89 and 17.12, the adjusted mean was 49.80. While the pretest achievement mean score and standard deviation of female students was 43.72, 13.68; post-test achievement mean score and standard deviation was 54.68. 15.95, adjusted mean was 53.86. This shows that female students performed better than male students in biology when taught in a technology-enhanced learning environment (TELE).

Research hypotheses

Ho_1: There is no significant difference in the mean interest scores of male and female students in biology

Table 3: Analysis of Covariance of Students' Biology Interest Rating Scores by Technology and Gender

Sources of Variation	Sum of Squares	Df	Mean Square	f	Sig	PARTIAL ETA SQUARED
Covariates Pretest Interest	169.683	1	169.683	8.170	.005	
Main Effects (Combined)	1426.670	3	475.557	22.899	.000	
Technology	1280.632	2	640.316	30.832	.000	.251
Gender	146.038	1	146.038	7.032	.009	.066
Model	1772.348	6	295.391	14.224	.000	
Residual	3426.692	165	20.768			
Total	5199.041	171				
			30.404			

a. Post-test Interest by Gender with Pretest Interest b. Covariates entered first

Table 3 revealed a significant main effect of gender F (1,165) = 7.032, p = .009, partial η^2 = .066. Since p (0.009) is less than 0.05. The null hypothesis was rejected, indicating that there was a significant difference in the mean interest scores of male and female students in biology, in favour of males.

Ho_2 There is no significant difference in the mean achievement scores of male and female students in biology.

Table 4: Analysis of Covariance of Students' Biology Achievement Scores by Technology and Gender

SOURCES OF VARIATION	Sum of Squares	df	Mean Square	f	Sig	PARTIAL ETA SQUARED
Covariates Pretest Interest	7556.893	1	7556.893	53.965	.000	
Main Effects (Combined)	14940.450	3	4980.150	35.564	.000	
Technology	14484.532	2	7242.266	51.719	.000	.261
Gender	455.917	1	455.917	3.256	.073	.013
Model	23381.406	6	3896.901	27.829	.000	
Residual	23105.309	165	140.032			
Total	46486.715	171	271.852			

a. Posttest by Technology, Gender with Pretest
b. Covariates entered first

Table 4 revealed no significant main effect of gender F (1,165) = 3.256, p = .073, partial η^2 = .013. Since p (0.073) is more than 0.05. The null hypothesis was upheld, indicating that there was no significant difference in the mean achievement scores of male and female students in biology. This means that only about 1% of the variation in the dependent variable is influenced by the independent variable.

Summary of Findings

Research findings revealed that:

- Male students had higher interest than female students in biology. The difference was statistically significant.
- Female students had higher achievement mean scores than male students in biology. The difference was not statistically significant.

Discussions

The findings from this study revealed that male students had higher mean interest scores than female students in biology when taught in a technology-enhanced learning environment. The difference was statistically significant. The finding is consistent with the work of Luik (2011) who reported that males held a more positive attitude and interest towards the use of computers in learning than females. This can be attributed to the fact that computers capture boys' attention more than girls during instructions and at all times. This invariably means that the use of computers in TELE captures male students' attention more than their female counterparts, and must have contributed to their obtaining higher mean interest scores than their female counterparts. Toh et al (2010) reported that attention is the first and single most important factor in arousing learners' interest. It is the key to gaining and maintaining learners' interest.

In addition, the findings of this study are consistent with the popular belief and statement that technology use is masculine-oriented, and males are more inclined to the use of technological tools and instruments. This social belief and gender construction might have aroused male students' interest in active participation in class and contributed to their obtaining higher mean interest scores than their female counterparts. However, this study finding contradicts Wang and Hung's (2022) and Dousay and Trujillo's (2018) work, which reported that technology arouses female students' interest to learn more than males. Other studies such as the one conducted by Aldalalah and Fong (2010) reported no gender differences in male and female learners' interest in the use of technology in learning.

This study also found that female students performed better than male students. In other words, female students had better mean achievement

scores than male students in biology, although the difference was not statistically significant. The implication is that they may be due to error and not attributed to variance. Gender was not a significant factor in students' academic achievement. This finding is consistent with that of Mwangi et al (2020) who reported that girls performed better than boys in mathematics when taught in a TELE. This study also supported earlier studies that showed that female students performed better than their male counterparts in sciences such as chemistry (Chikendu, 2018) when taught in a TELE. This can be attributed to the fact that female students appear to gain a deeper understanding of concepts in multi-modal learning than male students (Wang & Hung, 2022). Many studies on gender and technology-enhanced learning environments reported that females participate and achieve more in online learning opportunities than males (Nistor, 2013; Bollinger & Supanakorn, 2011).

On the contrary, some other studies reported that male students achieved better than females in a TELE. For example, Dania, (2014) reported a significant difference in favor of male students, in the mean achievement scores of male and female students taught social studies in a TELE. The study validated earlier studies which showed that male students achieved better than their female counterparts in chemistry (Adigwe, 2014) and, physics and biology (Adeyegbe, 2010). However, some other studies reported no significant gender difference in students' achievement in basic science (Sarfo et al, 2022; Owolabi & Oginni, 2014), biology (Hamzat, Bello & Abimbola, 2017), and mathematics (Nwoke, Okorie & Chile-Agada, 2021) when taught in a TELE.

Conclusion and Recommendations

The study revealed that learning in a technology-enhanced learning environment enhanced male and female undergraduate students' interest and achievement in biology. Male students showed greater interest in learning while female students performed better than male students. The difference in the achievement mean scores was not statistically significant. This indicates that TELE is gender friendly in enhancing undergraduate students' academic achievement in biology. Based on these findings, the study recommends that TELE should be adopted in teaching and learning biology at all levels of education. It can serve as a medium for improving both male and female undergraduate students' low interest and poor achievement in biology. Again, studies on how innovative technologies and interactive learning environments impact students' interest and achievement in other sciences should be encouraged and intensified.

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