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The Effect of Learning Cycle 5E Model on the Scientific Literacy of 10th Grade Students

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Abstract: This study aims to determine the effect of the Learning Cycle 5E model on the scientific literacy of tenth-grade students at SMA Negeri 2 Labuapi in 2024. This research employs a quasi-experimental design with Pre-Test and Post-Test Non-Equivalent Control-Group. The study population comprises 92 students divided into four classes (XA, XB, XC, XD). Random sampling was used to select two classes as the sample, totaling 44 students, with class XC as the experimental group and class XB as the control group. The instrument used was essay-type questions. Data on students' scientific literacy were collected from the Pre-Test and Post-Test results in both classes and analyzed using the Mann-Whitney test at a 5% significance level with SPSS 16.0. The test results indicated a p value of <0.05 (0.024<0.05), suggesting that the Learning Cycle 5E model has a significant effect on students' scientific literacy.

Keywords: Learning cycle 5E model; Scientific literacy

Introduction

One of the national goals that Indonesia must strive for is to educate the nation's life through national education. Through education, individuals can develop their potential, acquire knowledge and skills, and understand important values in life (Bahri, 2021). Mastery of scientific literacy by students is crucial because the level of scientific literacy in Indonesia is still relatively low (Dai, 2015). The level of scientific literacy among students in the NTB region is also still low (Turrayan, 2021). According to the results of the student science literacy achievement test in the report by the Organization for Economic Cooperation and Development (OECD, 2023) on the PISA (Programme for International Assessment) test, Indonesia's science score reached 383. This score is far below the OECD average, less than 95 points. Based on this science score, Indonesian students ranked 68th out of 81 OECD countries. Compared to other Southeast Asian countries, Indonesia is below Thailand, Malaysia, and Singapore. Compared to the PISA scores in 2018, the PISA scores in 2023 dropped by 13 points. One reason for the decline in Indonesian students' science scores is that the questions on the PISA test involve six different levels of cognitive processes (Hatami et al., 2017). Therefore, it can be concluded that the thinking abilities of Indonesian students are still below the average of OECD member countries.

In line with the results of Kuba et al. (2020), shows that the 5E cycle learning model has a significant influence in building critical thinking skills. Irhamna et al. (2017) with the conclusion that applying the learning cycle model can improve critical thinking skills (Superni, 2018) The 5E learning cycle learning model has a significant effect on junior high school students' critical thinking abilities in science learning (Amaliyah et al., 2023).

The process of meaningfulness in learning is very important in supporting the development of students' understanding of science concepts (Sumantri, 2010). When the level of scientific literacy is low, students tend to have limitations in understanding and applying scientific information. This can hinder their ability to

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solve science problems, analyze data, and think critically about natural phenomena. Additionally, several factors contribute to the low scientific literacy among students in Indonesia. These factors include non- contextual learning that is irrelevant to daily life, poor reading skills that affect the understanding of scientific texts, and an unconducive learning environment and climate that can hinder students' motivation and interest in learning science (Anjarwati et al., 2023).

The definition of scientific literacy is an individual's scientific knowledge and the use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions. Evidence-based conclusions about issues related to science, understanding of the characteristics of science as a form of human knowledge and inquiry, awareness of science and technology, intellectual and cultural environments, as well as a willingness to engage with issues related to science and with scientific ideas, as a thoughtful citizens (Utami et al., 2016). The low level of scientific literacy among students leads to a lack of awareness in addressing problems and changes occurring in the environment, difficulty in applying science in daily life, challenges in problem-solving, and delays in decision-making (Yusmar & Fadilah, 2023).

Scientific literacy can be defined as the understanding and skills in the scientific field that enable individuals to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts. Scientific literacy also involves understanding the nature of science, being aware of how science and technology affect the natural, intellectual, and cultural environment, and having the desire to engage with and care about issues related to science (OECD, 2016). Literacy plays a crucial role as the foundation of learning development in schools because it holds a strategic position. The core of scientific literacy is the ability to read and write, which must be optimized by students to acquire skills and support life long learning (Bahri, 2021). With the development of scientific literacy, students are expected to meet various demands of the times, particularly by becoming problem solvers with competitive, innovative, creative, collaborative, and strong character traits. This is because mastering scientific literacy skills supports the development and application of 21st-century competencies (Yuliati, 2017). Individuals with strong scientific literacy will have a deep understanding of the fundamental principles of science, the inherent characteristics of scientific knowledge, the ethics governing the conduct of scientists in research and work, the interaction between science, society, and the environment, the connection between science and the humanities, and the distinction between science and technology (Jufri, 2017). The three aspects of scientific literacy competence include: the ability to explain scientific phenomena, the ability to design and evaluate scientific investigations, and the ability to interpret data scientifically (Wasis et al., 2020).

In the learning process, the models and methods used significantly influence students' success in understanding the material being taught. Innovation in teaching methods is needed to help students grasp the lesson content more easily. Additionally, it is important to actively involve students in the learning process so they can become more engaged and interested in classroom activities. Therefore, appropriate teaching methods are required to provide good mastery and meaningfulness of the material presented (Zulpadly, 2016).

One teaching approach that can develop scientific literacy is the application of the Learning Cycle 5E model, which focuses on a constructivist approach. According to Sudirman et al. (2024) and Perta et al. (2017), one of the principles of constructivist learning theory is that learning occurs through social interaction, where collaborative discussions and the exchange of ideas with teachers and peers enable the development of deeper and more complex understanding. Constructivism serves as the philosophical foundation of contextual learning, where knowledge is gradually constructed by individuals and expanded through moderately limited contexts, rather than being acquired suddenly (Wahab & Rosnawati, 2021; Ratmawan & Abadi, 2020). Taking the time for students to build and create provides them with agency in their own learning, builds confidence in their abilities, and hones 21st-century skills that will help them become the inno-vators of tomorrow (Rodriguez et al., 2019).

The Learning Cycle 5E model consists of five stages: engaging students with an intriguing situation (Engagement), actively involving students in exploration activities (Exploration), collaborating with students to discuss the exploration results (Explain), expanding and applying the new knowledge or concepts learned (Elaboration), and finally, the teacher evaluates students' understanding and skills through various assessment methods (Evaluation) (Duran & Duran, 2004). The Learning Cycle 5E model is a structured approach designed to help students understand the skills they need to acquire by actively participating in learning activities. This model guides students in mastering the subject matter by engaging in observation or research, providing explanations of the material taught, and applying the knowledge gained during the learning process. Additionally, students are enabled to conduct various assessments related to the material they have learned (Fadly, 2022). According to Juhji (2015) the Learning Cycle offers several benefits, including student-centered learning, the integration of new

information with students' prior knowledge, and a focus on exploration, discovery, and problem-solving. The learning process becomes more meaningful by emphasizing real-world experiences, avoiding traditional teaching methods that lead to rote memorization, and encouraging students to be active, critical, and creative. The 5E Learning Cycle process can positively impact students' motivation to learn and their understanding of concepts (Hager & Wellein, 2021).

This study offers novelty by emphasizing the application of the 5E Learning Cycle model in science education, particularly within the context of Indonesian education, which has been underexplored. The 5E Learning Cycle model, encompassing the phases Engage, Explore, Explain, Elaborate, and Evaluate, has been proven effective in various international studies to enhance student engagement and understanding. However, this study specifically examines the impact of the model on students' conceptual mastery and science literacy, two important aspects of science education that are often not explicitly differentiated in previous research. Thus, this study provides a new perspective and empirical evidence on the specific impact of this instructional model on science education.

This research is important because science literacy are essential competencies for students to face the increasingly complex and knowledge-based challenges of the future. The application of the 5E Learning Cycle model is expected to offer more effective instructional strategies. By employing a rigorous and comprehensive methodological approach, this study not only enhances the validity and reliability of the findings but also provides practical guidance for educators and policymakers in designing and implementing better curricula. The practical implications of this research have the potential to significantly improve the quality of science education in Indonesia, thereby supporting efforts to enhance the global competitiveness of human resources. Each step in the Learning Cycle 5E model provides opportunities for students to develop thinking skills and stimulate cognitive aspects. Thus, this learning model encourages students to actively seek and develop their own knowledge (Sari et al., 2019). The 5E Learning Cycle model enhances students' higher-order thinking skills by requiring them to think critically and develop new concepts throughout the learning process (Sani et al., 2020).

Additionally, research by Parawangsa et al. (2022) and Liana (2020) shows that the Learning Cycle model can enhance students' scientific literacy in science subjects. Based on the above description, the study titled "The Effect of the Learning Cycle 5E Model on the Scientific Literacy of Tenth-Grade Students at SMA Negeri 2 Labuapi in 2024" is important to conduct.

Method

This research is a quantitative study with an experimental approach. The method used is a quasi-experiment with a Pre-Test and Post-Test Non-Equivalent Control-Group Design. This design involves administering Pre-Tests and Post-Tests to determine the differences in students' abilities before and after applying the Learning Cycle 5E model in the experimental class and using conventional methods in the control class. The independent variable in this study is the Learning Cycle 5E model, while the dependent variable is the students' scientific literacy ability.

The study was conducted at SMA Negeri 2 Labuapi during the second semester of the 2023/2024 academic year, from April 16, 2024, to May 1, 2024. The population includes all tenth-grade students at SMA Negeri 2 Labuapi, distributed across four classes: XA, XB, XC, and XD. To determine the sample, the Random Sampling method was used. The academic equivalence of students was tested using mid-semester grades through analysis of variance followed by the Least Significant Difference (LSD) test. Equivalent classes identified by the same LSD notation were XB and XC. The experimental class (XC) received the Learning Cycle 5E model, while the control class (XB) received conventional teaching methods, including lectures and exercises.

Comprehensive data collection and analysis were achieved using several research instruments, including an essay test related to ecosystem materials and a Teaching Module. The test consisted of eight questions validated for validity and reliability, with a Cronbach's alpha value of 0.710. All test items were aligned with indicators of scientific literacy, such as explaining scientific phenomena, designing and evaluating scientific investigations, and interpreting data scientifically. The hypothesis is that the Learning Cycle 5E model significantly affects the scientific literacy of tenth-grade students at SMA Negeri 2 Labuapi in 2024. The Mann-Whitney test was used to test this hypothesis as a non-parametric alternative to the t-test, with a significance level of 0.05. Prerequisites for the Mann-Whitney test include tests for normality and homogeneity.

Result and Discussion

The description of the average scientific literacy of the experimental and control classes is presented in Figure 1. Based on Figure 1, the average pretest score of the experimental class was 37.00 and the control class pretest was 36.00. While the average posttest score of the experimental class was 63.00 and the control class was 52.00. Based on Figure 1, it is known

that the posttest value of scientific literacy of the experimental class is higher than the control class.

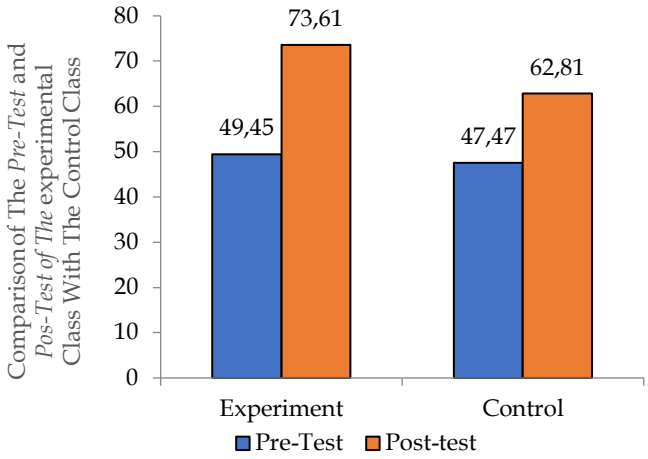

Figure 1. Corrected average of science literacy data

The results of the prerequisite tests obtained from the pre-test and post-test data in the experimental and control classes indicate that the data are not normally distributed but have homogeneous variance. Normality was tested using the Shapiro-Wilk test at a significance level of 5%. The post-test results for the experimental class showed a significance value of 0.090 (sig>0.05), indicating normal distribution of the data, while the post-test results for the control class showed a significance value of 0.015 (sig<0.05), indicating non-normal distribution of the data. Meanwhile, the homogeneity test results showed a significance value of sig>0.05 (0.557>0.05), indicating that the pre-test and post-test data for students' scientific literacy have equal variance (homogeneous).

With the non-fulfillment of the normality test prerequisite, the Mann-Whitney test was used to test the hypothesis. The test results showed a significance value of 0.024 at a significance level of 0.05. This indicates that the implementation of the Learning Cycle 5E model significantly affects the scientific literacy of tenth-grade students at SMA Negeri 2 Labuapi in 2024. The hypothesis test results are presented in Table 1.

Table 1. Hypothesis Test Results of Scientific Literacy Data

	Value
Mann-Whitney	147.000
Wilcoxon W	400.000
Z	-2.250
Asymp. sig. (2-tailed)	.024

The results of this study indicate that the use of the Learning Cycle 5E model enhances scientific literacy among tenth-grade students at SMA Negeri 2 Labuapi. There is a significant difference between the pre-test and post-test scores of the experimental and control classes, where the scientific literacy score in the experimental class is higher. This difference is evident from the average pre-test to post-test score difference in scientific literacy, with the experimental class achieving 24.16 while the control class scored 15.34, resulting in a difference of 8.82 points. A greater difference between pre-test and post-test scores indicates more effort made by students average pre-test to post-test score difference in scientific literacy, with the experimental class achieving 24.16 while the control class scored 15.34, resulting in a difference of 8.82 points. A greater difference between pre-test and post-test scores indicates more effort made by students.

There is a very strong and significant impact on students' scientific literacy after implementing the 5E Learning Cycle model in the control class. This is based on the results of the Mann-Whitney test analysis, which showed a (sig) value <0.05 (0.024<0.05), indicating that the application of the 5E Learning Cycle model has a significant effect on students' scientific literacy. This may be due to the exploration and elaboration stages, key steps in the 5E Learning Cycle model, which actively engage students in the learning process, helping them develop critical thinking skills. Additionally, the elaboration stage allows students to apply their knowledge in contexts relevant to everyday life, an important indicator of scientific literacy. This finding aligns with research revealing that students' scientific literacy skills significantly improve after the implementation of the 5E Learning Cycle model (Suryani et al., 2017; Sartika & Hadi, 2017).

The 5E Learning Cycle model is employed as a critical step to enhance students' achievement in science education. This model encourages students to construct new knowledge based on their prior understanding. Each stage of the 5E Learning Cycle reinforces critical thinking, problem-solving abilities, written communication, knowledge, and intrapersonal skills in scientific literacy, while also improving their ability to recall, understand, apply, and analyze in cognitive learning outcomes (Nugraheni et al., 2017). Individuals who possess the ability to explain, describe, and predict natural and social phenomena around them using scientific thinking are referred to as scientifically literate (Jufri, 2017).

The Learning Cycle 5E model enhances the learning process by leveraging the power of collaboration and social interaction to deepen conceptual understanding and student engagement in the learning process. This aligns with research findings that reveal the 5E Learning

Cycle model, with its constructivist approach, is a more effective method for improving students' conceptual understanding (Tegegne & Kelkay, 2023). In line with this, other research findings reveal that the use of the 5E Learning Cycle model can enhance students' learning activities and outcomes (Lasaiba, 2023; Nisa et al., 2022; Amalia et al., 2019). Learning is considered successful when at least 75 percent of students are actively engaged in the learning process, and both the activities and outcomes demonstrate that the implementation of the 5E Learning Cycle model effectively enhances learning activities. Therefore, the quality of learning is reflected in both the process and its outcomes (Mulyasa, 2004).

Conclusion

The This study concludes that learning with the Learning Cycle 5E model significantly influences improving scientific literacy among tenth-grade students at SMA Negeri 2 Labuapi in 2024. This is evidenced by the treatment significance value regarding scientific literacy, i.e., 0.024<0.05, and the corrected mean value in the control class of 15.34 compared to 24.16 in the experimental class.

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The author declares that there is no conflict of interest regarding the publication of this article.

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