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Effect of 7E Instructional Strategy on The Achievement and Retention of Students in Bıology in Public Secondary Schools in Adamawa State, Nigeria

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ABSTRACT
The abstract should be in Palatino Linotype as the font type, 9 pt., between 150-250 words. The aim of this study was to investigate the effect of the 7E instructional strategy on the achievement and retention of SS II (11th grade) Biology students in public secondary schools in Nigeria. Intact classes of 60 students were randomly selected and denoted as the experimental group, which was taught with the 7E instructional strategy, and the control group, which was taught using the traditional, teacher-centered instruction methods. The data were collected via Biology Achievement in Respiration Test (BART), and analyzed using descriptive statistics and Independent Samples t-test for both variables. The results of the independent-sample t-test for the post-test scores indicated a significant value of $p < 0.05$ for the achievement variable. Similarly, the statistic indicated a $p < 0.05$ for students' retention, when taught by the 7E instructional approach. The implication of these findings suggest that the adoption of the 7E instructional approach enhances students' achievement in Biology. The findings also imply that students are able to remember what they were taught, after a time lapse, which enhances their chance of passing examinations. The retention test was administered a month after the post-test.

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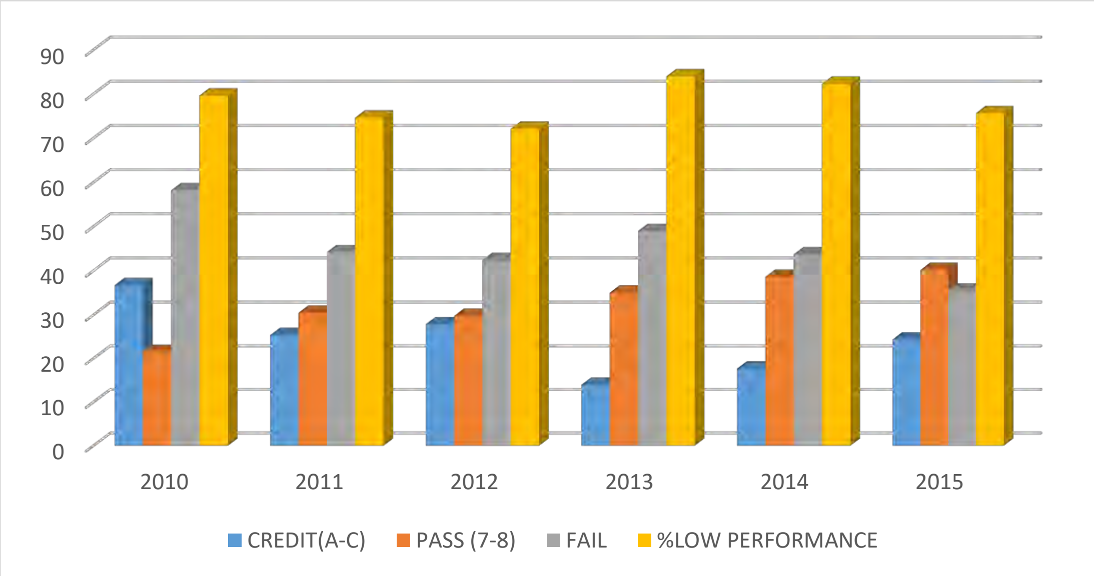
Introduction

The achievement of students in the end of school examination in biology, which qualifies students for admission into universities, is, to say the least, low in Nigeria (West African Examination Council, WAEC, 2010-2015 Annual Report). The percentage credit pass has been consistently less than 50% (Gambari, Yaki & Gana, 2014). In the area of study, students' achievement in biology is even worse, with students' credit pass peaking at 14% in a given year (2014) as shown in Figure 1.The development of a society, both socially and economically, is directly connected to the achievement of its students and it determines the quality of leadership and manpower of a country (Norhidayah, Kamaruzzaman, Syukriyah, Najah & Andin, 2009).

Figure 1

Performance of Biology students in May/June WASSCE from 2010-2015 at credit level in Nigeria



Note. West Africa Examination Council, 2010-2015 Annual report

It has become the yardstick for measurement of success in the competitive environment of student academic life. Academic achievement is the main mechanism by which students are apprised of their competencies, talents and abilities, and serves as a template that guides the aspirations for career development (Nazir, 2013). Illahi and Khandai (2013), opine that academic achievement is the performance level exhibited by the individual, or the skills obtained, and the knowledge developed in subjects offered in schools. It is indicated by test scores assigned by the instructor in a school setting (Roy, 2008), or grades obtained by students. On the other hand, acquisition of skills, objectives of learning and competencies are measured by assignments and course evaluations (Mustaq & Khan, 2012).

One of the most studied areas of educational research is instructional strategies, done with a view to find ways to achieve the needed outcomes of teaching (Ahmed & Abimbola, 2011). A variety of strategies, such as demonstration method, guided inquiry method, cooperative method, discussion method, and others, have been developed for science instruction, but these strategies are not widely used (Ahmed, 2008). In Nigeria, current curriculum and teaching methods impart facts and rote skills to students through lecture and reading of text books (Aladejana, 2007; Gambari, Yaki & Gana, 2014; Achor, Otor & Umoru, 2013; Akinwumi & Bello, 2015). In other words, traditional pedagogical setting of teacher-centered instruction dominates the Biology classroom. This instruction approach has proven to be in-effective (Ahmed & Abimbola, 2011).

As Ball (2008) and Kryukova, Starostenkov, Krapotkin, Timoshina, Makeeva and Yudina (2016) mentioned, a more active role for students in the whole of educational system is where today's educational system is heading. That means giving students a more active role in their schooling and education generally would bring greater benefits to schools (Whitty & Wisby, 2007). In this study, the learning cycle of 7E instructional strategy was employed to determine its effect on the variables under study. The 7E model was chosen because it is an improvement on the popular and most widely reported learning cycle model, which is the 5E learning cycle.

Retention is one of the factors responsible for poor achievement in Biology in secondary schools in Nigeria and it is pertinent to address the issue if desirable learning outcomes is to be achieved (Achor, Otor & Umoru, 2013). It is only instructional strategies that stimulate students' thinking and make understanding of concepts clear that enhances retention (Gbodi & Laieye, 2006).

Efforts in strengthening retention ability in students, therefore, should be pursued by Biology teachers in Nigeria

Literature Review

The learning cycle is an instructional philosophy based on the constructivist learning approach (Balci, Cakiroglu & Tekkaya, 2006). It is a student-centered approach to learning where students are encouraged to explore a concept and develop their understanding of it, before the concept is clarified by an instructor, who then guides the students to apply the concept to new situations (Wijaya, 2009). The learning cycle was developed to promote the understanding of concepts based on Piaget's constructivist model of learning (Gok, Vural & Oztekin, 2014). This approach could be employed to investigate its effectiveness on the variables of achievement, attitude and retention of students towards biology (Yilmaz, Tekkaya, & Sungur, 2011; Sam, Owusu & Anthony-Krueger, 2018; Shobirin, Corebima, & Lukiati, 2019). The learning cycle has undergone several modifications since its inception, moving from the 3E, 4E, 5E, 6E and 7E.

The 3E Instructional Strategy

This approach, as explained by Hanucin and Lee (2008), is made of the following phases:
a) Exploration: Students explore new material or situation, to provide first-hand experience of a science phenomenon. It is a phase that initiates debate among groups of students, generating discussions that analyse the reasons for each groups' ideas. The results obtained from such analyses could lead to acceptance or otherwise, of the alternative conceptions, while proper scientifically acceptable conceptions are retained. The interaction with a science phenomenon improves students' observation, skills, hypothesizing and testing, while enabling them to compare their prior conceptions and argue about them. This could lead to contradictions that create a disequilibrium that provides opportunity for proper conceptualization.
b) Concept Introduction: A concept is introduced which explains the phenomena encountered during the exploration phase. This enhances the understanding of science concepts through interaction with the instructor, peers and text. Students should be encouraged to identify as many new patterns as possible, before and after concept is revealed.
c) Concept Application: In this phase, students are required to apply concept to new situations, so as to test their understanding. This enables them to generalize concept understanding and not limit it to teacher's examples or classroom discussions. Another 3-phased model suggested by Danielson (2016), is the approach that has; Lesson Adjustment, Response to students and Persistence phases.

- Lesson Adjustment: This is the ability of a teacher to adjust a lesson during presenting it to students. It also refers to the stored instructional strategies of a teacher and the confidence with which the teacher makes a shift in strategy when it becomes desirable.
- Response to Students: Unexpected situations occasionally occur during a lesson which presents an opportunity for a true teachable moment. The ability of a teacher to capitalize on those moments to derive home conceptual understanding of students is referred to as response to students. In other words, the teacher adjusts the instruction in response to evidence that learning is taking place or not.
- Persistence: This is the trait in which a teacher displays his efficiency, especially when students exhibit difficulty in learning a concept.

Alternative approaches that will help students to successfully conceptualize are sought by the teacher to achieve the instructional goal. The 3E is an instructional strategy employed to modify students'misconceptions or alternative conceptions to conform to scientifically accepted paradigms (Ozbek, Celik, Ulukok and Sari, 2012). It also affords the teacher to display his teaching dexterity through responding to students' conception or lack of it, and seizing those moments during teaching to capitalize on promoting conceptual understanding (Danielson, 2016).

The 4E x2 Instructional Strategy

This approach, suggested by Marshall, Horton and Edmonson (2007), differs from the 3E learning cycle model by not commencing with the exploration phase and that the * 2 represents Meta-cognitive reflection and Assessment. This approach was further clarified by Marshall, Horton and Smart (2009). The study provides an overview in which the major constructs represented by Metacognitive reflection; Inquiry instructional model and Formative assessment interrelate.

a) Engage: This is the phase in which the learner is engaged through questions that perturb his mind and hooks the attention of the learner, initiating the learning process. It is the phase of inquiry that probes the prior knowledge of learners, identifies their alternative conceptions and provides interest that induces stimuli to learn the phenomenon under study. Exposing students' alternative conceptions is necessary in facilitating disequilibrium or a perturbation experience that is necessary for proper conceptualization. Marshall et al (2009) argues that effective questioning in all the phases is necessary and questions that facilitate teacher guidance in the engagement phase include; (a) what have you heard about that…………………? (b) Is it true that…………? and so on. This would promote metacognitive reflection and represents formative (diagnostic) assessment, which improves the academic achievement of all students. The integration of metacognitive reflection, asserts Marshall et al (2009), with formative assessment in the engage phase of inquiry, engages students in conceptual understanding, performing scientific inquiry and understanding about inquiry.

b) Explore: The explore phase requires students to reason, predict, design, collect or test questions that the instructor uses to facilitate aspects of the explore phase which include; (a) what happens when…………? (b) What if……...? (c) What information/data do you need to collect………? And so on. Meta-cognitive reflection and formative assessment become meaningful when individuals present their responses in group discussions (small or large). Students could log in their reflections of cognition of a problem in their notebooks and could discuss areas of problem (such as how to collect data) in their group (Marshall et al, 2007). The interaction of students' meta-cognitive reflection, formative assessment and the inquiry (explore phase), encourages deeper understanding and instructors can determine whether students have truly learned the concept before the end of the lesson (Marshall et al (2009).

c) Explain: In this phase, students can compare, reshape and align their alternative conceptions with their new learning by involving in explanation of evidence, interpreting, analysing and justifying data (Yilmaz & Cavas, 2006). Central to this phase are aspects that include: (1) data interpretation and findings. (2) Communicating findings orally or in writing, through the provision of evidence for claims and so on. (3) Teacher facilitates students' activity through questions such as; what patterns have you observed; what evidence do you have for your claims; what other explanations do you have for your finding (Marshall et al, 2009).

d) Extend: The extend phase is the stage in which students are asked to apply, evaluate, transfer and generalize obtained knowledge to new situations. Appropriate questions for this phase include: How do you think this applies to…...? Where can this be used in the real world? And so on. Students are required to think deeply about what they have learnt, and meta-cognitive reflection unites what is learnt with personal reflection, which exposes where knowledge is complete and where work still need to be done. It is noteworthy, however, to state that some studies are conducted under the 4E learning cycle model, without emphasis on the meta-cognitive and formative assessment aspects in their design. These are embedded in general flow of the cyclic process (Yilmaz and Cavas, 2006).

The 5E Instructional Strategy

Like the 4E, the 5E is made up of all the phases learning cycle of engage, explore, explain and extend, but an additional phase of "evaluate" is added (Sibel, Selma and Umit, 2011). The first three "E" s (engage, explore and explain) seek to enable students make meaning of content knowledge, while the last two "E"s (extend and evaluate), validate the scientific processes involved in the earlier steps (Kähkonen, 2016). Another contrast that the 5E has with the 4E is that summative evaluation is not done by the instructor at the "extent" phase of the cycle, but at the "evaluation" phase. The "extend phase in the 5E learning cycle model is that stage in which students apply learned concepts and skills to new but similar situations (Çepni and Şahin, 2012, Duran and Duran, 2006, Nas, Calik and Çepni, 2012), which corresponds to the concept application of the 3E learning cycle model.

The 6E Instructional Strategy

Different models for the 6E approach exist in literature. Chessin and Moore, (2004) added a sixth "E" to the 5E, which stands for "E-search". The new "E" represents the addition of technology, which is used to tie up the 5 phases together, using it in any or all the 5E stages. The "E-search" is the use of electronic media; power-point presentations, internet research, digital cameras as well as programs, such as Hyper Studio, CD-ROMs, emails and so on. The use of these technologies would depend on preference, nature of activity, needs and students' preference. Burke, (2014), proposed a different model of the 6E, which added an "E" for "Engineer" to the existing 5E. This "E" is added to enable students to model and design as engineers would. The model seeks to blend concepts and contexts (design) and inquiry, incorporating concepts of mathematical modeling, as well as teaching Design and learning Matrix, Burke (2014).

Furthermore, there is a version of the 6E, where an "E" which stands for "Exchange" has been added to the 5E (Kähkönen, 2016). In this phase, students learn the need to ask questions, use evidence and logic in presenting their explanations, recognize alternative explanations and communicate arguments that are scientific in nature. A different model of the 6E which is not built upon the addition of an "E" to the existing 5E model is the one reported by Zanaty and Eisaka, (2015). The phases in this model are represented as; Experimentation, Exploration, Explication, Elaboration, Evaluation and Extension. The model is suggested for instructional delivery using integrated digital equipment. It is specifically designated as FIR-6E instructional model, where FIR stands for Forming, Informing and Reforming-6E. Zanaty and Eisaka, (2015) explained the three (FIR) learning aspects as follows:

a) The Forming phase; Learning and Training: In this phase illustrates the learning approaches of input and output and learning concepts of experimentation and exploration, in respect of learning and training and how to access learning materials. Input is in terms of how language is used in different ways for a variety of purposes to make meaning of acquired information (Tomlinson, 2010). When conversant with language, students could then change their learning style to active learning approach using necessary. It is at this phase that students are formed into groups, assigned tasks and given performance sheets on which each group records its achievement, to maintain the motivation of individual group members (Zanaty and Eisaka, 2015). In addition, two instruction concepts, the Experimentation and Exploration, are developed in the forming phases.

1) Experimentation enables students to experiment in self-regulated learning, connecting the previous learning experiences to the present, as well as providing opportunities to learn from one another and independently.

2) Exploration provides opportunity to investigate and develop various contexts through learning tools, such as digital cameras and personal computers.

These concepts enable students to engage in effortful experiences that present a variety of activities to develop, innovate and solve problems that lead students to contribute to learning environment (Zanaty and Eisaka, 2015).

b) The Informing Phase; Intervention and Active Learning Environment: In this phase, active learning environment is maintained by focusing on the development of two approaches to learning; Outputs and Short-term outcomes: and two learning concepts; Elaboration and Explanation, as well as incorporating self-regulated individual learning with productive group learning (Zanaty & Eisaka, 2015). The digital content, design and illustrated guide of each group is assessed by other groups, and students are instructed to record their achievement in each task through evaluation and process guide sheets. In addition, two instruction concepts, Explication and Elaboration are developed in the Informing phase (Spector, Merill, Van Mesienboer and Driscoll, 2008). The authors explained the concepts as follows:

1) Explication enables the comparison of methods and achievement of students from other groups in interactive environment of learning, as well as present opportunity for method presentation and identification of easy features. The role of the teacher is to facilitate group presentations and processes leading to that.

2) Elaboration provides opportunity to students to develop logic modelling skills and sustainably implement their learning experiences.

These two concepts expand students learning and improve their
Communication abilities, as well as cross-cultural awareness (Zanaty and Eisaka, 2015).

c) The Reforming Phase; Longitudinal Learning Cycle: This is the phase that reflects the impact of the FIR-6E model on students' achievement and attitudes. Two learning approaches, Outcome and Impact, and the learning concepts of Evaluation and Extension, are illustrated at the reform phase, with a view to effectively create and reflect a new learning situation (Zanaty and Eisaka, 2015). Students are also enabled to apply and integrate their acquired skills into activities of the real world. Additionally, two instruction concepts are developed in the Reform Phase, according to Zanaty and Eisaka, (2015).

1) Evaluation, which allows the exchange of feedback between a student and a group member as well as the instructor, improves conceptual pedagogy and learns new methods.

2) Extension, that allows students to reengage in a new learning cycle of sustainable learning.

These instructional concepts enable students to challenge themselves in novel learning situations, reflect on new learning methods and communicate their information to other audiences.

Progression Of The E-Phases Of The Learning Cycle

Learning Cycle E-Phases.
3E: Exploration, Concept Introduction, Concept Application
4E/4E× 2: Engage, Explore, Explain, Extend/Metacognitive Reflection and Formative Assessment (emphasis)
5E: Engage, Explore, Explain, Extend and Evaluate
6E: In addition of all the phases in 5E, an additional 'E' for 'E-Search' or 'Exchange' or 'Engineer'.
6E: Experimentation, Exploration, Explication, Elaboration, Evaluation and Extension
7E: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend

In this study, focus will be given to the 7E learning cycle, which is an improvement of the popular 5E learning cycle strategy, and it will be employed to determine its effect on Biology students, on the variables under study.

The 7E Instructional Strategy

The 7E instructional approach is a comprehensive instructional model that accommodates various methods, such as cooperative learning, group work, lectures, laboratory investigations and direct instruction (Balci et al., 2011). It enables students to explore their beliefs and allow them to construct new knowledge, while discarding their misconceptions, by clearing their thought processes (Bulbul, 2010). The 7E learning cycle is a student-centered, inquiry learning strategy that lays the foundation for proper conceptualization by students through various activities, spread across seven phases (Eisenkroft, 2003). These phases, Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend, according to Gok et al. (2014), allows students to correct their misconceptions through exploration, and facilitate clarification by the teacher, and aided by explanations by the students themselves. The 7E model of instructional delivery similarly deepen understanding of concepts by other activities, such as evaluating students' conception against acceptable scientific explanations, as well as the extension (application) of obtained knowledge to new situations (Gok et al, 2014). This method encompasses various methods that aid students to construct new knowledge, such as cooperative learning, group work, laboratory investigations and direct instruction, by clearing their thought processes (Bulbul, 2010; Balci et al., 2011).

Furthermore, the 7E model, which is a constructivist approach to learning, encourages peer interaction, in which students collaborate and discuss concepts with a view to meaningfully understand them (Zimmerman, 2007). This increases conceptual understanding among students, probably due to gains in understanding during discussions, or because of knowledgeable students among the peer groups (Smith et al., 2008). Being a student-centered pedagogic approach, the 7E model of instruction significantly improves students' satisfaction, self-reported engagement and increases students' achievement (Armbuster, 2009).

Peer interaction or collaboration, in which students interact, collaborate and discuss in trying to meaningfully understand an introduced concept (Zimmerman, 2007), is a hallmark of the constructivist approach to learning. This interaction of students, which is encapsulated in the 7E model, has been found to not only increase achievement of students of various intellectual abilities, but also improves attitude (Zimmerman, 2007). Similarly, Smith et al. (2008), opine that peer collaboration increases conceptual understanding among students, probably due to gains in understanding during discussions, or due to influence of knowledgeable students among the peer group. The study surmises that discussions amongst peer groups enhance students' conceptualization even when none of the students in the discussion group knows the correct answer originally. The 7E learning cycle instructional model is a modification of the 5E model, where two "E"s are added. The additions were made to ensure that instructors correctly undertake to present lessons according to the learning requirements (Eisencraft, 2003). The Elicit component is added to underscore the need to verify students' prior understanding of a concept. Bordeaux and Mosner, (2011) explained that "Elicit" is made to be an independent component of "Engage" component, where students' attention is captured before the introduction of a concept. The phases of the 7E instructional model are briefly as follows:

a) Elicit- this phase elicits the prior understanding of students in topic. For example; What does respiration mean to you?

b) Engage- presents topic in a way that is exciting to the students. For example; Do we all agree that a human being needs energy for survival and growth? Where does a person get the needed energy among these: a) potato b) water c) meat d) air? Is this energy connected, in any way to respiration?

c) Explore- offers opportunity for examination of topic by students. For example; Do plants also engage in respiration? If yes, is it like human respiration? why?

d) Explain- students are introduced to scientific vocabulary, such as aerobic, anaerobic and cellular respiration.

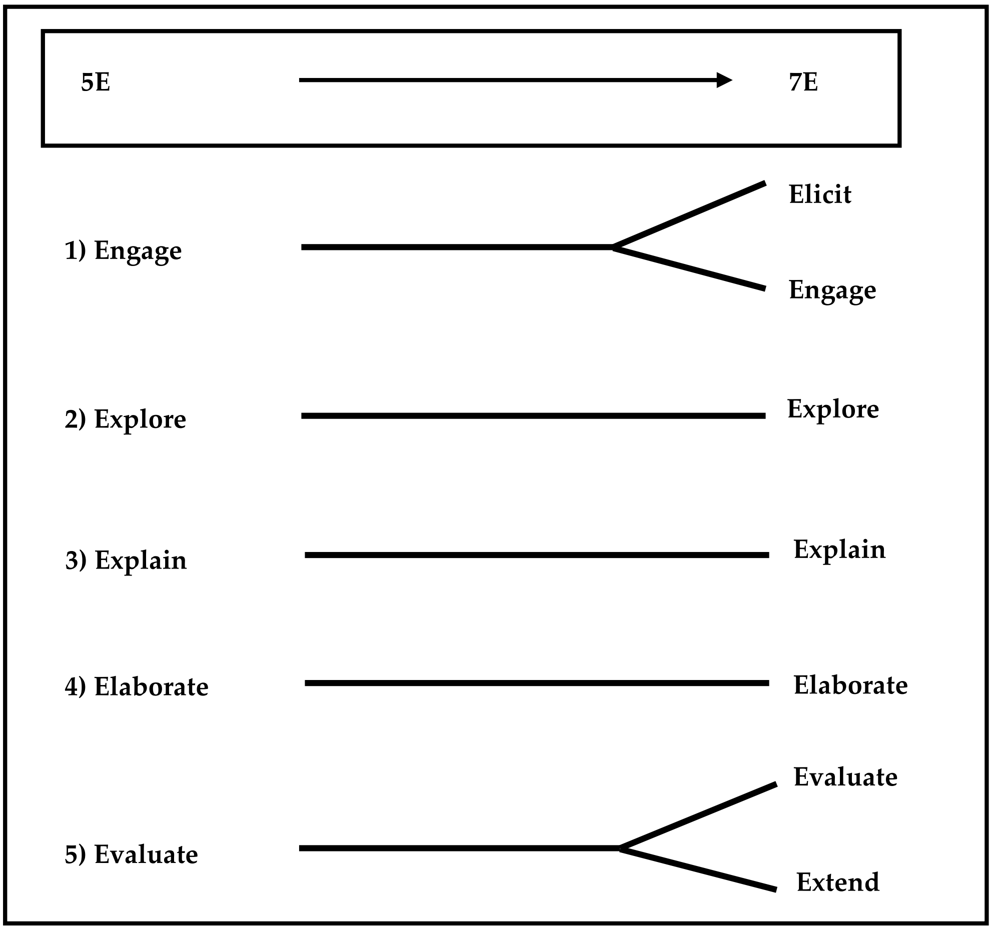
e) Elaborate- encourages students to investigate the topic further and expand their knowledge. For example; How do we define food for a human being? What is food made up of? What is the relationship among these terms; Respiration, Energy, Food?

f) Evaluate- provides the platform to examine or assess students' learning through tests or working on poster projects that would provide evidence that topic has been properly conceptualized.

g) Extend- students are challenged to explore how concept is applied to other situations, topics and daily lives. For example; finding application of respiration to previous topics, such as digestion and circulation; effect of respiratory diseases on the lives of patients; mechanics of anaerobic respiration on the muscle of man and so on. Figure 2 highlights the addition of the two "E"s to the 5E model, making it the 7E model.

Figure 2

7E Learning Cycle



Note. Adapted from Eisencraft (2003)

The aim of this study was to investigate the effect of the 7E instructional strategy on the achievement and retention of SS II (11th grade) Biology students in public secondary schools in Nigeria. Specifically, the research objectives and the research hypotheses are as below;

Research Question 1: Is there any difference in the Achievement of students who were taught Biology using the 7E instructional strategy and those taught by traditional methods?

Research Question 2: Is the 7E instructional strategy able to improve the retention of biology students in public secondary schools in Adamawa State, Nigeria?

Hypothesis 1: There is no significant difference in the Achievement of students who were taught Biology using the 7E instructional strategy and by traditional methods.

Hypothesis 2: There is no significant difference in the retention of students in biology when taught using the 7E instructional strategy and by the traditional methods.

Methods

This study adapted the quasi-experimental, pre-test, post-test control group design by Campbell and Stanley (1966). Quasi-experimental research has control for all major internal validity threats except for those associated with Selection and History, Selection and Maturation, and Selection and Instrumentation, Campbell and Stanley (1966). In this study, Selection and History as a threat was controlled because no major event that was disrupting to school activities occurred during treatment.

Random assignment of sampled schools to the experimental and control groups removed the threat of Selection and Maturation, while control to threat of Selection and Maturation was attained by keeping the conditions under which treatment was given to be similar (Githae, Keraro & Wachanga, 2015).

The schools used in this study were public secondary schools because majority of students attend these secondary schools in Nigeria. Two public secondary schools having similar characteristics were randomly selected and assigned as the experimental and control groups. An intact group was used in the selection of the experimental class because of the nature of the 7E instructional strategy. The strategy emphasizes active conceptualization through peer-group discussions during the process of making meaning of Biological phenomena. Substantive Biology instructors of the sampled schools were used to deliver instruction with participating students of 60 per group, giving a total of 120 students.

A Biology achievement in Respiration Test (BART) adapted from West Africa Examination Council (WAEC, 2018) was employed to measure students' achievement and this consisted of 14 short answer questions, 6 multiple-choice as well as 5 practical questions. Each correctly answered question was scored as 1 mark while incorrectly answered questions were scored 0. Test items represented: Knowledge, Comprehension, Application, Analysis and Evaluation categories.

The instructional plan as well as the instruments were validated by 3 experts from science education, thereafter, a pilot study was carried out in a public secondary school not involved in the study, to determine the reliability coefficient of the instrument. The KR-21 formula was used to calculate the reliability of the instrument and the result yielded a value of 0.75, which is above the recommended 0.70 threshold (Balta & Sarac, 2016). Biology teacher for the experimental group was trained for 1 week on the 7E instructional strategy technique and was made familiar with the instructional plan and materials.

Furthermore, a pre-test was given to the experimental and control groups to determine the behavior of students in the two groups before commencement of intervention. An independent sample t-test was used in the determination of the equality of this entry behavior. After the intervention which lasted for 6 weeks, in which the experimental group was taught using the 7E instructional strategy and control group being taught using the traditional teacher-centered methods, a post-test was administered to both groups. Generated data was analyzed using independent samples t-test to analyze data for the achievement and retention variables. The retention test was administered one month after the initial post-test.

Findings

The results were presented by describing the independent t-test statistic, which was used to establish that the experimental and control groups used in the study were equal in their knowledge before intervention is given. This is followed by the descriptive statistics that answers the research question and the independent samples statistic that analyzed the hypotheses.

Table 1

Descriptive statistics for Achievement

Variable	Experimental Mean (SD)	Control Mean (SD)	Mean difference (95% Confidence Interval)
Pretest scores	28.72 (5.84)	28.10 (5.07)	0.62 (-1.36, 2.59)
Posttest scores	72.03 (8.91)	61.2 (5.64)	10.75 (8.05, 13.45)

Table 1 shows that at entry level before intervention was given, the mean achievement of the experimental and control groups was similar, with the experimental group having a higher mean achievement score (M = 28.72) and (SD = 5.84), than the control group (Mean = 28.10) and (SD = 5.07) This concludes that the knowledge base of students in the two groups is similar.

Table 2

Independent Sample t-test for Pre-test

		Levene's Test Equality Variances		fort-test for Equality of Means of			
		F	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*
Pretest Scores	Equal variances assumed	.028	.867	.617	118	.538	.61
	Equal variances not assumed			.617	115.71	.538	.61

From Table 2, the p value is more than .05. Therefore, there is no significant mean difference between the two groups for pre-test. Table 2 statistically confirms the similarity of students' entry behavior by giving the significance value of the difference in achievement scores at 0.05 level of significance, since p> 0.05. Therefore, the pre-test is not considered as the covariate in this study.

Table 3

Effects of 7E Instructional Strategy on Students' Achievement in Biology using Independent Sample t-test for Post-test Scores

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Post Test Scores	Equal variances assumed	16.330	000	.894	118	.000
	Equal variances not assumed			.894	99.749	.000

The independent sample t-test for the post-test sores shows a significant value of p = .00 (p > 0.05). This means that the post-test scores of the experimental and control groups are different, suggesting that the 7E instructional strategy significantly and positively affects students' achievement in Biology. Based on this finding, the null hypothesis, which states that there is no significant difference in the Achievement of students who were taught Biology using the 7E instructional strategy and by traditional methods, is therefore rejected. For the retention variable also, the research question was answered by the means and standard deviation, while the hypothesis was analyzed by the independent samples' statistic.

Table 4

Descriptive Statistics for Posttest and Retention Scores

	The E7 Instructional Strategy	N	Mean	Std. Deviation	Std. Error Mean
Post Test Scores	Experimental	60	72.03	8.912	1.151
	Control	60	61.28	5.642	.728
Retention Scores	Experimental	60	65.20	8.15	1.052
	Control	60	53.67	4.76	.614

The descriptive statistics table (Table 4) shows the initial post-test scores of the experimental and control groups, which is named as post-test 1, and the retention scores of the two groups, named as post-test 2. The retention scores of students were obtained one month after the initial post-test, to determine the extent to which students in the two groups were able to recall information. From values obtained, it can be observed that the mean scores of students in the experimental group have higher mean scores (65.20) than students in the control group (53.67). This suggests that students in the experimental group have higher retention in Biology than those in the control group.

Discussion

The hypothesis addressing the effect of 7E instructional strategy on the achievement of students in Biology in public secondary schools was analyzed in Table 1 and it revealed that students taught by the 7E instructional strategy had higher mean score (Mean =72.03) in comparison to students taught by traditional methods, who had a smaller mean score (Mean = 61.28). When the results were subjected to analysis by the independent samples statistics, a significant value ($p > 0.000$) was obtained. This study, therefore, showed a positive influence of the 7E instructional strategy on students' achievement in Biology in public schools.

This finding agrees with the findings of Gok (2014), who reported that the students achieve better grades when taught using 7E instructional strategy because it enables students to better conceptualize and understand the human body system and science process skills. As a learning cycle instructional strategy, the 7E is an activity-based strategy which allows student-centeredness that challenges students' intellectual abilities. The strategy involves learning that is facilitated through and giving feedback (Adebola, 2007). It encourages students' creativity, peer interaction and builds confidence in problem solving, which promotes academic achievement. Students get the opportunity to participate in the learning process, which contrasts with the traditional methods of passivity of students in the learning process. Adebola (2007) is of the view that traditional methods of instruction generally affect the quality of instructional output in the teaching of science subjects in Nigeria. The inherent structure of the 7E instructional strategy, which allows the presentation concepts in 7 different ways help to facilitate learning. The active participation and peer involvement in making sense of conceptual phenomenon assist student in the teaching and learning process.

The finding of a post-test of this study is also supported by Shaheen and Kayani (2015), who reported that the 7E instructional strategy is an effective technique for promoting students' achievement, by developing in learner's inquiry skills, which motivates them to explain scientifically discrepant events, which is the hallmark of science. The finding also corroborates the work of Githae, Keraro and Wachanga, (2015), who investigated the effect of the learning cycle on students' achievement in Biology in secondary schools. The result of their work showed that the learning cycle group performed significantly better than the traditional method group.

In addition, enhanced achievement of students in Biological concepts, when taught by the learning cycle, had earlier been reported by Balci, Chakiroglu and Tekkaya (2006). The study reported improved conceptual understanding of students on the concept of photosynthesis, when compared to traditional methods of instruction.

Similarly, the result of the mean scores of the retention test indicated that the Biology students taught with the 7E instructional strategy have a higher mean retention (65.20) than their counterparts that were taught with the traditional instructional strategy (Mean = 53.66). Therefore, the null hypothesis, which states that there is no significant difference in the retention of students in biology when taught using the 7E instructional strategy and by the traditional methods, has been rejected. When the results were subjected to independent samples t-test analysis, the retention of the two groups were statistically significant because $p > 0.05$. This means that the 7E instructional strategy positively affects, therefore improves students' retention in Biology in public secondary schools.

The finding of a post-test also agrees with the assertion of Safitri and Nugrahalia (2015), that learning cycle instructional models positively affects students' retention of knowledge. The 7E learning cycle strategy carries students' conceptualization through seven phases of learning, namely; Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend. Following the processes associated with these instructional phases as stipulated by Eisencraft (2003), allows the construction of knowledge as envisioned by the constructivist theory of learning, which serves as a learning tool for retention of knowledge by students,

In addition, Okafor (2017), opined that the learning cycle instructional models improves students' retentive capacity, when compared to the traditional methods of instruction. The learning cycle models take care of both individual and social aspects of knowledge construction that make recall of knowledge more readily accessible. This recall allows students to pass their examinations, which is the reason that informs the conduction of this study.

It is worthy of note, that the 7E phases of 'explore' 'explain' and 'elaborate' proved to be the most impactful on students' behavior. Student enjoyed the opportunity of knowledge construction and were able to feel comfortable in making mistakes without the feeling of guilt or embarrassment.

Conclusion and Implications

The main reason educators constantly search for more efficient pedagogic methods is to improve students' achievement. Based on the data obtained by employing the 7E instructional strategy to determine students' achievement in Biology, it can be concluded that the strategy significantly produces better student achievement in Biology than traditional teacher-centered method. The use of the 7E instructional strategy would be an effective strategy of learning that could be used to overcome conceptualization problems encountered by students, through the 7E phases of Elicit, Engage, Explore, Explain, Elaborate Extend and Evaluate. This would certainly solve the perennial problem of low achievement, brought about by students' inability to recall information in examinations. This is exhibited by Biology students in the final school examination conducted by the West Africa Examination Council (WAEC). Based on the findings of this study, the following recommendations are made, i) there is the need for secondary school Biology teachers to be more innovative and resourceful in identifying, selecting and utilizing activity-based instructional strategies in the Biology classroom. To be able to do these, teachers would need to be trained by discipline-based instructional strategists; ii) Biology students should be given the opportunity to perform learning tasks and other activities to enable them to construct their own knowledge based on their previous conceptions, constructivist learning strategies need to be incorporated into Biology curriculum, if these opportunities are to be harnessed; iii) Biology lessons should be made more appealing to enable students develop positive perceptions about Biology, associating everyday phenomena or activities, be they cultural or industrial, to Biological principles, would be appealing to students; iv) curriculum planners for Biology should emphasize students-centered learning/teaching to boost students' achievement. To achieve this, the volume of topics required to be mastered by secondary school Biology students need to be reduced; v) more time need to be allocated to Biology lessons to allow for the implementation of student-centered pedagogic styles. Doing this would enable students to do their own knowledge construction, as well as enable Biology teachers to guide and facilitate students' understanding of Biological phenomena; and vi) the 7E instructional strategy needs to be adopted for use in the instructional delivery in Biology to enable students retain learnt Biological concepts, so that students' entry into universities could improve.

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Appendix A

Example of Instructional Plan 1.
Matrix Design for Goal number 1: Describe different types of respiratory systems and list the characteristics of respiratory surfaces

Objective	Information/Example	Practice/ Feedback	Review Respiration	Instructional Strategy	Assessment
Students should be able to: 1. Distinguish between breathing and respiration.	Respiration is the chemical process in which chemical energy in food is converted to a form usable by the cell (ATP). This is the source of energy for an organism's life processes. Breathing is part of respiration. it is the means through which O_2 is transferred into the body to oxidize food during respiration. Conduct activities for Inhalation and Exhalation; Breathing rate.	Food + O_2 = CO_2+H_2O + energy. Breathing involves gaseous exchange from the environment into organisms, simply by diffusion or by special organs that aid gaseous intake and removal. How is gaseous exchange in unicellular organisms differ from vertebrates?	is a process in which food is oxidized to release energy in the form of ATP. This is the source of energy that organisms use for their life processes.	Group-based strategy.	Post-test# 1(Essay). Post-test# 3(Essay). Post-tes#10 (Objective).
2: Describe different types of respiratory systems.	All organisms engage in respiration. Unless O_2 can diffuse into organisms directly from the environment, a system must be employed assist in doing so. For example, gaseous exchange in unicellular organisms is simply by diffusion of O_2 into, and CO_2 out the moist cell membrane. Fish use gills; insects and spider use breathing tube- trachea; respiratory system in birds consist of lungs and air sacs in bones; amphibians use their skins and lungs to	Gaseous exchange in unicellular organism takes place simply by diffusion from the environment into the cell. Vertebrates must have a system for bringing in O_2 and eliminating CO_2. They use blood as the medium for	Simple diffusion is enough for gaseous exchange in some organisms, while special systems, sometimes elaborate, are required in others, for respiration to take place.	Group-based strategy.	Post-test # 18 (objective). Post-test # 12 (Essay). Post-test # 8 (objective) Post-test # 17 (Essay).

	respire; human respiratory system consist of the lungs, bronchi and trachea. Examples of diseases affecting the respiratory system.	transporting the gases in and out.			
3. List characteristics of respiratory surfaces.	Respiratory surface is the part of the respiratory organ through which gaseous exchange take place. An organ of respiration is one through which O_2 is taken in and CO_2 is given off. For example, the whole body of a Ameoba is its respiratory surface. In humans, gaseous exchange takes place in the alveoli, which is found in the lungs. An earthworm uses its moist skin as a respiratory surface, while a frog employs its skin and lungs to respire. Why? Where do you find the respiratory surface of fish? To consume O_2, insects use breathing tubes- trachioles, which combine to form trachea. This exits through holes at the sides of the insects called spiracles, through which CO_2 is removed. What type of respiratory system do they have? To ensure quick gaseous exchange at respiratory surfaces, they need to:	Lower animals, such as amoeba and hydra, don't require organs to respire because of the simplicity of their body systems. Gaseous exchange by diffusion is enough. Therefore, what type of respiratory system do they have? In humans, however, O_2 must move from the nasal cavity up to the alveoli in the lungs for respiration to occur. Can you trace the pathway through which O_2 passes to reach the	Higher animals need organs to respire. Insects use breathing tubes. Lower . animals use their body surfaces to respire. Respiratory surfaces have common characteristics.	Group-based strategy	Post-test # 5 (Essay). Post-test # 11. (Essay).

	have thin walls, be moist, have large surface area and be richly supplied with blood.	alveoli? Nasal cavity → Pharynx → Epiglottis → Trachea → Bronchus → Bronchiole → Alveoli. What is the characteristic of this surface?			

Appendix B

Sample Questions for Bloom's Taxonomy

Knowledge:
Explain the characteristics associated with respiratory surfaces, such as ability to allow gases enter the organism quickly.
Comprehension:
What is the nature of the surface of an aquatic unicellular organism?
Application:
What are some of the industrial application of anaerobic respiration?
Analysis:
A fish taken out of water dies after sometime. Analyse the reason for its death, in relation to respiration and respiratory surfaces.
Evaluation:
What are the factors that affect the rate of diffusion?