IJAAR PUBLISHING®

West African Journal of Interdisciplinary Research | ISSN: 3027-1878
Volume 2, Issue 3 (July-September, 2024) | www.ijaar.org

EFFECTS OF 7E LEARNING CYCLE, PROBLEM-SOLVING AND LECTURE METHOD ON BIOLOGY STUDENTS' ACHIEVEMENT IN DELTA CENTRAL SENATORIAL DISTRICT

BY

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Abstract

The study's main objective was to investigate the effects of the 7E learning cycle, problem strategy, and lecture method on biology students' academic achievement in Delta Central Senatorial District. The constructivist and experiential learning theories guided the study. The study adopted a 3 x 2 pre-test post-test planned variation quasi-experimental design. A sample size of 218 biology students from six mixed secondary schools was selected using stratified random sampling techniques. The instrument for data collection was the Biology Achievement Test (BAT). The instrument was validated by experts. Mean, standard deviation, T-test, and ANOVA were used to analyse the data. The results revealed that the mean score of students taught using the 7E learning cycle was higher than that of those taught using the problem-solving strategy and lecture method. In terms of achievement, there was no interaction between methods and gender. The results also revealed that gender factors did not have any impact on teaching through the constructivist learning cycle. The study concluded that the 7E learning cycle or problem-solving strategies should be adopted by biology teachers. It was therefore recommended that biology teachers be trained on the application of these strategies in biology classrooms.

Keywords; 7E learning cycle, Problem-Solving, Lecture Method, Biology

Okate, U. P. & O. P. Ajaja. (2024). Effects of 7E Learning Cycle, Problem-Solving and Lecture Method on Biology Students' Achievement in Delta Central Senatorial District. *West African Journal of Interdisciplinary Research. 2*(3), 13-25. DOI: 10.5281/zenodo.13144182

Introduction

Biology is one of the fundamental science subjects offered in Nigeria's secondary schools. Since biology is the study of life, it is the foundation of science and is crucial to understanding how organisms interact with their surroundings. The scientific study of biology focuses on the structure, function, evolution, and interactions between living things and their surroundings. In addition to providing a basic grasp of how living things operate, it spans a wide range of subjects, including microbiology, marine biology, and medicine. It includes subjects that are pertinent to our everyday lives, such as cells, genetics, physiology, and ecology. People are able to make educated decisions about their lifestyle, diet, and general health because of this information. People who study biology are better able to comprehend illness origins, prevention, and therapy. Having this information is essential for making wise choices about one's own health and wellbeing. Additionally, it gives people the confidence to develop healthy behaviours and take preventative action. The following justifies the importance of biology education at the federal level. A population with a high level of education in biology guarantees a consistent flow of scientists, researchers, and subject-matter specialists. This is crucial for expanding scientific inquiry, developing novel technologies, and advancing science overall.

Despite the importance of biology, an examination of the WAEC Chief Examiner's Reports throughout the years reveals a consistently low level of student achievement in the subject. Ndayambaje, *et al.*,(2021) found that, among other things, biology instructors' use of inadequate teaching methods was the reason for students' subpar performance in the subject. The way that professors teach biology may have a big influence on how well their students do in the subject. Various instructional strategies may have varying effects on students' comprehension, involvement, and attitude towards biology. It's critical to remember that different teaching strategies may benefit certain people or groups more than others, and the impact of a given approach may vary among pupils. In order to improve relevant learning for all students, biology instructors must use the proper teaching approach or methods. The lecture technique is a conventional teaching approach in which the instructor uses oral presentations to impart knowledge to the pupils (Adebanjo, 2021). The teacher usually talks during a lecture, while the students listen and take notes. In large courses, when the instructor addresses a number of pupils at once, this technique is often used. A lecture's primary goal is to provide students with a thorough overview of a subject by introducing important ideas, theories, and case studies. However, the conventional lecture approach being used in schools today to teach biology is fairly limiting in some areas and adaptable in others.

The lecture method's non-transactional character, which discourages debate and other types of student participation, is one of its main drawbacks. The lecture technique just provides a means for educators to meticulously carry out their instruction in accordance with a well-planned curriculum. As a result, Adebanjo (2021) linked the use of inefficient teaching techniques to students' poor biology performance. Education research is gaining a lot of attention due to concerns about how instructional strategies affect student success. Constructivist teaching methodology was subsequently developed as a result to improve meaningful learning. Student-centred constructivist teaching methods place an emphasis on students' active engagement in the process of creating knowledge (Cherono, Samikwo, & Stella, 2021). Constructivism in the classroom stimulates students' active engagement and prior knowledge, which improves meaningful learning and comprehension of the subjects being taught. Although there are many constructivist teaching methods, this research will focus on the 7E learning cycle and instructional techniques related to problem-solving. According to Sam et al. (2018), the 7E learning cycle is a complete instructional paradigm

that supports a variety of modalities, including cooperative learning, group work, lectures, laboratory investigations, and direct teaching. It helps pupils examine their ideas, create new information, and get rid of their misunderstandings by unclogging their mental processes. The 7E learning cycle, which consists of a variety of activities divided into seven stages, is a student-centered, inquiry-based learning technique that lays the groundwork for students' appropriate conceptualization (Eisenkroft, 2003). According to Gok (2014), these phases—elicit, engage, investigate, explain, elaborate, assess, and extend—allow students to correct their misunderstandings via investigation and promote instructor clarification, supported by student explanations. Similar to previous activities, the 7E learning cycle of instructional delivery deepens students' comprehension of ideas by having them compare their conceptions to credible scientific explanations and extend (apply) their newly acquired information to novel contexts (Gok, 2014). This approach includes a range of techniques that help students build new information by streamlining their mental processes. These techniques include group projects, cooperative learning, laboratory studies, and direct teaching (Abdullahi, et al., 2021).

A problem-solving instructional strategy is an educational technique that focuses on problem solving and critical thinking in students. It is an approach that motivates students to actively participate in the process of recognising, deciphering, and solving challenging issues. An intentional selection and creation of problems that require critical thinking, problem-solving skills, self-directed learning strategies, and teamwork abilities from the learner characterises a problem-solving instructional method (Okafor & Agboghoroma, 2023). Less teacher-centred instruction—which, like the lecture approach, views students as passive participants in class activities and active listeners—is the result. By contextualising real-world problems, the problem-solving instructional technique provides learners with tools, guidance, and support as they develop their problem-solving skills and topic understanding.

According to El-Shaer and Gaber (2014), a teaching approach called problem-solving is used to engage students in active learning. They went on to argue that it provides a context or challenge for pupils to apply previously learned material and absorb new information. It is acknowledged as an effective teaching technique to increase student desire for learning, offer them the resources they need to do research, apply theory to real-world situations, and utilise their skills and expertise to come up with a feasible solution to a given issue. Academic achievement is a measure of performance outcomes that shows how well a person performed in relation to certain objectives that were the main focus of activities in the learning environment, particularly in schools, colleges, and universities. Academic achievement, according to Adam, et al., (2022), is shown by marks or scores and is described as a successful accomplishment or performance in a certain topic. Both great academic accomplishment and poor academic achievement may be facilitated by the teacher's method of instruction. That is, a teacher's approach to teaching biology may make or break their pupils' academic success. Therefore, the purpose of this research is to determine which of two approaches—problem-solving and lecture—will improve students' academic performance in biology.

The students' gender may impact how well the instructor teaches biology and how well the kids do academically. In a school context, sex simply refers to male and female pupils. Certain instructional strategies may have a greater positive impact on the academic success of male students than on female students, while other strategies may have an equal positive impact on both genders. The majority of these studies benefit male students, even if the study's findings on the impact of teaching tactics on the academic achievement of male and female students in the sciences are not entirely conclusive. Adopting instructional

practices that equally raise male and female students' academic success may be one way to reduce the achievement gap between the two groups of pupils. Regardless of the gender of the pupils, a well-designed teaching technique improves academic attainment. Therefore, the purpose of this study is to determine whether or not using a lecture style and problem-solving techniques would improve the academic achievement of both male and female students in the field of biology. In light of this, the purpose of this research is to determine how the 7E learning cycle, a problem-solving technique, and the lecture format affect the academic achievement of biology students in the Delta Central Senatorial District.

Statement of the Problem

Biology is a compulsory subject for science students at the secondary school level of education. This is because of its importance to individuals and the nation as a whole. Teaching biology to individuals and at a national level has wide-ranging implications for personal health, scientific literacy, career opportunities, research advancements, public health, economic growth, and environmental sustainability. Despite the importance of biology, students' performance in external examinations such as WASSCE still falls short of acceptable.

Empirical studies further confirm students' poor academic achievement in biology (Ndayambaje et al., 2021; Ahmed et al., 2021). This poor academic achievement in biology has been traced to the teaching strategy employed by biology teachers, among others. Hence, Umukoro & Oyovwi (2021) advocated teaching methods such as problem-solving and the 7E learning cycle, among others, to enhance students' achievement. Biology, being a very important science subject due to its high relevance to human life, needs to be taught in such a way that the students are fully engaged both practically and theoretically so that the knowledge gained can be extended and applied to other areas of contemporary concern. Therefore, the problem of this study is: will the use of the 7E learning cycle, problem-solving strategy, and lecture method have differential effects on students' academic achievement in biology?

Research Questions

The study was guided by the following research questions:

1. What is the effect of the 7E learning cycle, problem-solving strategy, and lecture method on students' mean achievement scores in biology?
2. What are the differences in the mean achievement scores of students taught biology using the 7E learning cycle, problem-solving strategy, and lecture method?
3. What is the interaction effect between teaching methods (7E learning cycle, problem-solving strategy, and lecture method) and sex on students' achievement in biology?

Research Hypotheses

The study was further guided by following hypotheses:

1. The 7E learning cycle, problem-solving strategy, and lecture method do not have a significant effect on students' mean achievement scores in biology.
2. There is no significant difference in the mean achievement scores of students taught biology using the 7E learning cycle, problem-solving strategy, and lecture method.
3. There is no significant interaction effect between teaching method (7E learning cycle, problem-solving strategy, and lecture method) and sex on students' achievement in biology.

Purpose of the Study

The main purpose of the study will be to investigate the effects of problem-solving strategy and lecture method on biology students' academic achievement in Delta Central Senatorial District. The study will specifically find out the:

1. effects of 7E learning cycle, problem-solving and lecture method on student' mean achievement scores in biology
2. difference between the mean achievement scores of students taught biology using 7E learning cycle, problem-solving and lecture method;
3. effect of interaction of teaching method (7E learning cycle, problem-solving and lecture method) and sex on students' achievement in biology.

Theoretical Framework

This study will be anchored in experiential learning theory, a comprehensive framework developed by educational psychologist David Kolb in 1984. This theory elucidates how individuals gain knowledge and skills through their experiences, proposing that learning occurs when learners actively participate in experiences, reflect on them, conceptualize new ideas, and apply these insights to new situations. According to Kolb, experiential learning encompasses a four-stage cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Each stage is interdependent and builds upon the preceding one.

Experiential learning emphasizes the importance of active engagement, reflection, and application to enhance the learning process. It recognizes that individuals possess diverse learning styles and preferences, with some favoring particular stages of the learning cycle, such as action or reflection, over others. This allows learners to adapt and tailor their learning experiences to align with their unique needs and styles. The theory has been extensively applied in various educational contexts, including classrooms, workplace training, and outdoor education, highlighting the value of hands-on experiences, reflection, and practical application in fostering deep learning and skill development. Through active engagement in experiential learning, learners acquire knowledge and skills that are more relevant, meaningful, and transferable to real-world contexts.

The theory underscores the significance of hands-on experiences, reflection, and practical application in cultivating deep learning and skill development. By immersing themselves in experiential learning, learners can gain knowledge and skills that are not only relevant but also meaningful and applicable to real-world scenarios. The integration of the 7E learning cycle and problem-solving strategies further supports hands-on experiences, reflection, and practical application, thereby promoting profound learning and skill development.

Research Design

This study will employ a pretest, posttest, planned variation, quasi-experimental factorial design. The design will comprise three instructional groups (7E learning cycle, problem-solving, and lecture groups), which are the independent variables, and two sex levels (male and female), which are the moderator variables. The dependent variable is achievement.The rationale behind the adoption of a quasi-experimental design is predicated on the non-randomization of subjects into the three experimental groups. In this study, intact classes will be used in order not to disrupt school activities. Quasi-experimental design is a practicable alternative to pure experimental design when randomization of subjects into experimental groups is not possible (Ajaja, 2013).

Population for the Study

The study's population consists of 17,914 SS2students offering biology in all the 187 public secondary schools in Delta Central Senatorial District.

Sample and Sampling Technique

The sample size for this study will consist of three hundred and nineteen (218) SSII biology students in six (6) public co-educational secondary schools' intact classes in Delta Central Senatorial District. These schools were selected using stratified random sampling techniques. Again, the researcher will randomly select one school each from the six local government areas using balloting with replacement. The choice of stratified random sampling is to ensure that all the schools in the study area have equal chances of being selected for this study. Since sex is a moderator variable in this study, only co-educational public secondary schools were sampled for this study to allow easy comparison of male and female students' academic achievement when using the problem-solving strategy and lecture method.

Research Instrument

The instrument used for data collection in this study is the Biology Achievement Test (BAT). The Biology Achievement Test (BAT) was constructed by the researcher from various biology contents. There were 50 multiple-choice test items in the BAT. The BAT was built from biology topics in six-week instructional units.

Validity of the Instrument

The face and content validity of the instrument were duly established. This is predicated on the fact that content validity is usually established for achievement test instruments. The face validity of the Biology Achievement Test (BAT) was determined by three experts made up of an experienced biology teacher in a school in the Uvwie local government area, an expert in the Science Education Department, and an expert in Measurement and Evaluation from Delta State University, Abraka. In order to validate the instrument, the researcher provided the three experts with the study's purpose, research questions, hypotheses, the instrument, and the intervention packages. At the end of the process, the researcher followed the recommendations of the three experts in constructing the final instrument draft.The content validity of the Biology Achievement Test (BAT) was established using a table of specifications.

Reliability of **the Instrument**

The reliability of BAT was established using Kuder-Richardson formula 21 because of its appropriateness for establishing the reliability index of multiple-option objective test items. The BAT was administered to 50 biology students in a school in Warri South Local Government Area of Delta State, which is outside the area of coverage for this study. The data obtained were analysed using Kuder-Richardson formula 21, which yielded a reliability coefficient index of 0.84.

Method of Data Analysis

The research questions will be answered using the mean and standard deviation, while the hypotheses will be tested using paired sampled t-test analysis since the pretest and posttest scores of the same group will be computed.

Presentation of Results and discussion

Research Question 1: What are the effects of 7E learning cycle, problem- solving strategy and lecture method on students' mean achievement scores in biology?

Table 1: Mean and Standard Deviation comparing the score of Biology exposed to 7E Learning cycle, Problem-Solving and Lecture Method on students'.

Methods	N	Pretest mean	Posttest mean	Mean diff	Pretest SD	posttest SD
7E	92	31.4983	61.3043	29.826	13.68361	19.77979
PS	53	28. 7925	59.9623	31.1698	12.68761	13.01768
LM	73	27.7560	53.3973	25.6413	10. 82341	16.25725

Table 1 shows that students instructed with the 7E learning cycle had an average pretest score of 31.49 (with a standard deviation of 13.68) and an average posttest score of 61.30, resulting in a mean difference of 29.83 favoring the posttest. Additionally, students taught using the problem-solving strategy had a pretest mean score of 28.79 and a posttest mean score of 59.96, yielding a mean difference of 31.17, also in favor of the posttest. Furthermore, the table reveals that students who were taught via the lecture method had an average pretest score of 27.75 (with a standard deviation of 10.82) and a posttest score of 53.39 (with a standard deviation of 16.25), leading to a mean difference of 25.64 in favor of the posttest. This highlights the improvement in scores across all instructional methods.

Hypothesis 1: There are no significant effects of 7E learning cycle, problem solving strategy and lecture method on students' mean achievement scores in biology.

Table 2: Paired sampled t-test statistics showing the Effect of 7E Learning cycle, Problem-Solving and Lecture on Biology students' achievement.

Method	N	Pretest mean	Posttest mean	Mean difference	S.D	Df	t	Sig(2tail)
7E	92	31.4983	61.3043	29.806	13.68361	91	20.913	0.000
P.S	53	28.7925	59.9623	31.1698	12.68761	52	17.979	0.00O
L.M	73	27.7566	53.3973	25.6413	10.82341	72	17.191	0. 000

Table 2 indicates that the three instructional methods have significant effects on achievement, as evidenced by the calculated value of 0.000 being less than the significance level of 0.005. Consequently, the hypothesis is rejected, demonstrating that the 7E learning cycle, problem-solving strategy, and lecture method significantly impact students' biology achievement scores.

Research Question 2: What is the Difference Among the Mean Achievement scores of students taught Biology using 7E learning cycle, Problem -Solving Strategy and Lecture Method?

Table 3:

Mean achievement scores of students taught Biology using 7E Learning cycle, problem-solving and lecture method.

Method	N	Mean	Standard deviation
7E	92	61.3043	19.77979
P.S	53	59.9623	13.01768
L.M	73	53.3973	16.25725

Table 3 displays the post-test mean scores of students instructed using different teaching methods. Students taught with the 7E learning cycle achieved the highest mean score of 61.30, with a standard deviation of 19.77. Those taught using the problem-solving strategy had a mean score of 59.96, with a standard deviation of 13.01. Meanwhile, students taught with the lecture method had a mean achievement score of 53.39, with a standard deviation of 16.25. The table clearly shows that students taught with the 7E learning cycle had the highest mean score, followed by those taught using the problem-solving strategy, and the lowest mean score was observed in students taught using the lecture method. This highlights the presence of a mean difference among the teaching methods.

Hypothesis 2: There is no significant difference in the mean achievement scores among students taught biology using 7E learning cycle, problem solving and lecture method.

Table 4

ANOVA statistics comparing the mean pre achievement test scores of students taught with 7E learning cycle, problem- solving strategy and lecture method.

	Sum of square	DF	Mean square	F	Sig(2 tail)
Between groups	615.274	2	307.637	1.954	.141
Within group	33844.194	215	157.415		
Total	34457.468	217			

Table 4 shows that the difference is no significant difference at pretest since the calculated P value of 0.141 is higher than 0.005 with this, Analysis of Variance (ANOVA) statistics becomes the appropriate statistics to test hypothesis 3 and the result is shown in table 4.

Table 4.

ANOVA statistics comparing the pretest mean achievement score of students taught with 7E learning cycle, problem –solving strategy and lecture method.

	Sum of square	dF	Mean square	F	Sig(2tail)
Between groups	2731.338	2	1365.669	7.255	0.001
Within group	40468.882	215	188.227		
Total	43200.220	217			

Table 4 shows that the observed difference is significant since the calculated P value of 0.001 is less than 0.005. To determine the direction of the significance Scheffe comparison was carried out and the result is shown in table 5.

Table 5: Scheffe test statistics showing the direction of significance among the three groups

Method	(j) groups	Mean difference	Std Error	SIG	95% Confidence interval	
					Lower bound	Upper bound
7E	problem solving	1.34208	2.36588	0.851	-4.4896	7.1738
	Lecture method	7.90709	2.15044	0.001	2.6065	13.2077
Problem	7E	-1.34208	2.36588	0.001	-7.1738	4.4896
solving	Lecture	6.56500	2.47587	0.031	.4622	12.6678
Lecture	7e	-7.90709	2.15044	0.001	-13.2077	-2.6065
method	Problem solving	6.56500	2.47587	0.031	-12.6678	-.4622

The Scheffe table above indicates that there is no significant difference between the 7E learning cycle and the problem-solving strategy, as evidenced by a calculated p-value of 0.851, which is greater than 0.05. However, a significant difference exists between the 7E learning cycle and the lecture method, with a p-value of 0.001, which is less than 0.05. Additionally, there was no significant difference between the problem-solving strategy and the lecture method, as indicated by the p-value of 0.851, which is greater than 0.05. Conversely, a significant difference was found between the problem-solving strategy and the lecture method, with a p-value of 0.031, which is less than 0.05. The table further shows that between the lecture method and the 7E learning cycle, a significant difference exists, as the p-value of 0.001 is less than 0.05. Finally, there is a significant difference between the lecture method and the problem-solving strategy, with a p-value of 0.031, which is less than 0.05. Therefore, there is a significant difference in the mean achievement scores of biology students taught using the 7E learning cycle, problem-solving strategy, and lecture method, favoring the 7E learning cycle.

Research Question 3: What is the interaction effect between teaching methods (7E learning cycle, problem solving and lecture) and sex on students' achievement in biology?

Table 6

Descriptive Analysis statistics of Mean and Standard Deviation showing the Interaction Effect Between Method and Sex on Student Achievement in Biology

Method	Sex	N	Mean	Mean difference	S.D
7E	male	41	60.6829	1.12099	12.3742
	female	51	61.8039		11.37896
P.S	Male female	26	60.7692	1.58405	13.98373
		27	59.1852		12.23185
LM	Male female	36	50.1111	6.4835	17.66963
		37	58.5946		14.27402

Table 6 reveals the mean interaction scores for male and female students taught using the 7E learning cycle, problem-solving strategy, and lecture method. For the 7E learning cycle, male students had a mean score of 60.6829, while female students scored slightly higher with a mean of 61.8039, resulting in a mean difference of 1.12099 favoring female students. In the group taught with the problem-solving strategy, male students had a mean score of 60.7692,

and female students had a mean score of 59.1852, with a mean difference of 1.58405 favoring male students. For the lecture method, male students had a mean score of 50.1111, whereas female students scored significantly higher with a mean of 56.5946, leading to a mean difference of 6.4835 in favor of female students. These results indicate noticeable differences in the mean scores across different teaching methods and between genders.

Hypothesis 3: There is no significant interaction effect between method and sex on students' mean achievement score.

Table 7:

ANCOVA statistic showing the interaction effect between teaching method and sex on students' achievement.

Source	Type 111 sum of squares	Df	Mean square	F	Sig
Corrected model	13737.071	6	2289.512	16.396	.000
Intercept	55773.775	1	55773.775	399.423	.000
Pre achievement score	10176.932	1	10176.932	72.882	.000
Group	1624.700	2	812.350	5.816	.003
Sex	642.716	1	642.716	4.603	.o33
Group*sex	97.148	2	48.574	.346	.707
Error	29463.149	211	139.636		
Total	784928.000	218			
Corrected total	43200.220	217			

Based on the data presented in Table 7, it is clear that there is no significant interaction effect, as indicated by the calculated p-value of 0.707, which is greater than the threshold of 0.005. Consequently, the null hypothesis (HO3) is not rejected. This implies that there is no significant interaction effect between teaching method and sex on students' achievement.

Discussion

The study's initial finding demonstrated that the 7E learning cycle, problem-solving strategy, and lecture method significantly impact students' mean achievement scores in biology. This was evident from the substantial increase in post-test scores compared to the pretest scores of all students who were taught biology using these three instructional methods. The observed improvement in post-test scores can be attributed to the instructional treatments, namely, the 7-step learning cycle, problem-solving strategies, and lecture methods. This suggests that these teaching strategies are effective in facilitating learning, as indicated by the positive mean difference between the pre-achievement and post-achievement scores of students taught biology through these methods.

The study also identified a significant difference in achievement scores among students exposed to the 7E learning cycle, problem-solving strategy, and lecture method. The variation in achievement scores may be due to the distinct instructional activities each group participated in, which likely influenced their performance on the achievement test. The post-test results showed that students in the 7E learning cycle and problem-solving strategy groups significantly outperformed those taught using the lecture method. This could be attributed to the active learning environment fostered in the 7E learning cycle and problem-solving groups, where students engaged in questioning, answering, and peer interactions. These activities, which are both cognitive and hands-on, likely enhanced their learning outcomes. This finding aligns with Oyovwi (2019), who noted that innovative teaching strategies like

the 7E learning cycle and problem-solving promote critical thinking and reasoning, thereby enhancing student achievement. In contrast, the lecture method's direct transmission of information from teacher to student may limit its effectiveness.

The higher achievement scores of students taught using the 7E learning cycle compared to those taught with problem-solving strategies may be due to the structured nature of the learning cycle, which ensures a coherent flow of information and activities at each stage, leading to a thorough understanding of concepts. This finding is consistent with the research by Umukoro and Oyovwi (2021), which supports the efficacy of innovative teaching strategies such as problem-solving methods.

Additionally, the study found no significant interaction effect between sex and instructional methods on students' achievement in biology. This indicates that the effects of the 7E learning cycle, problem-solving, and lecture methods on student achievement are not influenced by sex but are determined solely by the instructional methods. In other words, there was no significant interaction between sex and the teaching methods in affecting students' achievement in biology.

Conclusion

Based on the findings from this study, it is concluded that the 7E learning cycle and the problem-solving strategy have shown to be successful teaching methods for biology classes, as seen by the study's results, which show that both approaches outperform the lecture method in terms of academic achievement.

Recommendations

1. In senior secondary schools, biology instructors have to be motivated to use the 7E learning cycle and problem-solving techniques while instructing biological subjects.
2. Schools should be outfitted with resources and facilities that support the teaching and learning process, and biology should be taught by experienced and well-trained instructors.
3. To help biology instructors use the 7E learning cycle and problem-solving techniques in their instruction, seminars and conferences on these topics need to be arranged.

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