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COMPUTER-BASED LABORATORY SIMULATION (CBLS): AN EFFECTIVE INSTRUCTIONAL APPROACH FOR ELECTROCHEMISTRY LESSONS AND RIVERS STATE STUDENT ACADEMIC PERFORMANCE IN CHEMISTRY

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ABSTRACT

Computer-Based Laboratory Simulation (CBLS) as an effective instructional approach for electro-chemistry lessons and Rivers State students' academic performance in chemistry was investigated in this study. Quasi experimental research design was adopted for the study. The purposive sampling technique was used to select Emohua local government area out of the nine (9) local government areas in Rivers State central educational zone in Rivers State. Simple random sampling by balloting was used to select four (4) senior secondary schools out of the eighteen (18) schools inn Emohua local government area that participated in the study. The non-ramdomized sampling was used to obtain a sample size of one hundred (100) SS2 chemistry students comprising 55 males and 45 females that participated in the study. The chemistry performance test instruction was used to collect data for the study. The data collected were analysed by using mean and standard deviation to answer all the research questions while analysis of covariance was used to test the hypothese at .05 level of significance. The study found that, there is significant difference between the mean performance of students exposed to CBLS in chemistry and those taught using lecture method, P<.05. Gender had no significant effect on academic performance of students taught by both CBLS and lecturer method, P>.05. The study recommends that chemistry teachers should often CBLS to enhance higher performance of students in chemistry.

Introduction

The need for chemistry as an indispensible science subject in Nigeria secondary school curriculum cannot be overemphasized. The usefulness of chemistry in economic and national development could be felt by the role it plays in various sectors such as; synthetic industry, chemical engineering, agricultural science, textile technology, printing technology, medical services and pharmacy (Garcia-Gonzalez et al., 2019). Moreso, chemistry as a central science, is a veritable fulcrum on which scientific literacy and human capacity building of the citizens in a nation can be achieved (Wagbara & Mark, 2024). Chemistry is also a practical oriented subject that could develop students' process skills (Nbina, 2011).

Despite, the immense importance of chemistry as the hub of modern technological activities and careers available for people who have good qualifications in chemistry students still perform poorly in chemistry at the secondary school level (Nbina, 2011 & Alozie, 2012) cited in (Wagbara, 2015). The fact that chemistry is a practical oriented subject, there is the feeling that, the cause of students failure in chemistry may be

due to the lack of practical skills in chemistry (Nbina, 2011).

Several efforts have been made by government and stakeholders in science to improve instructions in the teaching of chemistry but students still show lack of interest towards the subject.

This could be due to students' perception of chemistry as a difficult subject that looks abstract without having a human face. Also, the incessant use of non-innovative methods in teaching chemistry, such as lecture and discussion methods (Birgen, 2013). Students poor attitude towards chemistry can be due to their perception that chemistry is complex (Flaherty, 2020). Students' anxiety about chemistry may stem from their perception of its complexity (Kolil et al., 2020).

The anxiety in students can lead to loss of interest in the sciences, low motivation and engagement in chemistry (Potvin & Hasni, 2014). Although, literature have revealed that, a good number of students in Nigeria secondary schools lack sufficient information and the understanding of chemistry principles and concepts (SMASSE, 2001). Furthermore, the topics in electrolysis has shown tremendous challenges for both the learners and teachers as indicated by the baseline review conducted by SMASSE which revealed that, 58% of the teachers and 62% of the learners perceived electrochemistry to be complex (SMASSE, 2005).

Above all, in order to curb the ugly trend an innovative technique in the form of blended learning like Computer-Based Laboratory Simulation (CBLS) as it can be effective in the teaching of secondary school electrochemistry. The use of appropriate equipment and methods can boast effective learning of chemistry, especially the acquisition of process skills in electrochemistry. Learning by activity centred strategy that puts the students into creative thinking abilities and instruction with the environment can uplift performance in science (Wagbara, 2020). The use of computer-based simulation becomes an appropriate strategy for the teaching of electrochemistry. The strategy enables the teacher to use the computer as the audio-visual educational media that animates the instructional package for the students while the teacher uses simulation as an exercise or form of instructional scenario to control the parameters of the world which the learner is required to achieve the instructional result. Ordu (2016) asserts that, instructional simulation are goal-oriented and focus learners on specific facts, concepts and application of the system or environment. Adesoji (2008) cited in Ordu (2016) identified three major types of simulation which include; live, virtual and constructive. Live simulation deals with (live action), virtual is used for training while constructive is used to view and predict the outcome. The reality is that all are used to provide the learner with pseudo-experience without the danger or complexity of the real life. Also, it provides critical reasoning and engages the learners in enjoyable motivating activities (Ajeyami & Owoyemi, 2014).

Above all, computer-based simulation promotes the understanding of concepts through experimental activities that increases the engagement of students in activities that helps them to gain detailed understanding of subject matter. Hence, it becomes necessary to investigate the effectiveness of the use of computer-based simulation for electrochemistry lessons on academic performance of students in chemistry.

Statement of the Problem

The problem of this study borders on lack of interest and poor performance of students in chemistry. These identified problems were justified by the report from literature about students' perception of chemistry s a difficult subject that, looks abstract and absence of innovative method that could give the teaching and learning of chemistry a human face can also account for poor academic performance of students in chemistry.Chemistry is human endeavour that requires basic teaching qualities like creativity, insightful reasoning, animation of concepts and abstract topics, the skills of well structured content that can make it activity oriented as well as student centred. In viw of the above, computer-based simulation can be useful for the teaching of

electrochemistry to boast students' academic performance in chemistry.

Purpose of the Study

The main purpose of this study was to investigate the effect of using Computer-Based Laboratory Simulation for electrochemistry lessons on students academic performance inn chemistry. Specifically, the study sought to;

1. *determine the effect of computer-based laboratory simulation and lecture method in the teaching of electrochemistry lessons on academic performance of students in chemistry.*
2. *investigate the effect of gender on academic performance of students taught electrochemistry lessons in chemistry by the use of computer-based simulation instructional approach.*
3. *determine the effect of gender on academic performance of students taught electrochemistry lessons in chemistry by the use of lecture method.*

Research Questions

1. *What is the mean performance score difference of students exposed to electrochemistry lessons in chemistry by the use of Computer-Based Laboratory Simulation and those taught by the use of lecture method?*
2. *What is the mean performance score difference of male and female students exposed to electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach?*
3. *What is the mean performance score difference of male and female students exposed to electrochemistry lessons in chemistry by the use of lecture method?*

Hypotheses

The following null hypotheses which were tested at .05 level of significance guided the study.

HO_1: *There is no significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method in chemistry.*

HO_2: *There is no significant difference between the mean performance scores of male and female student taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach.*

HO_3: *There is no significant difference between the mean performance scores of the male and female students taught electrochemistry lessons in chemistry by the use of lecture method.*

Methodology

Quasi experimental research design was adopted for this study. The study was carried out in Emohua local government area of Rivers State. Emohua local government is one of the twenty-three (23) local government areas in Rivers State, Nigeria. The purposive sampling technique was used to select Emohua local government area out of the nine (9) local government areas of central educational zone in Rivers State. Simple random sampling by balloting was used to select four (4) schools out of the eighteen (18) senior secondary schools in Emohua Local Government Area. The non randomized sampling was used to obtain a sample size of one hundred (100) SS2 chemistry students comprising 55 males and 45 females that participated in the study. Chemistry Performance Test (CPT) instrument was used to collect data for the study. The data collected were analysed by using mean and standard deviation to answer all the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at .05 level of significance.

Result

Research Question 1: *What is the mean performance scores difference of students exposed to electrochemistry lessons in chemistry by the use of computer-based laboratory simulation ad those taught by the use of lecture method?*

Table 1: *Mean ad standard deviation academic performance score difference of students exposed*

to electrochemistry lessons in chemistry by the use of computer-based laboratory simulation and those taught by the use of lecture method

Teaching Method	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
CBLS	50	34.60	11.28	87.20	7.50	52.60
Lecture	50	35.40	11.28	57.10	5.72	21.70
Mean Diff.						30.90

Table 1 has shown that, the mean score of students taught electrochemistry by the use of computer-based laboratory simulation was 34.60 with standard deviation of 11.28 in the pretest group while in the posttest group the students had mean score of 87.20 with associated standard deviation of 7.50 and a mean gain of 52.60 was obtained. Table 1 shows that, the students exposed to lecture method in electrochemistry lessons had mean score of 35.40 with standard deviation of 11.28 in the pretest group whereas in the posttest group they had mean score of 57.10 and mean gain of 21.70 was obtained. The students taught by the use of computer-based laboratory simulation in chemistry had a higher academic performance mean score than those taught by the use of lecture method with a mean score difference of 30.90 in favour of the students taught by the use of computer-based laboratory simulation instructional approach.

Hypothesis 1

HO_1: There is no significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method.

Table 2: Analysis of covariance (ANCOVA) of significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulations and those taught by the use of lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	22650.292[a]	2	11325.145	257.817	.000
Intercept	48230.312	1	48230.312	1072.409	.000
Pretest	0.42	1	.042	.001	.976
Method	22619.042	1	22619.042	502.938	.000
Error	4362.458	97	44.974		
Total	547575.000	100			
Corrected Total	27012.750	99			

a. R-Squared = .839 (Adjusted R-Square = .835)

The result of table 2 was used to determine whether there is significant difference between the mean performance scores of students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation and those taught by the use of lecture method. Table 2 shows that an F-ratio of 502.9 with probability value of .00 were obtained.

The probability value of .00 was compared with .05 and it was found to be significant as .00 was less than .05 (P<.05). The null hypothesis one, HO_1 was therefore rejected and inference drawn that, there is significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method in chemistry.

Research Question 2: *What is the mean performance score difference of male and female students exposed to electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach?*

Table 3: *Mean and standard deviation academic performance mean score difference of male and female students exposed electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach*

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Teaching Method	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	28	35.00	11.38	86.79	7.35	51.79
Female	22	34.09	11.40	87.27	7.97	53.18
Mean Diff.						1.39

Table 3 shows that, the male students taught electrochemistry lesson in chemistry by the use of computer-based laboratory simulation had a mean score of 35.00 with standard deviation of 11.38 in the pretest group while in the posttest group they had mean score of 86.79 with standard deviation of 7.35 and mean gain of 51.79. Also, in Table 3 the female students taught electrochemistry by the use of CBLS had mean score of 34.09 with standard deviation of 11.40 in the pretest group whereas in the posttest group they had mean score of 87.27 with associated standard deviation of 7.97 and mean gain of 53.18. The female students had slightly higher performance mean score than the male students with obtained mean difference of 1.39 in favour of the females.

Hypothesis 2

HO_2: *There is no significant difference between the mean performance scores of male ad female students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach.*

Table 4: *Analysis of covariance (ANCOVA) of the difference between the academic performance mean scores of male and female students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.384[a]	2	2.192	.037	.964
Intercept	3528.450	1	3528.450	593.943	.000
Pretest	1.462	1	1.462	.025	.876
Gender	3.087	1	3.087	.052	.821
Error	2795.616	47	59.481		
Total	381250.000	50			
Corrected Total	2800.000	49			

a. ***R-Squared = .002 (Adjusted R-Squared = 0.41)***

The result of Table 4 was used to determine whether there is significant difference between the mean performance mean scores of male and female students taught electrochemistry by the use of computer-based laboratory simulation instructional approach.

Table 4 shows that an F-ratio of .052 with associated probability value of .82 were obtained. The probability value of .82 was compared with .05 and it was found not to be significant as .82 was greater than .05 (P>.05). Hence, the null hypothesis two, HO_2 was accepted and inference

drawn that, there is no significant difference between the mean performance scores of male and female students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach.

Research Question 3: *What is the mean performance scores difference of male and female students exposed to electrochemistry lessons in chemistry by the use of lecture method?*

Table 5: *Mean and standard deviation score difference of male and female students exposed to electrochemistry lesson in chemistry by the use of lecture method*

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Gender	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Male	27	34.44	11.29	5778	5.60	23.34
Female	23	35.22	11.62	57.17	5.60	21.95
Mean Diff.						1.39

Table 5 shows that, the mean score of the male students taught electrochemistry in chemistry by the use of lecture method was 34.44 with standard deviation of 11.29 in the pretest group while in the posttest group they had mean score of 57.78 with standard deviation of 5.60 and mean gain of 23.34 was obtained. Also, table 5 shows that female students had mean score of 35.22 with standard deviation of 11.62 in the pretest group while in the posttest group they had mean score of 57.17 with associated standard deviation of 5.60 and mean gain of 21.95. The mean score difference of 1.39 was obtained in favour of the male students.

Hypothesis 3

HO_3: *There is no significant difference between the mean performance scores of the male and female students taught electrochemistry lessons in chemistry by the use of lecture method.*

Table 6: *Analysis of covariance (ANCOVA) of the difference between the academic performance mean scores of male and female students taught electrochemistry lessons in chemistry by the use of lecture method*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24.814[a]	2	12.407	.392	.678
Intercept	14352.785	1	14352.785	453.453	.000
Pretest	20.285	1	20.285	.641	.427
Gender	5.208	1	5.208	.165	.887
Error	1487.88	47	31.653		
Total	1682.500	50			
Corrected Total	1512.500	49			

a. ***R-Squared = .016 (Adjusted R-Squared = 0.25)***

The result in Table 6 was used to determine whether there is significant difference between the mean performance scores of the male and female students taught electrochemistry lessons in chemistry by the use of lecturer method. Table 6 shows that an F-ratio of .165 ad probability value of .88. The probability value of .88 was compared with .05 and it was found not to be significant as .88 was greater than .05 (P>.05). Hence, the null hypothesis three, HO_3 was accepted and inference drawn that, there is no significant difference between the mean performance scores of the male and female students taught electrochemistry lessons in chemistry by the use of lecture method.

Discussion

The result of the analysis of covariance which was used to test hypothesis one, HO_1 was shown in table 2 and yielded an F-ratio of 502.69 with associated probability value of .00. the result show that P<.05 which means that, there is significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method. Hence, the null hypothesis one, HO_1 which states that, there is no significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method in chemistry was rejected. The findings of this study agree with the findings of Wagbara (2021) as he reported that, there is significant difference between the academic achievement of students taught Basic Science by the use of instructional simulation strategy and those taught by the use of lecture method. This study have confirmed that, computer-based laboratory simulation have significant effect in the teaching of electrochemistry lessons in chemistry than the use of lecture method.

Table 4 shows that an E-ratio of .052 with probability vlue of .82 were obtained. The result of the study in Table 4 indicates that gender do not have significant effect in the teaching of electrochemistry by the use of computer-based laboratory simulation in chemistry. The findings of this study is in line with the findings of Wagbara (2021) as he asserted that gender do not have any significant effect on students taught Basic Science by the use of simulation strategy.

However, the findings of Porpio (2008) disagree with the findings of this study as he has stated that there was significant difference between the achievement mean scores of the male and female students exposed to simulation strategy in chemistry. This study have confirmed that, there is no significant difference between the mean performance scores of male and female students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach.

Table 6 shows that an F-ratio of .165 with associated probability value of .887 were obtained. The result of the study in Table 6 showed that gender does not have significant effect on mean performance mean scores of students taught electrochemistry by the use of lecture method in chemistry as P>.05. Hence, the null hypothesis three, HO_3 was accepted. The findings of this study is in line with the findings of Wagbara & Mark (2024) as they asserted that, there is no significant difference between the mean achievement scores of the male and female students exposed to hydrocarbon lessons in chemistry by the use of lecture method. This study have confirmed that, there is no significant difference between the mean performance scores of the male and female students taught electrochemistry lessons in chemistry by the use of lecture method.

Conclusion

First, the result of this study has shown that, there is significant difference between the mean performance scores of students taught electrochemistry lessons by the use of computer-based laboratory simulation and those taught by the use of lecture method in chemistry.

Secondly, the result of the study found that gender do not have significant effect on the academic performance mean scores of male and female students taught electrochemistry lessons in chemistry by the use of computer-based laboratory simulation instructional approach.

Thirdly, gender do not also have significant effect on the academic performance mean scores of students taught electrochemistry by the use of lecture method.

Recommendations

1. *Chemistry teachers should imbibe the knowledge of the use of blended learning strategy of the use of computer-based laboratory simulation as a common teaching approach, they should often use to teach electrochemistry in chemistry as it is activity based and blends up simulation*

with technology of the use of computer to make lessons real and explicit.

2. *All the chemistry students should be exposed to the lessons irrespective of gender as the approach do not have any gender sensitivity, both males and females learn optimally with the CBLS approach.*

Contributions of the Study to Knowledge

The study have innovated an approach that blends conventional teaching with technology that uplifts students' understanding of abstract and complex chemistry topics in the classroom. That also, help to arouse students' interest and improve their academic performance in chemistry.

References

Ajegamin, D. & Owoyemiri, T.E. (2024). Strategies for teaching carbon and its compounds, hydrocarbons and crude oil in senior secondary school. Chemistry Panel Series.

Birgen, A. C. (2013). Influence of computer mediated instructions on facilitation of chemistry teaching in Nigeria secondary schools. Case study of Kapsaret constituency, Warent District. Ph.D dissertation. University of Niarobi.

Flaherty, A. A. (2020). A review of effective chemistry education research and its implication for future research. Chemistry Education Research and Practice, 21(3), 693-713.

Garcia-Gonzalez, C. A., Budxova, T., Duraes, L., Erkey, E., Del Gaudio, P., Guiriko, P. & Suninova, I. (2019). An opinion paper on aero sets for biomedical and environmental applications. Molecules 24(9), 1815.

Kolil, V. K., Muthupalani, S. & Achuthan, K. (2020). Virtual experimental platforms in chemistry laboratory education and its impact on experimental self-efficiency. International Journal of Educational Technology in Higher Education 17(1), 1-22.

Nbina, J. B. (2011). A handbook of laboratory organization and management. Paragraphic Publishers Services.

Ordu, P. (2016). Effects of simulation gaimes methods on academic achievement of basic sciences students in Emohua local government area, Rivers State. Unpublished Ignatius Ajuru University of Education, Port Harcourt, B.Ed Student Project.

Porpio, J. (2008). Effects of simulation of male and female students' academic achievement in chemistry in Bayelsa State, Nigeria. Izontini Publishers.

Potvin, P. & Hasni, A. (2014). Analysis of the decline in interest towards school science and technology from grade 5 through 11. Journal of Science Education and Technology, 23(6), 748-802.

SMASSE, (2001). Towards better teaching and learning of chemistry. SMASSE Project national insert unit chemistry development. Nairobi Self.

SMASSE, (2005). Trends in teaching approaches and methods in science and mathematics education SMASSE Project National Insert Unit. Nairobi Self.

Wagbara, O. S. (2020). Effect of brainstorming on senior secondary school student academic achievement in chemistry in Rivers State. Nigeria Publishing House Education and Science. Middle Europe Scientific Bullet in 5(1), 77-82.

Wagbara, S. O. & Mark, D. O. (2024). Effect of using concept mapping strategy for hydrocarbons lessons on students' academic achievement in chemistry. International Journal of Discovevicies and Innovation in Applied Science 4(2), 44-52.

Wagbara, O. S. (2-15). Influence of cognitive style on secondary school student interest and acquisition of practical skills in chemistry. Unpublished Student Ph.D Thesis UNN.