Conservation Learning Model to Improve Students' Scientific Literacy and Environmental Literacy

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Abstract. Science learning is inherently linked to the environment and its sustainability. It can serve as a vehicle for developing scientific literacy, which includes the ability to process information in the form of concepts and procedures to be applied in everyday life, and also enhances students' awareness of environmental conditions. This study describes the Web-Based Conservation Learning Model (CLM), which features learning phases or stages: Ecology, Science, Mathematics, Solution, and Recommendation, all integrated within a web application. The Web-Based CLM is an innovative learning model that can enhance both scientific literacy and environmental sustainability awareness among students.

Keywords: Conservation Learning Model, Scientific Literacy, Environmental Literacy

1 Introduction

Science learning activities will help students acquire knowledge and experience about their surrounding natural environment. Science learning is not only limited to knowing science content, but also to train scientific literacy and serve as a medium for teaching students the importance of responsibility in preserving the environment.

The 2018 PISA findings show that Indonesia's science literacy is still lagging behind other countries, with Indonesia ranking 73 out of 79 countries and scoring 396 in science literacy [1]. Similarly, preliminary assessments of the science literacy skills of secondary school students also indicate low levels. This suggests that science literacy needs to be further cultivated among students.

Likewise, environmental literacy and the sense of responsibility towards environmental conservation are still low. Environmental damage caused by a lack of concern and responsibility has led to disasters such as floods and forest fires. This demonstrates the low level of public education about environmental literacy and the sense of responsibility for environmental sustainability.

Environmental literacy, science literacy, and responsibility towards the environment can be improved and trained in students through science learning using the developed hypothetical learning model called the Conservation Learning Model. The Conservation Learning Model includes

ICWSDGs 2024, September 09-10, Banjarmasin, Indonesia

DOI 10.4108/eai.9-9-2024.2359052

learning phases such as Ecology, Science, Mathematics, Solution, and Recommendation. In the Ecology phase, science learning activities are based on environmental phenomena observed around the students. In the Science phase, learning activities focus on reviewing concepts, principles, or other scientific knowledge to explain the observed phenomena. In the Mathematics phase, learning activities focus on a mathematical approach to understanding scientific phenomena. In the Solution phase, the focus is on finding solutions from a scientific perspective to the identified problems. In the Recommendation phase, students are allowed to make recommendations based on the results of their learning, as a form of responsibility and ownership of environmental sustainability based on the studied scientific phenomena.

Interactive web use has also been applied in science learning[2]–[4], but so far it has not focused on innovative learning models that take environmental aspects into account. Therefore, the Web-Based Conservation Learning Model can become an innovative learning model that improves students' environmental literacy, science literacy, and sense of responsibility, supported by the use of technology.

The research problem formulation in this study is: "What is the profile of the feasibility of the Web-Based Conservation Learning Model in Science Learning for developing Science Literacy and Environmental Literacy?"

Science literacy refers to an individual's scientific ability to identify phenomena, explain, and provide explanations regarding science-related issues [5]. Science education has been implemented for a long time, but the science literacy results obtained by PISA are very low [6]. The low score of science literacy in Indonesia is due to the teaching and learning process focusing on mastering and memorizing theories, and the evaluation instruments used do not provide literacy experience [7].

Today's education must promote the development of sustainability and responsibility to protect the environment and the planet Earth [7], [8]. Environmental literacy focuses on four main aspects: (a) concern/sensitivity towards the environment, (b) behavior of ownership and responsibility, (c) knowledge about the environment, and (d) skills in managing the environment [9]. These four main aspects form a quartet in environmental literacy and include the essential goals of science education, going beyond the concept of science literacy. Kahyaoglu et al. [8] and [10] emphasized the importance of environmental responsibility, stating that children who do not have an emotional connection with nature are unlikely to feel nature, understand the human-nature relationship, and demonstrate behaviors that protect nature.

Previously, Mahardika, Wiranda, and Kamal conducted research to improve student learning outcomes using interactive web-based science learning, which provides opportunities for independent and interactive learning, as well as allowing teachers to assess student activities directly through the interactive web application system. However, this research has not yet linked environmental literacy, science literacy, and students' sense of responsibility [2].

A learning model is defined as a conceptual framework that describes a systematic and systemic process in organizing learning experiences to achieve the set learning objectives. Joyce, Weil, & Shower [11] state that each learning model has its purpose and theoretical rationale, and it must have five characteristic elements, namely syntax, social system, reaction principles, support system, as well as instructional and accompanying impacts. Framework formation Hypothetical model syntax Conservation Learning Model can seen as following :

Table 1. Phases Learning and Review CLM Model Theory

Phase Learning	Theory Supporters
Ecology	Eco-educator must include science ecology on learning science in the future come [12]. Science education based on ecology is an educational program that improves awareness will nature and environment on individuals , protecting biotic and abiotic in nature [9].
Science	Science competencies consist of from three aspects , namely explain phenomenon scientific, evaluating, and designing investigation scientific, as well as interpreting data and evidence scientific [13], [14].
Mathematics	Model mathematics, and mathematical reasoning is required For lower formula science or prediction phenomenon science [15], [16].
Solution	constructivist perspective holds that learners of all ages are actively involved in the process of obtaining information and constructing their own knowledge [17], [18].
Recommendation	The task of social recommendation is to predict and prioritize interaction and interrelation social among creatures, to reduce the problems that will happen in the future come [19].

After formation, the next stages of the CLM model will be developed in a web-based learning application according to the CLM syntax, resulting in the Web-Based Conservation Learning Model.

2 Methods

The study method generally uses the ADDIE development model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation [20]. Specifically, for the Development stage, the Web-Based Conservation Learning Model was developed using the extreme programming method for the web application, with stages including planning, design, coding, and testing [21], [22]. For the Implementation stage (limited trials, field trials, and product testing), the experimental research method was used.

This study was preceded by identifying problems related to environmental literacy, and scientific literacy. This was done through observations and preliminary analysis in Lampihong Senior High Schools in in South Kalimantan Province with a total of 72 students involved. In addition, a literature review was conducted, which showed the need to improve environmental literacy and scientific literacy, as well as the need for a technology-based approach to facilitate educators in delivering science learning.

In the analysis stage, this step was carried out to identify the main research problem, develop strategies for problem-solving, analyze resources, and assess the necessary technology to address the study issues. The design stage aimed to create a framework and initial prototype of the Web-

Based Conservation Learning Model (CLM), along with measurement instruments for environmental literacy, scientific literacy, and students' sense of responsibility for science learning. The development stage focused on creating the Web-Based CLM model and measurement instruments for environmental literacy, and scientific literacy. The model was developed into a web application using the extreme programming method. This involved integrating literacy questions on environmental literacy, and scientific literacy into the Prototype-1 application, and conducting an initial validation of Prototype-2. The implementation stage aimed to generate effectiveness data from the Web-Based CLM product through a tiered trial process. At the end of the study, the Web-Based CLM model and a report will be produced.

Data Collection Techniques (a) Questionnaires were used to collect data environmental literacy. (b) Tests were conducted post-tests to assess cognitive abilities after using the product. The test results were analyzed to determine the product's effectiveness.

The subject of this study is the Web-Based CLM model, with Lampihong senior high school students as the field test subjects. Meanwhile, the object of this study is the eligibility of the Web-Based CLM product, evaluated in terms of its effectiveness. Effectiveness refers to the level of success in achieving the learning objectives, as measured by environmental literacy and scientific literacy. Research Data Analysis using quantitative descriptive analysis was used for implementation CLM.

3 Results and Discussion

The Conservation Learning Model, with the syntax Ecology, Science, Mathematics, Solution, and Recommendation, is designed using a holistic and integrative approach to enhance scientific literacy, environmental literacy, and students' responsibility toward the environment. This syntax outlines the stages of learning that aim not only to teach science content but also to develop students' understanding of the interconnectedness of science, mathematics, and the environment, along with their ability to offer solutions based on natural phenomena they observe [23], [24]. Below is a discussion of each stage:

Ecology, this stage emphasizes the importance of students' understanding of ecological phenomena in their surroundings. Learning begins with the observation of real natural phenomena around the students, such as climate change, pollution, or the conservation of natural resources. Through this stage, students are encouraged to become more sensitive to the environment and understand that these natural phenomena have a direct impact on their daily lives [25]. This stage aims to build environmental awareness and sensitivity in students.

Science, in the Science stage, students are invited to explore relevant scientific concepts, principles, and theories to explain the ecological phenomena they have observed. This stage focuses on developing students' scientific thinking skills, including the ability to understand and apply complex scientific concepts. Through the understanding of scientific theory, students can critically analyze natural phenomena and explain their causes based on the knowledge they have learned [26].

Mathematics, in the Mathematics stage, students are trained to use mathematical approaches in understanding and analyzing scientific data related to natural phenomena. Mathematics is used to strengthen scientific reasoning, for example, through the collection, analysis, and interpretation of quantitative data [27]. This stage is essential as it teaches students logical and systematic thinking and provides them with tools to make predictions or calculate the impacts of certain phenomena such as temperature changes, rainfall, or pollution levels.

Solution, the solution stage focuses on students' ability to formulate scientific solutions to environmental problems they have identified. Students are tasked with thinking about practical and innovative steps that can be taken to address environmental issues, based on their understanding of ecology, science, and mathematics [28]. This is the phase where students' critical and creative thinking skills are honed, positioning them as problem-solvers.

Recommendation, in the final stage, Recommendation, students are given the opportunity to develop recommendations or action plans that can be implemented to protect the environment. These recommendations represent the students' responsibility for what they have learned and serve as a tangible contribution to preserving and protecting the environment [29]. Additionally, this stage involves students' ability to communicate their results and solutions to others, whether through presentations, writing, or group discussions.

The Conservation Learning Model syntax is then integrated into web-based learning media with the following display:

Fig. 1. Syntax of CLM in Web Application

Figure 1 shows the appearance of the web-based CLM application, which has the CLM syntax in the navigation bar. Thus, when students engage in learning, they can directly follow the stages of CLM that support the development of scientific literacy and environmental literacy among learners.

Fig. 2. Examples of Ecological Phenomena in the Web Application

Figure 2 shows several ecological phenomena that will be studied by the learners. With this stage, it is expected that the learners will gain a better understanding of environmental issues and enhance their sense of responsibility towards their surrounding environment.

Implementation of the Conservation Learning Model involves several structured stages, focusing on the integration of science, the environment, and social responsibility. This model aims to enhance scientific literacy and environmental literacy while encouraging students to actively engage in solving environmental problems. The following are the steps in implementing CLM:

Ecology (Ecology Stage), initial Approach: Learning begins with observing ecological phenomena in the students' surroundings, such as environmental degradation, water or air pollution, and natural disasters like floods or wildfires. Activities: Students engage in direct observation or use relevant teaching materials (e.g., videos, images, or digital simulations). They are directed to recognize the impact of these phenomena on ecosystems and human life. Objective: This stage aims to cultivate students' awareness of environmental issues and build their sense of responsibility.

Science (Science Stage), Scientific Understanding: In this stage, students learn concepts, principles, and scientific theories that explain the observed phenomena. For instance, they study concepts related to climate change, the water cycle, ecosystems, or biogeochemistry. Activities: Students analyze these phenomena using a scientific approach, such as conducting experiments or reviewing literature. The use of digital aids, like science simulations or educational software, can be applied to deepen understanding. Objective: Students connect the phenomena they observe with scientific principles, training their critical thinking and analytical skills.

Mathematics (Mathematics Stage), Quantitative Approach: This stage focuses on using mathematics to understand and model natural phenomena. Students can carry out measurements, collect data, and perform statistical analyses related to the ecological phenomena they observe. Activities: For example, students might calculate greenhouse gas emissions from various human activities or determine deforestation rates and their impacts on biodiversity. They may also engage in simple mathematical modeling to predict future environmental impacts. Objective: Through this stage, students learn to employ quantitative approaches in analyzing and solving scientific and environmental problems.

Solution (Solution Stage), Problem Solving: In this stage, students are encouraged to seek solutions to environmental problems they have observed, based on their understanding of ecology and the science and mathematics concepts they have learned. Activities: Students may work individually or in groups to design solutions. These solutions could involve innovative ideas such as eco-friendly technologies, conservation strategies, or environmental policies that can be implemented at the local level. Objective: Students practice critical and creative thinking skills in finding science-based solutions to real-world problems in their environment.

Recommendation (Recommendation Stage), Action Plan: After identifying solutions, students are asked to provide recommendations for actions that can be taken to preserve the environment. They should be able to make recommendations based on their analyses and apply them in everyday life. Activities: Students can present their solution findings through presentations, written reports, or group discussions. They may also create environmental campaigns at school or in the community to raise awareness about the importance of protecting the environment. Objective: This stage encourages students to take tangible actions in protecting the environment, enhancing their sense of ownership and responsibility for natural preservation.

Use of Technology in CLM Implementation, Web-Based CLM: This model utilizes digital applications or interactive web platforms to enhance learning. Web-based CLM facilitates students' access to learning materials, evaluation tools, and online simulations. This technology helps teachers monitor student progress, provide assessments, and offer a more interactive learning experience. Online Activities: Students can complete assignments, collect data, and engage in discussions through the web-based learning platforms provided in this model.

Collaboration with Teachers, Collaboration: The implementation of CLM involves close collaboration between students and teachers. Teachers act as facilitators who help students connect the phenomena they observe with the scientific concepts they learn. Teachers also play a role in guiding the development of solutions and recommendations, as well as utilizing technology in learning.

Figure 3a and 3b. Learning Activities Using the Web-Based CLM Application

Figure 3 above shows students' learning activities using the web-based CLM application, where the teacher acts as a facilitator in the learning process. The teacher must manage the virtual classroom, supervise interactions among students, and maintain ethics and norms in online learning. Teachers can encourage students to take the initiative in their own learning. Providing constructive feedback to students is essential to help them understand areas that need improvement and to motivate them in their studies. The results of the students' science literacy and environmental literacy scores can be seen in Table 2 and Table 3.

Table 2. Average Science Literacy Scores of Students Taught with CLM-Web Based

No	Science Literacy Indicator	Average Score
1	Science as a body of knowledge	84.2
2	Science as a way to investigating	88.3
3	Science as a way of thinking	84.5
4	Interaction of science, technology, and society	85.0

Table 2 above shows that the average score for Science as a Body of Knowledge is 84.2, this score reflects students' understanding of established scientific concepts, facts, and theories. An average score of 84.2 indicates a strong grasp of core scientific knowledge. However, it also suggests there may be room for improvement, particularly in ensuring that all students achieve a deeper understanding of the material. Average score for Science as a Way of Investigating is 88.3, this is the highest score among the indicators, suggesting that students excel in practical aspects of science, including experimental design, data collection, and analysis. Average score for Science as a Way of Thinking is 84.5, this score suggests that students are adept at applying scientific reasoning and critical thinking skills. While the score is slightly lower than that for investigating, it still reflects a solid foundation. Emphasizing problem-solving and analytical skills may enhance this aspect further. Average score for Interaction of Science, Technology, and Society is 85.0, this indicator shows how well students understand the interconnections between scientific knowledge, technological advancements, and societal implications. The score suggests that students recognize the relevance of science in real-world contexts, which is essential for fostering responsible citizenship and informed decision-making.

The average scores indicate a generally positive trend in science literacy among students, with the highest achievement in the investigative aspect of science. However, while the scores are all relatively high, there is still potential for improvement in all areas, particularly in enhancing the understanding of scientific knowledge and fostering critical thinking. Continuous assessment and feedback will be essential in helping students bridge any gaps in their understanding and further improve their science literacy.

Table 3. Average Environmental Literacy Scores of Students Taught with CLM-Web Based

No	Environmental Literacy Indicator	Average Score
1	concern/sensitivity towards the environment	85.2
2	behavior of ownership and responsibility	82.4
3	knowledge about the environment	82.1
4	skills in managing the environment.	80.5

Table 2 above shows that the average scores for various indicators of environmental literacy among students, showcasing their performance in key areas related to understanding and interacting with the environment. Here’s a detailed discussion of each indicator. Average score for Concern/Sensitivity Towards the Environment is 85.2, this score is the highest among the four indicators, indicating a strong awareness and sensitivity to environmental issues among the students. It suggests that students are likely to recognize the importance of environmental conservation and may feel a personal responsibility towards environmental stewardship. This high level of concern could be attributed to educational programs that emphasize the urgency of environmental issues, such as climate change, pollution, and biodiversity loss. Average score for Behavior of Ownership and Responsibility is 82.4, with a score slightly lower than concern, this indicates that students recognize the need for personal responsibility regarding environmental actions. This suggests that while students may understand the significance of being responsible stewards of the environment, there may still be a gap in translating this understanding into consistent behavioral practices. Average score for Knowledge About the Environment is 82.1, this score shows that students possess a reasonable level of knowledge about environmental issues, including concepts related to ecology, sustainability, and conservation. However, this score being lower than the concern/sensitivity score might suggest that while students feel deeply about the environment, they may lack detailed knowledge about specific environmental issues or the science behind them. Average score for Skills in Managing the Environment is 80.5, this indicator has the lowest average score, suggesting that students may struggle with practical skills necessary for effective environmental management. Skills could include waste management, conservation practices, and sustainable resource use. The lower score indicates a potential area for improvement, emphasizing the need for hands-on learning experiences, such as projects and activities that allow students to practice these skills in real-world contexts.

The overall data suggests that while students demonstrate a strong sensitivity to environmental issues, there is room for growth in their knowledge and practical skills related to environmental management. This highlights the importance of integrating experiential learning opportunities into the curriculum to build both knowledge and practical skills.

Additionally, the data underscores the role of educational models, such as the Conservation Learning Model, which can bridge the gap between theoretical understanding and practical application, fostering a more holistic approach to environmental literacy. By reinforcing skills and knowledge alongside sensitivity and responsibility, educators can better prepare students to tackle environmental challenges in their communities and beyond.

The implementation of the Conservation Learning Model significantly contributes to the enhancement of students' science literacy. By emphasizing the interaction between science and the environment, CLM not only reinforces scientific knowledge but also facilitates the development of investigative skills and critical thinking necessary to address environmental challenges. This data indicates that the use of this learning model is effective in improving students' understanding of science, as well as their awareness of environmental issues. Further development of CLM in the educational context can continue to strengthen students' science literacy and promote responsibility towards the environment.

The Conservation Learning Model (CLM) is a comprehensive educational framework designed to foster both scientific and environmental literacy among students. Here's how CLM can enhance both scientific and environmental literacy: (a) Interdisciplinary Integration, CLM promotes a holistic understanding of environmental issues by intertwining scientific concepts, ecological principles, and social responsibility. This interdisciplinary approach enables students to grasp the complexities of environmental problems, such as climate change or biodiversity loss, and understand their scientific, ecological, and social dimensions [30],[31]. For instance, while studying the water cycle, students learn about its scientific mechanisms and the implications of water pollution on ecosystems and human health. (b) Active Learning Through Direct Observation, the model encourages students to engage in direct observation of their surroundings, allowing them to identify and analyze ecological phenomena. Such hands-on experiences deepen students' understanding of environmental issues, fostering a sense of responsibility and stewardship [32]. By witnessing the impacts of environmental degradation or conservation efforts firsthand, students can relate theoretical concepts to real-world situations, thereby enhancing both scientific and environmental literacy. (c) Development of Critical Thinking and Problem-Solving Skills, in CLM, students are tasked with finding solutions to observed environmental problems based on their scientific understanding. This emphasis on problem-solving nurtures critical and creative thinking skills essential for scientific inquiry [33],[34], [35]. For example, students might develop conservation strategies or eco-friendly technologies as part of their learning process, equipping them with practical skills to address real-world environmental challenges. (d) Fostering Social Responsibility and Community Engagement, CLM emphasizes the importance of social responsibility in environmental contexts. By participating in community projects or awareness campaigns, students learn about the impact of their actions on the environment and the importance of collective efforts for conservation [36]. This engagement not only enhances their environmental literacy but also encourages a sense of ownership and agency in contributing to sustainability efforts. (e) Utilization of Technology in Learning, incorporating digital tools and resources in CLM enhances students' learning experiences and engagement. Web-based platforms provide access to simulations, data analysis tools, and collaborative projects, enriching students' understanding of scientific concepts and environmental issues [37]. This technology-driven approach also prepares students for a world where digital literacy is essential for scientific inquiry and environmental advocacy.

Others Findings on the Advantages of the Model: (a) Interdisciplinary Approach, by combining ecology, science, and mathematics, this model teaches students to view environmental issues from multiple perspectives, (b) Development of Literacy Skills, this model enhances scientific literacy and environmental literacy through applied learning experiences, (c) Social Responsibility, by emphasizing solutions and recommendations, this model instills a sense of social and environmental responsibility in students.

4 Conclusions

The implementation of the Conservation Learning Model is an innovative approach that integrates scientific and mathematical understanding with real environmental issues. This model not only enhances scientific knowledge but also fosters environmental awareness and responsibility among students in preserving nature. With the support of web-based technology, this model becomes more interactive and aligns with the demands of modern learning. This model can also help in developing students' science literacy and environmental literacy.

Acknowledgments.

Thank you to Lambung Mangkurat University and the Research and Community Service Institute of Lambung Mangkurat University for their financial and moral support, which has enabled this research to be carried out.

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