INTERACTION EFFECT OF GENDER AND INSTRUCTIONAL STRATEGIES ON ACADEMIC ACHIEVEMENT AND RETENTION IN CHEMISTRY IN CALABAR EDUCATION ZONE, CROSS RIVER STATE,NIGERIA

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Abstract
This study investigated the interaction effect of gender and teaching methods on academic achievement and retention in chemistry in Calabar Education Zone. Two hypotheses guided the study. quasi-experimental research using a non-randomized pre-test, post-test group design with a 2 x 2 factorial arrangement was adopted for the study. The population comprised of 3,985 Senior Secondary School One (SS1) Chemistry students in 80 public schools in the Calabar Education Zone of Cross River State. The study sample consisted of 122 Senior Secondary School One (SS1) Chemistry students selected using the Multistage sampling approach. A researcher-made instrument tagged: Chemical Bonding Achievement Test (CBAT), a 50- item multiple choice test with four response options drawn from the concept of chemical bonding was used for data collection. The instrument had a reliability index of .72 determined using the split-half method. Data generated from the pre-test, post-test, and retention test were analyzed using Analysis of Covariance (ANCOVA) statistics at a .05 level of significance. The results of the data analysis showed that the interaction effect of treatment and gender on students' achievement was not statistically significant but the interaction effect of treatment and gender on students' retention was statistically significant; Consequently. It is recommended that Chemistry teachers should make effective use of Blended Learning in teaching Chemical Bonding given its enhancing effect.

Key Words: Blended Learning. Computer Simulation, Achievement, Retention, Gender

Introduction

All over the world, science is regarded as the bedrock of modern technology. Nations especially developing countries like Nigeria are making frantic efforts to technologically and scientifically develop their economies, this is why the world is progressively becoming scientific. The purpose of science education is to train students to acquire a proper understanding of basic scientific principles as well as applications that are aimed at developing appropriate scientific skills and attitudes as a prerequisite for future scientific activities. The recent changes in the world and within nations have brought about changes in educational goals, and to achieve these goals and objectives, active participation and collaborative learning activities become imperative and these need functioning instructional media to make science instructions effective (Samuel, 2018). It is, therefore, no gainsaying to state that the quality of education is largely dependent on the quality of instruction provided in the classroom. Chemistry is one of the branches of science that helps to expand the learner‘s knowledge of the universe and his position in it. It also prepares learners for professional careers in such fields as medicine, and biotechnology. Despite the importance of Chemistry in the science curriculum and its relevance in the advancement of science and technological growth of a nation, students‘ performance in the subject has remained poor as evidenced in the statistics summary of the performance trend in the subject from 2014 to 2018 conducted by West African Examination Council (WAEC).See Appendix

Kola (2013) observed that the rate of failure has been consistent over the years, one of the reasons for such decline observed is the approach to the teaching of chemistry and the instructional strategy used is the most implicated cause of the poor performance of students in chemistry. Danjuma (2015) posited that for any meaningful teaching and learning to take place, there should be a suitable means of presenting the content to the learners at all levels of education. The introduction of technologies in teaching and learning is no longer a new paradigm in today's education. Undoubtedly, the 21st century is characterized by a technology- infused environment with a nascent generation of digitally conscious youths that are highly conversant with the various forms of electronic gadgets and tools from the information and Communication Technology (ICT) Sector. Due to the rapid increase in the use of technologies in different fields in our society today, educators are getting involved in the use of computers in education because they believe it is more effective and advantageous as an educational tool, compared with other tools (Scott, 2015). Studies have shown that if teaching-learning strategies are improved, achievement and retention can be enhanced. Some student-centered teaching strategies have been identified to help reduce the abstract nature of chemistry concepts and improve the achievement and retention of learned concepts. Active learning methodologies have been widely celebrated in recent years as pedagogical processes that engage students in activities to excite cognitive abilities and promote deep learning and one such method is blended learning and computer simulation. Blended instructional strategy according to Patrick and Sturgis (2015) is an instructional strategy that leverages technology and student-teacher interaction to enhance independence, engagement, and achievement. The uniqueness of the blended learning instructional strategy is in its ability to use the refined technique from both e-learning and conventional methods, and as a result, creates an opportunity to provide students with scientific materials in an easy, fast, and originated forms of e-learning to suit the needs of learners. Several studies indicated a statistically significant increase in students learning out and retention of learned concepts after being exposed to a blended learning strategy (Anari, 2021; Seaqe & Turegun, 2020; Schettini et al. 2020; Fitriyana et al, 2020; Mandina; 2019).

Okolo and Oluwasegun (2020) defined computer simulation as a computer production of a model which is an enriched device in which pictures, sound, and motion processes are synchronized and projected for effective teaching and learning process. For instance, a demonstration of how chemical reactions and processes take place can be observed on a computer screen in different forms, ranging from 3-dimensional geometric shapes to highly interactive computerized laboratory experiments. Hence the concretization of atoms and molecules makes learning meaningful and appealing to real-life situations. Such an artificial creation helps a learner explore, navigate or obtain more information about that system or environment that cannot be acquired from mere experimentation. Studies from the review of the literature indicated the significant enhancing effect of computer simulation instructional strategies on students' academic achievement in chemistry (Adekunle, 2018; Nkemakolam et al., 2018; Julius et al.,2018; Uzezi & Deya, 2020; Jere,2020; Omoniyi,2021).

Gender is used as ―the socially constructed roles, behaviors, activities, and attributes that a given society considers appropriate for males and females‖ (WHO, 2015). It impacts attitudes, roles, responsibilities, and behavior patterns of boys and girls, men and women in all societies. Abdullahi (2014) stipulated that there is a general imbalance that exists in gender and technology-based teaching strategies used among students. Gender differences concerning academic achievement and retention by secondary school students in chemistry remain an important issue in educational research as these may affect enrollment in science-related courses and career choices in science. Abdullahi (2014) observed that when there are gender-related differences in science, the method of teaching could be the cause, Abdullahi further opined that an appreciable way of obtaining optimal achievement is to engage students using strategies that are gender bias-free. In Nigeria, gender bias is still prevalent within the science classroom where males are depicted as experts in science and the learning task has different goals for boys and

girls (Khatoon & Mahamood, 2010). Some studies showed significant gender differences in science achievements, favoring girls over boys (Okoyefi &Uchenna, 2013). while, some studies argued in favor of boys' superiority over girls' learning outcomes in science and Mathematics (Odagboyi, 2015). However, in some studies, it was observed that boys and girls are at equal performance levels in their achievements in science (Omenka & Kurumeh, 2013). Olorukooba et al. (2016), observed that gender was not significant when a computer simulation strategy was used to teach chemistry in Zaria. Similarly, studies carried out by (Ogembo, 2017; Mihindo et al.,2017; Julius et al.,2018) also showed gender was not statistically significant in the academic performance of students in chemistry.

Retention plays a major role in understanding, comprehension, and application of Chemistry concepts to everyday life. It is an important variable in learning because only a learned experience is recalled, and learning cannot be said to have taken place if there is no proper retention. Retention is the ability to hold, keep or recall past experiences and reproduce learned concepts when the need arises (Bukunola & Idowu, 2012). The ability of students to recall past learned science concepts is one of the objectives of science teaching and learning. Kurumeh *et al.* (2016) reported that students' retention in science depends on the instructional strategy adopted by teachers. Any instructional strategy which elicits adequate student participation has a profound effect on retention, this implies that students' retention abilities could improve if Chemistry teachers employ strategies that would enhance the effective assimilation of information toward meaningful recall and retrieval when the need arises. Several studies observed that retention of scientific concepts was enhanced when students were taught using blended learning and computer simulation instructional strategy (Olorukooba et al., 2016; Suleiman et al.,2017; Agu & Samuel, 2018; Anusiuba et al., 2019; Aniefiok & Udo,2020; Oyenma &Olele,2020; Edem & Anari, 2021)

Research Hypotheses

i. There are no significant interaction effects of treatment and gender on students' achievement on the concept of chemical bonding in Calabar Education Zone.
ii. There is no significant interaction effect of treatment and gender on students' retention of the concept of chemical bonding in Calabar Education Zone.

Design of the Study

The study adopted a quasi-experimental design. Specifically, the study used a non-randomized pre-test and post-test group design with a 2 x 2 factorial arrangement. The factorial design was adopted because it allowed the evaluation of the outcome of the independent variables separately and their joint effects (Onwioduokit, 2000).

The population of the Study

The study population consists of 3,985 Senior Secondary School Two (SS1) Chemistry students in 80 public schools in Calabar Education Zone of Cross River State. This population is considered most appropriate for this study because chemical bonding is indicated in their curriculum,

Sample and Sampling Techniques

The sample for this study consisted of 122 Senior Secondary School Chemistry students. A multistage sampling approach was used for this study. Each of the Local Government Areas in Calabar Education Zone was considered a stratum. From the seven local government areas existing in the research area, two local government areas were chosen by the hat and draw techniques involving the ballot method. Using the same method two co-educational schools were chosen from two selected LGAs with computer laboratories. Two intact SSI chemistry classes were respectively selected in each school, this in effect means that all members of the intact classes used were considered as subjects for the study, and an intact class in each of these

schools was assigned to each of the treatment groups. The schools were far away from each other to avoid interaction between the subjects of the groups. Assignment of the subjects to the experimental groups was not by randomization since intact classes were used.

Instrumentation

A researcher-made instrument tagged: Chemical Bonding Achievement Test (CBAT), a 50-item multiple-choice test with four response options drawn from the concept of chemical bonding was used for data collection. The CBAT was used for pre-test, post-test, and retention measurement. The post-test and retention tests were reshuffled versions of the CBAT arranged differently in serial numbering and response options.

Reliability of the Instrument

Trial testing was done to determine the reliability of the instrument using the split-half form of reliability. The instrument was administered to SS1 students from a school not chosen for the study, and the completed test was split into two halves during scoring. From this procedure, a reliability coefficient of .72 was obtained.

Experimental Procedure

After selecting the schools, the researcher visited and obtained permission from the principals to use their school, each of the classes was then assigned to experimental groups one and two respectively. The students in Group One were taught using Blended learning, and those in Group Two were taught using Computer Simulation instructional strategy.

Chemical Bonding Achievement Test (CBAT) was administered to all the groups before treatment as a pre-test by the research assistants. Thereafter, the treatment package was used in teaching the concepts of chemical bonding for four weeks. At the end of classroom instructions, Chemical Bonding Achievement Test (CBAT) was reshuffled and administered to both experimental groups as a post-test. This provided baseline data that was used to compare the students in both groups. The teaching in all the groups was done during the normal class periods for Chemistry and in the intact class setting to avoid disrupting the school program. Three weeks after the post-test, the Chemical Bonding Achievement Test (CBAT) was reshuffled and re-administered as a retention test.

Method of Data Analysis

The data generated from the pre-test, post-test, and retention tests were analyzed using Mean, Standard Deviation, and Analysis of Covariance (ANCOVA) statistics at a .05 level of significance.

Result

Hypothesis One: There are no significant interaction effects of gender and instructional strategies on students' achievement mean scores on the concept of chemical bonding.

Table 1
Summary of Analysis of Covariance (ANCOVA) of the student's achievement mean scores classified by treatment groups and gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	279.16[a]	4	69.79	4.16	.003	S
Intercept	12883.92	1	12883.92	767.05	.000	S
Pretest	214.93	1	214.93	12.80	.001	S
Treatment	34.00	1	34.00	2.02	.157	Ns
Gender	9.76	1	9.76	.58	.447	Ns
Treatment * Gender	.48	1	.48	.03	.867	Ns
Error	1965.21	117	16.80	-	-	-
Total	173507.00	122	-	-	-	-
Corrected Total	2244.37	121	-	-	-	-

a. R Squared = .124 (Adjusted R Squared = .094),
Source: Author's Field Data (2021)

In Table 1 the calculated F-ratio for the interaction effects of treatment and gender on the student's achievement at df 1, 117 is 0.03, while its corresponding calculated level of significance is .867 alpha. This level of significance is greater than .05 on which the decision is based; indicating that there were no significant interaction effects of treatment and gender on the achievement of the students in the concepts taught. With this observation, the null hypothesis was upheld. The observation indicates that the two instructional strategies had the same effects on the two levels of gender, and vice versa.

Hypothesis Two: There is no significant interaction effect of treatment and gender on students' retention of the concept of chemical bonding.

Table 2
Summary of Analysis of Covariance (ANCOVA) of the students' retention mean scores classified by treatment groups and gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	1674.75[a]	4	418.69	188.93	.000	s
Intercept	30.63	1	30.63	13.82	.000	s
Posttest	1558.68	1	1558.68	703.33	.000	s
Treatment	10.10	1	10.10	4.56	.035	s
Gender	2.04	1	2.04	.93	.339	ns
Treatment * Gender	11.94	1	11.94	5.39	.022	s
Error	259.29	117	2.22	-	-	-
Total	161417.00	122	-	-	-	-
Corrected Total	1934.04	121	-	-	-	-

a. R Squared = .823 (Adjusted R Squared = .814)

Source: Author's Field Data (2021)

In Table 2 the calculated F-ratio for the interaction effect of treatment and gender on the students' retention at df 1,117 is 5.39, while its corresponding calculated level of significance is .022 alpha. This level of significance is less than .05 on which the decision is based;

indicating that there was a significant interaction effect of treatment and gender on the retention of the students in the concepts taught. With this observation, the null hypothesis was rejected. This observation indicates that the two instructional strategies did not have the same effects on the two levels of gender, and vice versa.

Discussion of Findings

The findings for interaction effects of treatment and gender on students' achievement showed no significant interactions effect of treatment and gender on the achievement of the students in the concepts taught. This observation indicates that the two strategies had the same effects on the two levels of gender, and vice versa. This corroborates the findings of Olalekan and Oludipe (2016), Olurukooba *et al.* (2016) Mihindo *et al.* (2017), Gongden and Gongden (2017) Rhesa *et al.* (2018), who observed that gender is not a significant predictor of student's achievements in chemistry. This implies that when instructional strategies that are gender bias-free and gender- friendly classrooms are promoted in science teaching, gender stereotypes in science classrooms which can result in low confidence in students causing science anxiety will decline causing boys and girls to be at equal performance levels in their science achievement. The result of the findings could also be a result of the two strategies used being student-centered enhanced active participation of the students in the learning process, hence stimulating their interest in the concept taught which resulted in improved performance.

On the interaction effects of treatment and gender on students' retention the findings showed a significant interaction effect of treatment and gender on the retention of the students in the concepts taught. This agrees with the findings of Agu and Samuel (2018) Anusiuba *et al* (2019) and Edem and Anari (2021) which indicated a significant difference across the two groups retention scores of students and retention of content was not dependent on gender. This implies that students tend to retain what was learned only when they are actively involved in the lesson and when rich learning experiences are provided, thus the use of blended learning and computer simulation instructional strategies is one of the means through which retention can be facilitated by providing multiple learning experiences for the learning.

Conclusion

Based on the findings of the study, it is hereby concluded that Blended-Learning and computer simulation are effective in facilitating students' achievement and retention in chemical bonding. Also, that gender has no statistically significant influence on students' achievement in chemical bonding.

Recommendations

Based on the findings and the conclusions reached, the following recommendations are made:

i. Chemistry teachers should make effective use of Blended Learning and Computer Simulation in teaching chemical bonding given their enhancing effects.
ii. Curriculum planners should ensure the incorporation of Blended Learning and Computer Simulation modes of teaching and learning in the Chemistry curriculum.

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APPENDIX I

Percentage distribution of Chemistry Student's Achievement in May/June Senior Secondary Certificate Examination (SSCE) in Cross River State from 2014 to 2018

Year	Total no of candidates that registered for the exams	Total no. of candidates that sat for the exams	Total no. of candidates with 1-5 credit in Chemistry	Percentage of candidates with credit passed (%)
2015	6, 415	6, 221	3,029	48.69
2016	6, 952	6, 468	2,767	42.78
2017	7, 842	7,727	3,867	50.05
2018	7, 947	7,853	3,813	48.55