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Learning Cycle 7E-Based Chemistry Learning: Its Impact on Grade X Students' Achievement and Motivation

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ABSTRACT

Purpose of the study: This study aims to determine the effect of implementing the Learning Cycle 7E learning model on student learning outcomes and motivation in chemistry learning for class X, especially on the material of electrolyte and non-electrolyte solutions, and to compare its effectiveness with conventional learning models applied in schools.

Methodology: The study used a quasi-experimental method with a posttest control group design. Samples were taken using a saturated sampling technique on grade X students of State Senior High School 1 Brang Rea. The research instruments included a learning motivation questionnaire and a learning outcome test on electrolyte-nonelectrolyte solutions. Data analysis used the Lilliefors, Kruskal-Wallis, Mann-Whitney normality tests, and IBM SPSS Statistics 22.0 software.

Main Findings: The results of the study showed that the Learning Cycle 7E learning model did not have a significant effect on students' chemistry learning outcomes (sig. $0.392 > 0.05$) or student learning motivation (sig. $0.386 > 0.05$). Multivariately, the application of this model also did not show better effectiveness than conventional learning in improving the learning outcomes and motivation of class X students.

Novelty/Originality of this study: The novelty of this research lies in the simultaneous analysis of the influence of the 7E Learning Cycle model on two important variables, namely the learning outcomes and motivation of 10th grade chemistry students on the topic of electrolyte and nonelectrolyte solutions.

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1. INTRODUCTION

Education is a crucial aspect in developing quality human resources [1], [2]. Through education, students are expected to develop the knowledge, skills, and attitudes necessary to face the challenges of modern development. The learning process in schools is the primary means of achieving these educational goals [3], [4]. Learning success is strongly influenced by the strategies, methods, and learning models implemented by teachers [5], [6]. Therefore, selecting an appropriate learning model is a crucial factor in improving the quality of student learning outcomes.

Chemistry learning at the high school level is often considered a difficult subject by most students [7], [8]. This is due to the abstract, complex nature of chemistry material, which requires a deep understanding of concepts. Furthermore, chemistry learning is often teacher-centered, resulting in students being passive in the learning process [9], [10]. This situation can impact student learning outcomes. Furthermore, student motivation for chemistry often declines due to a lack of active involvement in learning activities [11], [12].

Learning outcomes and learning motivation are two important, interrelated components of the educational process [13], [14]. Learning outcomes indicate a student's level of mastery of the material they have learned. Meanwhile, learning motivation is both an internal and external drive that influences students' enthusiasm for learning [15], [16]. Students with high learning motivation tend to demonstrate better learning outcomes than those with low motivation [17], [18]. Therefore, efforts to improve learning outcomes need to be accompanied by increased student learning motivation.

One alternative learning model that can be implemented to address this issue is the 7E Learning Cycle. This model is a development of the constructivist approach that places students at the center of learning [19], [20]. The stages in the 7E Learning Cycle include elicit, engage, explore, explain, elaborate, evaluate, and extend [21], [22]. Through these stages, students are encouraged to actively construct their knowledge through meaningful learning experiences. The implementation of this model is expected to create a more interactive, engaging, and effective learning environment [23], [24].

The advantage of the 7E Learning Cycle model lies in its ability to encourage active student engagement throughout the learning process [25], [26]. In the exploration stage, students are given the opportunity to discover concepts independently through discussion and observation. The explanation stage allows students to communicate their thinking, strengthening conceptual understanding [27], [28]. Furthermore, the elaboration and extension stages provide space for students to apply concepts to new situations [29], [30]. Thus, this model has the potential to improve understanding of chemistry concepts while fostering student learning motivation.

Various previous studies have shown that the 7E Learning Cycle model has a positive impact on improving student learning outcomes in various science subjects [20], [31]. However, most of these studies have focused primarily on cognitive learning outcomes and have not comprehensively examined its impact on student motivation, particularly in 10th-grade chemistry. Furthermore, the implementation of this model in the context of chemistry learning at the high school level is still relatively limited. This situation indicates a research gap that requires further study. The novelty of this study lies in the simultaneous assessment of the influence of the 7E Learning Cycle model on 10th-grade chemistry students' learning outcomes and motivation within a single research design. This research is crucial and urgent given the need for learning innovations that can improve the overall quality of chemistry learning processes and outcomes.

The urgency of this research is further strengthened by the need in education to implement innovative learning models that meet the demands of 21st-century learning. Learning is no longer solely oriented toward knowledge transfer but also toward developing critical thinking skills, creativity, and student learning independence. The 7E Learning Cycle model is believed to address these needs through student-centered and experience-based learning. This research is expected to provide empirical evidence regarding the effectiveness of implementing this model in chemistry learning. Based on this description, the main objective of this research is to determine the effect of the 7E learning cycle model on the learning outcomes and motivation of 10th-grade chemistry students.

2. RESEARCH METHOD

2.1. Type of Research

This study used a quasi-experimental method, a research approach that aims to examine the effect of a particular treatment on other variables in a controlled setting [32], [33]. This method is applied to determine the extent to which a given treatment can produce changes in the research object. In experimental research, cause-and-effect relationships are the primary focus of analysis. This is done by administering treatment to the experimental group and comparing the results with those of the control group. Thus, the differences that emerge between the two groups can be used as a basis for assessing the extent of the treatment's effect.

2.2. Research Population and Sample

A population is the entirety of the subjects, objects, or events that are the focus of attention in a study. The population is the primary source of data that will be studied to obtain information in accordance with the research objectives. In this study, the population used was all 10th-grade students at Brang Rea 1 State Senior High School. All members of this population served as the basis for determining the research sample [34]. Thus, this study focuses on the characteristics of 10th-grade students as the object of study. The sample is a portion of the population selected to represent the overall characteristics of the population in the study. Sample selection significantly determines the quality of the research results because the conclusions obtained depend on the representativeness of the sample.

The sampling technique used was saturated sampling, a sampling technique where all members of the population are used as research samples. The use of this technique was based on certain considerations, such as student conditions, the limited number of classes, and the school situation that allowed the research to be conducted in only two classes. Therefore, both classes were used as samples to support the research implementation. To ensure similar characteristics between the sampled classes, a homogeneity test was first conducted. The homogeneity test aims to determine whether the data from the sample have the same variance or not [35], [36]. The test criteria state that a sample is considered homogeneous if the significance value is greater than 0.05, while a significance value less than 0.05 indicates the data is not homogeneous. Based on the results of the homogeneity test on chemistry learning outcomes, a significance value of 0.378 was obtained. This value is greater than 0.05, so it can be concluded that the research sample is homogeneous and suitable for use in research.

2.3. Research Design

This study used a posttest control group design. The research design can be seen in Table 1.

Table 1. Research Design

Experiment	X	O_1
Control	-	O_2

2.4. Data Collection Techniques

A questionnaire is a data collection instrument containing a series of questions or statements structured according to the aspects to be measured in the research. This instrument is used to systematically obtain information from respondents regarding the variables being studied. In this study, the questionnaire was used to collect data on student learning motivation. The questionnaires were administered to students before and after the learning process in both research classes: the control class and the experimental class. The purpose of administering the questionnaires before and after the treatment was to determine changes in student learning motivation following the learning process. Student learning outcome data was obtained through a test designed to address the topic of electrolyte and non-electrolyte solutions [37], [38]. This test was administered to students in both sample classes after the entire learning process had been completed. The test aimed to measure students' mastery of the material. The data collection process involved administering a final test (post-test) after the material was completed. The test results were then used to analyze the effect of the treatment on student learning outcomes.

2.5. Data Analysis Techniques

Before hypothesis testing, prerequisite analysis tests were conducted to ensure that the data met the required statistical requirements. These prerequisite tests included normality tests, general linear model tests, and covariance matrix similarity tests. The entire data analysis process was conducted using SPSS Statistics 22.0 software. The results of these prerequisite tests served as the basis for determining the appropriate analysis technique to be used. Hypothesis testing in this study was conducted using nonparametric statistical tests, namely the Kruskal-Wallis and Mann-Whitney Tests [39], [40]. The use of these two tests was adjusted to the characteristics of the research data. This analysis aimed to determine the effect of the Learning Cycle 7E learning model on student learning outcomes and motivation. Data processing was carried out using SPSS Statistics 22.0 software.

3. RESULTS AND DISCUSSION

Before conducting the hypothesis test, the prerequisite analysis test was first carried out in this study, the results of which are as follows:

Table 2. Output of Normality Test Results

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Experimental_learning_outcomes	.171	33	.016	.943	33	.085
Control_Learning_Outcomes	.195	33	.003	.896	33	.004
Experimental_Motivation	.163	33	.026	.953	33	.162
Control_Motivation	.164	33	.024	.908	33	.009
a. Lilliefors Significance Correction						

Based on the table above, the sig value for the experimental class' learning outcomes is 0.085 > 0.05, indicating a normal distribution of the data. Meanwhile, the control class' data is not normally distributed, as it is 0.004 < 0.05. The sig value for the experimental class' motivation is 0.162 > 0.05, indicating a normal distribution of the data. For the control class, the sig value is 0.009 < 0.05, indicating a non-normal distribution of the data.

Because the data are not normally distributed, the hypothesis test used is a non-parametric test, namely the Kruskal-Wallis test and the Mann-Whitney test. Based on the prerequisite test results, the data are not normally distributed, so the hypothesis test used is a non-parametric test. The non-parametric tests used to test the hypothesis in this study are the Kruskal-Wallis test and the Mann-Whitney test. The results of the Kruskal-Wallis test and the Mann-Whitney test can be seen in the table below:

Table 3. Multivariate Hypothesis Test Output

Test Statistics[a,b]	
	motivational_learning_outcomes
Chi-Square	5.128
Df	3
Asymp. Sig.	.163
a. Kruskal Wallis Tes	
b. Grouping Variable: kelas	

Based on the sig value of 0.001 < 0.05, it means that Ha is rejected and Ho is accepted. Ho has no effect of the 7E learning cycle learning model on the learning outcomes and motivation of chemistry students of class X at State Senior High School 1 Brang Rea.

Table 4. Partial Hypothesis Test Output

Test Statistics[a]		
	learning_outcomes	Motivation
Mann-Whitney U	493.500	492.000
Wilcoxon W	1054.500	1.053E3
Z	-.856	-.867
Asymp. Sig. (2-tailed)	.392	.386
a. Grouping Variable: kelas		

Based on the sig value of learning outcomes 0.392 > 0.05, it means that Ha is rejected and Ho is accepted. Based on this, it can be concluded that there is no effect of the 7E learning cycle learning model on the learning outcomes of chemistry students of class X of State Senior High School 1 Brang Rea in the 2019/2020 academic year. Meanwhile, the sig value of motivation is 0.386 > 0.05, so it can be concluded that there is no effect of the 7E learning cycle learning model on the motivation of chemistry students of class X of State Senior High School 1 Brang Rea.

The findings of this study indicate that the implementation of the Learning Cycle 7E model did not significantly influence students' chemistry learning outcomes or learning motivation. These findings suggest that the effectiveness of a constructivist learning model is not solely determined by the theoretical advantages of the model itself, but is also strongly influenced by classroom conditions, student readiness, and the way the model is implemented during the learning process. Although the 7E Learning Cycle emphasizes active student involvement through stages such as exploration, elaboration, and extension, students may still require a longer adaptation process to become fully engaged in student-centered learning [41], [42]. In chemistry learning, especially on electrolyte and non-electrolyte solution material which contains abstract concepts, students may experience difficulties when they are not yet accustomed to constructing knowledge independently.

The absence of significant differences between the experimental and control groups may also indicate that conventional learning used in the school still provides sufficient support for achieving learning objectives. In some classroom contexts, conventional approaches can remain effective when teachers are able to explain concepts clearly and maintain classroom interaction effectively. This condition shows that innovative learning models do not automatically produce better outcomes if they are not accompanied by optimal classroom management, adequate learning resources, and strong student participation. Therefore, the success of the Learning Cycle 7E model depends not only on the learning syntax but also on the readiness of teachers and students to implement active learning processes consistently [26], [43].

Furthermore, student motivation in learning chemistry is influenced by many internal and external factors beyond the applied learning model. Internal factors such as self-confidence, prior knowledge, and interest in chemistry may affect students' enthusiasm during learning activities [44], [45]. Meanwhile, external factors including classroom environment, learning facilities, peer interaction, and teacher communication styles can also shape student motivation. This explains why the implementation of the Learning Cycle 7E model in this study did not significantly increase learning motivation compared to conventional learning. Motivation tends to develop gradually and often requires long-term learning experiences rather than short-term instructional interventions.

These findings are consistent with the view that constructivist learning models require sufficient time and repeated practice to produce meaningful impacts on cognitive and affective aspects. The stages in the 7E Learning

Cycle encourage students to actively investigate and connect concepts with real-life situations, but students who are unfamiliar with inquiry-oriented learning may initially feel confused or less confident during the process. As a result, the potential benefits of the model may not be fully realized during the limited duration of the study. This condition highlights the importance of continuous implementation and teacher guidance in maximizing the effectiveness of innovative learning models in chemistry education.

The study also provides important implications for chemistry teachers and educational practitioners. Even though the Learning Cycle 7E model did not show statistically significant effects, the model still has potential to create a more interactive and student-centered learning atmosphere. Teachers can use the findings of this study as an evaluation to improve the implementation of constructivist learning strategies, particularly by adjusting learning activities to students' characteristics and levels of understanding [46], [47]. In addition, the study contributes to the development of chemistry education research by providing empirical evidence that the effectiveness of learning models may vary depending on educational context, learning material, and student conditions.

The impact of this study extends to the broader field of educational innovation, particularly in supporting the implementation of 21st-century learning approaches. The findings emphasize that learning innovation should not only focus on changing instructional models but also on strengthening student readiness, teacher competence, and learning environments that support active participation. This research can serve as a reference for schools in designing more adaptive and contextual chemistry learning strategies. Moreover, the study encourages educators to integrate constructivist approaches gradually so that students become more familiar with active learning processes that promote critical thinking, collaboration, and conceptual understanding.

However, this study has several limitations that should be considered. First, the research was conducted only in one school with a relatively limited number of participants, which may reduce the generalizability of the findings to broader educational contexts. Second, the duration of the treatment was relatively short, so the long-term effects of the Learning Cycle 7E model on learning outcomes and motivation could not be fully observed. Third, the study focused only on learning outcomes and motivation without examining other important variables such as critical thinking skills, scientific attitudes, or student engagement during the learning process. In addition, the use of nonparametric statistical analysis due to non-normal data distribution may also limit the depth of interpretation regarding the effectiveness of the treatment. Therefore, future studies are recommended to involve larger samples, longer implementation periods, and additional variables to obtain a more comprehensive understanding of the effectiveness of the Learning Cycle 7E model in chemistry learning.

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the application of the Learning Cycle 7E learning model does not have a significant effect on the learning outcomes and motivation to learn chemistry of class X students when compared with the conventional learning model. The results of the multivariate analysis showed a simultaneous difference between learning outcomes and student learning motivation, which is indicated by a significance value of $0.001 < 0.05$. However, when analyzed partially, the learning outcome variable showed a significance value of $0.392 > 0.05$, which means there is no significant difference between students taught using the Learning Cycle 7E model and students taught with the conventional model. Similarly, in the learning motivation variable, a significance value of $0.386 > 0.05$ was obtained, indicating that there is no significant difference in chemistry learning motivation between the two groups. Thus, it can be stated that the Learning Cycle 7E learning model has not shown better effectiveness than the conventional learning model on the learning outcomes and motivation to learn chemistry of class X students. Future research is recommended to involve larger and more diverse samples from different schools or educational levels to obtain findings that are more generalizable regarding the effectiveness of the Learning Cycle 7E model in chemistry learning. In addition, future studies should examine the long-term implementation of the model and include other variables such as critical thinking skills, scientific attitudes, learning engagement, or collaborative abilities to provide a more comprehensive understanding of its impact on students.

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AUTHOR CONTRIBUTIONS

Conceptualization, E.A. and C.R.; Methodology, E.A.; Software, E.A.; Validation, E.A. and C.R.; Formal Analysis, E.A.; Investigation, E.A.; Resources, E.A.; Data Curation, E.A.; Writing – Original Draft Preparation,

E.A.; Writing – Review & Editing, C.R.; Visualization, E.A.; Supervision, C.R.; Project Administration, E.A.; Funding Acquisition, C.R.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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