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Caplaire Learning Model: An Effective Strategy to Improve Science Literacy Skills

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Abstract

The issue of science literacy has gained significant importance in recent years, particularly as the world faces complex, technology-driven challenges that demand scientifically literate citizens. Science literacy, which encompasses the knowledge and skills needed to understand and engage with scientific concepts, is a critical element of modern education. However, despite its importance, many educational systems, particularly in developing countries, struggle to effectively enhance students' science literacy. This study aims to evaluate the effectiveness of the Caplaire Learning Model in improving science literacy among students in the elementary school teacher education program at Universitas Negeri Medan (UNIMED). The study uses a mixed-methods approach, incorporating both quantitative (pre-test and post-test) and qualitative (interviews and surveys) data collection techniques to assess the impact of the model. Findings indicate a significant improvement in students' scientific literacy following the implementation of the Caplaire model, with higher post-test scores and positive feedback from students and lecturers. The Caplaire model, which integrates inquiry-based learning and reflection, effectively engaged students and fostered a deeper understanding of scientific concepts. These results suggest that the Caplaire model can be a valuable tool for improving science literacy in teacher education programs, with potential implications for broader adoption in educational curricula.

Keywords: Caplaire, Science Literacy, Learning Model

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INTRODUCTION

Science literacy, defined as the knowledge and skills necessary to understand and engage with scientific concepts and issues, has become a critical component in modern education. However, across the globe, science education continues to struggle with low levels of engagement and achievement. This problem is particularly evident in many developing countries, where educational systems face difficulties in preparing students to meet the growing demands of a knowledge-based economy. The incorporation of socioscientific issues into science teaching to promote students' scientific literacy may require that science teachers reconsider and transform their teaching practices (Bossér, 2024). A key indicator of this challenge is the Programme for International Student Assessment (PISA), which assesses the abilities of 15-year-old students in reading, mathematics, and science.

Results from the PISA 2018 assessment highlighted a significant gap between students in countries like Indonesia and those from more scientifically advanced regions such as OECD countries and Southeast Asia (Center for Educational Assessment, 2019) This gap underscores the need for robust interventions in science education, particularly in teacher education programs that are expected to equip future educators with the necessary skills to foster science literacy in young students.

The importance of developing science literacy at an early age cannot be overstated. Students who are able to engage critically with scientific concepts are better prepared to navigate the challenges of the 21st century, such as climate change, technological advancements, and public health crises. In light of this, science literacy is a cornerstone of the curriculum in many countries. However, the effectiveness of existing teaching models and methodologies in achieving high levels of science literacy remains a topic of ongoing concern. Researchers continue to explore innovative approaches to teaching science that not only enhance student engagement but also build the necessary competencies for critical thinking and scientific inquiry. In this context, various pedagogical models have been proposed, emphasizing active learning, inquiry-based methods, and the integration of problem-solving skills into science education. Despite these efforts, there remains a lack of consensus on the most effective ways to integrate science literacy into curricula, particularly in the context of teacher education programs where pre-service teachers are expected to develop both their own scientific understanding and the pedagogical skills to teach science effectively. Curricular integration in formal teaching of citizen science can bring to the classroom aspects of scientific literacy that encourage the involvement of citizens (Queiruga-Dios et al., 2020)

The primary issue addressed in this study is the need to improve science literacy among students of elementary school teacher education study programs in Indonesia, particularly those enrolled in the Elementary School Teacher Education program at Universitas Negeri Medan (UNIMED). This issue is critical, as the quality of science education provided by future teachers directly influences the science literacy of elementary school students. Current teacher education programs, however, lack an integrated approach to developing science literacy, which limits the effectiveness of future teachers in fostering such literacy in their students. Thus, there is a clear gap in teacher education that needs to be addressed by developing new, more effective teaching models that can help pre-service teachers acquire the necessary skills to teach science literacy effectively. The scientific literacy needed to engage with topics of global importance may be constrained by patterns of reasoning that emerge in childhood but persist long thereafter (Shtulman & Harrington, 2016).

A promising solution to this issue lies in the development of an innovative instructional model that integrates science literacy with inquiry-based learning. This study proposes the CAPLAIRE model—an acronym for Case Investigation, Plan A Solution, Implementation, and Reflection/Evaluation—as a potential solution to the identified problem. CAPLAIRE merupakan sebuah model pembelajaran berbasis literasis sains yang dikembangkan pada penelitian sebelumnya (L. Ananda et al., 2024). The CAPLAIRE model combines elements of problem-based learning (PBL) and project-based learning (PjBL), two well-

established pedagogical approaches known for their effectiveness in promoting active learning and enhancing critical thinking skills. By incorporating these strategies, the CAPLAIRE model aims to engage students of elementary school teacher education study programs in authentic scientific practices, allowing them to develop both their scientific knowledge and their ability to teach science in an inquiry-based, student-centered manner (L. J. Ananda et al., 2024). Preliminary observations of science teaching in the elementary school teacher education study program at UNIMED suggest that current instructional methods fail to fully support the development of science literacy among students. There is a need for an integrated approach that not only enhances teachers' scientific understanding but also equips them with the pedagogical tools necessary for fostering science literacy in elementary school students.

Several previous studies have examined the effectiveness of various teaching models in improving science literacy. For example Fahmawati (Fahmawati, 2018) developed the "GREATER" model, which integrates inquiry-based and project-based learning strategies to enhance science literacy in secondary school students. The GREATER model was found to be effective in improving students' ability to engage with scientific phenomena and interpret scientific data. Similarly, Astuti (2018) examined various teaching methods and models for improving science literacy, including the use of virtual labs and inquiry-based learning strategies. Her study highlighted the importance of using interactive, student-centered approaches to teaching science, which have been shown to enhance students' critical thinking and problem-solving skills. Another notable study by Kimianti and Prasetyo (Kimianti & Prasetyo, 2019) explored the use of e-modules based on problem-based learning to improve science literacy in students. These studies provide valuable insights into the types of pedagogical models that can promote science literacy, but they also reveal gaps in their application to students of elementary school teacher education study program, particularly in the context of Indonesian teacher preparation programs.

Building on these studies, the proposed CAPLAIRE model addresses several key gaps in the literature. First, it directly targets the need for an integrated model of science literacy that can be effectively implemented in elementary teacher education program study. While previous models have focused on improving science literacy in students, the CAPLAIRE model extends this focus to elementary teacher education program study, who play a pivotal role in shaping the science literacy of future generations. Second, the CAPLAIRE model incorporates both inquiry-based and project-based learning strategies, which have been shown to be effective in enhancing student engagement and critical thinking. In a study, it was proven that project-based learning with the inquiry method was able to improve the information-based teaching design skills of prospective teachers with PPT (Power Point) skills training (Liu et al., 2019). By using real-world case investigations, the model encourages students to explore scientific issues in depth, plan solutions, implement their ideas, and reflect on their learning experiences. This active learning process mirrors the types of tasks that students will encounter in the classroom, thus providing elementary teacher education program study with valuable teaching experience.

Despite the growing body of research on science literacy and innovative teaching models, there remains a gap in the literature regarding the development of comprehensive models that integrate science literacy into elementary school teacher education program study in Indonesia. While models like GREATER and PjBL have been shown to be effective in improving science literacy in students (Fahmawati, 2018) , there is a lack of research focusing on their application in teacher education programs. Furthermore, existing studies have not adequately addressed the need for an integrated approach that combines both science content knowledge and pedagogical strategies in teacher preparation. This study aims to fill this gap by developing and testing the CAPLAIRE model, which seeks to improve both the science literacy and pedagogical skills of students of elementary school teacher education study program in Indonesia.

The purpose of this study is to test the CAPLAIRE model for enhancing science literacy among students of elementary school teacher education study program at UNIMED. The novelty of this research lies in its focus on an integrated model that combines science literacy with inquiry-based learning, offering a comprehensive approach to teacher education. This study will assess the effectiveness of the CAPLAIRE model in improving the science literacy of students of elementary school teacher education study program. By doing so, it aims to contribute to the development of more effective teacher education programs that can better prepare future educators to teach science literacy in elementary schools. Ultimately, the findings of this study will inform the design of future teacher education curricula and teaching models, with the goal of improving science literacy outcomes for students across Indonesia.

METHODS

This study employs a Research and Development (R&D) approach to evaluate the effectiveness of the CAPLAIRE model in improving scientific literacy among students of elementary school teacher education studi program at UNIMED. The R&D methodology is particularly useful for developing and testing new educational models and has been widely used in the field of educational research (Sugiyono, 2015). This methodology is chosen because it allows for systematic design, development, and evaluation of the CAPLAIRE model, with a focus on its effectiveness in a real-world educational context.

The study's participants consist of 40 students enrolled in the elementary school teacher education study program at UNIMED. These participants were selected through purposive sampling, which is a non-random sampling technique where individuals are selected based on specific criteria relevant to the research. In this case, participants were selected because they were enrolled in the fourth semester of the elementary school teacher education study program and were enrolled in a course focused on teaching science in elementary schools. This sampling technique ensures that the participants have a certain level of understanding of science education and are able to benefit from the intervention provided by the CAPLAIRE model. The selection of 40 students was made to provide a manageable sample size that allows for meaningful analysis while

ensuring that the findings can be generalized to other cohorts of students in similar educational settings. In addition to the students, three lecturers who teach the science education courses in the elementary school teacher education study program were also involved in the study. These lecturers provided expert feedback on the model's implementation, and evaluation, contributing to the overall validity and reliability of the research.

The data collection methods for this study include a combination of quantitative and qualitative approaches to capture both the measurable impact of the CAPLAIRE model on scientific literacy and the experiences and perceptions of the participants and lecturers. The research's implementation phase involved applying the CAPLAIRE model in a classroom setting. During this phase, students were asked to participate in lessons using the CAPLAIRE model, which was structured around four main activities: Case Investigation, Plan A Solution, Implementation, and Reflection/Evaluation. These activities were designed to engage students in active learning, where they investigated real-world scientific problems, developed solutions, implemented their plans, and reflected on their experiences.

Throughout the implementation, students' engagement and participation were observed and recorded. Reflection sessions were conducted after each lesson, where students shared their thoughts on the model, the challenges they faced, and the benefits they gained from the process. These reflection sessions provided valuable qualitative data on the practicality of the model and its effectiveness in fostering scientific literacy. To measure the effectiveness of the CAPLAIRE model in improving scientific literacy, a pre-test and post-test design was employed. The pre-test assessed the students' baseline knowledge of scientific literacy, while the post-test evaluated the changes in their knowledge and skills after completing the lessons using the CAPLAIRE model. The tests included a range of items designed to assess the key components of scientific literacy, including the ability to identify scientific questions, explain phenomena, evaluate scientific evidence, and apply scientific knowledge in real-world contexts. The pre-test and post-test were developed based on the framework provided by the OECD, which outlines the competencies and skills associated with scientific literacy. The tests were administered to the participants before and after they completed the series of lessons based on the CAPLAIRE model. The results from these tests provided quantitative data on the impact of the model on students' scientific literacy.

In addition to the tests, qualitative data were gathered through interviews and surveys. The interviews were conducted with both students and lecturers to obtain in-depth insights into their experiences with the CAPLAIRE model. The students were asked about their perceptions of the model, its usefulness in enhancing their scientific literacy, and any challenges they encountered during the implementation phase. Lecturers were interviewed about the feasibility of implementing the model in their own courses, the level of engagement it fostered among students, and their overall assessment of the model's effectiveness. A survey was also administered to all participants at the end of the study to gather their opinions on the practicality of the model, its ability to improve scientific literacy, and its potential for wider adoption in the PGSD curriculum. The survey included both closed-ended and open-ended questions, allowing for a broad range of responses and insights.

The data collected from the pre-test and post-test were analyzed using statistical methods to determine the extent to which the CAPLAIRE model improved scientific literacy among the participants. Paired t-tests were conducted to compare the pre-test and post-test scores, providing a measure of the model's effectiveness in enhancing students' scientific literacy. Additionally, descriptive statistics were used to summarize the survey and interview data, providing a comprehensive overview of participants' experiences with the model.

Qualitative data from the interviews and reflection sessions were analyzed using thematic analysis. This method involved identifying recurring themes and patterns in the data, which were then used to gain insights into the strengths and weaknesses of the CAPLAIRE model and its impact on scientific literacy. The combination of quantitative and qualitative data analysis allowed for a comprehensive evaluation of the CAPLAIRE model's effectiveness and provided a more complete understanding of its potential for improving scientific literacy among students of elementary school teacher education study program. The complete research flow can be seen in the diagram below.

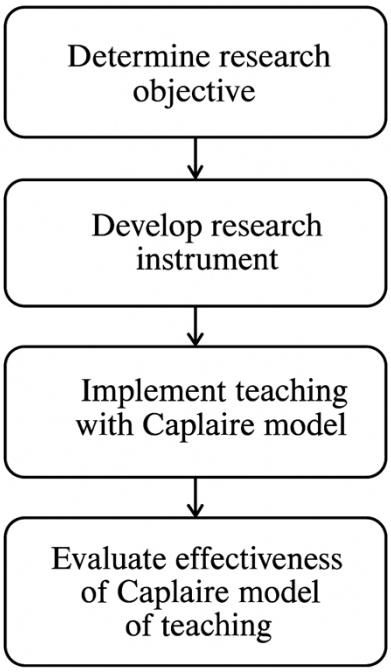

Figure 1. Research Flow Diagram for CAPLAIRE Model Effectiveness

RESULTS & DISCUSSION

Results

This section presents the findings of the study conducted to evaluate the effectiveness of the CAPLAIRE model in improving scientific literacy among students in the elementary school teacher education study program at UNIMED. The study used a mixed-methods approach, incorporating both quantitative and qualitative data collection techniques to assess the impact of the CAPLAIRE model

on scientific literacy, as well as its practicality, validity, and effectiveness. The implementation phase of the study involved applying the CAPLAIRE model in a classroom setting with student enrolled in the elementary school teacher education study program at UNIMED program. During this phase, students participated in lessons that were structured around four key activities: Case Investigation, Plan A Solution, Implementation, and Reflection/Evaluation. These activities were designed to promote active learning and foster scientific inquiry, with a focus on real-world problems.

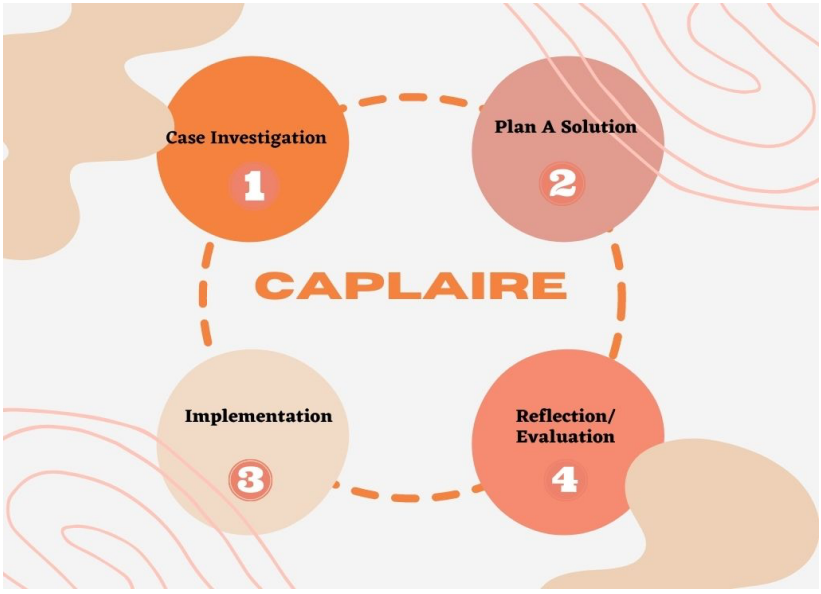

Figure 2. Caplaire Model Learning Steps (Ananda et al., 2024)

Throughout the implementation, students were engaged in investigating scientific issues, developing potential solutions, implementing their plans, and reflecting on their experiences. The activities were designed to encourage students to think critically, analyze scientific phenomena, and apply their knowledge in practical settings. Reflection sessions were conducted after each lesson, during which students shared their experiences and challenges. The reflection sessions revealed that students found the CAPLAIRE model to be an effective way to engage with scientific content and develop their critical thinking skills. Many students reported that the activities helped them better understand complex scientific concepts and appreciate the real-world relevance of science.

Students also indicated that the reflective nature of the model allowed them to consider alternative solutions to scientific problems, thereby enhancing their problem-solving skills. The effectiveness of the CAPLAIRE model in improving scientific literacy was measured through a pre-test and post-test design. The pre-test assessed students' baseline knowledge of scientific literacy, while the post-test measured the changes in their knowledge and skills after completing the lessons using the CAPLAIRE model. The pre-test and post-test were designed based on the OECD's framework for assessing scientific literacy, which includes the competencies needed to identify scientific questions, explain phenomena, evaluate

scientific evidence, and apply scientific knowledge in real-world contexts (Kordigel Aberšek, n.d.).

The following table presents the results of the pre-test and post-test of students' scientific literacy skills.

Table 1. Pretest and posttest results of students' scientific literacy skills

Interval Score	Pre-Test Frequency	Post-Test Frequency
[52, 57)	12	0
[57, 62)	6	0
[62, 67)	7	0
[67, 72)	10	0
[70, 75)	0	10
[75, 80)	0	7
[80, 85)	0	4
[85, 90)	0	6
[90, 95)	0	11

Below are the results of the pretest and posttest in bar chart form

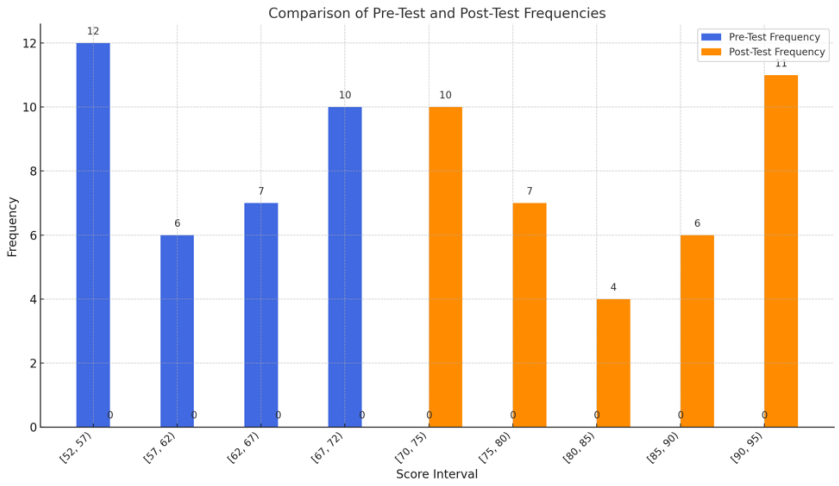

Figure 2. Diagram of pretest and posttest results

The table above contains the frequency distribution of pre-test and post-test scores literacy science skills for 40 students. Pre-Test Frequency: This column shows how many students scored within specific intervals for the pre-test. Total of 12 students scored between 52 and 57, 6 students scored between 57 and 62, 7 students scored between 62 and 67, and 10 students scored between 67 and 72. Post-Test Frequency: This column shows how many students scored within specific intervals for the post-test. Notably, post-test scores are higher in the higher intervals, indicating an increase in scores following the intervention. Total of 10

students scored between 70 and 75, 7 students scored between 75 and 80, 4 students scored between 80 and 85, 6 students scored between 85 and 90, and 11 students scored between 90 and 95, while none scored in the lower intervals (52-72). In summary, the frequency distribution shows that the post-test scores, particularly in higher intervals, were significantly higher than the pre-test scores, suggesting an overall improvement in the students' scientific literacy after the intervention.

The following table presents the results of the t-test from the results of the pretest and posttest of students' scientific literacy abilities.

Table 2. Pretest and posttest results of students' scientific literacy skills

Pre-Test Mean	Post-Test Mean	T-Statistic (Frequency Analysis)	P-Value (Frequency Analysis)
61.64	82.63	2.75	0.02

The results of the t-test based on the frequency distribution of pre-test and post-test scores are as follows: Pre-Test Mean: 61.64, Post-Test Mean: 82.63, T-Statistic: 2.75, P-Value: 0.02487. The t-test was conducted to compare the means of the pre-test and post-test scores. The t-statistic value of 2.75 indicates that there is a significant difference between the two sets of scores. The p-value of 0.02487 is less than the commonly used significance level of 0.05, indicating that the null hypothesis (which states there is no difference between pre-test and post-test scores) is rejected. Therefore, we can conclude that the post-test scores are significantly higher than the pre-test scores, suggesting an improvement in scientific literacy as a result of the intervention.

The results of the pre-test and post-test revealed a significant improvement in students' scientific literacy after participating in the CAPLAIRE model. A paired t-test analysis was conducted to compare the pre-test and post-test scores, and the results showed that the students' scores on the post-test were significantly higher than their scores on the pre-test. This finding suggests that the CAPLAIRE model effectively improved students' ability to engage with scientific concepts, apply evidence-based reasoning, and understand scientific phenomena. The improvement in scientific literacy was particularly evident in the areas of explaining scientific phenomena and evaluating scientific evidence. The post-test results showed that students were better able to apply their scientific knowledge to real-world scenarios and make informed decisions based on evidence.

In addition to the pre-test and post-test assessments, qualitative data were gathered through interviews and surveys. The interviews were conducted with both students and lecturers to obtain in-depth insights into their experiences with the CAPLAIRE model. The students were asked about their perceptions of the model, its usefulness in enhancing their scientific literacy, and any challenges they encountered during the implementation phase. Lecturers were interviewed about the feasibility of implementing the model in their own courses, the level of engagement it fostered among students, and their overall assessment of the model's effectiveness.

The students reported positive experiences with the CAPLAIRE model, highlighting its engaging and interactive nature. Many students expressed that the

model helped them better understand the scientific concepts being taught and enabled them to connect theoretical knowledge with real-world applications. The surveys also indicated that students valued the collaborative aspect of the model, as it encouraged them to work together in investigating scientific problems and sharing ideas.

The following is a table of student response questionnaires regarding implementing the Caplaire learning model.

Table 3. Response questionnaires regarding the implementation of the Caplaire learning model

No	Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The CAPLAIRE model helped me understand scientific concepts more effectively.	1	2	3	4	5
2	The activities in the CAPLAIRE model were engaging and interesting.	1	2	3	4	5
3	The CAPLAIRE model encouraged me to think critically about scientific problems.	1	2	3	4	5
4	I felt that the CAPLAIRE model promoted collaboration with my peers in solving scientific problems.	1	2	3	4	5
5	The CAPLAIRE model improved my ability to apply scientific knowledge to real-world situations.	1	2	3	4	5
6	The reflection and evaluation activities in the CAPLAIRE model helped me consolidate my learning.	1	2	3	4	5
7	The CAPLAIRE model was easy to follow and understand.	1	2	3	4	5
8	The CAPLAIRE model allowed me to	1	2	3	4	5

	improve my scientific literacy.					
9	The learning activities in the CAPLAIRE model were well-structured and organized.	1	2	3	4	5
10	Overall, I am satisfied with the CAPLAIRE model in helping me improve my scientific literacy.	1	2	3	4	5

The following is a table of the results of the student response questionnaire regarding the implementation of the Caplaire learning model.

Table 4. Results of the student response questionnaire regarding the implementation of the Caplaire learning model

	Question 1	**Question 2**	**Question 3**	**Question 4**	**Question 5**	**Question 6**	**Question 7**	**Question 8**	**Question 9**	**Question 10**
1	1	3	1	3	1	2	0	2	3	2
2	3	2	4	4	3	1	6	3	4	5
3	7	9	7	13	10	9	6	11	8	8
4	13	14	10	10	16	11	12	13	13	10
5	16	12	18	10	10	17	16	11	12	15

Based on the table above, most respondents gave positive feedback on the CAPLAIRE model, with many strongly agreeing or agreeing on almost all questions, especially those related to scientific understanding, knowledge applications, and collaboration. The aspect that received the highest score was the ability to improve the understanding of scientific concepts and the application of knowledge in a real-world context. Collaboration between participants and structured activities can be areas that can be continuously improved, although generally respondents feel that this model is quite effective.

Lecturers, on the other hand, noted that the CAPLAIRE model offered a structured and effective way to integrate scientific literacy into their teaching. They appreciated the model's emphasis on inquiry-based learning and problem-solving, which are critical skills for fostering scientific literacy in future teachers. Lecturers also noted that the model could be easily adapted for different subject areas and educational contexts, making it a versatile tool for teacher education programs.

The quantitative and qualitative data were analyzed to provide a comprehensive evaluation of the CAPLAIRE model's effectiveness. The pre-test and post-test scores were analyzed using paired t-tests, which revealed a significant improvement in students' scientific literacy after using the CAPLAIRE model. Additionally, descriptive statistics were used to summarize the survey and interview data, providing insights into students' experiences and lecturers' perspectives on the model's effectiveness. The qualitative data from the interviews and reflection sessions were analyzed using thematic analysis. The analysis revealed several key

themes related to the effectiveness of the CAPLAIRE model, including the importance of active learning, the value of reflective practice, and the need for inquiry-based learning experiences to foster scientific literacy.

Discussion

The CAPLAIRE model emerged as a promising approach to enhancing scientific literacy among students, particularly in elementary teacher study program at UNIMED (Ananda et al., 2024). The learning theories that support the CAPLAIRE model are 1) Constructivism and Social Constructivism: These theories emphasize that knowledge is constructed through individual and social processes. Constructivism focuses on the learner's active role in building understanding, while social constructivism highlights the importance of social interactions and cultural context in learning. Both perspectives are integral to developing scientific literacy, as they encourage learners to engage with scientific concepts actively and collaboratively (Driver et al., 1994). (Sarini et al., 2024); 2) Information Processing and Cognitiv e Development: Information processing theory and cognitive development theories, such as those by Piaget and Vygotsky, provide insights into how learners process and internalize scientific information. These theories suggest that scientific literacy can be enhanced by structuring learning experiences that align with cognitive development stages and by using strategies that facilitate effective information processing (Tenney et al., 2023) (Sarini et al., 2024); 3) Inquiry-Based and Culture-Based Learning Models: The OMIRE learning model, which synthesizes inquiry-based and culture-based approaches, is designed to improve scientific literacy by engaging learners in observation, mind mapping, investigation, reconstruction, and evaluation. This model is grounded in various learning theories and aims to foster a deeper understanding of scientific concepts through active inquiry and cultural relevance (Sarini et al., 2024). This study aimed to evaluate the effectiveness of the model in fostering scientific literacy, focusing on the practical application of scientific knowledge, problem-solving, and reflective practices. The mixed-methods design, combining quantitative and qualitative data, allowed for a thorough examination of the impact of the CAPLAIRE model. This section will discuss the findings of the pre-test and post-test scores, the results from the student questionnaires, and the reflections provided by the students and lecturers involved in the study.

The results from the pre-test and post-test showed a significant improvement in the students' scientific literacy, as measured by the frequency distribution of their scores. The pre-test, which assessed students' baseline knowledge, revealed that a majority of students scored within the lower intervals, with 12 students scoring between 52 and 57 and 10 students scoring between 67 and 72. These findings indicate that the participants had limited prior knowledge in scientific literacy at the start of the program.

However, the post-test results were markedly different, with students' scores significantly higher in the higher intervals. The frequency distribution revealed that 10 students scored between 70 and 75, 7 students between 75 and 80, and 6 students between 85 and 90, with 11 students scoring between 90 and 95. This shift suggests a substantial improvement in scientific literacy, particularly in the application of

scientific knowledge and critical thinking skills. The findings align with the OECD's framework for assessing scientific literacy, which emphasizes the competencies necessary to identify scientific questions, evaluate evidence, and apply scientific knowledge in real-world contexts. This is in line with the results that the integration of STEAM-PjBL into science learning encourages students to be able to see the relevance of science knowledge to phenomena in everyday life, develop curiosity and problem solving, and increase students' courage to ask questions and explore various sources to find information (Adriyawati et al., 2020). Based on the results of another study which stated "Using a pretest versus posttest design, we show that students who completed the experimental course significantly improved their critical-thinking skills and were more willing to engage scientific theories the general public finds controversial (e.g., evolution), while students who completed a general education science course did not. Our results demonstrate that a general education science course emphasizing the process and application of science rather than just scientific facts can lead to improved critical thinking and scientific literacy (Rowe et al., 2015).

A paired t-test was conducted to compare the pre-test and post-test means, with results showing a statistically significant difference ($p = 0.02487$). The t-statistic value of 2.75 supports the hypothesis that the CAPLAIRE model effectively improved students' scientific literacy, highlighting the model's impact on fostering a deeper understanding of scientific concepts and their real-world applications.

Qualitative feedback from students, collected through surveys and interviews, provides further insight into the effectiveness of the CAPLAIRE model. Many students reported that the CAPLAIRE model helped them understand complex scientific concepts more effectively. In particular, the combination of the four key activities—Case Investigation, Plan A Solution, Implementation, and Reflection/Evaluation—allowed students to engage deeply with the content and apply their learning to real-world scenarios.

Reflection sessions, conducted after each lesson, were particularly beneficial in consolidating students' learning. According to the students, these sessions provided an opportunity to reflect on their problem-solving approaches and consider alternative solutions. The collaborative aspect of the CAPLAIRE model also played a crucial role in enhancing students' scientific literacy. By working together to investigate scientific problems, students were able to share ideas, discuss their reasoning, and learn from one another's perspectives.

Lecturers involved in the implementation of the CAPLAIRE model also provided positive feedback regarding its effectiveness. They observed that the model encouraged students to think critically and engage in meaningful problem-solving activities. The inquiry-based approach, which emphasizes the exploration of scientific phenomena through investigation and experimentation, was particularly well-received by the lecturers. They noted that the model's flexibility allowed it to be adapted to different subject areas and educational contexts, making it a versatile tool for fostering scientific literacy across various disciplines.

In addition to fostering critical thinking and problem-solving skills, lecturers also appreciated the structured nature of the CAPLAIRE model. The four key activities provided a clear framework for both students and instructors, helping

to ensure that the learning objectives were met while promoting active participation. The reflective component of the model, in particular, allowed students to consolidate their learning and assess their progress, which is crucial for developing self-regulated learning skills.

The findings of this study have important implications for science education, particularly in teacher education programs. The CAPLAIRE model has proven to be an effective tool for enhancing scientific literacy by promoting inquiry-based learning, critical thinking, and problem-solving. The model's emphasis on reflection and collaboration further supports the development of scientific literacy, as students are encouraged to consider alternative solutions and engage with their peers in meaningful discussions.

Moreover, the pre-test and post-test results suggest that the CAPLAIRE model can help bridge the gap between students' prior knowledge and the desired level of scientific literacy. The significant improvement in post-test scores highlights the model's potential to enhance students' understanding of scientific concepts and their ability to apply scientific knowledge in real-world contexts.

Despite this study's promising results, several limitations must be acknowledged. The study relied on a single cohort of students in the elementary school teacher education study program at UNIMED, which may limit the generalizability of the findings. Future research should explore the effectiveness of the CAPLAIRE model across different student populations and educational contexts to determine its broader applicability.

Additionally, while the pre-test and post-test design provided valuable insights into the impact of the CAPLAIRE model on scientific literacy, further research is needed to examine the long-term effects of the model. Longitudinal studies could provide a deeper understanding of how the CAPLAIRE model influences students' scientific literacy over time and whether the skills developed during the program are retained in subsequent courses or professional settings.

CONCLUSION

This study evaluated the effectiveness of the CAPLAIRE model in enhancing scientific literacy among students in the PGSD FIP UNIMED program. The findings from the pre-test and post-test scores demonstrated a significant improvement in students' scientific literacy, as evidenced by the higher post-test scores in the upper intervals compared to the pre-test. This suggests that the CAPLAIRE model successfully facilitated the development of scientific knowledge, critical thinking, and problem-solving skills.

The student feedback, gathered through surveys and reflections, further supports these findings, with many students expressing that the model helped them understand scientific concepts more effectively and appreciate the real-world application of science. Additionally, the collaborative and reflective components of the model were identified as valuable in fostering a deeper understanding of scientific issues. Lecturers also provided positive feedback, highlighting the model's structured approach and its ability to engage students actively.

The study’s results suggest that the CAPLAIRE model offers a promising

method for improving scientific literacy in teacher education programs, particularly through its inquiry-based learning approach. This research contributes to the growing body of knowledge on inquiry-based learning models and their impact on scientific literacy. Future research could explore the long-term effects of the CAPLAIRE model on students' scientific literacy and its applicability in different educational contexts to further assess its effectiveness.

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