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The Effect of Contextual Problem-Based Learning Model on Students' Environmental Literacy in Environmental Education Course

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ABSTRACT

Objective: The 21st century is characterized by transformation and advancement across multiple domains. These modifications encompass requirements within the educational sector. This essay seeks to analyze the opportunities and obstacles of environmental literacy and awareness in 21st-century schooling. This study aimed to assess the influence of contextual problem-based learning on students' environmental literacy.. The research employed a posttest-only approach and constituted a quasi-experimental study. The control group underwent conventional training, while the experimental group engaged in contextual problem-based learning. The environmental literacy of students was the dependent variable in this study. The independent variable in this study was contextual problem-based learning. Sixty pre-service biology educators from two complete courses participated in the research during their first semester. The assessments of recent environmental literacy competencies were utilized as study instruments. The research findings indicate a disparity in students' environmental literacy between those subjected to contextual problem-based learning and those who undergo traditional education. The experimental group exhibited superior environmental literacy compared to the control group. Consequently, contextual problem-based learning is a viable approach for augmenting students' environmental knowledge.

INTRODUCTION

Numerous individuals conflate environmental literacy solely with knowledge pertaining to the environment. Environmental literacy is especially crucial for marginalised groups who endure adverse environmental consequences. Environmental literacy encompasses students' awareness, knowledge, attitudes, skills, and predispositions to tackle environmental challenges (Lee et al., 2020). Literacy refers to the capacity to read and write, as well as the level of knowledge in a specific domain. Environmental literacy is an essential competency at all educational levels and a vital component for attaining success in 21st-century skills (Farida et al., 2023). The significance of acknowledging environmental literacy as a human and societal concern (Guerrero & Sjöström, 2025). The primary elements of environmental literacy encompass an individual's knowledge, attitudes, and behaviours. The utilisation of environmental science and literacy to tackle environmental challenges is essential (Suherman & Vidákovich, 2025). Community engagement includes enhancing environmental literacy among present stakeholders and future generations concerning lake management, ecology, and eutrophication (Armstrong et al., 2021). Studies conducted by Maknun et al. (2017) and Meilinda et al. (2017) demonstrate that high school students' environmental literacy is insufficient. Multiple studies have shown that the environmental literacy of undergraduate students is insufficient (Farwati et al., 2017; Liang et al., 2018). A distinct study identified a group of students with inadequate environmental literacy (Apriana, 2017). The implications for education require educators to adopt innovative learning strategies to foster environmental literacy and prepare them for future challenges in sustainable living and decision-making (Agustira).The advancement of science and technology in the 21st century is becoming increasingly inevitable (Andrews et al., 2019). This is due to the absence of boundaries between nations for communication and

3 collaboration, necessitating that all sectors prepare accordingly. Therefore, schools play a major role in mitigating environmental issues by improving the environmental literacy (knowledge, attitude, and behavior) of students. In the realm of education, modifications in learning paradigms are essential to accommodate advancements of the 21st century (Kennedy & Odell, 2014), which demands the ability and proficiency in 21st-century skills (Kwan, 2019). The demands of the 21st century lead to the formation of quality individuals who are in accordance with the demands of the times (Mak et al., 2025). Adapting to the needs of the times is essential to avoid being left behind and maintain one's existence (Reinke, 2020).

4 The National Education Standards Agency emphasized the significance of acquiring 21st-century skills in 2010. The declaration asserts that 21st-century national education seeks to fulfill the nation's ideals, including a prosperous society and an equal and respected position among other nations globally, based on the formation of quality human resources, namely independent figures, and the desire to realize the nation's ideals. It can be said that the demands of this change are aimed at preparing individuals who are qualified and can adapt to the developments of the current century.

4 This aligns with Buchori (Wiltbank et al., 2019), who stated that in facing 21st-century life, mastery of three key understandings is necessary, including cultural understanding (cultural literacy), understanding of knowledge (scientific literacy), and understanding of the environment (environmental literacy). Environmental literacy has become an important understanding or ability that needs to be mastered in the 21st century (Mcneal et al., 2020). This is also stated in the P21 framework for 21st-century learning, which identifies environmental literacy as one of the key themes in 21st-century learning (Driessen et al., 2020). Environmental literacy comprises three components: attitudes, knowledge, and behavior towards the environment. Environmental awareness is one of the components of environmental literacy (Corwin et al., 2019).

6 A person's environmental awareness is said to stem from their environmental knowledge. A person with good environmental literacy is considered to possess good environmental awareness (Clements et al., 2022). This is crucial in this century, not only because of the demands of progress and paradigm shift, but also because it helps solve existing problems and instill a disciplined and wise attitude towards the environment (Dulai et al., 2022). In practice, both environmental literacy and environmental awareness certainly face challenges (Mcdaniel et al., 2022). However, both skills also hold significant potential for application in the 21st century (Qu et al., 2024). Contextual problem-based learning and teamwork can increase student interest in a topic (Yang & Hardy, 2015), contextual problems to enhance students' creative thinking skills (Satriawan et al., 2020), and Contextual problem-based learning (CPBL) enhances problem-solving abilities (Agustoni et al., 2021). This essay aims to analyse the influence of contextual difficulties in education on students' environmental literacy in the 21st century.

RESEARCH METHOD

The research methodology utilised was quasi-experimental. The main difference between this study and real experimental research is how participants were classified. Participants were selected randomly to mitigate bias in experimental investigations. Quasi-experimental research is the optimal alternative when individual selection is deemed difficult or unfeasible. Due to the lack of complete control in a quasi-experimental approach, researchers must consider factors influencing both internal and external validity when analysing their research results (Shortlidge et al., 2019).

The dependent variable in this study is environmental literacy, whereas the independent variable is contextual problem-based learning. This study employed a posttest-only design without a comparable group as the foundation for the quasi-experimental methodology. The experimental and control classes were selected from two classes with similar characteristics. The same lecturer taught both classes, followed the same curriculum, and had equivalent class hours and campus facilities. Furthermore, based on previous academic records, the average scores of both classes on the college entrance exam were relatively similar. Under these conditions, the two classes could be considered equivalent before the treatment and, therefore, suitable for comparison in a post-test-only design.

NR X O₁
NR O₂

Notes:

- There is not any = Non-random
- X = Contextual problem-based learning
- O₁ = O₂ = Environmental literacy

The experimental and control sample classes are delineated by a dashed line, signifying that they were not established through random assignment of individuals or study participants. During the second semester, sixty biology student instructors from two full classes took part in the study. Contextual problem-based learning was implemented to instruct students in the experimental classes. The control group, however, delivered conventional teaching to the participants in the study. The teacher provided contextual problem-based learning services with more clarity (Stanley, 2021). Following the instructional session, students in both sample classrooms underwent an assessment (O₁ = O₂) to evaluate their environmental literacy.

RESULTS AND DISCUSSION

Results

Literacy is examined in environmental education courses involving first-semester pre-service biology educators for two complete courses. The mean and standard deviation offer a summary of students' environmental literacy competencies. Three basic levels of environmental literacy are presented, along with two treatment groups. Table 1 illustrates students' environmental literacy.

Table 1. Description of Students' Environmental Literacy

Treatment	Average	Standard Deviation	N
CPBL	70.53	8,653	30
Control	53.03	8,656	30

The control class comprised 30 students, while the Contextual Problem-Based Learning (CPBL) session also included 30 students. With a standard deviation of 8.653, the students in the CPBL class achieved an average environmental literacy score of 70.53. The average environmental literacy score for the control group was 53.03, with an 8.656 standard deviation. The mean for both groups was 66.28, and the standard deviation was 15.880. Students' environmental literacy scores ranged from 0 to 100, with the

experimental/CPBL class showing high literacy levels and the control/traditional class showing much lower literacy levels.

When assessing data normality for learning techniques, the Kolmogorov-Smirnov test shows that both the CPBL and traditional models provide p-values below 0.05. Likewise, the CPBL and control groups have p-values less than 0.05 according to the Shapiro-Wilk test. Considering these two parameters, the data has a non-normal distribution. The p-value exceeding 0.05 obtained from the homogeneity of variance test between the two groups signifies the equivalence of variances. Consequently, according to the learning model, it may be inferred that the students' environmental literacy data does not originate from a regularly distributed population, yet exhibits comparable variations (Udeozor et al., 2021).

The Mann-Whitney test was used in non-parametric statistical tests (non-normal distribution found using the Kolmogorov-Smirnov and Shapiro-Wilk tests) to examine whether there were similarities/relationships/differences between the environmental literacy skills of students in the experimental and control classes (Gopalan et al., 2020). Table 2 displays the results of this test. Although the data had a non-normal distribution (confirmed by Kolmogorov-Smirnov and Shapiro-Wilk tests), the homogeneity of variance test showed equivalence between the groups, justifying the use of the non-parametric Mann-Whitney test.

Table 2. Mann-Whitney test

Test Statistics a	
	EL
Mann-Whitney University	3,000
Wilcoxon W	468,000
Z	-6,627
Asymp. Sig. (2-tailed)	.000

a. Grouping Variables: Treatment

Discussion

Table 2 displays model-related factors (learning techniques) with a p-value of less than 0.05. The contextual problem-solving learning (CPBL) model influences students' environmental literacy. This study aimed to ascertain if CPBL exerts a more significant impact on biology education compared to traditional teaching methods and to evaluate its effect on students' environmental literacy competencies. This is evidenced by the enhancement of students' academic performance, their fervor for biology, and their engagement in class activities.

Environmental literacy is crucial for cultivating committed future leaders and is a fundamental component of 21st-century skills, alongside creative thinking, critical thinking, communication, and cooperation (Bauer et al., 2020). Research by Nuraini Sirajudin et al., who investigated environmental literacy through the development of instruments spanning from elementary to tertiary education over a two-year period, specifically in 2001 and 2022, served as the foundation for choosing environmental literacy as the main focus of this study. This aligns with the assertions of (Shortlidge et al., 2019), which emphasize that environmental literacy is a crucial criterion for cultivating committed leaders in the future (Riggs et al., 2020). Furthermore, Sukma, Aditya, and (Rodríguez et al., 2019) assert that literacy skills are among the most vital

competencies in the 21st century. This research indicates that environmental literacy necessitates greater focus than other factors, as it is inferior to other cognitive elements (Sirajudin, 2019a, 2019b).

Instructors must furnish educational tools/models that cultivate environmental literacy competencies. Practical learning tools will produce optimal outcomes when conveyed through suitable learning methods or models (Leupen et al., 2020). A learning strategy that allows students to devise multiple solutions to a problem can be utilized to enhance environmental literacy (Riggs et al., 2020). A learning model that demonstrates this characteristic is the contextual problem-based learning model (Bassett et al., 2020). Research conducted by Sihaloho, Sahyar, and (Prochazkova et al., 2019) indicates that the contextual problem-based learning model significantly influences students' environmental literacy and problem-solving skills (Wahid & Talib, 2017). This finding aligns with (Wilton et al., 2019), who assert that the principal objective of advanced science education is to enhance students' competencies in environmental literacy and problem-solving.

This study aims to establish an environmental education learning model utilizing contextual problem-based learning to enhance students' environmental literacy skills (Taylor & Gavin, 2015). Goodwin & Goodwin (2016) assert that problem-based learning is effective in enhancing creative thinking skills. Researchers advocate for the implementation of a contextual problem-based learning (CPBL) approach in environmental education to enhance the environmental literacy competencies of biology education students. Research by Rambonilaza & Brahic (2016) has showed that this methodology is effective in enhancing students' environmental literacy skills. The findings of (Ndzimbomvu & Rampedi, 2021) demonstrate that the implementation of a contextual problem-based learning (PBL) model enhances student learning outcomes. This research corresponds with investigations carried out on alternative materials or topics. District et al., (2023) established an environmental education learning paradigm grounded in contextual problem-based learning, emphasizing the concept of environmental issues. A study determined that the contextual problem-based learning model enhances students' environmental literacy skills in science education. Lovren (2023) did research in several subjects. The study sought to assess the enhancement of students' mathematical representation skills and curiosity dispositions through the implementation of environmental education models utilizing contextual problem-based learning. The study concluded that the contextual problem-based learning model can improve students' mathematical representations and curiosity attitudes toward optical device material.

The study by Vasquez & Atwood (2023) demonstrated that the application of a contextual problem-based learning paradigm enhances students' academic performance in English. Moreover, the study conducted by Rasis & Kuswanto (2023) sought to establish a contextual problem-based learning paradigm suitable for mathematics education. The research conducted by Almarashdi & Jarrah (2022) sought to ascertain if contextual problem-based learning enhances elementary students' environmental literacy in scientific education. The research determined that the contextual problem-based learning paradigm enhances environmental literacy abilities in science education using digital media innovations, narratives, films, and practice questions.

The research conducted by Karamik (2023) created a pedagogical module utilizing the contextual problem-based learning model to enhance students' problem-solving abilities. The findings indicated that the contextual problem-based learning approach led

to an enhancement in problem-solving abilities. Consequently, the contextual problem-based learning paradigm positively influences higher-order thinking skills (Hobbins et al., 2020). This indicates that the contextual problem-based learning model can function as a significant educational resource for students and educators to attain learning goals and fulfill the requirements of the 21st century (Almarashdi, 2023).

The contextual problem-based learning strategy employed in this study has positively influenced the environmental literacy skills of biology education students. High skill proficiency signifies substantial knowledge. Therefore, the contextual problem-based learning model has contributed to helping students construct their knowledge. Environmental literacy is crucial for cultivating committed future leaders and is a fundamental component of 21st-century skills, alongside creative thinking, critical thinking, communication, and cooperation. Therefore, this study has addressed one of the weaknesses of problem-based learning.

CONCLUSION

This study demonstrates how students' environmental literacy skills are influenced by the contextual problem-based learning (CPBL) model. Consequently, Contextual Problem-Based Learning (CPBL) can improve biology teaching by positively influencing students' environmental literacy competencies in environmental education courses.

Students' understanding of biological principles is significantly enhanced through critical analysis of the environment. To facilitate pupils' reflection and reasoning regarding their behaviors, an environment conducive to the study of biology might be established. As a result, by improving students' environmental literacy (knowledge, attitudes, and behaviours), schools greatly help to mitigate environmental concerns. The attitude domain deals with individual opinions, values, and feelings about nature, while the knowledge domain includes information on how humans interact with natural systems. Environmental literacy transcends mere awareness or individual knowledge; it is cultivated within a particular context, while behaviour may evolve due to shifts in attitudes and understanding. Environmental literacy constitutes a fundamental aspect of an individual's essential literacy. Homework can enhance students' capabilities and refine their environmental literacy skills.

This study illustrates the impact of students' past environmental literacy and their learning practices on their environmental literacy development. Moreover, the two parts do not engage with each other. Consequently, CPBL represents an appropriate and distinctive methodology for addressing the subject of cognition and achieving educational objectives. Students in the experimental group appeared more proficient in formulating the strategy, enhancing critical thinking skills, deriving conclusions, and delivering a succinct explanation. It demonstrated that students' comprehension of environmental issues in environmental education courses may be significantly influenced by Contextual Case Based Learning, potentially improving biology instruction.

REFERENCES