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### Eco-literacy in the digital age: Comparing student comprehension with AI capabilities

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#### **ABSTRACT**

#### **Keywords**

*Artificial Intelligence, Educational Tools, Text Comprehension, Eco-literacy, Text Writing*

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*The role of AI in eco-literacy education is crucial in today's technological era. Students increasingly engage with digital texts, such as fiction, enhancing their understanding of eco-literacy. This study compares the eco-literacy skills of university students and AI to evaluate their effectiveness in environmental education. Participants included 199 students from Makassar State University and Timor University in Indonesia and ten web-based AI chatbots running various large language models. Instruments included a 20-item multiple-choice test for input eco-literacy and a short story synopsis task, "Pohon Larangan di Bengayaoan" (Prohibited Tree in Bengayaoan) for output eco-literacy, distributed via Google Forms. The study applied independent sample t-test analysis and Yuen's test for robustness using Jamovi 2.4.8.0 software. Results showed no significant gender differences in students' eco-literacy but significant differences between universities, with Makassar State University students performing better. AI outperformed students, highlighting AI's potential in eco-literacy education and the need for curriculum enhancement in universities. Future research should involve broader samples and comprehensive assessment methods.*

#### **Introduction**

Eco-literacy, the ability to understand and make the right decisions about the environment, is becoming increasingly important in the era of climate change and environmental degradation in the era of globalization. As the next generation, students must have a deep understanding of eco-literacy. For instance, enhancing the climate literacy of local leaders is crucial for effectively addressing the escalating challenges posed by the climate crisis (Johns et al., 2024).

However, as AI capabilities become more sophisticated and widely used in education, it is essential to evaluate how AI can match or surpass human understanding in eco-literacy (Juanda & Afandi, 2024; Suwandi et al., 2024). Potentially ChatGPT, the Freirean perspective suggests its integration serves the goals of equality, social justice, and the development of critical consciousness rather than just the efficiency aspect (Alm & Watanabe, 2023). Furthermore, meaning-making involves responding to the capabilities and constraints present in the environment (Campbell & Olteanu, 2024).

The study of eco-literacy understanding between students and AI has been conducted in several previous studies (Dai, 2024; Geriguis, 2021; Juanda & Afandi, 2024; Rantung et al., 2023; Schoeffler et al., 2021; Sigit et al., 2023; Zhang et al., 2024; Zhao et al., 2022). Geriguis (2021) found that teaching methods that link the reading of "Ethan Frome" with its paratext can increase students' awareness of the novel's ecocritical significance and engagement with disability issues, thus promoting ecological literacy through bioregional theory and economic paradigms. Schoeffler et al. (2021) found that people perceived automated decision systems to be fairer than human decision-makers, especially among those with higher AI literacy, while those with low AI literacy showed no significant difference in their perceptions. In addition, Zhao et al. (2022) found that teachers' ability to apply artificial intelligence has a significant positive effect on understanding, evaluation, and ethics related to artificial intelligence, making it essential for the government to improve teachers' artificial intelligence literacy through diverse curricula and training. Rantung et al. (2023) showed that song lyrics can be used in language teaching to improve students' ecological literacy while developing their language skills, with song lyrics that address ecological issues such as deforestation and biodiversity loss and encourage critical and creative thinking.

In addition, Sigit et al. (2023) found a positive relationship between ecological literacy and students' creative thinking skills, with the mean scores of ecological literacy and creative thinking skills of female students higher than those of male students. Dai (2024) found that the experimental group showed significant improvements in AI knowledge, skills, ethical awareness, increased self-confidence, intrinsic motivation, and decreased learning anxiety. Juanda and Afandi (2024) found that ChatGPT was significantly better at reprocessing text than university students, except in the Multiple Choice Test Score (MCT\_Score) aspect, where Makassar State University students were slightly superior. This finding suggests the need for better educational curriculum development with artificial intelligence technology in Indonesia. Finally, Zhang et al. (2024) proved that the AI literacy curriculum taught by teachers in the classroom significantly improved the understanding of AI concepts, positive attitudes towards AI, and readiness to face an AI-based future in experimental group students compared to the comparison group.

Based on some of the research previously mentioned, the study of the eco-literacy of college students with AI needs to be adequately explored. The novelty of this research lies in comparing students' and AIs' understanding of eco-literacy in short story literary texts. Under the guidance of the researcher, this study sets out to compare the eco-literacy understanding of students and

various AI chatbots. The researcher has formulated the following hypotheses, which will serve as the basis for drawing conclusions.

**H<sub>1a</sub>:** There is a significant difference in eco-literacy skills between students based on gender groups.

**H<sub>1b</sub>:** There is a significant difference in eco-literacy skills between students based on university group.

**H<sub>2</sub>:** AIs have a better understanding of eco-literacy than university students.

This research contributes significantly to several academic, technological, and practical aspects. Academically, it enriches the literature on the role of AI in education, particularly in the context of eco-literacy, by providing empirical data comparing human and AI understanding. It opens up further discussion on the effectiveness and limitations of AI technology in replacing or complementing traditional learning processes. The results of this study can be used by educators and technology developers to design more effective curricula and learning tools by combining the potential of humans with AI. Thus, this research can improve the quality of eco-literacy education, producing a generation aware and responsible for the environment as technology develops.

## Literature Review

### *Eco-literacy*

Eco-literacy, or ecological literacy, refers to an individual's ability to understand natural systems and the complex interactions between biological and physical components in ecosystems. Eco-literacy includes knowledge of ecological principles, awareness of environmental issues, and the skills to apply this knowledge to make sustainable decisions (Rafi & Fox, 2024, p. 1). In an educational context, eco-literacy aims to equip students with a deep understanding of how human actions affect the environment and how they contribute to preserving and restoring ecosystems (Juanda, Afandi, et al., 2024; Read, 2024).

Concerning literature, eco-literacy can be strengthened through literary works that raise environmental themes. Literature can detail the emotions and imagination of readers, thus increasing awareness and empathy toward ecological issues (Hermes & Rimanoczy, 2018, p. 460; Juanda & Azis, 2023). Literary works that explore human relationships with nature, environmental degradation, and conservation efforts can enrich the understanding of eco-literacy by presenting a deep and reflective perspective (Fennell, 2022; Juanda, Djumingin, et al., 2024). Literature is a medium for effectively conveying environmental messages, inspiring action, and building collective awareness of the importance of maintaining ecosystem balance (Dubourg et al., 2024, p. 1). Research indicates that secondary school students learning a foreign language tend to be less engaged with foreign-language literary texts, which is associated with a lower appreciation for them than translations in their native language (Ramachers & Willems, 2024, p. 1). Thus, integrating eco-literacy in literature can be a powerful tool in environmental education, encouraging readers to understand better and appreciate nature and take action to protect the surrounding nature from environmental damage.

### *Ecocritic*

Ecocriticism, or ecological criticism, is an interdisciplinary approach to literary studies that focuses on the relationship between literary texts and the natural environment. As a field of study, ecocriticism explores how literary works represent nature, construct environmental concepts, and depict human interactions with ecosystems. It also assesses how literary texts influence readers' perceptions and attitudes towards environmental issues (Fadli, 2022). Garrard (2012) classifies environmental phenomena into six parts, namely pollution, wilderness, disaster, animals, dwelling, and earth. Ecocriticism aims to reveal the ecological ideology implied in texts and explore how literature raises environmental awareness and action (Mohammed, 2024; Rawlins & Hooper, 2023).

Ecocriticism involves the critical analysis of representations of nature in various literary genres, including poetry, prose, and drama. Mireille Gagné (Isle-aux-Grues, 1982), a prominent writer in the Quebec literary scene, published *Bois de fer* in 2022, a collection of poetic fragments narrated by a tree-woman. Gagné defines this work as an ecological and critical text that defends the hope of new life, saving it from extinction (Aguilar Miró, 2023). The environmental problem depicted in the anime *Weathering With You* is the problem of extreme climate change that results in various negative impacts such as falling air temperatures, erratic seasonal changes, economic losses, and others (Mulyadi, 2022). Ecocritics often examine how literary works reflect environmental change, ecological degradation, and climate crisis through fictional texts (Rogers & Hamilton-McKenna, 2023, p. 605). They are interested in literary texts that express ecocentric values and place nature at the center of attention by recognizing the intrinsic rights of the environment (Sultoni et al., 2023). Moreover, ecocriticism highlights the role of literature in inspiring environmental movements and shaping ecological policies. As such, ecocriticism serves as a literary analysis tool and a means of environmental advocacy that seeks to promote ecological sustainability and justice.

### *AI Implementation in Environment Education*

Implementing artificial intelligence (AI) in environmental education offers various opportunities to improve the effectiveness and accessibility of ecological learning. AI is used to develop interactive and personalized learning tools, such as virtual tutors, environmental simulations, and educational games (Sun et al., 2021). For example, AI-driven ecosystem simulations can provide an immersive learning experience by allowing students to see the impact of various human actions on the environment in real time. Psychological competence is essential in the context of widespread change through AI systems (Carolus et al., 2023, p. 1). Personal factors represent AI proficiencies in technical comprehension, critical evaluation, and practical implementation (Laupichler et al., 2023). In addition, AI technologies analyze students' learning patterns and provide customized feedback, helping them understand better ecological concepts and correct ecological errors effectively (Gleissner, 2021; Mrugalski, 2021; Zvereva, 2020).

AI supports environmental education by providing data and analysis of global ecological issues. AI platforms collect, process, and visualize environmental data from various sources, such as climate sensors, satellite images, and scientific reports, to provide accurate and up-to-

date insights to students. Individuals with higher motivation and skills using AI technologies tend to have an enjoyable experience (Celik, 2023). With these tools, students learn to interpret environmental data, recognize trends, and understand the implications of ecological change. In addition, AI helps identify local and global environmental issues, thus encouraging students to engage in sustainable conservation projects. Implementing AI literacy in ECD provides a reference for educators and researchers to design interventions by engaging them in learning using AI (Su et al., 2023). Thus, implementing AI in environmental education improves the quality of learning and inspires concrete actions to protect and conserve nature.

## Method

### *Participants*

This study involved two types of participants: human and non-human. Human participants consisted of 199 students drawn from two universities, namely Makassar State University and Timor University. The two universities were chosen because they represent significant geographical and cultural diversity, allowing for richer comparative analysis regarding students' eco-literacy understanding. Demographic details are presented in Table 1; most participants were female (83.9%) and between 18 and 20 years old (78.4%).

**Table 1**

### *Demographics Data of Human Participants (Students)*

| Demographics                 | n   | Percentage | Cumulative |
|------------------------------|-----|------------|------------|
| Gender                       |     |            |            |
| Male                         | 32  | 16.1%      | 16.1%      |
| Female                       | 167 | 83.9%      | 100%       |
| University                   |     |            |            |
| State University of Makassar | 132 | 66.3%      | 66.3%      |
| Timor University             | 67  | 33.7%      | 100%       |
| Age                          |     |            |            |
| Less than 18 y/o             | 1   | 0.5%       | 0.5%       |
| 18 – 20 y/o                  | 156 | 78.4%      | 78.9%      |
| 21 – 23 y/o                  | 36  | 18.1%      | 97.0%      |
| 24 – 26 y/o                  | 6   | 3.0%       | 100%       |

The non-human participants are the various AI chatbots used in this study, summarized in Table 2. These AI chatbots include ChatGPT from OpenAI, which uses the GPT-4 model; Google Gemini from Google DeepMind; Microsoft Copilot, which also uses GPT-4; and others such as Perplexity AI, Claude AI, Chatsonic, HuggingChat, YouChat, DeftGPT, and DeepAI which use various large language models from different developers. These two groups of participants were compared in terms of eco-literacy comprehension to evaluate the effectiveness and limitations of each in the context of environmental education.

**Table 2**  
*Involved AI and Language Models*

| AI                | Language Model    | Developer       |
|-------------------|-------------------|-----------------|
| ChatGPT           | GPT-4             | OpenAI          |
| Google Gemini     | Gemini            | Google DeepMind |
| Microsoft Copilot | GPT-4             | Microsoft       |
| Perplexity AI     | GPT-3.5           | Perplexity      |
| Claude AI         | GPT               | Anthropic       |
| Chatsonic         | GPT-3.5           | Writesonic      |
| HuggingChat       | Cohere Command R+ | Hugging Face    |
| YouChat           | Llama 3           | You.com         |
| DeftGPT           | GPT-3.5           | Deft            |
| DeepAI            | M-BERT            | Deep AI, Inc.   |

### *Instrumentation and Data Collection*

The instrument used in this study was a two-part test to measure students' eco-literacy skills. The first part was a multiple-choice test of 20 questions designed to assess input eco-literacy understanding. The second part was a story synopsis writing assignment, which was used to assess output eco-literacy skills. The short story used in this assignment was "*Pohon Larangan di Bengayoan*" (Prohibited Tree in Bengayoan) by Nafi'ah Al-Ma'rab, published in Kompas newspaper and available online at ruangsastra.com. The instrument was distributed to participants through Google Forms, allowing efficient and organized data collection.

### *Data Diagnostics*

Ten data duplicates and 39 outliers were removed to avoid violating the assumption test. The duplicate data detected were entries 015, 154, 012, 029, 030, 177, 068, 067, 171, 168. The basis for determining outliers in this data is an extreme deviation from the mean and standard deviation. A data is categorized as an outlier if its observation value is smaller than  $\mu - 3\sigma$  or larger than  $\mu + 3\sigma$ . The total number of data outliers for the eco\_input variable is 8, for the eco\_output variable is 25, and for the overall eco-literacy variable is 6. The total number of data outliers identified in this study is 39. The data outliers that have been traced are presented in Table 3 below.

This diagnosis of homogeneity and normality of data distribution was conducted to ensure the validity of the statistical analysis used. Based on Table 5, the homogeneity test using Levene's statistics showed that the eco-literacy variable was homogeneous for groups based on gender ( $p = 0.373$ ) and participant type (student and AI) ( $p = 0.533$ ) but not homogeneous for groups based on the university ( $p = 0.023$ ). It means Welch's t statistic is more appropriate for analyzing differences in eco-literacy ability by university group.

**Table 3**  
*Tracking Outliers Derived from Extreme Data*

| Dependent Variables | Grouping Variable Data Outliers                                                                    |                                                                                                                                  |                                        |                                                                                                                                  |
|---------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
|                     | Type                                                                                               | Gender                                                                                                                           | University                             | Age                                                                                                                              |
| Eco_input           | 208, 091, 179                                                                                      | 208, 091, 179                                                                                                                    | 232, 074, 230, 192, 218                | 074, 192, 208, 230                                                                                                               |
| Eco_ouput           | 003, 001, 006, 023, 007, 014, 167, 016, 123, 117, 103, 070, 134, 167, 122, 166, 236, 163, 208, 192 | 004, 006, 023, 017, 025, 003, 007, 008, 167, 016, 014, 001, 123, 103, 117, 070, 122, 134, 166, 236, 169, 163, 208, 192, 163, 192 | 127, 123, 134, 070, 236, 208, 192      | 003, 024, 009, 167, 014, 018, 026, 107, 034, 070, 103, 134, 236, 169, 163, 208, 192, 001, 007, 011, 016, 100, 025, 017, 175, 166 |
| Eco-literacy        | 070, 163, 192, 208                                                                                 | 166, 070, 175, 163, 192, 208                                                                                                     | 074, 232, 134, 123, 127, 070, 208, 192 | 163, 070, 208, 192                                                                                                               |

Meanwhile, Table 4 shows the results of the normality test using Kolmogorov-Smirnov statistics which shows that the eco-literacy data is normally distributed in all groups based on gender ( $p = 0.299$ ), university ( $p = 0.480$ ) and participant type ( $p = 0.110$ ).

**Table 4**  
*Homogeneity Test for Independent Samples T-test Analysis*

| Grouping variables                                        | Homogeneity test (Levene's) |    |     |       | Normality test (Kolmogorov-Smirnov) |       |
|-----------------------------------------------------------|-----------------------------|----|-----|-------|-------------------------------------|-------|
|                                                           | F                           | df | df2 | p     | Statistics                          | p     |
| Gender (male & female)                                    | 0.798                       | 1  | 197 | 0.373 | 0.0690                              | 0.299 |
| University (Makassar State University & Timor University) | 5.24                        | 1  | 197 | 0.023 | 0.0596                              | 0.480 |
| Type (Students & AI)                                      | 0.390                       | 1  | 207 | 0.533 | 0.0833                              | 0.110 |

*Note. Dependent variable: Eco-literacy*

*Analytic Strategy*

This study applied parametric analysis to test the hypothesis. The analysis used was an independent sample t-test conducted in two sessions. The first session compared the eco-literacy ability scores between students based on gender and university groups. Furthermore, the second session compared the eco-literacy skill scores between students and AIs. Student's t statistic was used to compare eco-literacy skill scores based on grouping variables of gender and type. Meanwhile, Welch's t statistic was used to compare eco-literacy ability scores based on grouping variable universities because the homogeneity assumption was unmet.

Yuen's test plays a crucial role in this study as a robustness test, ensuring the influence of extreme data or outliers is minimized in the analysis of mean differences between two groups. This method uses a trimming procedure, which ignores a certain percentage of the lowest and highest data before calculating the means and variances so that the analysis results become more resistant to data that are not normal or contain outliers. Yuen's test calculates trimmed

means and corresponding variances, and then conducts a t-test based on these trimmed values. Thus, Yuen's test provides more stable and reliable estimates under the condition that the assumptions of homogeneity of variance or normality may not be fully met, thereby strengthening the validity of the research results. The software program Jamovi 2.4.8.0 was used to run this analysis.

## Results

### *Descriptive Statistics*

Table 5 displays the descriptive statistics for the eco-literacy variable. Of the 209 samples analyzed, there were no missing data. The mean eco-literacy score was 76.7, with a 95% confidence interval between 75.6 and 77.9, indicating a reliable mean estimate. The standard error (SE) was 0.588, and the standard deviation (SD) was 8.549, indicating the variability of scores among participants. The lowest recorded score was 44.2, and the highest was 93.3. The distribution of scores was slightly skewed to the left (skewness = -0.616) and had a kurtosis close to a normal distribution (kurtosis = 0.355). The relatively small skewness and kurtosis values indicate that the data distribution is fairly symmetrical and not too different from a normal distribution. These data suggest that most participants have a high eco-literacy level, and the scores' distribution is close to normal.

**Table 5**

### *Descriptive Statistics*

| Measures of data centering and dispersion | <i>Eco-literacy</i> |
|-------------------------------------------|---------------------|
| N                                         | 209                 |
| Missing                                   | 0                   |
| Mean [CI (95%)]                           | 76.7 [75.6; 77.9]   |
| SE                                        | 0.588               |
| SD                                        | 8.549               |
| Minimum                                   | 44.2                |
| Maximum                                   | 93.3                |
| Skewness (Std. error skewness)            | -0.616 (0.168)      |
| Kurtosis (Std. error kurtosis)            | 0.355 (0.335)       |

*Note. The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom*

### *Comparison between Students*

Table 6 shows the independent t-test results to compare eco-literacy skills by gender and university. Analysis based on gender using Student's t-test resulted in a t-value of -1.45 with degrees of freedom (df) of 197 and a p-value of 0.149, indicating that there was no significant difference in eco-literacy skills between male (mean = 74.5, SD = 9.78) and female (mean = 76.9, SD = 8.13) students. Meanwhile, analysis based on the university using Welch's t-test resulted in a t-value of -3.30 with a df of 108 and a p-value of 0.001, indicating a significant difference in eco-literacy skills between students of Makassar State University (mean = 78.0, SD = 7.44) and Timor University (mean = 73.6, SD = 9.52). The mean difference in eco-literacy skills between universities was 4.39, with an effect size (Cohen's d) of -0.513, indicating a

moderate effect. Overall, there were significant differences in eco-literacy skills between universities but not by gender.

**Table 6**

*Comparison of Eco-literacy Comprehension based-on Gender and University Group Using Independent Sample T-test*

| Statistics               | Grouping variable   |                   |
|--------------------------|---------------------|-------------------|
|                          | Gender              | University        |
| t-value                  | -1.45 (Student's t) | -3.30 (Welch's t) |
| df                       | 197                 | 108               |
| p-value                  | 0.149               | 0.001             |
| Mean (group 1   group 2) | 74.5   76.9         | 78.0   73.6       |
| SD (group 1   group 2)   | 9.78   8.13         | 7.44   9.52       |
| Mean difference          | -2.35               | 4.39              |
| SE difference            | 1.62                | 1.33              |
| Effect size (Cohen's d)  | -0.280              | -0.513            |

Note.  $H1_a \mu \text{ Male} \neq \mu \text{ Female}$ ;  $H1b \mu \text{ Makassar State University} \neq \mu \text{ Timor University}$

Table 7 shows the robustness test results using Yuen's test to see the difference in eco-literacy ability based on gender and university group. For gender, the t-value of 0.618 with p-value = 0.542 indicates no significant difference, with almost the same trimmed mean (76.3 for men and 77.5 for women). The effect size ( $\xi$ ) of 0.0921 indicates a small effect. In contrast, for universities, a t-value of 2.87 with p-value = 0.006 indicates a significant difference, with a trimmed mean of 78.6 for Makassar State University and 74.1 for Timor University. An effect size ( $\xi$ ) of 0.346 indicates a moderate effect. Thus, the results of this robustness test confirm a significant difference in eco-literacy ability by the university but no significant difference by gender group.

**Table 7**

*Comparison of Eco-literacy Comprehension Based-on Gender and University Group Using Independent Sample T-test*

| Statistics                          | Grouping variable |             |
|-------------------------------------|-------------------|-------------|
|                                     | Gender            | University  |
| t-value                             | 0.618             | 2.87        |
| df                                  | 25.7              | 59.4        |
| p-value                             | 0.542             | 0.006       |
| Trimmed mean (group 1   group 2)    | 76.3   77.5       | 78.6   74.1 |
| Winsorized mean (group 1   group 2) | 75.7   77.2       | 78.6   74.1 |
| Mean difference                     | -1.19             | 4.50        |
| Effect size $\xi$                   | 0.0921            | 0.346       |

Note.  $H1_a \mu \text{ Male} \neq \mu \text{ Female}$ ;  $H1b \mu \text{ Makassar State University} \neq \mu \text{ Timor University}$

#### *Comparison between Students and AI*

Hypothesis testing results with a one-way hypothesis ( $\mu \text{ AI} > \mu \text{ Students}$ ) showed that AIs had better eco-literacy skills than students, with a t-value of 2.02 and p-value = 0.022. The AI mean

(82.0) exceeded the student mean (76.5). The robustness test results using Yuen's test also supported this finding, with a t-value of 2.97 and p-value = 0.025. The trimmed and winsorized mean showed that AIs had higher eco-literacy scores (84.2 and 83.7) than students (77.3 and 77.0). Effect size showed these results as significant and moderate, with Cohen's d of 0.654 and  $\xi$  of 0.550. Hypothesis testing and comparison of eco-literacy scores between students and AIs are presented in Table 8 and Figure 1 below.

**Table 8**

*Comparison of Eco-literacy Comprehension between Students and AI Using Independent Sample T-test*

| Statistics                          | Tests             |                               |
|-------------------------------------|-------------------|-------------------------------|
|                                     | Student's t       | Robustness test (Yuen's test) |
| t-value                             | 2.02              | 2.97                          |
| df                                  | 207               | 5.92                          |
| p-value                             | 0.022             | 0.025                         |
| Mean (group 1   group 2)            | 82.0   76.5       | -                             |
| SD (group 1   group 2)              | 8.47   8.43       | -                             |
| Trimmed mean (group 1   group 2)    | -                 | 84.2   77.3                   |
| Winsorized mean (group 1   group 2) | -                 | 83.7   77.0                   |
| Mean difference                     | 5.52              | 6.90                          |
| SE difference                       | 2.73              | -                             |
| Effect size                         | 0.654 (Cohen's d) | 0.550 ( $\xi$ )               |

Note.  $H_2 \mu AI > \mu Students$

**Figure 1**

*Comparison of Eco-literacy Comprehension between AIs and Students*

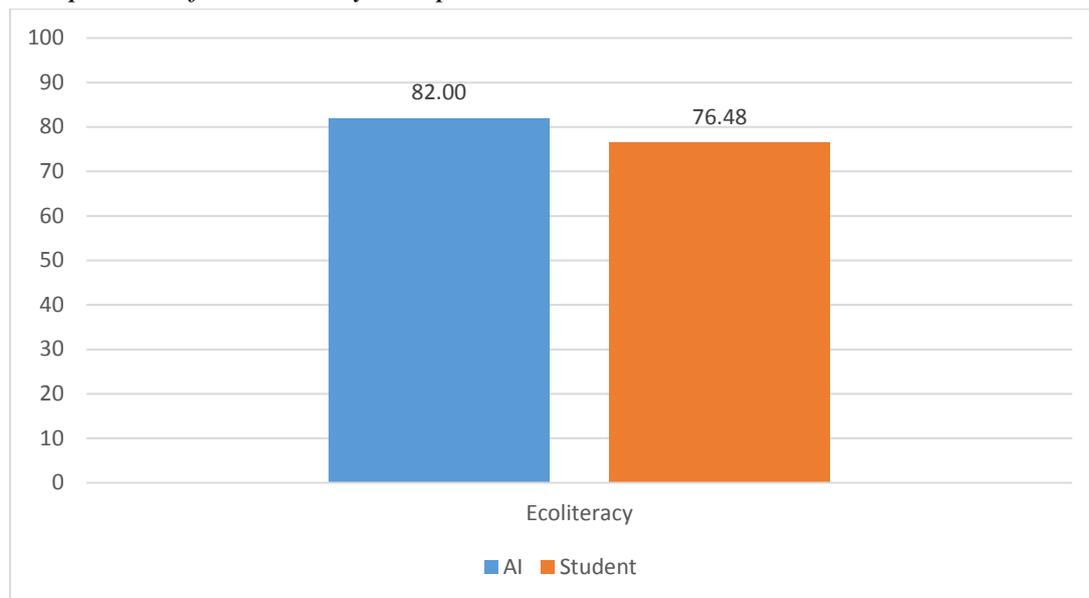
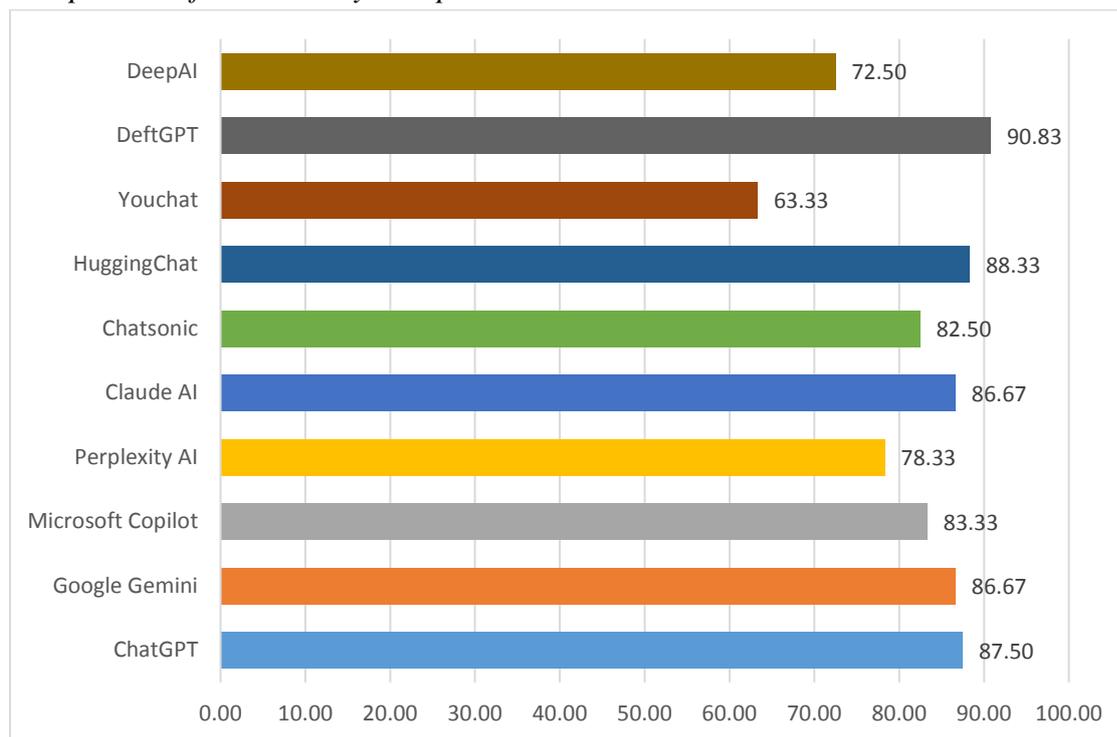


Figure 2 below shows a comparison of the eco-literacy scores of the various AI chatbots. The highest score was achieved by DeftGPT with a score of 90.83, followed by HuggingChat

(88.33), ChatGPT (87.50), and Google Gemini and Claude AI which both scored 86.67. The lowest score is obtained by YouChat with a value of 63.33. This variation in scores is influenced by a combination of factors. The different Large Language Models (LLM) used by each chatbot and their respective training algorithms and datasets collectively affect their ability to understand and process eco-literacy-related information. Chatbots with more sophisticated LLM models and broader training datasets tend to have higher scores in eco-literacy comprehension.

**Figure 2**

*Comparison of Eco-literacy Comprehension Score between AIs*



The difference in student and AI synopsis writing quality is evident in the thoroughness, completeness, and depth of analysis. Based on Figure 3, students' writing tended to be concise. It focused on the main storyline, with a brief explanation of the events experienced by the main character, but less detailed in explaining the context and meaning of the story. On the other hand, Figure 4 proves that the synopsis produced by AI is more comprehensive and in-depth. The AI not only outlines the story's plot but also adds an analysis of the story's themes, conflicts, moral messages, and connections to environmental issues and traditional values. The AI provided a more informative and analytical synopsis than the students.

**Figure 3***Result of Synopsis Writing Assignment by Participant no. 021 (Student Best Score)*

Dalam cerpen ini bercerita tentang bagaimana kehidupan Alman dan adiknya Uil yang setia harinya membuat rakit untuk berangkat ke sekolah dari Dusun Bengayoan ke Desa Rantau Langsat. Rakit-rakit itu biasanya diberikan ke perempuan-perempuan yang menanti mereka di tepi sungai. Adiknya Uil sempat bertanya ke kakaknya Alman bahwa sampai kapan mereka membuat rakit untuk berangkat ke sekolah? Alman menjawab sampai mereka mendapat uang dan bisa membeli motor. Suatu hari Alman tidak pergi ke sekolah dan pergi bersama Minha untuk mencari uang. Sepulangnya ia menunjukkan uang yang berhasil ia kumpulkan bersama Minha hari ini. Uang sebanyak itu bisa ia dapat dalam sehari sedangkan kalau untuk ayahnya harus menunggu berhari-hari. Disitu Alman bersikeras untuk menebang pohon yang di larangan oleh ayahnya. Ia mengatakan dengan menebang pohon-pohon itu mereka bisa mendapatkan uang untuk membeli motor. Ayah Alman tidak menyetujui hal tersebut karena hutan itu merupakan kawasan inti taman nasional yang harus mereka jaga dan rawat. Tetapi akhirnya ayah Alman tidak bisa berkata-kata karena Alman bersikeras dan meyakinkan ayahnya untuk menebang pohon-pohon tersebut. Dia sedih anaknya mau menebang pohon-pohon itu. Ia hanya bekerja mencari jernang, menantik pohon getah yang tidak seberapa menjual petai atau mencari ikan mana mungkin bisa membeli motor. Alman pergi mencari Minha tetapi Minha tidak ada di rumah dan seorang perempuan mengatakan bahwa Minha di tangkap polisi karena mencuri sawit milik pak Acim. Dada Alman terasa nyeri mendengar ucapan perempuan itu. Dia tidak mampu berkata-kata lagi. Di dalam hujan dia berlari pulang. Dia aja bilang ke adiknya Uil mulai besok mereka akan membuat rakit lagi untuk berangkat ke sekolah di Rantau Langsat.

**Figure 4***Result of Synopsis Writing Assignment by Participant no. 257 (AI Best Score)*

The screenshot shows a chat window from 'DeftGPT' with a GPT-3.5-16K model. The chat history includes a prompt to read a story and a response providing a synopsis. The synopsis discusses the lives of Alman and Uil in a village, their traditional bamboo boat travel, and the conflict between Alman's desire for economic improvement through logging and the traditional values of environmental preservation. It also mentions a subplot where Alman's friend Minha is caught stealing rubber wood.

**DeftGPT**  
+ New Chat  
Search Chats  
Baca Cerpen 'Po...'  
Earn Free Credits  
Current Plan Free  
Add to chrome  
Settings  
Light Dark

GPT-3.5-16K > 10

Sinopsis cerpen "Pohon Larangan di Bengayoan" mengisahkan kehidupan dua anak, Alman dan Uil, yang tinggal di dusun Bengayoan yang terletak di kawasan Taman Nasional Bukit Tiga Puluh. Setiap hari, mereka membuat rakit bambu untuk pergi ke sekolah di Desa Rantau Langsat. Keduanya hidup sederhana, bergantung pada alam sekitar, seperti mencari jernang, menantik pohon getah, dan menjual ikan. Namun, konflik muncul ketika Alman ingin mengubah cara hidupnya dengan menanam sawit di kawasan yang seharusnya dilindungi, kontra dengan nilai-nilai tradisional ayahnya yang ingin menjaga hutan dan lingkungan.

Ayah Alman menentang rencana Alman dan temannya, Minha, untuk menebang pohon-pohon di seberang sungai dan menanam sawit, karena itu merupakan tindakan melanggar aturan dalam kawasan hutan yang dilindungi. Meskipun Alman tergoda dengan potensi ekonomi yang dihasilkan dari menanam sawit, ayahnya mencoba menjelaskan pentingnya menjaga hutan untuk kesejahteraan bersama. Konflik antara keinginan Alman untuk meningkatkan kesejahteraan ekonomi dan nilai-nilai menjaga lingkungan dan alam menjadi fokus utama dalam cerita.

Dalam resolusi cerita, setelah Minha tertangkap mencuri kayu di hutan, Alman akhirnya menyadari pentingnya menjaga lingkungan dan menaati aturan. Ia kembali membuat rakit bambu untuk berangkat ke sekolah dan memilih untuk tidak melanggar larangan menanam sawit di kawasan hutan terlarang. Dengan demikian, cerpen ini menyampaikan pesan tentang pentingnya menyeimbangkan kebutuhan ekonomi dengan menjaga kelestarian lingkungan, serta pentingnya menjaga warisan alam bagi generasi yang akan datang. Cerita ini menggambarkan interaksi kompleks antara tokoh-tokoh cerita dengan lingkungan alam sekitar dan nilai-nilai tradisional yang mereka anut.

Send a message...

**Discussion**

The findings of this study show that there is no significant difference in students' eco-literacy ability based on gender, with a p-value of 0.149 and almost the same average eco-literacy score between men (mean = 74.5) and women (mean = 76.9), but women's scores are slightly higher. It could be because gender does not significantly affect the understanding of eco-literacy in an

academic environment. Sigit et al. (2023) also found similar findings that females had higher ecological literacy scores and creative thinking skills than male students. Eco-literacy aims to equip students with a deep understanding of how human actions affect the environment and how they contribute to the preservation and restoration of ecosystems (Juanda, Afandi, et al., 2024; Read, 2024). Secondary school adolescents learning a foreign language tend to be less immersed in literary texts in that language, which is linked to a lower appreciation of these texts compared to translations in their native language (Ramachers & Willems, 2024, p. 1). Further research findings showed a significant difference in students' eco-literacy skills based on university, with Makassar State University students having a higher average score (mean = 78.0) than Timor University students (mean = 73.6). It is indicated by a t-value of -3.30 and a p-value of 0.001. This difference is attributed to curriculum, educational facilities, or teaching methods. It suggests that educational institution factors are essential in developing students' eco-literacy skills. It is in line with Geriguis (2021), who showed that the method of teaching literary paratexts of novels increases students' awareness of the ecocritical significance of the novel and its engagement with disability issues, thus promoting ecological literacy through bioregional theory and the economic paradigm. Rantung et al. (2023) proved that song lyrics can be used in language teaching to enhance students' ecological literacy while developing their language skills, with song lyrics addressing ecological issues such as deforestation and biodiversity loss, and encouraging critical and creative thinking. Literature has the detailed ability to stir the emotions and imagination of readers, increasing awareness and empathy toward ecological issues (Hermes & Rimanoczy, 2018, p. 460; Juanda & Azis, 2023). Ecocritics often examine how literary works reflect environmental change, ecological degradation, and climate crisis through fictional texts (Rogers & Hamilton-McKenna, 2023, p. 605). Therefore, literature is very effective as a medium for eco-literacy learning in educational institutions.

The findings show that AI has better eco-literacy skills than students, with AI achieving an average score of 82.0 compared to 76.5 for students, which is supported by a t-value of 2.02 and a p-value of 0.022. This is because AI has access to vast databases of information and can analyze data more efficiently than humans. In addition, AI is trained with advanced algorithms that enable a more profound and faster understanding of eco-literacy concepts. Zhao et al. (2022) found that teachers' ability to apply artificial intelligence has a significant positive effect on understanding, evaluation, and ethics related to artificial intelligence, making it essential for the government to improve teachers' artificial intelligence literacy through diverse curricula and training. This finding was confirmed by Juanda and Afandi (2024) that ChatGPT was significantly better at reprocessing text compared to university students. This evidence is also supported by Zhang et al. (2024) who found that the AI literacy curriculum taught by teachers in the classroom significantly improved the understanding of AI concepts, positive attitudes toward AI, and readiness for an AI-based future in experimental group students compared to the comparison group.

The effects of implementing AI in the learning curriculum were also found by Dai (2024), who found that the experimental group showed significant improvements in AI knowledge, skills, and ethical awareness, as well as increased self-confidence, intrinsic motivation, and decreased

learning anxiety. AI technology analyzes students' learning patterns and provides customized feedback, helping them understand better ecological concepts and correct ecological errors effectively (Gleissner, 2021; Mrugalski, 2021; Zvereva, 2020). Implementing AI literacy in ECD provides references for educators and researchers to design interventions by engaging them in AI learning (Su et al., 2023). Psychological competence is essential in the context of widespread change through AI systems (Carolus et al., 2023, p. 1). Personal attributes demonstrate AI capabilities in technical knowledge, critical assessment, and practical usage (Laupichler et al., 2023).

## Conclusion

There is no significant difference in students' eco-literacy skills based on gender. It suggests that gender factors do not affect the understanding of eco-literacy in an academic environment. However, there was a significant difference between the two universities, with Makassar State University students having higher eco-literacy skills than Timor University students, which may be due to differences in curriculum, educational facilities, or teaching methods. In addition, AIs were shown to have better eco-literacy skills than university students, thanks to access to extensive information databases and sophisticated algorithms that enable efficient data analysis and an in-depth understanding of eco-literacy concepts. This research contributes to environmental education and technology by showing that AIs have better eco-literacy skills than university students, underscoring the potential use of AI as a practical learning tool. Implications of these findings include the need for educational institutions to consider integrating AI technology in the eco-literacy curriculum to improve students' understanding of environmental issues. In addition, the significant differences in eco-literacy skills by university highlight the importance of improving the quality of curriculum, facilities, and teaching methods in various educational institutions. Overall, this study paves the way for developing more innovative and technology-based educational strategies to support better environmental literacy.

This study has several limitations, including the limited sample that only includes two universities, so the results may need to be more generalizable to all students in various educational institutions. In addition, the comparative analysis between AI and university students was based on more than one type of eco-literacy test and story synopsis, which may reflect only some of the spectrum of eco-literacy ability. For future research, it is recommended to be conducted with a broader and more diverse sample, covering various universities and educational institutions. Research should also consider a comprehensive range of eco-literacy assessment methods, including practical and interactive tasks. In addition, it would be beneficial to explore more deeply the specific factors in curricula and teaching methods that can improve eco-literacy.

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## Ethics Declarations

## Competing Interests

No, there are no conflicting interests.

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