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The 5E Learning Cycle Instructions and Biology Academic Achievement among Students in Kwara State's Colleges of Education

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Abstract
Instructional strategies adopted by teachers have been linked by researchers to students' conceptions, misconceptions and difficulties with some concepts as well as poor performances in science subjects. This study examined the effect of 5E learning instructions on the teaching of undergraduate students offering biology in Kwara State College education. The study is a quasi-experimental type. The sample comprised 144 NCE two students in two private Colleges Of Education in Ilorin City. A purposive sampling technique was adopted to select two private colleges in the Ilorin district. A Biology Achievement Test on Photosynthesis (BAToP) was used for data collection. Mean and ANCOVA statistical tools were used for analysis. The study revealed a significant difference between the experimental and control groups in favour of the experimental group students. It was therefore recommended among others that 5E instruction should be adopted to teach biology in high institutions, particularly concept photosynthesis.

Keywords: Learning-Cycle, Instruction, Academic, Achievement, Biology

Introduction

The development of a nation depends on its scientific and technological advancement. This can only be achieved in the 21st century through innovative teaching of Science at all levels of education. Science can be described as a systematic way of studying natural phenomena in the environment (Soyibo et al., 2013). Biology is the study of living things and their vital processes. It's subdivided into botany, zoology and the study of morphology and physiology of organisms (Green et al.,2024). In Nigeria, Biology is a natural science subject offered at the secondary school level in Nigeria. Biology is also perceived as the most popular science subject offered amongst secondary school students in Nigeria (Jibril et al., 2015). Despite the importance and popularity, biology instructors and students still regard some concepts as difficult and unattractive to teach, among these are genetics, ecology, photosynthesis, cell-division e.t.c. (Amy, 2013). One of the problems reported to have contributed to the difficulty of these concepts was the methodology employed by teachers. (Abdulrahim, 2019).

The learning cycle is a systematic approach that promotes a deep conceptual understanding of scientific ideas. It outlined a sequence of how and when certain scientific ideas should be introduced (Songer et al., 2005). According to Walbert (2003) stated that the learning cycle is a generic term that describes a model of scientific inquiry, which encourages students to develop their understanding of scientific concepts, explore the concept deepen their understanding and apply the knowledge of these concepts to new situations. According to Cavallo et al. (2001) described the learning cycle as a teaching procedure that is consistent with the inquiry nature of science and with the way children naturally learn. Learning cycle instructions improve learner enthusiasm for investigation, science processes and skills and encourage active research. It is a sequence of instruction that guides students to learn the content of the lesson meaningfully (Bybee, 2001). According to Sadi and Çakıroğlu (2010) concluded that the learning cycle is an activity-oriented instructional method that promotes students' meaningful understanding of scientific concepts and explores and deepens that understanding in application to new situations. Also, it deals with the selection and organization of content and experience to facilitate the materials to be learnt within learners' cognitive structures and create new knowledge; structures to bring about cognitive development (Qarareh, 2012). The learning cycle is an innovative teaching and learning strategy with different phases, ranging in number from

three, five and seven phases. But irrespective of the number of phases, all the learning cycles have the same purpose (Ajaja, 2013; Bybee, 1997). Most studies on the learning cycle strategy showed it guides students to make sense of scientific ideas, improve their scientific reasoning and their attitudes toward science, increase their engagement in science class, and overcome misconceptions and academic achievements. (Ercan, 2014; Generaux,2014; Lalla, 2014). The 5E learning phase was adopted for this research.

Several studies have been conducted on the 5E learning cycle in the field of science and science education. According to Sadi et.al (2010) researched to investigate the effect of the 5E learning cycle on students' human circulatory system achievement; the study was conducted with 60 students in 11th grade from four classes of two teachers in a private high school in Ankara, Turkey. Each class of each teacher had both experimental and control groups. The experimental group consists of 31 students and the control group consists of 29 students. The experimental group was taught with 5E learning cycle instruction and the control group was taught with traditional instruction. The instruments used in data collection were the Human Circulatory System Achievement Test (HCSAT). Data collected were analyzed using analysis of variance (ANOVA). The result revealed that there was a significant difference between students taught using the 5E learning instructional strategy and those taught with the traditional method. The finding concluded that 5E learning cycle instruction increased students' achievement in Biology than traditional instruction. Aktas (2013) examined the effect of the 5E learning model and cooperative learning method on students' attitudes towards Biology lessons. The study was quasi-experimental. The sample consisted of 93 students in the 3rd-grade science field at Ankara, Cankaya Mitli Ptyango Anadolu High School in 2010-11 school years. The lesson units taught were heredity genetic engineering and biotechnology in Biology. Two experimental groups and a control group constituted the group studied. The first experimental group learnt by employing the 5E learning model, the second experimental group learnt by cooperative method and the control group by traditional teaching method. The findings revealed that the 5E learning model was the most effective method. Also, it was proved that the 5E learning method increases students' attitude towards the Biology lessons.

According to Opara and Waswa (2013) investigated the effect of the 5E learning cycle on students ' achievement in Chemistry. The study was a quasi-experimental pretest-posttest control group design. The sample for the study was made up of 430 form II chemistry students from 3 male-only and 3 female-only schools in Bureti district, Kenya. Data collected was analyzed using mean, standard deviation, ANOVA and t-test. Findings revealed that the learning cycle enhanced the achievement of students in the experimental group. According to Siddiqui (2016) conducted a study to examine the effectiveness of the 5E learning cycle and traditional instructions on ninth-grade students' understanding of suspensions in chemistry. The study was a pretest-posttest control group quasi-experimental design. The sample was composed of 60 ninth-grade male chemistry students in a secondary school in Kishanganj, Bihar, India. The Experimental Group was taught with a learning cycle, while the control group was taught with the traditional method. Data collected were analyzed with a t-test and Analysis of Covariance (ANCOVA). The result revealed that the learning cycle model of instruction was more effective in enhancing students' achievement in Chemistry than traditional instruction. Akinwumi and Bello (2015) compared the effectiveness of the learning cycle, Inquiry teaching and teacher-expository approaches on students' academic performance in Physics. The study was a non-equivalent pre-test, post-test control group design. The study comprised two experimental groups and a control group. The one experimental group was taught with a learning cycle and the other inquiry teaching approach. While the control group was taught with an expository approach. A simple random sampling technique was used to select 103 Senior Secondary School two (SSSII) physics students from three schools. The Physics Achievement and Retention Test (PART) and Physics Attitude Questionnaire (PAQ) were used for data collection. Data collected were analyzed using d Analysis of Variance (ANOVA). The results showed that students in the learning cycle approach had the highest mean scores and students' retention of physics concepts.

According to Kingir et.al.(2013) investigated the effect of the 5E learning cycle method on college students' understanding of gas concepts in a public university. The sample was composed of 26 students (9 males and 17 females) studying physics education. The study involved only one group (experimental group). A researcher-designed Gas Concept Test was administered as a pre-test and post-test to the group. Also, a semi-structured interview was conducted with 6 girls and 4 boys to students' ideas about gas concepts and the 5E learning cycle. Data collected were analyzed with t-test statistics. The study concluded that 5E learning cycle instruction was effective in students' understanding of gas concepts as well as the development of favourable attitudes toward chemistry. Ercan (2014) examined the effects of using the 5E learning cycle and V-d -diagram in general chemistry

laboratories on science teachers' candidates' attitudes, anxiety and achievement, who attended a State University in Turkey. The study was a quasi-experimental design with unequal control group. The sample consisted of 34 students, 17 students in the experimental group exposed to treatment (5E learning cycle instructions) and 17 students in the control group. Data collected were analyzed using t-test, ANOVA, MANOVA and ANCOVA. The results of the study revealed that the academic achievement of the experimental group differed from that of the control group; this was in favour of the experimental group.

According to Anil et.al. (2015) compared the 5E learning model with traditional methods on students' academic achievement, retention and attitude. The study used a meta-analytical method to calculate the effect of size on the impact of the 5E instructional model on students' achievement, retention and attitudes. This study used the meta-analytical method to calculate the effect size of the impact of the 5E instructional model on academic achievement, retention and attitudes. From the meta-analyses, the study concluded that the 5E model has a positive effect on the academic achievement, retention and attitude scores of the experimental group. Lalla (2014) conducted a study to monitor the use of the 5E learning cycle as a constructive approach for the development of conceptual understanding in the topic "Reactivity of metals" among 16 students in form four integrated science class. The study was an action research. A purposive sampling technique was employed, the researchers used a 5E learning cycle and concept maps to develop and monitor the students' conceptual understanding of the reactivity metals. Data collected were analyzed using mean, standard deviation, and t-test. Results indicated that the 5E learning cycle did affect the conceptual understanding of the students in the lessons taught and the students also expressed that the learning cycle did help in their understanding and learning

Table 1: Review of Recent Literature on 5E Learning Instruction

Author	Field	Method	Findings	Location	Focus
Lasaiba, M. (2023)	(Science) Geography	Mean and %	+	Indonesia	Optimizing students' activities and learning outcomes
Varoglu, L., Yilmaz, A. & Sen, S. (2023)	Chemistry	Standard Deviation, t-test	+	Ankara, Turkiye	Conceptual understanding
Agbidye, A. & Oyinlo, F. A. (2022)	Physics	Mean, Standard Deviation and ANCOVA	-	Nigeria	Critical thinking
Bahadir, F. & Dikmen, M. (2022)	science subjects & social sciences	Mean, Standard Deviation	+	Turkey	Students' academic achievement
Eroglu Seyide & Oktay Bektas (2022)	Chemistry	ANCOVA	+	Turkey	Academic achievement and scientific creativity
Jesulowo, J. K. (2021)	Biology	Mean, Standard Deviation, t-test, MANOVA	+	Nigeria	Creativity, performance and retention
Tenzin, S., Kinley, K. & Wangchuk, T. (2021)	Biology	Mean and Standard Deviation	+	Hutan	Conceptual understanding
Priyadharshini, N. & Singaravelu, G. (2019)	Science measurement	Mean, Standard Deviation & t-test	+	Bharathiar, Coimbatore	Learning science among middle school students.
Febrianto, P., Ika, Y. N., Ani, R. & Bambang, S. (2018)	Physics	Percentage	+	Indonesia	Conceptual understanding and learning motivation
Opera M. (2018)	Chemistry	Mean, Standard Deviation & ANCOVA	+	Nigeria	Students' interest

Some of the recently reviewed studies' findings revealed a positive significance (+) while few had no significance(-). Studies conducted by (Tenzin et.al., 2021; Asrizal et.al.,2022; Bahardir et.al,2022; Eroglu et.al.,2022; Lasaiba, 2023 & Varoglu et.al,2023) were conducted outside the country. While (Agbidye et.al.,2022; Jesulowo, 2021; Jibril et.al.,2019 &Abdulrahim,2019) studies conducted in Nigeria. Most of the recent studies conducted in the different fields of knowledge on the 5E learning cycle strategy showed a significant (+) improvement in students' academic

achievement (Lasaiba, 2023; Varoglu et.al, 2023; Agbidye et.al,2022 & Jesulowo,2021). According to Agbidye et.al. (2022) study revealed no significant (-) improvement in students' achievement when used in teaching. This study would contribute to the reviewed literature by examining the direction of the significance of the 5E learning cycle on concept photosynthesis in biology in deviation from the reviewed studies.

Objectives

The objectives of the study are to:

1. Find out the difference in the academic achievement of students taught with 5E learning instructions and those taught with the conventional method
2. Determine the difference in the achievement of male and female students taught using 5E learning cycle instructions

Research Questions

3. What is the difference in the academic achievement of students taught with 5E learning instructions and those taught with conventional methods?
4. Is there a difference in the achievement of male and female students taught using 5E learning cycle instructions?

Hypotheses

1. There is no significant difference in the academic achievement of students taught with 5E learning instructions and those taught with conventional methods.
2. There is no significant difference in the achievement of male and female students taught using 5E learning cycle instructions.

Methodology

This was a quasi-experimental study which involved pre-test, post-test, non-randomized, control and non-equivalent intact groups. It is a 2 x2 experimental design (experimental groups and control group) as well as gender (male and female). All NCE Biology students in Ilorin Colleges of Education constituted the population, while NCE II Biology students were the target population. A purposive sampling technique was used to select two private colleges of education in Ilorin City. School location (urban), and years of establishment (above 5 years and accredited) were criteria considered for selection. Of the schools. A researcher-designed test entitled 'Biology Achievement Test on Photosynthesis (BAToP) was used for data collection. The test contains 20 multiple-choice items and questions on photosynthesis. The questions went through item analysis to ensure that the items were appropriate in terms of difficulty index and discrimination power. Item analysis was done by trial testing the drafted test item on colleges of education not participating in the study. The Item difficulty and discrimination decisions for the selection of the test questions were based on established guidelines (Abiri, 2006). The reliability of the instrument was determined using the test-retest method of three weeks' intervals on the students of non-participating schools. A reliability of 0.66 was obtained using Pearson's product-moment correlation.

The researcher sought permission to conduct the study in the sampled schools by presenting an introduction letter to the authorities of the selected schools for consideration. After permission was given, the researcher was introduced to the Head of the Biology department for familiarity and arrangements were made for the study to take place. The researcher and Biology lecturers who were the Research assistants distributed the consent forms to the students. A form was given to each student to be completed and returned to the Research assistants. The completed consent forms were given to seek their consent to participate in the study. The copies of the collected consent forms were returned to the Researcher. Pretests were administered to the participating students in both experimental and control groups before the commencement of the treatment. After the treatment, a post-test was administered to all the groups. Data collected were analyzed with the Analysis of Covariance (ANCOVA). at 0.05 level of significance.

Results

Research Question 1: What is the difference in the academic achievement of students taught with 5E learning instructions and those taught with the conventional method?

Table 2: The Posttest Mean Scores of Experimental and the Control Groups.

Groups	Mean	SD	N
Convectional	18.12	6.87	73
Learning cycle Instructions	35.58	6.06	71
Total	26.72	10.88	144

The result from Table 2 reveals the mean scores for the experimental group and the control groups. The result reveals that the experimental group has an approximate mean score of 35.58 and a standard deviation of 6.06 and the control group has an approximate mean of 18.12 with a standard deviation of 6.87

Hypothesis 1: There is no significant difference in the academic achievement of students taught with 5E learning instructions and those taught with conventional methods.

Table 3: Result of ANCOVA on the Posttest for the two Experimental Groups and the Control Group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	12182.388[a]	2	6091.194	180.582	.000
Intercept	11447.500	1	11447.500	339.378	.000
Pretest	1217.165	1	1217.165	36.085	.000
Groups	9967.699	1	9967.699	295.507	.000
Error	4756.050	141	33.731		
Total	119819.000	144			
Corrected Total	16938.438	143			

a. R Squared = .719 (Adjusted R Squared = .715)

From the result shown in Table 3, the calculated F-value is 294.507 at 2 degrees of freedom computed at 0.05 level of significance. Since the calculated level of significance 0.000 is less than the level of significance 0.05, ($P<0.05$). Hypothesis one is hereby rejected, which means that there is a significant difference in the academic achievement of students who were exposed to 5E learning instructions and conventional instruction. This is in favour of students taught with 5E learning instructions.

Research question 2: Is there a difference in the achievement of male and female students taught using 5E learning cycle instructions?
Table 4 shows that male and female students have mean scores of 34.63 and 36.27 respectively. This indicates that there was no difference in the achievement of the students when taught biology using 5E learning instructions based on their gender.

Table 4: Post-Test Mean Scores of the Participants based on gender in the Experimental Group

Gender	N	Mean
Male	30	34.63
Female	41	36.27

Hypothesis 2: There is no significant difference in the achievement of male and female students taught using 5E learning cycle instructions.

Table 5 revealed that the calculated F value is 1.698 at 1 degree of freedom. The calculated significance is 0.197 greater than 0.05 level of significance ($P>0.05$). Hypothesis 2 is therefore not rejected. This means there is no

significant difference in the achievement of male and female students when taught biology using learning cycle instructions.

Table 6: ANCOVA of the Post-Test of Experimental Group based on Gender

Source	SS	DF	MS	F	Sig.	Remark
Corrected model	496.454[a]	2	248.227	8.135	.001	
Intercept	9971.830	1	9971.830	326.808	.000	
Pretest	450.146	1	450.146	14.753	.001	NS
Cognitive Style	57.811	1	51.811	1.698	.197	
Error	2074.870	68	30.513			
Total	92440.000	71				
Corrected Total	2571.324	70				

a. R squared = .193 (Adjusted R squared = 0.169)

Discussion

The study revealed that 5E Learning instructions have a positive effect on students' academic achievement in photosynthesis. The students in the experimental group performed better in the BAToP than those in the control group. Therefore, hypothesis one which states that there is no significant difference in the academic achievement of students taught with 5E learning instructions and those taught with conventional method was rejected. Because there was a significant difference in the academic achievement of the students in favour of the 5E learning instruction group. This finding contradicts the findings conducted by Agbidye et.al (2022) study which revealed no significant improvement in students' academic achievement when exposed to 5E learning cycle instruction. But the finding supported the conclusions Lasaiba, 2023; Varoglu et.al, 2023; Agbidye et.al,2022 & Jesulowo,2021 studies on 5E learning cycle. The study also found out that gender has no influence on the instructions and both male and female students' achievement improved when exposed to treatment. Therefore, hypothesis two which stated that, no significant difference in the achievement of male and female students taught using 5E learning cycle instructions was not rejected. This result on gender is in line with studies of Sadi et.al (2010) Lallah (2014) and Abdulrahim (2019) conclusions on the 5E learning method,

Conclusion

The 5E Learning instructions improved the academic achievement of NCE II students in the test conducted on concept photosynthesis compared with the conventional method. The 5E learning is not gender sensitive when employed to teach a lesson particular concept of photosynthesis, and 5E learning instruction is an appropriate method that improves students' understanding of the concept of photosynthesis.

Recommendations

Based on the findings, the following recommendations were made;

1. Science instructors should be encouraged to employ innovative teaching strategies like 5E learning to teach sciences, particularly biology to improve students' conceptual understandings and academic performances.
2. 5E learning instructions should be employed to teach students the content of instruction irrespective of their gender.
3. Biology instructors at high institutions should be trained through workshops and seminars on how to incorporate these innovative strategies in teaching and learning biology and sciences in general.

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