

Research Article

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Integrating Experiential Learning Through e-River Worksheets: Enhancing Student Creativity and Promoting Environmental Care Attitude

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Abstract

Background/purpose. Students' creativity and awareness must be developed to overcome environmental problems through effective learning methods. This study examines the effect of experiential learning models combined with e-river worksheets on students' creativity and environmental awareness.

Materials/methods. The research method employed is a quasi-experimental design with a Pretest-Posttest Control Group. 70 high school students were divided into experimental classes (N = 35) and control classes (N = 35). Data on creativity and environmental awareness were collected using the Torrance Test of Creative Thinking (TTCT) and New Ecological Paradigm (NEP) questionnaires. Parametric statistics, namely the independent t-test, were used to determine the difference in the influence of creativity and environmental awareness.

Results. The results showed a significant influence of using experiential learning models and e-river worksheets on creativity and environmental awareness. The structured reflection facilitated by the e-River Worksheet enhanced experiential engagement and supported student creativity and environmental values.

Conclusion. The results showed that the experiential learning model and e-river worksheets influenced students' creativity in developing new ways to overcome environmental problems. Future studies are recommended to extend the application of this model to various educational contexts and to examine its long-term effects on behavioral transformation.

1. Introduction

For several decades, environmental issues have become a widespread concern (Sousa et al., 2021). Global issues like climate change (Weaver et al., 2023), water pollution (Mascherpa et al., 2023), deforestation (Wahelo et al., 2025), loss of biodiversity (Carmenta et al., 2025), and damage to local ecosystems, especially in river areas (Endalemaw et al., 2025; Mekuria et al., 2023), are serious threats to the ability of future generations to live sustainably. Scientific processes do not solely cause these challenges but are largely anthropogenic (Muñoz-López & Rivera-Rondón, 2025; Smith & Lacey, 2024). The causes stem from unsustainable behavior and inadequate ecological awareness among individuals and communities (Gansser & Reich, 2023; Savari & Khaleghi, 2025).

Human behavior plays a vital role in maintaining current environmental conditions (Sorour et al., 2025). Several studies examining the role of environmental attitudes have revealed that individuals with high environmental attitudes tend to be more concerned about the environment (Agrawal et al., 2023; Si et al., 2022). However, environmental problems, such as river pollution caused by human activities, are particularly prevalent in urban areas of developing countries like Indonesia (Basuki et al., 2024; Chauhan et al., 2023; Kumar et al., 2024). This is because public awareness of environmental issues still needs to be increased, especially among people who live on riverbanks. If this problem is not handled correctly, it will cause disaster. Likewise, as a river city, Palembang City has challenges in protecting the environment. Throwing rubbish directly into the river (trash culture) has become a habit for most people on the banks of the Musi River, so it has an impact on river water quality (Rahutami et al., 2022). A similar phenomenon also occurred in the Turag River, Bangladesh (Khan et al., 2024), and the Adi Ganga, India (Chakrabarty, 2020).

One way to mitigate environmental problems is to change students' perspectives and behavior to be more environmentally conscious (Iwan et al., 2023). In response to this condition, education plays a crucial and strategic role in shaping individuals who are responsible for the environment (Negi, 2024). Forming an attitude of caring for the environment from an early age is a crucial solution for the younger generation to develop a correct and adequate understanding of the environment (Mutia et al., 2023; Sumarmi et al., 2020, 2022). Environmental concern is reflected in students' knowledge, attitudes, behaviors, and skills in addressing environmental problems (Aliman et al., 2019; Dekoninck & Schmuck, 2025; Miguel et al., 2024; Mustika et al., 2025). In addressing environmental problems, attitude alone is insufficient. The complexity of today's environmental problems necessitates the ability to produce innovative and adaptive solutions, which requires creativity that allows individuals to think outside conventional solutions and develop approaches tailored to the context to solve environmental problems (Z. Han et al., 2025; Meirun et al., 2024). Creative thinking with environmental values is critical in cultivating future generations who are not only aware of ecological challenges but also empowered to act in innovative ways.

Therefore, efforts are needed to foster creativity and an attitude of environmental care to mitigate environmental problems. This research addresses the challenges of 21st-century learning, particularly in developing a generation of students who are creative and environmentally conscious. Creativity and environmental care are two key goals in education about the Sustainable Development Goals (SDGs) (Alayar et al., 2025; Hensley, 2020; Manolis & Manoli, 2021; Shu et al., 2020). Creativity is essential for generating innovative ideas and solutions to environmental problems (Sanz-Hernández & Covaleda, 2021), while environmental awareness reflects students' emotional and ethical engagement with the natural environment (Cayolla et al., 2023). Apart from that, creativity is one of the essential competencies in 21st-century learning (Zeng, 2025), which needs to be developed through active, exploratory, and collaborative learning approaches.

To foster students' environmental care and creativity, learning needs to be packaged in a context that is meaningful and relevant to everyday life. The subject that contributes to environmental

education as a curriculum focus is geography (Chang & Kidman, 2024). In addition to subjects, we need an appropriate learning model to cultivate creativity and environmental awareness. We can use experiential learning as one model. The EL model can foster a sense of environmental responsibility among students (Hung et al., 2023; J. Liu et al., 2024; Shutaleva, 2023). The EL model has been widely applied in the learning process (Adib, 2024; Blankesteyn et al., 2024; Vankov & Wang, 2024; Yazici & Uzuner, 2024). Although the EL model has been widely implemented, no one has integrated EL according to the local values of the student learning environment and integrated EL with digital-based worksheets.

The implementation of EL is often limited by time (Jacob & Boyter, 2023). To enhance the effectiveness of EL implementation in Palembang City, a river-based e-worksheet is necessary, enabling more focused and efficient learning stages. This is because Palembang City, a waterside city, has environmental problems surrounding its river. This research aims to investigate two key aspects: first, the impact of implementing the EL learning model, combined with river e-worksheets, on student creativity, and second, the influence of the EL learning model, combined with river e-worksheets, on students' environmental awareness. For this purpose, the research questions are (a) What is the effect of applying the EL model combined with an e-river worksheet on student creativity? (b) What is the effect of applying the EL model, combined with an e-river worksheet, on students' environmental caring attitudes? It is hoped that the results of this research will serve as a basis for enhancing student creativity in addressing environmental problems and increasing students' environmental awareness in river basins.

2. Literature Review

2.1. Experiential Learning (EL)

Experiential Learning (EL) is a real-world, experience-based learning model that fosters a more meaningful learning process through events, followed by reflection and contemplation in a continuous process directed at achieving goals and taking action (Blankesteyn et al., 2024). The EL model is more effective than a cognitive or information-based approach (Vromans et al., 2023). EL includes various learning opportunities (Wilson et al., 2021), such as field experiences (Salmona et al., 2015), outdoor learning (Jose et al., 2017), and service-learning (Henderson, 2018). EL is an essential foundation in fostering creativity and forming an environmental care attitude (Abbasi et al., 2023; Tien et al., 2019). Through direct involvement in environmental activities, students gain learning experiences that encourage the development of creative thinking while instilling sustainability values (Choi et al., 2024).

2.2. e-river Worksheets

Worksheets are scaffolding tools that guide students through problem-solving, encourage the application of their knowledge, facilitate the documentation of their thinking processes, and promote reflection on their learning experiences (Kusno & Setyaningsih, 2021). Worksheets serve as an essential teaching tool by illustrating the procedural steps that students must take, supporting them in cognitively organizing information, and, at the same time, facilitating the active participation of the entire class in the assigned activity (Powell et al., 2024). The e-River Worksheet is a digital tool designed to assist students in experiential learning using a reflective and systematic approach. "e-River" is an acronym for Experience, Reflection, Information, Values, Expression, and Revision. The objectives of using the e-River Worksheet include:

- Guiding students to document and reflect on their learning experiences (Sri Utami et al., 2016)
- The e-River Worksheet integrates real-life experiences with theoretical concepts (Suryani, 2024)

- Encouraging students to think critically, assess the values they encounter, and apply them to real-world situations (Widodo et al., 2023)

The components of the e-River Worksheet are as follows:

- Experience: Recording the activities or experiences undertaken.
- Reflection: Describing the feelings and thoughts triggered by the experience.
- Information: Connecting the experience with relevant theories or concepts.
- Values: Identifying the values learned from the experience.
- Expression: Expressing ideas or actions based on experience and understanding.
- Revision: Evaluating the process and developing plans for improvement or further action.

Worksheets are essential for achieving clear goals, as they allow students to interact actively with the content and engage in critical self-assessment during the learning process.

2.3. Creativity

Creativity is an essential skill students need (X. Liu et al., 2023). Creativity generates original ideas, solutions, and new and valuable products within a particular context (X. Gu et al., 2023; J. Han et al., 2023). Original ideas can be characterized by novelty, while valuable ideas are highly effective or practical (Acar et al., 2017). The concept of novelty or originality is such that creativity must produce something new and different (Aguilera & Ortiz-Revilla, 2021). Creativity stimulates students' senses, produces previously unknown knowledge, and helps students synthesize information while adding meaning to their educational experiences (Bullard & Bahar, 2023). Creativity is a core component that can be complemented through environmental knowledge (Kashefiyeh et al., 2024). Experiential Learning stimulates creativity by offering opportunities to face situations and challenges that require creative problem-solving (Edgell & Lee, 2023; Li & Yu, 2025). This process encourages learners to think critically and adapt to new problem-solving methods

2.4. Environmental Care Attitude

Environmental concern is a tendency that influences how a person perceives and interprets physical, social, and cultural conditions that affect the development of an organism (Sapanova et al., 2024). Attitudes toward the environment have received special attention since the 1970s, when one of the instruments (the New Ecological Paradigm scale) was developed to monitor the existence of an environmental paradigm as an alternative to the social paradigm that was considered dominant in society at that time (R. Dunlap, 2008). Environmental concerns are significant to understand so that they can overcome various environmental problems, ranging from local problems, such as water pollution, to global problems, such as climate change (Cruz & Manata, 2020). Environmental concerns must start with early awareness (Wibowo et al., 2023). Such learning can be initiated with simple activities from childhood, as the brain can quickly absorb all the information obtained at this stage (Intishar et al., 2020). The young generation, which has developed environmental awareness, possesses excellent potential to become the primary agents of change in efforts to protect and manage the environment sustainably (Alfarizi & Herdiansyah, 2024). The participation and efforts of the young generation in improving the environment will influence and inspire adults (Thor & Karlsudd, 2020). Therefore, schools, as institutions in the learning process, are responsible for fostering students' environmental awareness (Al Balushi & Ambusaidi, 2023; Del Rey et al., 2022).

3. Methodology

3.1. Research Design

Senior high schools in Palembang City conducted this research. This research design employs a quasi-experimental approach with a pretest-posttest control group design. In this study, the research design used was a nonequivalent control group design. The control and experimental classes were administered a pretest before treatment (Creswell, 2012). The independent variable is EL combined with an e-river worksheet, and the dependent variables are creativity and environmental care attitude. The structure of the research design is shown in Figure 1.

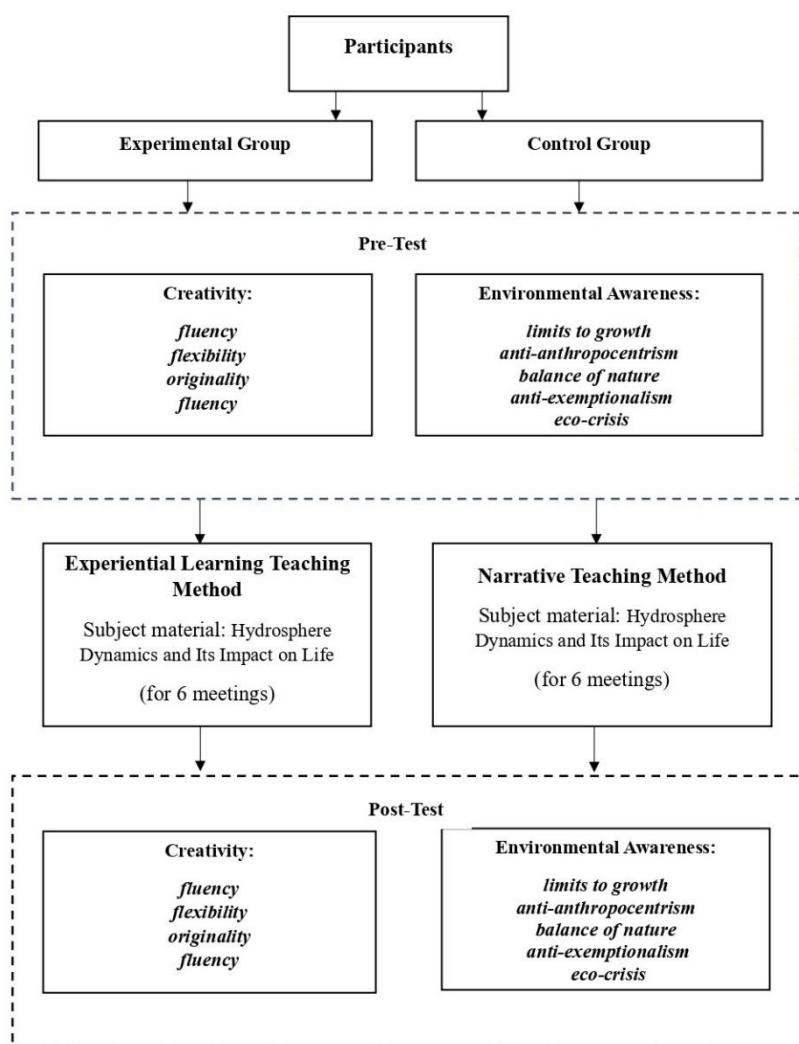


Figure 1. Research Design

The stages of implementing the EL model in learning are explained in the following image:

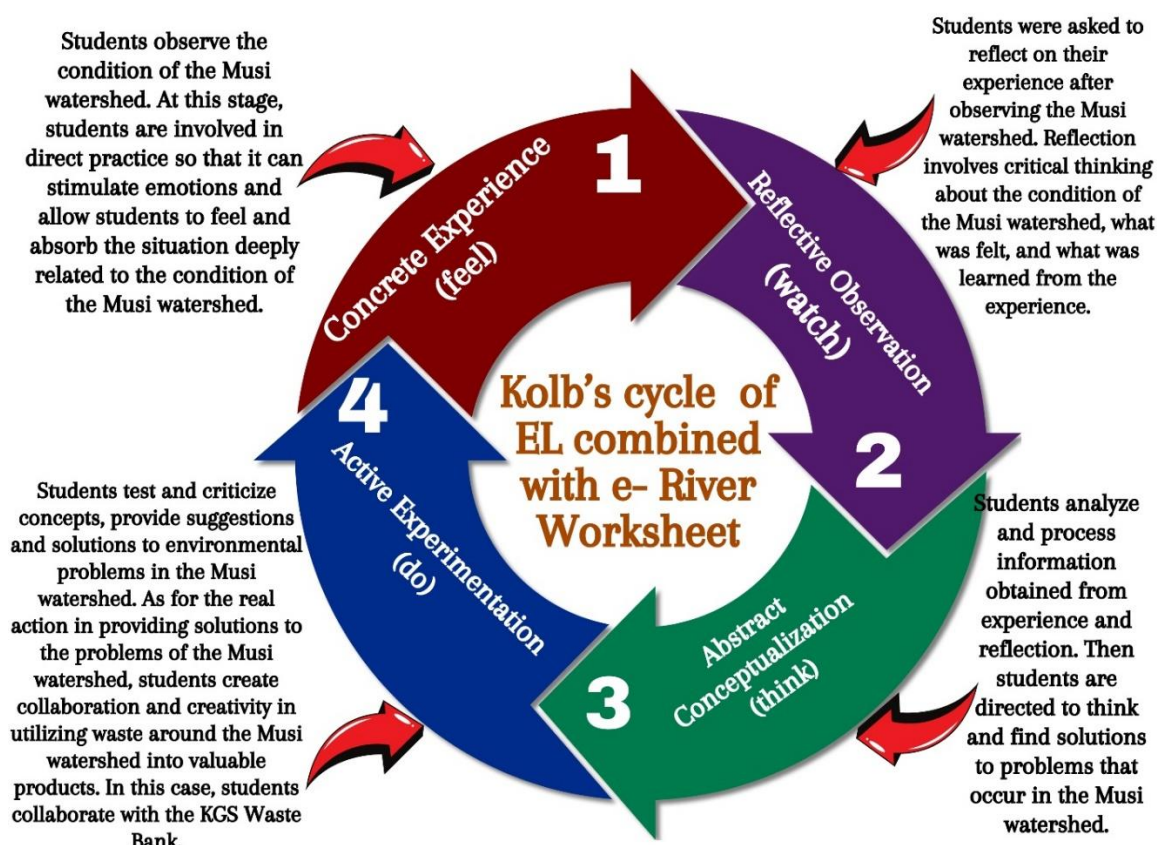


Figure 2. Stages of implementing EL learning combined with e-river worksheets

EL is implemented in Kolb's four stages (Figure 2), involving students in learning about the environment and developing environmental care attitudes (Hung et al., 2023) as well as fostering student creativity (Lin & Chang, 2024). Implementing the e-River Worksheet within the EL model is carried out by integrating each stage of Kolb's learning cycle, promoting a more structured, reflective, and meaningful learning process. This approach aligns with the components of the e-River Worksheet: experience, reflection, information, values, expression, and revision.

Students were actively engaged in using the experiential learning model throughout the learning process. The activity involved students bringing e-river worksheets while walking and observing conditions around the school environment towards the river. The activity aimed for students to gain concrete experience of environmental problems around the river and then reflect, criticize, and provide creative solutions to environmental issues around the river. The teacher facilitated learning activities by guiding students through observation, questions and answers, and discussions about the dynamics of the hydrosphere and its impact on human life.

3.2. Participants

The population in this study consisted of all Class X students at SMA Negeri 9 Palembang City, totaling 327 students. The sampling technique employed was purposive sampling, aimed at selecting participants who were considered most relevant to the research's aims and focus (Campbell et al., 2020). We divided this technique into two groups: the experimental class (X3), comprising 35 students, and the control class (X1), also comprising 35 students. Both groups learned the same subject but with different approaches. The experimental group was taught using the EL model integrated with e-River Worksheets, while the control group received conventional learning without intervention.

3.3. Instrument

A descriptive test was used to determine students' creativity (Torrance Test of Creative Thinking) (Humble et al., 2018). Meanwhile, to measure environmental care attitude based on the new ecological paradigm (NEP) scale. The test used four indicators to measure creativity: fluency (Rubenstein et al., 2022; Segundo-Marcos et al., 2023), flexibility (Jankowska & Karwowski, 2025), originality (Guzik et al., 2023), and elaboration (Xia et al., 2025). Meanwhile, the indicators of environmental attitudes consisted of five aspects: (1) limits to growth to determine human knowledge of environmental attitudes; (2) anti-anthropocentrism to determine the role of humans in utilizing natural resources and the environment; (3) balance of nature to determine human behavior in balancing the sustainability of life; (4) anti-exemptionalism to determine the sense of responsibility in managing the environment and utilizing it; and (5) eco-crisis to determine behavior in preventing environmental damage (R. E. Dunlap et al., 2000; Madeira et al., 2025)

3.4. Analysis of Data

Before the instrument was used, a Pearson correlation validity test and a Cronbach alpha reliability test were first conducted on different classes (XI2) with 29 students as respondents. The aim was to ensure that the instrument measures the intended construct. This process aims to avoid data contamination, reduce risk bias, and provide an opportunity to turn on and revise the instrument before it is applied to the main study.

After the instrument was declared valid and reliable, a pretest was conducted on the experimental and control classes. During the learning process, the experimental class received treatment in the form of EL combined with the e-river worksheet model, and a post-test was administered at the end of the treatment. The pre-test and post-test results were then analyzed using the average difference test with the independent t-statistical test. Before performing the t-test analysis, an immersion test was conducted, consisting of two tests: the normality test (Kolmogorov-Smirnov) and the homogeneity test using the Levene test.

4. Results

This study examined the impact of the experiential learning model, combined with e-river worksheets, on students' creativity and environmental awareness. Two research instruments were adapted for this study: the Torrance Test of Creative Thinking and the New Ecological Paradigm (NEP). The results of the NEP validity ($P = 0.615$; $P > 0.05$), while the creativity validity ($P = 0.698$; $P > 0.05$). For the NEP reliability ($\alpha = 0.879$; $\alpha > 0.6$), while the creativity reliability ($\alpha = 0.879$; $\alpha > 0.6$). The results show that the data is valid and reliable. Furthermore, a descriptive statistical test was conducted to examine the distribution of the data. The Kolmogorov-Smirnov test was used to assess the normality of the data with a sample size of 70 students. The results showed a creativity normality test of $0.083 > 0.05$ and an environmental concern attitude of $0.224 > 0.05$. It was proven that the data was normally distributed. Then, the homogeneity test was carried out using the Levene test. The results of the homogeneity test of creativity were $0.718 > 0.05$, and environmental care attitude was $0.945 > 0.05$. The results show that creativity and environmental care attitudes are homogeneous. Data were analyzed using an independent t-test, with a confidence level of 95%. Samples were tested to determine experiential learning combined with e-river worksheets on creativity and environmental care attitudes.

4.1. Creativity

To determine whether there is a significant difference between the pre-test and post-test, four creativity indicators were tested: fluency, flexibility, originality, and elaboration. A t-test measurement was carried out to determine the effect of experiential learning combined with an e-

river worksheet on creativity by conducting a pre-test and post-test. Table 3 illustrates the difference in students' creativity scores between the control and experimental classes.

Table 1. Student Creativity t-Test

Poin	Group	N	$\bar{X}$	SD	t-test		
					t	df	Sig
Creativity	Experiment	35	26.57	2.01	17.93	68	0.00
	Control	35	16.20	2.76			

The study's results indicated a significance level of less than 0.05, demonstrating that the combination of experiential learning (EL) and e-river worksheets had a significant impact on student creativity. The following image depicts student learning activities that involve the application of EL combined with e-river worksheets.



Figure 3. Students observe the condition of the Musi River Basin

The reflective observation stage invites students to discuss their experiences in groups and reflect on what they have learned. In this case, students observe the situation and conditions of the school environment from various perspectives. At this stage, students rely on patience and objectivity. The learning process at the abstract conceptualization stage involves using theory, logic, and ideas to solve problems. Furthermore, at the active experimentation stage, students criticize and provide suggestions and creative solutions for environmental problems in the Musi Watershed. Furthermore, to find out the comparison of the pre-test, post-test, and each indicator in the control class and the experimental class is shown in Figure 4 below:

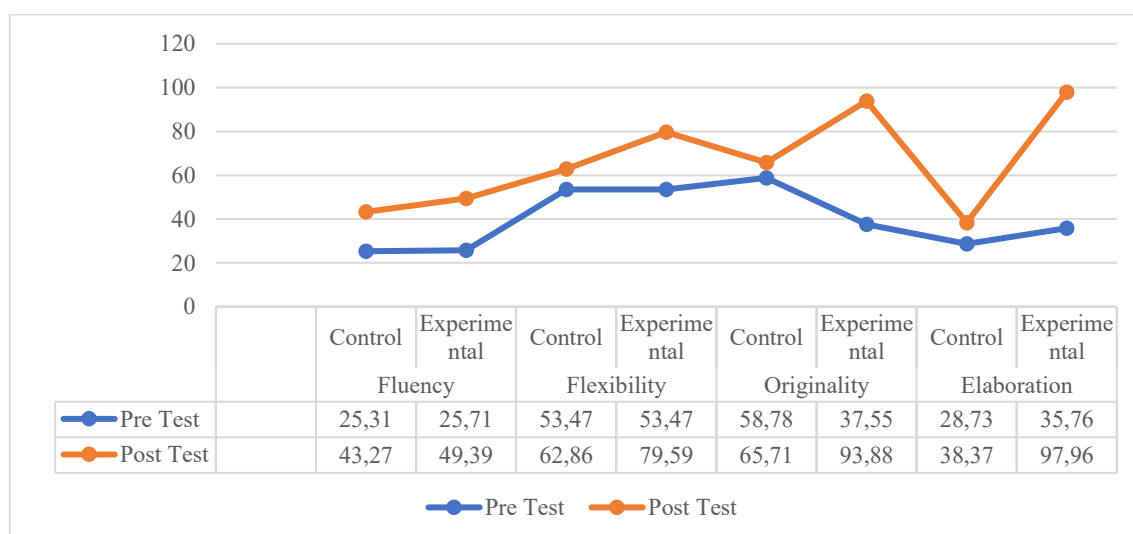


Figure 4. Pre-Test Post-Test Comparison of Student Creativity

Of the four indicators of creativity, elaboration experienced a very significant increase. The fluency indicator shows that the experimental class had a better average increase than the control class. The increase in the experimental class was 92.10% of the 35 students, while the increase in the control class was only 70.96% of the 35 students. Fluency in the experimental class is the maximum value obtained. However, the fluency increase in the control class was 42.86%, while the experimental class excelled with a higher average value of 25.71%, compared to the control class's average of 23.31%. The increase in the fluency indicator in the experimental class was influenced by a learning environment designed to encourage the free exploration of ideas without pressure, allowing students to express their ideas more freely. Additionally, applying the experiential learning model offers students opportunities to develop their creative thinking skills. The presence of e-river worksheets as an innovative learning medium also strengthens this positive impact by creating a learning atmosphere conducive to developing student creativity. The flexibility indicator in the control and experimental classes had the same value, 53.47%. However, after being given the experiential learning model combined with e-river worksheets, there was a higher difference in the experimental class, namely 16.73%.

The minimum score in the control class was 42.86%, and the experimental class was 28.57% during the pre-test, while the post-test results were 42.85% in the control class and 57.16% in the experimental class. These results indicate that the method applied in the experimental class can improve the development of students' thinking flexibility more effectively. Experiential learning combined with e-river worksheets involves problem-solving-based learning strategies, interactive discussions, and assignments that require cross-disciplinary thinking. The average value of the originality indicator increased significantly in the experimental class, namely 150.01%. The difference in pre-test and post-test results in the control class was 6.93%, while in the experimental class it was 56.32%. This increase indicates that the learning approach in the experimental class has been successful in creating a learning environment that encourages students to think creatively and innovatively. The experiential learning model combined with the e-river worksheet involves project-based learning techniques, creative exploration, and media and technology that stimulate divergent thinking. In addition, the support of a learning atmosphere that values new ideas and the opportunity to explore concepts independently also contributes to the development of student originality.

Furthermore, in the elaboration indicator, the difference between the pre-test and post-test in the control class was only 9.63%, and in the experimental class, it was 62.2%. The elaboration indicator increased due to the stimulation of learning that encouraged students to develop ideas in depth and detail. In addition, the presence of e-river worksheets requires detailed idea development accompanied by constructive guidance and feedback.

4.2. Environmental Care Attitude

To determine whether there is a significant difference between the pre-test and post-test, the data were analyzed using five indicators of environmental care attitudes: Limits to Growth, Anti-anthropocentrism, Balance of Nature, Anti-exemptionalism, and Eco-Crisis. A t-test was used to determine the effect of experiential learning combined with e-river worksheets on environmental care attitudes. The results are presented in Table 4.

Table 2. T-test of environmental concern attitude

Point	Group	N	$\bar{X}$	SD	t-test		
					t	df	Sig
Environmental Care Attitude	Experiment	35	60.03	4.92	-2.53	68	0.13
	Control	35	62.83	4.28			

The results of the t-test showed a significance level of less than 0.05. This finding demonstrates a significant influence of EL combined with e-river worksheets on attitudes toward environmental care. The results indicate that combining experiential learning models with e-river worksheets can have a positive impact on awareness and concern for environmental issues. This intervention has succeeded in showing the enormous potential of integrating e-river worksheets in supporting contextual learning approaches.



Figure 5. Students utilize water hyacinth waste

In the picture above, students collaborate with a waste bank to utilize water hyacinth waste to make valuable products. This activity applies to the active experimentation stage, where students carry out projects related to environmental sustainability.

With EL combined with e-river worksheets, students receive a more meaningful learning experience and are guided to internalize environmental values through engaging, direct learning activities. This finding significantly contributes to environmental literacy and underscores the importance of implementing learning models to cultivate a generation that prioritizes environmental sustainability. Furthermore, the following picture presents the increase in students' environmental care attitudes for each indicator:

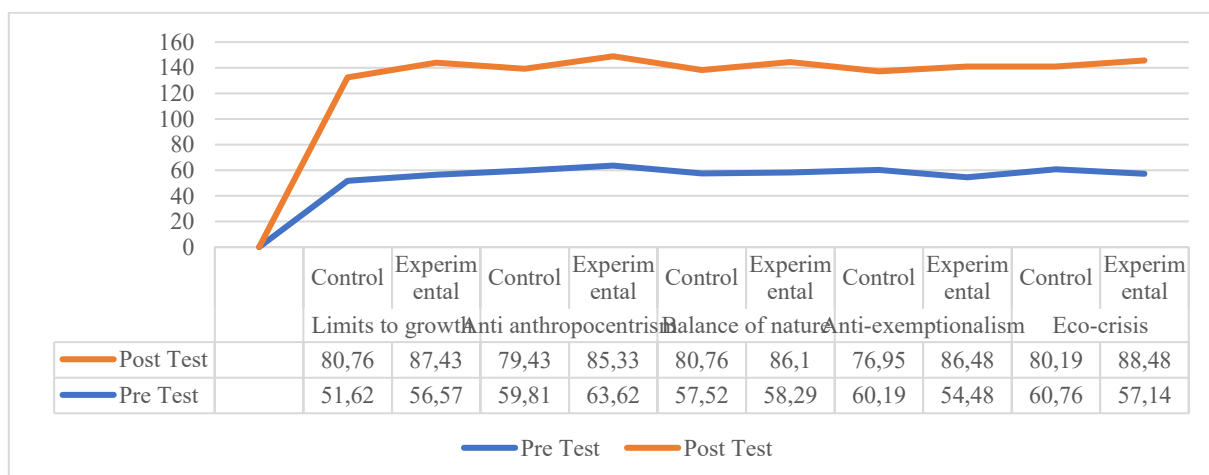


Figure 6. Pre-Test Post-Comparison of Test Environmental Care Attitudes

Overall, the environmental awareness of students in the experimental class increased after learning treatments with the EL model and e-river worksheets compared to the control class. The increase in scores for the limits to growth indicator was 54.55% before and after the EL learning treatment combined with e-river worksheets. This improvement is because students needed help understanding how to utilize natural resources properly before being given the treatment. For instance, the management of used goods, including plastic, paper, and water hyacinth waste, is dispersed throughout the Musi Watershed near the school. The anti-anthropocentrism indicator showed the lowest increase in score, namely 34.12%, with a minimum value of 40% and a maximum of 80%. The balance of nature indicator experienced an increase in score of 47.71%, anti-exemptionalism 58.74% and eco-crisis 54.85%, with the difference between the pre-test and post-test being 27.81%, 32%, and 31.34%, respectively. Thus, of the five indicators of environmental concern, the indicator with the lowest score is anti-anthropocentrism, and the indicator with the highest score is anti-exemptionalism.

5. Discussion

5.1. *The influence of EL on student creativity*

The results of this study indicate that integrating EL with e-river worksheets significantly positively affects students' creativity. This finding aligns with research (Lin & Chang, 2024; Zhou, 2024). Students who engage in structured learning activities from e-river worksheets show higher levels of creative thinking than those who experience conventional learning. This finding supports the idea from (A. Y. Kolb & Kolb, 2017) that the EL learning process, which includes being actively involved, reflecting, thinking about concepts, and trying things out, is crucial for helping students develop their creativity.

E-river worksheets enhance creativity by offering a structured mechanism for students to systematically document and reflect on their learning experiences. The Experience and Reflection components encourage students to critically analyze their activities, while Information and Values help bridge concrete experiences with abstract ideas. Expression and revision further stimulate students to develop original ideas and solutions based on their reflection and theoretical understanding. This comprehensive cycle strengthens cognitive engagement and fosters an environment conducive to divergent and innovative thinking. In addition, EL and e-river worksheets encourage students to find creative solutions to solving environmental problems (Martin, 2024). Increased creativity is influenced by ecological stimulation (C. Gu et al., 2020; Meusburger, 2009).

This stimulation is obtained through the development of creativity that occurs through the stages of the EL learning cycle, namely concrete experience, reflective observation, abstract conceptualization, and active experimentation. The structured guidance provided by e-river worksheets can guide students in field observations and explorations (Behrendt & Franklin, 2014), making learning more structured and efficient. EL, combined with e-river worksheets, is designed with interactive river content that can attract students' interest and increase their participation in the learning process. EL, combined with e-river worksheets, consists of instructions and learning steps to build students' knowledge. E-river worksheets also allow students to explore various river-related concepts and ideas, thus triggering their creativity in solving environmental problems and developing innovations.

In the EL learning model combined with e-river worksheets, the direct learning process and reflection will increase knowledge (Lepp et al., 2023), develop skills (Babu et al., 2020), and develop students' values and creative capacity in contributing to the environment (Richardson & Mishra, 2018). Students' ability to propose innovative solutions tailored to local areas regarding water pollution and river degradation reflects this. These results align with previous research, which shows that experiential and project-based learning can stimulate students' divergent (De Jong & Dexter,

2025; Kaufman, 2018). Unlike conventional methods that rely on abstract instruction, the use of e-River Worksheets allows students to observe real-world challenges and directly apply their knowledge in a meaningful context.

By observing and experiencing the river firsthand, students will develop a deeper connection to the river and a greater sense of responsibility to protect it, promoting positive change and environmental sustainability, especially in the Musi River Watershed. By encouraging students to think critically at every step of the learning process, e-River Worksheets boost their creativity and offer a clear way to include hands-on learning in traditional classrooms. Environmental problems in the future tend to be complex and dynamic, making individual creativity essential for designing innovative, adaptive, and contextual solutions, such as encouraging environmentally friendly innovation and a green economy (Chen & Liu, 2025; Gyamfi et al., 2023; Kafeel et al., 2025; Nuryanto et al., 2024; Truc, 2024; Wang et al., 2022) to prepare future generations and leaders who are not only knowledgeable but also involved in protecting the environment.

5.2. The Influence of EL on Environmental Care Attitude

The EL model is recognized as a practical approach to engaging students in environmental education (Adib, 2024; J. Liu et al., 2024; Martin, 2024). Data analysis showed a significant difference in students' attitudes toward environmental awareness after implementing EL combined with e-river worksheets. This is evidenced by the pretest and post-test results, which showed an increase in the scores for each indicator of environmental awareness attitudes. Students' awareness increased after they saw firsthand the condition of the Musi Watershed. These findings support the idea of experiential learning, which suggests that engaging deeply and thoughtfully with real-world problems helps people think better and change their feelings and behaviors (D. A. Kolb, 1984).

The reflection process on the causes and impacts of stagnant waste in the Musi Watershed made students rethink their environmental indifference. The experiential learning (EL) model allows students to develop creativity and environmental awareness attitudes by connecting learning materials and real situations. EL guides students to improve environmental literacy and management (Bloom & Fuentes, 2019; Lee & Perdana, 2023). So this model has an impact on increasing environmental awareness (Gaffney & O'Neil, 2019; Spörk et al., 2023) and student creativity (Dorland, 2024).

Furthermore, this model can improve academic achievement (Ranken et al., 2024) and the development of social and emotional skills (Kumari & Rao, 2024). Experience is important for students in the 21st century as it encourages a deep and meaningful understanding of learning (Jeet & Pant, 2023). Experiential learning is one of the foundations for developing knowledge and values about environmental issues (J. Liu et al., 2024). The growth of environmental awareness is influenced by students' knowledge (Cao & Jian, 2024; Lupoae et al., 2025). Knowledge encourages students to take action to address current and future environmental problems (Fields et al., 2023; Jasim et al., 2025; Tolppanen et al., 2022). Direct learning in nature allows students to deepen their understanding of environmental problems and the effects of human activities on ecosystems. Previous research conducted by Moseley et al. (2020) demonstrated that when students participate actively in activities, they tend to remember their experiences more easily. So that it has a maximum impact on students, for this reason, educators need to design explicit learning that emphasizes the relationship between humans and the environment through specific and integrated learning experiences at each stage of learning. Students also become facilitators in protecting the environment and can share their learning experiences with their families and communities (Kay & Brogan, 2024). In addition to knowledge, awareness and responsibility increase students' environmental concerns (Kollmuss & Agyeman, 2002). This awareness and responsibility are obtained at the reflective observation stage. The EL learning process necessitates that students exercise initiative, make decisions, and assume

responsibility for their own learning. Combining the EL model with e-river worksheets has been shown to significantly influence students' environmental awareness more than without using the EL model combined with e-river worksheets.

Combining river-based e-river worksheets with experiential learning in river environments can provide an interesting framework for environmental education. EL combined with e-river worksheets enhances the learning experience by focusing on relevant local environmental issues, engaging students, and empowering them to become active stewards of their environment (Miao & Nduneseokwu, 2024). Students who learn with the EL model and e-river worksheets gain firsthand experience and a deeper understanding of the importance of keeping rivers clean. This aligns with research (Levy & Mensah, 2021). When this experience is combined with e-river worksheets that provide additional information and supporting activities, students can deepen their understanding and develop environmental awareness more effectively. This combination fosters holistic and meaningful learning, which can lead to students developing a greater concern for the environment (Muñoz-García et al., 2022; Spsychalski, 2023). These results support the eco-pedagogical theory (Kahn, 2010; Kopnina & Bedford, 2024; Manteaw & Enu, 2025; Misiaszek, 2020, 2023), which advocates for the integration of direct natural interactions and critical reflection to foster sustainability values. The combination of the EL learning cycle and e-river worksheets, tailored to the local ecosystem, provides pedagogical value. This research contributes to the growing discourse on education for sustainable development. Additionally, this study adds to the relatively limited body of research on river-based environmental education in Southeast Asia by highlighting the potential for integrating local ecology in formal educational settings.

6. Conclusion

The conclusion of this study suggests that the use of the EL learning model, combined with the e-river worksheet, has a positive impact on enhancing students' creativity and environmental awareness. Creativity increases as a result of environmental stimulation and learning experiences, while personal beliefs enhance environmental awareness and moral understanding regarding the importance of preserving the environment. Environmental stimulation, learning experiences, knowledge, and responsibility for the environment can be developed with the EL learning model combined with the e-river worksheet. This method enriches students' learning experiences through direct interaction with the natural environment and encourages their active involvement in the learning process. As a result, students show increased creativity in solving problems and a more caring and responsible attitude toward the environment.

7. Suggestion

We propose several suggestions for future research and educational practice based on the findings of this study. First, educators should expand the integration of experiential learning with structured tools such as e-River Worksheets to various subjects to evaluate their broader applicability. Second, future studies should employ longitudinal designs to investigate the sustainability of improvements in creativity and environmental attitudes over time, as short-term studies may not fully capture the lasting behavioral changes. Third, combining multiple data collection methods, such as observational studies, portfolio assessments, and peer evaluations, is suggested to enrich the understanding of students' cognitive and affective development. Finally, it is important to look into how factors like students' motivation, cultural background, and teaching style can affect the success of hands-on and reflective learning programs.

Declarations

Author Contributions. Siti Asiyah: was involved in the conceptualization of the study, manuscript preparation, data analysis and interpretation, and funding acquisition. Sumarmi provided critical

revisions, contributed to the study design, supervised the research process, and granted final approval of the manuscript. I Komang Astina: participated in critical revisions, study design, and supervision. Sugeng Utaya: contributed through critical revisions, study design, and technical assistance. Syamsul Bachri: was engaged in critical revisions and contributed to the study design. All authors have read and approved the final version of the manuscript for publication.

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Ethical Approval. This research was conducted by the ethical standards governing the use of human participants. Ethical approval for this study was obtained from the Research Ethics Committee of State Senior High School 9, Palembang City, on February 22, 2024, with approval number 070/378/SMA.N 09/Disdik.SS/2024. All participants featured in photographs provided written informed consent for their images to be included in the publication. For participants under the age of 18, both written parental consent and participant assent were obtained before participation and image use. Personal data and visual materials were handled with strict confidentiality and used solely for academic purposes as outlined in the approved protocol.

Data Availability Statement. The data used in this study will be available upon request from the corresponding author.

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