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Effects of 7E's Learning Cycle Instruction on Secondary School Students' Performance in Biology in Bauchi, Nigeria

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Abstract

The study investigated the Effects of 7E's Learning Cycle Instruction on Secondary School Students' Performance in Biology in Bauchi state, Nigeria. The study had three specific objectives, three research questions, and two null hypotheses. Sequential explanatory mixed-method design was adopted. The researchers sampled two intact classes of 137 SS II biology students from the population of 3328. Nine students were used for Qualitative data. The instrument for data collection was adopted multiple choice question titled Biology Academic Achievement Test (BAAT). The instruments were validated by experts and subjected to pilot study using Guttman Split-Half Coefficient. A reliability coefficient of 814 with difficulty index of 98.87% and discriminating index 0.7were obtained. The pre-test was administered before the treatment while the post-test was administered after the treatment. At the end of the test, Focus Group Interview was conducted. The data collected from the field were subjected to descriptive statistics of mean, standard deviation and mean difference to answer the research questions. Inferential statistics of independent sample t-test was used to test the null hypotheses at 0.05 levels of significance and qualitative data was analyzed by merging the sub-theme into similar categories and interpreting the data. The result revealed that 7Es learning cycles has positive effects on the academic achievement of secondary school students in biology science in Bauchi state, Nigeria. It was concluded that adopting 7Es learning cycle will help to improve secondary school student's performance in biology. The study recommended that school principals through the head of department should encouraged Biology teachers at secondary school level to incorporate 7Es teaching strategy into their teaching, and to gradually customize the approach into their own personalized teaching method in Bauchi state.

Keywords: 7Es, Learning Cycle, Performance, Biology

Introduction

Science subjects (Biology, Physics and Chemistry) have been recognized worldwide to be the instrument for technological development. According to Olasehinde and Olatoye (2014), Science subjects are designed to promote a scientific literate society for technological advancement and development. Biology the subject under study is usually regarded as the most popular among science subjects; hence it usually attracts the widest enrolment among students. The objectives of biology at secondary school level according to Federal Government of Nigeria (2014) in the National Policy on Education is to prepare students to acquire: (1) adequate skills on the use of biology equipment/facilities in laboratory; (2) meaningful and relevant knowledge in biology; (3) apply scientific knowledge to every day's life in matters of personal and community health and agriculture; and (4) reasonable and functional scientific attitude.

Biology piques intellectual curiosity of students, increases their awareness of the fragile ecosystem, and stimulates critical thinking (Marten, 2018). The author added that, the importance and application of biology cut across many disciplines. This explained why Tom, Coetzee and Heyns (2014) earlier reported that solid foundation as well as achievement in the subject will enable students to become familiar and attain competencies in related subjects such as health science, agriculture, animal husbandry and horticulture among others. It then follows that students understanding of biology will go a long way in facilitating their performance in the above-mentioned science related subjects.

Despite the popularity of biology and its role on future career of students, researches evidences indicated that the academic performance of secondary school students in the subject over the years is alarming. Empirical evidence from Yabugbe (2009) reported that the performance of most of the students in external examinations is not encouraging. The WAEC Chief Examiners' Reports of 2014, 2015, 2016, 2017, 2018 and 2019 disclosed that, majority of the students that registered and sat for the subject scored below credit pass in public examinations. The persistent poor performance still remains the same over the years. The report indicated that only 41.24% of candidates that enrolled for Biology examination had credit pass and above. The report of shows that only 45.14%, 42.73% and 43.77% students obtained credit pass and above respectively in WASSCE. The cause of low performance of biology students is generally attributed to the teaching methods adopted by their teaches..

In an attempt to improve students' performance and retention ability, many researchers acknowledged the use of constructivist instructional strategies on promoting student's proficiency and performance in classrooms. For instance, Babasule(2018) established that 7Es based teaching approach enhances science students' achievement and facilitates effective learning in Physics. Specifically, Filgona, Filgona and Sababa (2017) reported that 7Es teaching strategies has the potentials to improve students' learning outcomes, achievement n all spheres of cognitive domain in Physics and Geography. The study conducted by Francis and Mabel (2015) also reported that 7Es based teaching approach has positive effects on secondary school students' academic achievement in chemistry.

The 7E's Learning Cycle Instruction (LCI) is an educational pattern that consists of seven teaching and learning steps that involve Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (Gülsüm, 2014). The learning cycle instruction is aimed at guiding inquiry approach that involves students to actively develop their understanding of concepts or skills with the teacher acting as the instructional director. The nature of the instructional task during each phase varies from activity to activity aimed at improving the students learning outcome. Study conducted by Khaled (2016) disclosed that 7E's learning cycle instruction fosters student's motivation and performance in chemistry. Rowan (2014) argued that, 7E's improve students' learning motivation and successful accomplishment of a task of students. The positive effect of 7Es learning cycle in Physics, Chemistry and Geography prompted the researchers to investigate its effectiveness of on biology students in Bauchi Metropolis, Bauchi State, Nigeria.

Objectives of the Study

Specifically, the study:

1. determine the difference between the pre-test mean academic performance of biology students in control and experimental group in Bauchi state.
2. determine the difference between the post-test mean academic performance of of biology students in control and experimental group in Bauchi state.
3. explore the in-depth views of biology students on the effects of 7Es learning cycle instruction on their performance in Bauchi state.

Research Questions

In line with the research objectives, the following research questions were raised to guide the study

1. What is the difference between the pre-test mean academic performance of biology students in control and experimental group in Bauchi state?
2. What is the difference between the post-test mean academic performance of biology students in control and experimental group in Bauchi state?
3. What are the in-depth views of biology students on the effects of 7Es learning cycle instruction on their performance in Bauchi state?

Research Hypotheses

The following hypotheses were raised and tested at 0.05 level of significance.

1. There is no significant difference between the pre-test mean academic performance of biology students in control and experimental group in Bauchi state.
2. There is no significant difference between the post-test mean academic performance of biology students in control and experimental group in Bauchi state.

Methodology

The study employed sequential explanatory mixed-method design. The design consists of two different phases. The first phase was quantitative in nature and the second phase was qualitative. The design involved quasi experimental design and Focus Group Interview (FGI). The quasi-experimental design was used to eliciting quantitative on students' academic achievement while the FGI was used to collect qualitative data on in-depth views of students on the effectiveness of the 7Es learning cycle. The choice of the design was considered appropriately because it enabled the researchers collect data from the respondents and sought for more explanation from them using the qualitative approach. Creswell (2014) opined that sequential explanatory mixed-method enables researcher to collect quantitative data and integrate it with the qualitative data.

Population and Sample of the Study

The population of the study comprises 3328SSII biology students in 2020/2021 academic year in Government Secondary Schools in Bauchi Metropolis, Bauchi state, Nigeria. The researchers sampled two intact classes of 137 students for the study. The students were randomly assigned to experimental and control group. Sixty-six (66) students constitute the control group while seventy-seven (71) constitute the experimental group. The researchers randomly selected 9 students for the Focus Group Interview.as suggested by Monishankar and Christine (2017); Amena (2017) who opined that, 9 participants should be consider adequate for focus group discussion.

Instruments

The instruments for the data collection are Biology Academic Achievement Test (BAAT) and Focus Group Interview. The BAAT is multiple choice questions adopted from past SSCE examinations question papers. The instrument was used to collect quantitative data on academic achievement of students in Biology. The BAAT instrument is categorized into Pre-Diagnostic Biology Academic Achievement Test (PDBAAT) and Diagnostic Biology Academic Achievement Test (DBAAT). The PDBAAT also known as pre-test was used to determine the entry level of the students prior to the treatment. The DBAAT otherwise known as post-test was used to collect data on academic achievement of students after the treatment. The PDBAAT and DBAAT are equivalent but reshuffled after the pre-test.

The Focus Group Interview (FGI). The instrument was used to sought for in depth views of the students which will be used to explain the results of the statistical tests obtained in the quantitative aspect. The interview protocol was developed based on the results of the study(Creswell, 2014).

Validation and Reliability of the Instrument

The BAAT was subject to validity by 3 experts in science education who were requested to ascertain their appropriateness. Their comments and observations were incorporated into the instrument before administering. The finding of FGI and the raw data were also given to the colleagues for peer review to check agreement of the emerging findings with the raw data (Merriam, 2009). The outcome of the peer review confirmed the congruency of the emerging findings with the raw data.

The researchers pilot tested the instruments using secondary school students in Gombe state. The state is outside the study area but share common characteristics with Bauchi state in terms of culture, weather and educational attainment as stipulated by NECO and WASSCE Chief Examines Reports. The data collected from the pilot study was coded into Statistical Package of Social Science (SPSS), 25; the package was used to run Split half Test, for the test of achievement test and reliability coefficient of 0.814 was obtained. The result indicated that instruments are reliable as suggested by George and Mallery (2003) who opined that a minimum reliability coefficient of .65 is acceptable for experimental study.

Discriminating and Difficulty Index of the Instruments

The analysis of difficulty index of the instrument ranges from 75.4 to 92.7 with average difficulty index of 98.8. The result suggested that the questions were satisfactory for the study. as suggested by Anowar and Rohani (2013) who opined that, Ideal Difficulty of Four-response multiple-choice should be at least 74. The discriminating index score of the instrument ranged from 0.5-0.9 with the average discriminating index of 0.7. The discriminating indexes of the items were satisfactory and retained as suggested by Ebel and Frisbie (1986) who reported that a discriminating index score of >0.39 should be considered satisfactory and retained for 4 multiple choice questions. Based on these, all the items were retained.

Method of Data Collection

In the stage one of data collection; the researchers trained the research assistant used in the study. To prevent the subjects from acting in any manner that can affect the outcome of the study, the researchers used the regular biology teachers as the research assistants who are responsible for teaching and administering the instruments. Before the exercise, the research assistants undergone competencies training for three days; two hours per day after school hours. The competencies training involved detailed explanations on the instructional strategy and how to use the strategy in the class. To ensure that the research assistants mastered the strategies as expected, the researchers organized microteaching session at the end of the training. Copy of the instructional package comprising three (3) weeks instructional units and a comprehensive lesson plans were given to the research assistants.

In the first stage of the research, the pre-test was administered to both experimental and control groups. This enabled the researchers to establish the equivalence of the participants in the study prior to the treatment. In the next stage, the students in the experimental group were taught using 7E-LCI. The students in this group were taught Genetics using 7Es-LCI guided by drawn lesson plans. The learning environment entails exploration, explanation, understanding, applying of knowledge, evaluation and connection of the content and the concepts to be taught. The student in the control group were taught

using the conventional teaching approach guided lesson plans. The researchers brief the teacher to adhere to the conventional teaching method strictly. The content to taught and the lesson are the same. The only difference is the teaching Instruction. At the end of the 3 weeks treatment, the posttest Achievement test was administered to both the experimental and control students. The scripts of the test were marked by the researcher using drawn marking scheme. The exercise is expected to last for 4 weeks.

The qualitative data was collected from the participants through Focus Group Discussion Interview (FGDI). The research assistants/teachers informed the participants about the date, time and venue for the focus group. Prior to commencement of the FGDI the teachers ensured the environment is quite and conducive for the interview. Attendance will also be taken to ensure all selected students are present. The interview lasted for 1 hour 45 minutes.

Procedure for Data Analysis

Data collected from qualitative data were analyzed using Statistical Packages of Social Sciences (SPSS) version 25. The package was be used to compute descriptive statistics of mean score, standard deviation and mean difference to answer the research questions. *Independent Sample t-test* was employed to test the research hypotheses at 0.05 level of significance. In the test of null hypotheses, where the p- value is found to be equal or less than the alpha value of 0.05 ($P \leq \alpha$) the null hypothesis was rejected and on the other hand where the p-value is found to be greater than the alpha value of 0.05 ($P > \alpha$) the null hypothesis was retained.

The qualitative aspect of the data collected through focus group discussion (FGD) was thematically analyzed using Microsoft Excel Package (MEP). The choice of MEP was based suggestions of Meyer and Leanne (2009) who opined that Excel can be used for qualitative analysis using conditional formatting and other functions. Based on this, the researchers considered the package appropriate for the analysis.

Results of the Study

Results of Research Questions

The descriptive statistics used to answer research questions were presented in Table 1 to 2.

Research Question One:

What is the difference between the pre-test mean academic performance of biology students in control and experimental group in Bauchi state?

The result of research question one revealed the mean score of 31.55 with standard deviation of 10.132 for students taught biology using conventional method (control group). Students taught biology using

7Es (experimental group) had the mean of 31.60 with the standard deviation of 10.350. The mean difference of ±0,05 obtained suggested that there was trivial difference in the pre-test mean performance of the two groups of the students.

Table 1: Pre-test mean difference between students taught biology using 7Es LC and those taught using conventional methods

Group	N	Mean	Std. Deviation	Mean difference	Remark
Control	66	31.55	10.132	±0,05	Trivial Difference
Experimental	71	31.60	10.350		

Source: Pilot study, 2021

Research Question Two

What is the difference between the post-test mean academic performance of biology students in control and experimental group in Bauchi state?

From Table 2, the post-test mean academic achievement of biology students in the control group was 32.95 with standard deviation of 8.57. Students in experimental group had mean of 50.45 with the standard deviation of 12.19. The mean difference between the two groups of students (Control & experimental) was ±17.5. The observed difference suggested that there was large difference between the mean performance of students taught biology using 7Es learning cycle and those taught using conventional teaching method. The result favoured students in the experimental group.

Table 2: Post-test mean difference between students taught biology using 7Es LC and those taught using conventional method

Group	N	Mean	Std. Dev.	Mean Difference	Remark
Control	66	32.95	8.57	±17.5	Large Difference (LD)
Experimental	71	50.45	12.19		

Source: Fieldwork, 2021

Results of Research Hypotheses

The *independent-sample t-test* of hypotheses were presented in Table 3 to 4.

Hypothesis One

There is no significant difference between the pre-test mean academic performance of biology students in control and experimental group in Bauchi state.

The t-test result used to test null hypothesis one in Table 3 revealed the mean score of 31.55 for students in conventional method against 31.60. The *p-value=.648.* The obtained p-value was greater than the level of significance (.648>0.05), the result therefore indicated that, there was no significant difference between the pre-test mean achievement of two groups of students used for the study. The hypothesis was therefore retained.

Table 3: Pre-test mean difference between students taught biology using 7Es LC and those taught using conventional method

Group	N	Mean	Std. Dev	Std. Error Mean	F	t	Sig. (2-tailed)
Control	66	31.55	10.132	1.602	.085	-.458	.648
Experimental	71	31.60	10.350	1.636			

Source: Pilot study, 2021

Research Hypothesis Two

There is no significant difference between the post-test mean academic performance of biology students in control and experimental group in Bauchi state.

The *Independent Sample t-test* used to determine the difference between the post-test mean academic achievement of students in control and experimental group is as presented in Table 4. From the Table, the mean score of students in control group stood at 32.95 and those in experimental group was 50.45 with standard deviations of 8.57 and 12.19 respectively. The obtained p-value of .000 was less than 0.05 level of significant. The hypothesis was therefore rejected; hence the result favoured students in the experimental group.

Table 4: Post-test mean difference between students taught biology using 7Es LC and those taught using conventional method

GROUP	N	Mean	Std. Dev.	Std. Error Mean	T	P-value	Remark
Control	66	32.95	8.57	1.055	-9.775	.000	HO^1 Rejected
Experimental	71	50.45	12.19	1.446			

Source: Fieldwork, 2021

Analysis of Qualitative Findings

The Results of FGI as presented in Table 5 and Figure 1.

Theme One:

Students views on the effects of 7Es learning cycle instruction on their academic performance in biology in Bauchi state

The interview conducted to explore the students views on the effects of 7Es LC on their performance indicated that the teaching approach has positive effect on their performance The views of the participants led to the development of four sub-themes (see Table 15) under the main theme, performance. Figure 1 shows the link between the main theme and four sub-themes.The outcomes of the interview in Figure 1 revealed that participants 1,3,5, and 7, opined the7Es teaching approach promotes their zeal in biology. Consequently, one of the participants argued that the teaching approach enhance their relationship with their teacher which help in improving their academic achievement in the subject. Furthermore, participants 1,2,4,5 and 9 reported that the teaching approach has made them to actively participate in the classroom activities. Participant 9 categorically, emphasized that the classroom participation has help him in understanding the subject. Similarly, participant 2 argued that the approach has improve is understanding of concept which seems to be difficult.

Likewise, four of the participants (1,3, 6, 7 & 9) maintained that the teaching approach is friendly and has improving their performance in biology. Participant 6 emphasized that he finds biology when taught using 7Es LC very easy to understand. The students maintained that that, during the

method inspired him as it is step by step approach. In a similar vein, participant 3 stated that the teaching approach encourage him to prepare himself before the lesson and put more effort to perform better.

From the Table, participants 1,2,5,6, and 9 opined that the method is lovely and promote their understanding of the biology. Particularly, participant 2 and 9 reported that increase their interest in the subject because their teachers encourage teamwork and the teacher consider the ability of the students. Responding to the question of academic achievement, all the nine participants maintained that the method has improve their performance in biology. Particularly, participant 5 opined that he has mean difference of 12 marks. Participant 1 emphasized that, if all the science teachers will adopt the teaching approach, it will help to address the problem of poor performance of students in science subjects at SSCE level. Participant 6 argued that 7Es influences his performance in biology because the method is motivating and encouraging.

Table 5: Views of Biology Students on Role of 7Es LC on their Learning and Performance

Views	Focus Group Participant								
	1	2	3	4	5	6	7	8	9
Zeal	√		√		√		√		
Participation	√	√		√	√				√
Performance	√	√	√	√	√	√	√	√	√
friendly	√		√			√	√		√
Lovely	√	√			√	√			√

Source: Fieldwork, 2021

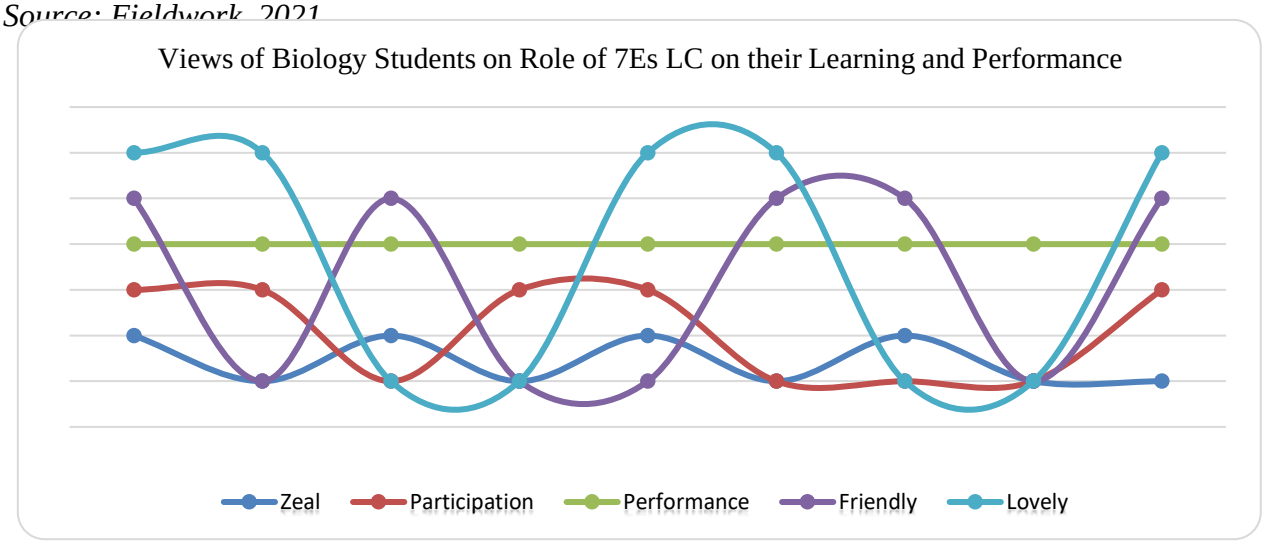

Figure 1: Model for Students' Performance in Biology: *Source: Fieldwork, 2021*

Discussion of the Findings

The finding of research question one which was further affirmed by test of corresponding null hyp one disclosed that there was large (significant) difference between the mean performance of students in experimental and control group. The outcome of the study was found to be in line with the submission Ahmad and Khudair(2014) on effect of Constructivist Learning in teaching science on the academic achievement and in developing the social skills among the students of the first preparatory grade in

Egypt reported that there was statistically significant difference in cognitive achievement and social skills among the study groups in favor of the group that studied science by using Constructivist Learning. Also, this result corroborates the findings of Kajuru, and Kauru. 2014), who carried out studies to investigate the effect of 7E's's constructivist approach on Polytechnic student's achievement and retention in trigonometry in Polytechnics in Kaduna State. The study revealed that students taught trigonometry using 7E's's constructivist model did better than those taught using the conventional method in both achievement and retention. The result also agreed with the report of Yenice (2014) argued that, 7E learning cycle in science courses increases students' academic and conceptual achievement more efficiently since the model give students the chance to explore. Moreover, since the phases of the model are clear effective learning takes place. Similarly, the study conducted by Ayaz (2015) reported that 5E learning strategy has positive effect on the students' attitudes towards the subjects they learn. The study further revealed that, the effect of 7E learning cycle on the students 'achievement is very large while that of 5E on students' attitudes is small.

The outcome the study is in consonant with the findings of Naade, Alamina and Okwelle (2018) whose study indicated thatstudents taught electromagnetic induction using the 7Es constructivist approach performed better than those taught with the lecture method. The authors attributed the differences in the mean achievement of the two groups of students could be attributed to the fact that the teachers teaching experimental group took time to elicit the student's prior knowledge to ascertain what they know about the new concept; the teacher using this as tool in the teaching could have helped the experimental group to perform better than the control group.

The result of FGI indicated students in the experimental group performed better as a result of stage-by-stage teaching method adopted in the 7Es learning cycle. The students maintained that the friendly nature of the 7Es learning cycle encourage students to participation in classroom activities which enhance their performance. From the FGI, the participants reported that the teaching method is motivating, promote student's curiosity and enhance their class participation biology. The general opinion of the students was that; the teaching approach has made has enhanced their academic achievement. The opinion agreed with that of Çepni, Ayas, Ekiz and Akyıldız (2010) who reported that constructivist learning approach enhances construction of knowledge ed by the students via participating into the learning process actively and students combine new knowledge with their existing knowledge which thereby enhance their performance. Similarly, Özbek, Çelik, Ulukök and Sarın (2012) reported that by using the learning cycle students can learn science concepts, fix their incorrect or incomplete knowledge, learn the concepts profoundly, and adapt the learnings gained in school to their daily life. So also, the study conducted by Şadoğlu and Akdeniz (2015) shows that the use of 7Es learning cycle in science courses increases students' academic and conceptual achievement more efficiently since the model give students the chance to explore.

Conclusion

The outcome of the study indicated that 7Es learning cycle has positive effects of academic achievement, retention and motivation of biology students. This therefore suggested the instructional approach has the potential of enhancing secondary school student's academic achievement in biology, promotes their retention ability and motivate them.

Recommendation

Based on the outcome of the study, it was recommendations that school principals through the head of department should encouraged Biology teachers at secondary school level to incorporate 7Es teaching strategy into their teaching, and to gradually customize the approach into their own personalized teaching method in Bauchi state

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