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Effectiveness of 7e Instructional Model on Students' Academic Achievement in Grade 9 Biology at Gilgel Beles Secondary School, Western Ethiopia

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Abstract

This study examined the effect of the 7E learning cycle model on students' academic achievement in Biology at Gilgel Beles Secondary School, Ethiopia. Using a quasi-experimental design, two randomly selected student groups were compared: one taught with the 7E model and the other using conventional methods. Biology achievement tests were administered as pre-tests and post-tests. The results showed that the experimental group scored significantly higher (17.38) than the control group (15.77) on the post-test. However, there were no significant differences in scores between high and low achievers or between male and female students in either group. The study concluded that the 7E learning cycle model is an effective teaching strategy that can enhance students' academic performance in biology compared to traditional methods. It suggests that the 7E model may offer more positive outcomes in biology education.

1. Introduction

1.1. Background of the study

Education plays a crucial role in an individual's success in life. Its significance lies in nurturing a new generation capable of addressing the real problems in our society. Education aims to bring meaningful change to the lives of learners, achieved through providing appropriate and engaging learning experiences. These valuable learning experiences are delivered through effective teaching (Tebabal & Kahssay, 2011). The teacher's responsibility is to select suitable teaching methods and techniques that facilitate understanding of the subject matter for the learners. It is evident that positive changes in learners are best achieved through the use of appropriate teaching methods. Okafor and Okewale (2016) noted that teaching methods work most effectively when they align with the needs of learners, as each learner interprets and responds uniquely to issues and experiences. Given its importance in the educational setting, various teaching methods and strategies have been developed to enhance the effective delivery of content by teachers while ensuring that students easily and meaningfully comprehend concepts (Ajewole, 1991). These teaching approaches are grounded in learning theories that serve as their philosophical foundations. In its broadest sense, teaching approaches can be categorized into two main types: teacher-centered and student-centered approaches. Teacher-centered approaches are based on behavioral learning theory, which focuses on providing stimuli that are expected to generate desired outcomes in learners(Abell, Appleton, & Hanuscin, 2010). In this model, students are passive participants, reacting to the teacher's instructions rather than actively engaging in the learning process. On the other hand, student-centered approaches are rooted in constructivist theories, emphasizing the active involvement of students in constructing their knowledge through interactions with peers and experiences in their environment (Dhindsa & Roger Anderson, 2011). Among the various constructivist teaching methods, the learning cycle has emerged as one of the predominant approaches(Abell et al., 2010).

The learning cycle is an inquiry-based teaching strategy that promotes learning through engaging, hands-on activities. Hassard and Dias (2013) notes that supporters of this teaching approach advocate for instruction to be sequenced into distinct phases. The learning cycle can vary in terms of its phases and overall length. Over the years, several types of learning cycle models have emerged, including 3E(Karplus & Thier, 1967), 5E(Bybee, 1997), 7E(Eisenkraft, 2003), and 9E (Kaur & Gakhar, 2014). Among these models, the 3E, 5E, and 7E learning cycles have become particularly popular in science education.

This study specifically investigates the effectiveness of the 7E model, which is organized into seven successive stages: elicit, engage, explore, explain, elaborate, evaluate, and extend (Eisenkraft, 2003). The 7E learning cycle emphasizes that learning should begin with the following steps: (1) eliciting prior knowledge from learners; (2) engaging students by presenting a discrepant event to spark their interest; (3) allowing learners to explore and develop their skills and knowledge; (4) having students explain new concepts to encourage verbalization and clarification; (5) elaborating on newly learned concepts through targeted questioning; (6) evaluating student learning outcomes via formative assessments; and (7) extending knowledge by helping students connect concepts to different contexts and apply their new learning. The stages of the 7E learning cycle are interconnected and designed so that learners actively engage in scientific inquiry by exploring instructional materials and applying learned ideas or principles in new situations.

Several studies have investigated the effectiveness of constructivist teaching approaches on student learning (Bülbül, 2010; Celik, ÖZBEK, & KARTAL, 2013; Eshetu, Atnafu, & Woldemichael, 2022; Gönen, Kocakaya, & Inan, 2006; Kocakaya & Gonen, 2010; Miadi, Kaniawati, & Ramalis, 2018; Sarac & Tarhan, 2017; Warliani, Muslim, & Setiawan, 2017; Wodaj & Belay, 2021). Most of these studies, which compared academic achievement between constructivist and conventional learning environments, have shown more favorable results for constructivist learning environments (Adak, 2017; Balta & Sarac, 2016; Cherono, Samikwo, & Kabesa, 2021; Chopra & Gupta, 2011; Khan, Islam, & Islam, 2020; Primanda, Distrik, & Abdurrahman, 2019). For instance, Chopra and Gupta (2011) conducted a study to examine the effect of the 7E Learning Cycle Model (LCM) on science achievement among 8th-grade students. In this study, the experimental group was taught using the 7E LCM, while the control group received instruction through conventional methods. The results indicated that students taught with the 7E LCM performed better than those instructed using conventional methods. Similarly, Balta and Sarac (2016) studied the effects of the 7E learning cycle model in teaching science subjects and concluded that the model had a higher effect size on learning outcomes. In 2017, Adak's research found that students who were taught using the 7E model achieved higher scores on assessments compared to those instructed using traditional methods. Additionally, students taught with the 7E LCM showed improvement across all intelligence levels, leading to a greater mastery of content at higher cognitive levels. A study examining the impact of worksheets on Newton's laws of motion, utilizing the 7E instructional model, found that this approach enhances both conceptual understanding and problem-solving skills(Primanda et al., 2019). Khan et al. (2020) researched the effectiveness of instructional methods on academic achievement in Pakistan, demonstrating that the 7E instructional model significantly outperforms traditional methods in enhancing students' academic success.

Most of the published research on the 7E inquiry model of instruction has been conducted in developed countries, where the contexts differ from those in developing countries. There are few studies focusing on the effectiveness of 7E instructional models in Africa models. For instance, Gyampon, Aido, Nyagbblosmase, Kofi, and Amoako (2020) investigated the impact of the 7E Learning Cycle Model of Inquiry-Based Instruction on students' achievement in science in Ghana. The study found that students who were taught using the 7E learning cycle model demonstrated better performance and understanding of concepts compared to those who received conventional instruction. Additionally, Cherono et al. (2021) examined the effect of the 7E Learning Cycle Model on students' academic achievement in biology in secondary schools in Kenya. The findings revealed that students in the experimental group outperformed those in the control group and had a positive attitude towards the 7E Learning Cycle Model. This study indicates that the 7E Learning Cycle Model is an effective method for improving students' academic achievement in biology. A study conducted in Nigeria by Bimbola and Daniel (2010) found that students taught using the constructivist method of instruction performed significantly better on both pre-tests and delayed post-tests compared to those taught using traditional methods. As a result, the constructivist group had a higher mean score on their post-test in comparison to their pre-test scores. Students in the constructivist group retained 80% of the concepts taught, while the control group retained only 10%. Additionally, Naade, Alamina, and Okwelle (2018) demonstrated that the 7E Learning Cycle Model (LCM) was more effective than teacher-centered methods in Nigerian senior secondary schools. Students in the 7E LCM environment achieved higher scores than those in conventional classrooms, and their interest and enthusiasm for learning were stimulated. This led to a greater eagerness to learn among those students. In another study, Wodaj and Belay (2021) investigated the impact of the 7E instructional model, combined with metacognitive strategies, on students' biology learning and motivation in secondary schools in Addis Ababa, Ethiopia. Their findings indicated that the 7E instructional model was superior to conventional instruction in enhancing students' achievements, conceptual understanding, and retention of concepts in biology, while also reducing misconceptions.

The Ethiopian education and training policy, launched in 1994, emphasized a constructivist, learner-centered approach that utilizes various active learning techniques, departing from the traditional "chalk and talk" method of instruction (MoE, 2002). This policy clearly stated that curriculum development and textbook preparation should be informed by contemporary pedagogical and psychological principles. According to this theory, learning involves constructing knowledge through individual interactions with tasks, peers, and teachers, rather than simply absorbing information passively. However, applying this broad concept in the classroom has proven challenging. Studies in Ethiopia indicate that teachers' understanding and skills in implementing effective learner-centered methodologies in biology classes are limited, resulting in a predominance of traditional lecture methods(Bekele & Melesse, 2010; Teshome, 2012). Additionally, the national learning assessments and examination results for students in the country are disappointing (NEAEA, 2022). The Benishangul Gumuz region is among the three lowest-performing areas in Ethiopia regarding academic achievement (NEAEA, 2022). It is evident that one of the factors affecting students' meaningful learning is the teaching and learning process (Wodaj & Belay, 2021). The researcher has observed that teachers in the Benishangul Gumuz secondary schools utilize

inquiry-based teaching in biology very infrequently, which may contribute to poor academic performance in this subject. There is a need for an appropriately designed instructional model that promotes learner engagement, encourages interaction among students, and highlights the teacher's role in facilitating knowledge construction and development. Thus, it is essential to design suitable instructional approaches that help students learn effectively and enhance their creativity, enabling them to address various problems within society. The purpose of this study is to examine the effect of the 7E Learning Cycle Model on students' academic achievement in biology at Gilgel Beles Secondary School, Ethiopia.

1. 2. Statement of the Problem

Constructivist theories have significantly influenced education, particularly science education, since the early 1980s (Abell et al., 2010). These theories have shaped educational policies and classroom practices, serving as benchmarks for effective teaching (Moreno, 2010). As a result, many countries and educational institutions have emphasized the adoption of various constructivist approaches as the preferred instructional strategies. However, biology instruction in most secondary schools in Ethiopia primarily relies on conventional teaching methods, such as lectures, few demonstrations, and excessive drilling of students using past exam papers. These instructional methods limit opportunities for group discussions and practical activities. It is essential for students to achieve the desired learning outcomes. Unfortunately, national learning assessments in Ethiopia indicate that many students struggle to meet the minimum learning competencies set by the Ministry of Education. The overall performance of students is significantly below expectations; more than 50 percent fail to score above 50 points, with average scores of 38 for Grade 8, 47 for Grade 10, and 45 for Grade 12 students. The achievement gap is particularly pronounced in certain regions, with Gambella, Benishangul Gumuz, and Afar consistently performing the lowest(NEAEA, 2022). One contributing factor is that many teachers in these areas were not trained in modern teaching and learning methodologies, and some have been unable to access in-service training (Bekele & Melesse, 2010). This suggests a link between the low academic achievement of students in biology and the failure to identify and implement suitable learner-centered instructional approaches in schools. Observations in Benishangul Gumuz secondary schools reveal that teachers' use of inquiry-based teaching in biology is very limited. In many biology classrooms in this region, teachers predominantly rely on traditional lecture methods. As a result, students often find themselves passively listening and taking notes. Even when laboratory experiences are included in the curriculum, students typically follow procedures step-by-step to verify known results, rather than engaging in true scientific inquiry. Biology holds specific significance for students as individuals and for society at large, especially concerning Ethiopia's growth and development. Therefore, teaching biological sciences requires instructional approaches that enable students to understand the subject and apply their knowledge in everyday life. There is a pressing need to explore effective learner-centered instructional methods that enhance biology learning and improve student performance in the Ethiopian context. This study aims to examine the effect of the 7E Learning Cycle Model on students' academic achievement at Gilgel Beles Secondary School in Ethiopia. Implementing this model may lead to improved academic outcomes in biology for these students.

The investigation aimed to address the following research questions: i) Is there a significant difference in the mean scores of academic achievement in biology between students instructed using the 7E Learning Cycle model and those taught through conventional methods? ii) Is there a significant difference in the mean scores of biology achievement between low-achieving and high-achieving students when taught using the 7E Learning Cycle model in comparison to conventional instructional methods? iii) Is there a significant difference in the mean scores of biology achievement between male and female students when taught using the 7E Learning Cycle model versus conventional instructional methods?

2. RESEARCH METHODOLOGY

2.1. Research approach

The aim of this study was to examine the effect of the 7E instructional model on student academic achievement. A quantitative research approach was employed to achieve this objective.

2.2. Research Design

This study utilized a quasi-experimental research design, specifically a nonequivalent (pretest and posttest) control-group design (Creswell, 2009). The purpose of this design was to determine whether there was a significant difference in the academic achievement of students taught using the 7E learning cycle compared to those instructed with the conventional method. In this research, the teaching strategies (the 7E learning cycle and the conventional approach) served as independent variables, while the academic achievement of the students was the dependent variable. The study involved two treatment groups: one experimental group that received instruction through the 7E learning cycle and one control group that was taught using traditional classroom lecture methods. Both groups were pre-tested, given their respective treatments, and then post-tested. The content to be learned was the same across all groups, but the teaching methods varied. Lesson plans were developed based on identical content for each group and taught by the same instructor to minimize the potential impact of the teacher's influence on the results.

2.3. Target Population

The target population for this study included ninth-grade students and biology teachers at Gilgel Beles Secondary School in the Metekel Zone, Ethiopia. The focus on ninth-grade students was intentional, as "Classification of Organisms" is a part of their biology curriculum. Grade nine was chosen for this study because it marks the beginning of secondary education in Ethiopia. This topic was selected for instruction due to its conceptual complexity and its suitability for the chosen instructional model.

2.4. Sample Size and Sampling Procedures of the Study

The subjects of this study consisted of 92 ninth-grade students and one biology teacher in Ethiopia. The participants were drawn from two sections of students who were randomly selected at Gilgel Beles Secondary School. The experimental group included 45 students, while the control group comprised 47

students. The two groups were not equal in size, as the sections were intact groups with different student numbers. The study employed simple random sampling procedures. Simple random sampling was applied to select the school. Additionally, simple random sampling was used to determine which sections would be designated as the experimental group and the control group. The section chosen first became the control group, while the second selected section constituted the experimental group. Students in the selected classes were automatically included in the study, as they had not yet been taught the content relevant to this research. Furthermore, one biology teacher was randomly selected to participate in the study, based on the classes chosen for the research.

2.5. Research Instruments

In this study, the research instruments included Biology Achievement Tests (BAT). The BAT, designed by the researcher, originally consisted of 30 multiple-choice questions. However, after conducting a pilot study and reliability tests, five questions were removed. Both the experimental and control groups were administered the Biology Achievement Tests on classification to assess their achievement levels. A pre-test was conducted before instruction began to evaluate the participants' cognitive understanding of classification. Following the instruction period, a post-test was administered one week later to measure the effect of the treatment on the experimental group.

2.6. Piloting

A pilot test was conducted at a school outside the study sample to evaluate the practicability of the models, test item difficulty, discrimination levels, and instrument reliability. A Biological Achievement Test was administered to 46 grade 10 students for reliability assessment.

2.6.1. Item Analysis

The mean difficulty level of the classification achievement test was 0.4, indicating that the test was of average difficulty and that the items were moderately challenging for students. Out of the 30 items, most fell within an acceptable difficulty range; however, three items were particularly difficult and were consequently removed. Additionally, the mean discrimination index of the test was 0.3, suggesting that it was effective in distinguishing between high and low achievers. Out of the 30 items, 25 demonstrated good discrimination. However, five items had low discrimination indices and did not effectively differentiate student performance. Three of these items were reviewed, and it was decided to remove five of them. Thus, the final version of the classification achievement test, which included 25 items, was given to all treatment and comparison groups as both a pre-test and a post-test.

Table 1. Item Difficulty (P) and Discrimination Index (D) for the Classification Achievement Test.

Test item type	Difficulty indices (p)	No of items	Discrimination indices (D)	No of items
Achievement test	$(0.4 \leq D < 0.6)$	25	$p \geq 0.4$	7
	$(0.3 \leq D < 0.4)$	2	$0.3 \leq P \geq 0.39)$	15
	$(0.2 \leq D \leq 0.39)$	0	$(0.2 \leq P \leq 0.29)$	3
	$(P< 0.2)$	3	$(D < 0.2)$	5
	Mean = 0.4	Total = 30	Mean = 0.3	Total = 30

2.6.2. Validity and Reliability of the Instruments

To establish face validity and content validity of the instructional manual and the BAT, two biology teachers evaluated their format and appropriateness. Additionally, the validity of the instructional manual and BAT was affirmed by two Doctor of Education (DEd) students, and their feedback was incorporated into the final drafts prior to the pilot test. The difficulty and discrimination indices of the biology achievement test items were analyzed. The reliability of the achievement tests was assessed using the Kuder-Richardson coefficient alpha, utilizing SPSS version 26. The reliability coefficients for the biology achievement test were found to be 0.78, indicating that the values for all instruments fall within acceptable ranges. As a result, the test items were deemed reliable and valid for use in the current study.

2.7. Intervention Procedure

The research intervention comprised seven main procedures. First, the researcher visited the participating schools. Second, two sections were randomly selected and assigned as the treatment group (experimental) and the comparison group (control). Third, the biology teacher and students in the experimental group received thorough training on how to use the 7E Learning Cycle Model (LCM) instructional manual. Fourth, both instructional groups took a pre-test before the intervention began. Fifth, instructional programs were implemented over a three-week period on the topic of classification. The experimental group was taught using the 7E LCM, while the control group received instruction through Conventional Instructional Methods (CIM) by their regular teacher. Sixth, the regular teachers administered a post-test one week after the instructional program was completed. Finally, the researcher collected the pre-test and post-test scores for analysis.

2.7. Data Analysis

Data analysis was conducted using both descriptive and inferential statistics. Descriptive statistics were employed to summarize, compare, and explain the results from the experimental and control groups based on mean scores and standard deviations. For inferential statistics, a t-test was utilized to determine whether the two groups differed significantly from each other at a significance level of α =

0.05. The reliability of the test was assessed using the Kuder-Richardson coefficient alpha, which yielded a reliability coefficient of 0.78 for the biology achievement test.

2.8. Ethical Issues of the Study

Ethical considerations were a top priority throughout the investigation. After obtaining permission from our university, formal requests were sent to the participating schools. Participants were informed about the purpose of the research, the voluntary nature of their involvement, and the measures taken to ensure confidentiality. They were not required to provide any identifiable information while completing the tests.

3. Result

3.1. Results of Pretest and Posttest Scores Analysis

Before analyzing the pre-test and post-test scores, researchers assessed the assumptions of the t-test, including normality (skewness and kurtosis) and homogeneity of variance (Levene's test). The results presented in Table 2 indicate that the skewness and kurtosis values range from − 1 to 1. This suggests that the variables in each group were at least approximately normally distributed, with both the pre-test BAT and post-test BAT resembling scale variables in each group. Additionally, the homogeneity of variance, as assessed by Levene's test, was not violated (P > 0.05). Therefore, it was appropriate to use the t-test to compare the means of the two groups for these variables. The descriptive statistics for skewness, kurtosis, and Levene's test values for the pre-BAT and post-BAT tests are summarized in Table 2 below.

Table 2
Skewness, Kurtosis, and Levene's Test for Homogeneity of Variances

Variables	N	Skewness	Kurtosis	Levene Test of Homogeneity of Variances	
				F	P
Pre- BAT	92	− 0.01	− 0.74	1.98	0.12
Post- BAT	92	− 0.026	-0.78	1.00	0.39

3.1.1. Comparison between academic achievement scores of Experimental and control group

The researcher aimed to compare academic achievement in biology between students taught using the 7E Learning Cycle Model (LCM) and those instructed using the Conventional Instructional Model (CIM). The pre-test and post-test scores were analyzed descriptively, including mean and standard deviation, as well as inferentially using an independent sample t-test. The independent sample t-test revealed that there was no statistically significant difference between the experimental and control groups regarding their pre-test mean scores in biology at Gilgel Beles Secondary School. As shown in Table 3, the p-value of 0.468 is greater than 0.05, indicating no significant difference in academic achievement between the

experimental and control groups. The mean score for the experimental group was 4.27, while the control group's mean score was 4.6.

Table 3
Comparison of academic achievement scores between the experimental and control groups on the pre-test for Biology.

Group	N	mean	S.D	t-value	df	p-value
Experimental	45	4.27	1.814	0. 729	90	0.468
Control	47	4.60	2.455			
*Significant, since p < 0.05						

The independent sample t-test revealed a statistically significant difference between the post-test means of students in the 7E learning cycle and those in the conventional approach, with $p < 0.05$. As shown in Table 4, the post-test scores for the two groups were significantly different ($t(90) = -4.609$, $p < 0.05$). Furthermore, Table 3 indicates that since the p-value is 0.00, which is less than 0.05, there is a significant difference in academic achievement between the experimental group and the control group in biology. The mean academic achievement score for the experimental group was 17.38, while the control group's mean score was 15.77.

Table 4
Comparison of post-test academic achievement scores in Biology between the experimental and control groups.

Group	N	mean	S.D	t-value	df	p-value
Experimental	45	17.38	1.114	-4.609	90	0.00
Control	47	15.77	2.077			
*Significant, since p < 0.05						

3.1.2. Comparison between academic achievement scores of Experimental and control group based on achievement level

The researcher aimed to compare academic achievement in biology between high achievers and low achievers who received instruction using the 7E Learning Cycle Model (7E LCM) and those instructed using the Conventional Instruction Model (CIM). The study analyzed and compared pre-test and post-test scores descriptively, including mean and standard deviation, as well as inferentially using an independent sample t-test. The results for the pre-test and post-test scores of high and low achievers using the conventional approach are presented in Table 5. The t-test results were significant ($p < 0.05$) for the pre-test scores, with means of 6.2 for high achievers and 2.77 for low achievers. This indicates that the scores of low achievers were more dispersed than those of high achievers. In the post-test

results, the performance difference between high and low achievers in the conventional approach remained statistically significant (t(45) = -6.65, p < 0.05). The mean post-test scores were 14.56 for high achievers and 12.86 for low achievers.

Table 5
Results of the Independent Samples t-test on the pre-test and post-test scores of high and low achievers using the Conventional approach.

Test	Achievement level	N	mean	SD	t	df	p
Pre-test scores	High achiever in CA	25	6.2	2.198	-6.65	45	0.00
	Low achiever in CA	22	2.77	1.066			
Post test scores	High achiever in CA	25	14.56	2.46	-3.033	45	0.004
	Low achiever in CA	22	12.86	0.94			
*Significant, since p < 0.05							

The independent sample t-test was conducted to analyze the pre-test and post-test scores of both high and low achievers using the 7E approach, as presented in Table 6. According to the data in Table 6, high achievers outperformed low achievers in the pre-test conducted prior to the experiment (t(43) = -10.774, p < .05). However, in the post-test following the experiment, the performance of low achievers significantly improved to the point where there was no longer a significant difference between them and the high achievers (t(43) = -1.093, p > .05). The post-test mean scores for high achievers and low achievers were 17.57 and 17.21, respectively.

Table 6
Results of the Independent Samples t-test on pre-test and post-test scores of high and low achievers in the 7E group.

Test	Achievement level	N	mean	SD	t	df	p
Pre-test scores	High achiever in 7E	21	5.90	1.044	-10.774	43	0.000
	Low achiever in 7E	24	2.83	0.868			
Post test scores	High achiever in 7E	21	17.57	1.326	-1.093	43	0.280
	Low achiever in 7E	24	17.21	0.884			
*Significant, since p < 0.05							

3.1.3. Comparison between academic achievement scores of Experimental and control group based on gender

The researcher aimed to compare academic achievement in biology between male and female students who were instructed using the 7E Learning Cycle Model (LCM) and those who were instructed using the Conventional Instructional Model (CIM). The analysis of pre-test and post-test scores was conducted

descriptively—by calculating the mean and standard deviation—and inferentially using an independent sample t-test. Descriptive statistics for pre-test and post-test scores across genders were first computed for the conventional approach. As shown in Table 7, the mean pre-academic achievement score for male students (4.92) was slightly higher than that of female students (4.23) in the control group. However, there was no significant difference between male and female students regarding academic achievement ($t(45) = 0.964$, $p > .05$). In the post-test results, male students scored an average of 16.48, while female students scored an average of 14.95 in the control group. This indicates a significant difference in academic achievement between the genders ($t(45) = 2.675$, $p < .05$). Table 4 presents the descriptive statistics of the pre-test and post-test scores across genders for the conventional approach.

Table 7
Results of the Independent Samples t-test on pre-test and post-test scores for males and females using the Conventional approach.

Test	gender	N	mean	SD	t	df	p
Pre-test scores	male in CIM	25	4.92	2.344	0.964	45	0.34
	female in CIM	22	4.23	2.581			
Post test scores	male in CIM	25	16.48	1.873	2.675	45	0.01
	female in CIM	22	14.95	2.035			
*Significant, since p < 0.05							

A descriptive analysis of pre-test and post-test scores across genders in the treatment group was conducted. As shown in Table 8, the mean pre-test achievement test score for male students was 4.29, which is almost identical to the mean score of female students at 4.24. The results indicate no significant difference in academic achievement between male and female students ($t(43) = 0.098$, $p > .05$). In terms of post-test scores, male students had a mean score of 17.63, which was slightly higher than that of female students, who scored a mean of 17.1. Similarly, there was no statistically significant difference in post-test scores between male and female students in the 7E approach ($t(43) = 1.621$, $p > .05$).

Table 8
Results of Independent Samples t-test on pre-test and post-test scores of males and females using the 7E Approach

Test	gender	N	mean	SD	t	df	p
Pre-test scores	Male in 7E	24	4.29	1.429	0.098	43	0.923
	Female in 7E	21	4.24	2.211			
Post test scores	Male in 7E	24	17.63	1.056	1.621	43	0.112
	Female in 7E	21	17.10	1.136			
*Significant, since p < 0.05							

4. DISCUSSIONS

The study aimed to examine the effect of the 7E Learning Cycle Model on students' academic achievement in biology at Gilgel Beles Secondary School in Western Ethiopia. A total of 92 ninth-grade students and one biology teacher participated in the study. A biology achievement test was developed based on the ninth-grade biology textbook, consisting of 25 items. The pilot testing showed that the test was reliable, with a mean difficulty level of 0.4 and a discrimination index of 0.3. This test was used to categorize students as high or low achievers. Two groups were formed for the study: one experimental group that was taught using the 7E method, and a control group that received instruction through the traditional lecture method. Both groups were taught by the same classroom teacher over a period of three weeks. The effectiveness of each teaching method was assessed using pre- and post-tests to compare the mean scores of both groups.

An independent t-test was conducted to evaluate the effectiveness of the 7E Learning Cycle Model (LCM) on the academic achievement of secondary school students in biology. Analysis of pre-test scores indicated that students in both the experimental and control groups had similar average scores. The results of the t-test showed no significant difference between the mean scores of the two groups, with a p-value of 0.468, which is greater than the $\alpha = 0.05$ significance level. This finding suggests that both instructional groups had comparable abilities before the intervention, a factor that is important for the study. Conversely, the analysis of post-test scores revealed a significant difference in achievement between the experimental and control groups at the 0.05 level. The results indicated that the experimental group outperformed the control group, with a mean score of 17.38 for the experimental group compared to 15.77 for the control group. This significant difference in post-test scores demonstrates the effectiveness of the 7E LCM in enhancing students' learning outcomes in classification at Gilgel Beles Secondary School.

The findings of this study align closely with previous research conducted by Chopra and Gupta (2011) ; Balta and Sarac (2016);Adak (2017);Shaheen and Kayani (2015);Primanda et al. (2019); and Khan et al. (2020), 2016, all of whom identified a significant impact of the 7E Learning Cycle Model (LCM) on students' academic achievement. Additionally, similar results were reported by Gyampon et al. (2020), Cherono et al. (2021), Bimbola and Daniel (2010), and Wodaj and Belay (2021), who found that the 7E learning cycle model was a more effective teaching strategy compared to traditional lecture methods in Africa. The 7E LCM was shown to positively influence students' academic performance in biology, likely due to its structured approach, which involves seven distinct phases. Eisenkraft (2003) emphasized that the elicit phase is essential for understanding learners' prior knowledge, allowing educators to assess and correct any misconceptions. This process helps prevent the development of unintended concepts. Additionally, learners actively construct knowledge based on their prior understanding and experiences(Adesoji & Idika, 2015).

An independent t-test was conducted to compare the academic achievement of low-achievers and high-achievers in secondary biology classes taught using the 7E Learning Cycle Model and a conventional

approach. The analysis revealed a significant difference in mean post-test scores between low achievers and high achievers using the conventional method, with the high achievers scoring higher. However, there was no significant difference in mean scores between low-achievers and high-achievers regarding biology achievement when using the 7E LCM. Specifically, the mean score for high achievers was 17.57, compared to 17.21 for low achievers. Thus, this study supports the findings of Yager and Simmons (2013) and Wodaj and Belay (2021), which indicated that low-achievers in the experimental group performed better than those in the control group in the "classification" achievement as compared to their pretest result.

An independent t-test was conducted to evaluate the effectiveness of the 7E Learning Cycle Model (LCM) on the academic achievement of male and female students in biology at Gilgel Beles Secondary School. Analysis of the pre-test scores indicated that both male and female students in the experimental and control groups had similar mean scores. The t-test results further demonstrated that there were no significant differences in the mean scores between males and females in either the experimental or control groups, with p-values of 0.92 and 0.34, respectively. However, a significant difference was observed in biology achievement between male and female students taught using the conventional method, with a p-value of 0.01. In contrast, there was no significant difference in biology achievement between genders when the 7E approach was used, with a p-value of 0.112 in the post-test. The independent t-test results suggested that there was no significant difference in achievement between male and female students in the classification aspect of the subject. Consequently, it can be concluded that both male and female students benefited equally from the implementation of the 7E LCM intervention. The research findings indicated that science is a field where gender differences in achievement are often observed, with some studies favoring males, others favoring females, and some showing no difference at all. These results align with previous studies investigating the effectiveness of learning cycles across genders. Several studies have indicated that there is no significant difference in science learning outcomes between male and female students (Dogru-Atay & Tekkaya, 2008; Okafor & Okewale, 2016; Wodaj & Belay, 2021).

The 7E Learning Cycle Model (LCM) has proven to be an effective teaching methodology, yielding positive results. In the near future, it is anticipated that the 7E model will encompass effective strategies for fostering deep conceptual understanding and long-term retention. This approach encourages active participation, enhances problem-solving and decision-making skills, builds students' confidence in their abilities, and generates interest and inspiration. Ultimately, it aims to help secondary biology students achieve their goals in a short amount of time.

5. Conclusions

The findings of this study provide strong evidence for the effectiveness of the 7E Learning Cycle Model (7E LCM) in enhancing students' academic achievement in biology at Gilgel Beles Secondary School in Western Ethiopia. The results of the pre- and post-test comparisons revealed a significant improvement in the performance of students taught using the 7E LCM compared to those taught with traditional

lecture methods. The experimental group, which experienced the 7E approach, outperformed the control group, demonstrating the positive impact of this student-centered, interactive teaching strategy on students' academic outcomes.

The study also revealed that the 7E model was particularly beneficial in leveling the playing field for students of varying achievement levels. While high-achieving students performed better with the traditional method, low-achieving students in the experimental group showed notable improvement, effectively narrowing the achievement gap. This suggests that the 7E LCM provides a more inclusive learning environment, catering to the needs of both high and low achievers. Furthermore, the approach had no significant effect on gender differences, indicating that both male and female students benefited equally from this method, reinforcing the model's applicability across diverse student groups.

The findings align with previous studies that highlighted the effectiveness of the 7E Learning Cycle in improving student achievement in science education.

6. Recommendation and suggestions

The following recommendations are based on the findings of the research: 1. The Ministry of Education, the Benishangul Gumuz Region Education Bureau, zonal educational authorities, local education authorities, and other educational stakeholders should provide in-service training for teachers on the effective use of the 7E learning cycle model. 2. The Ministry of Education, the Benishangul Gumuz Region Education Bureau, and other educational stakeholders should ensure that adequate resources are available for effective teaching. 3. A long-term study should be conducted that focuses on a broader topic, investigating additional variables to understand how these factors interact with the 7E model to promote meaningful learning. 4. Further studies are recommended to explore the effects of the 7E learning cycle model on students' conceptual understanding, retention, motivation, attitudes, and critical thinking skills. 5. It is also suggested that research be conducted on the impact of combining the 7E learning cycle model with a technology-based constructivist approach to assess effects on students' learning outcomes and motivation.

Declarations

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Author contributions: All authors have sufficiently contributed to the study and agreed with the results and conclusions.

Competing interests: The authors declare no competing interests.

Ethics approval: This study was reviewed and approved by the Faculty of Science Research Ethics and Review Committee, Bahir Dar University (PRCSVD/175/2014). All methods were performed in accordance with the relevant guidelines and regulations of the Faculty of Science Research Ethics and Review Committee, Bahir Dar University.

Consent to participate: Informed consent was obtained from the parents or legal guardians of all minor participants under the age of 16 who took part in this study. In addition to parental/guardian consent, assent was obtained from the participating students themselves. All participants were fully informed of the study's purpose and their rights, including the voluntary nature of their participation and their freedom to withdraw from the study at any time without penalty. Furthermore, informed consent was obtained from the participating biology teacher before the commencement of the study, following a comprehensive explanation of the research objectives, procedures, and the voluntary nature of involvement.

Consent for publication: Not Applicable.

Data availability: The datasets generated and/or analysed during the current study are not publicly available due to the institutional ethics policy to protect participant anonymity and privacy but are available from the corresponding author on reasonable request.

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