International Journal of Innovative Research and Scientific Studies, 8(3) 2025, pages: 3676-3685

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Ethnoscience integrated project-based learning model for enhancing students' creative thinking skills and cultural literacy: Expert perspectives and preliminary testing

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Abstract

The development of creative thinking skills and cultural literacy is crucial for preparing students to navigate the challenges of globalization while preserving their cultural identity. This study aims to develop the Ethnosains Integrated Project-Based Learning (PjBL) model and evaluate its validity and effectiveness in enhancing students' creative thinking skills and cultural literacy. Employing a Research and Development (R&D) methodology, the model was developed with a structured six-phase learning process: ethno-orientation, ethno-problem, ethno-project design, ethno-project investigation, ethno-presentation, and ethno-reflection. The validation process, conducted from experts' perspectives, involved Focus Group Discussions (FGDs) with five expert validators to assess the model's content and construct validity. Additionally, 16 biology education students from Universitas Pendidikan Mandalika, Indonesia, participated in preliminary field testing to evaluate the model's practical application. Validation results confirmed the model's content and construct validity, with high average scores (content: 3.92; construct: 3.87 out of 4.00), indicating its alignment with educational needs and theoretical frameworks. Descriptive and inferential statistical analyses, including ANOVA, demonstrated significant improvements in students' creative thinking skills, with an increase in the average score from 2.28 ("less creative") in the pretest to 3.28 ("creative") in the posttest ($F > 101.33$, $p < .001$, $\eta^2 > 0.77$). Similarly, cultural literacy scores improved significantly, with the average rising from 2.41 ("moderately literate") to 4.09 ("highly literate") ($F > 179.52$, $p < .001$, $\eta^2 > 0.85$). These results highlight the success of the Ethnosains Integrated PjBL model in fostering creativity and cultural awareness through culturally contextualized projects. The study underscores the potential of this model as an innovative strategy for holistically integrating creative thinking and cultural literacy into educational practices and recommends further exploration across diverse contexts.

Keywords: Creative thinking skills, Cultural literacy, Ethnoscience, Expert perspectives, Preliminary testing, Project-based learning.

DOI: 10.53894/ijirss.v8i3.7376
Funding: This study received no specific financial support.
History: Received: 12 March 2025 / **Revised:** 14 April 2025 / **Accepted:** 16 April 2025 / **Published:** 26 May 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

The urgency of developing creative thinking skills and cultural literacy has been emphasized by the Indonesian government through educational initiatives that prioritize global diversity, encourage learners to preserve local culture, and foster creativity to enable students to produce original, meaningful, and useful outcomes. These efforts aim to facilitate students' growth in creativity, innovation, capacity, and personality development. Consequently, university students are expected to possess creative thinking abilities and cultural literacy, which are necessary competencies to navigate the demands of today's globalized world.

Creative thinking development is essential, as students today are required to be innovative and competitive in response to globalization [1]. In an era where society increasingly relies on innovation and knowledge creation, creative thinking plays a crucial role in addressing emerging challenges [2]. Students who can think creatively are better equipped to handle the complex and dynamic nature of global competition [3]. They are able to generate new ideas and solve problems in innovative ways, enhancing their capacity for metacognitive skills and problem-solving [4].

The need to enhance students' creative thinking is further underscored by the 2022 PISA assessment, which ranked Indonesia 68th out of 80 countries in terms of creative thinking [5]. A study revealed that 90.47% of teachers were unfamiliar with the concept of creative thinking skills, and 99.04% had never assessed students' creative thinking abilities [6]. Similarly, preliminary studies found that biology education students in Indonesia had low creative thinking skills. As a result, it becomes imperative to enhance students' creative thinking abilities to enable them to develop original ideas, think outside the box, and address complex problems innovatively.

In addition to creativity, students are expected to have strong cultural literacy skills in order to respond effectively to advancements in information technology [7]. The rapid progress of information technology has provided unlimited access to information, influencing the cultural behaviors of students [8]. Many students today are easily influenced by foreign cultures, primarily through social media platforms [9]. Consequently, students tend to idolize foreign cultures and neglect their own. A preliminary study found that 43.63% of biology education students admitted to never wearing local cultural attire [10]. This situation poses a direct threat to the preservation of local culture [11] and increases the likelihood of cultural assimilation [12].

Students with strong cultural literacy skills are better equipped to navigate the overwhelming influx of information from social media [13], thereby avoiding negative influences in the age of information openness. Cultural literacy enables students to understand cultural practices, fostering a sense of pride in their own heritage and encouraging active contributions to its preservation [14]. Ultimately, students will develop a mindset for cultural preservation, protecting them from the risks of cultural assimilation and acculturation [15].

The emphasis on creative thinking skills and cultural literacy has been enshrined in Indonesia's National Higher Education Standards and serves as a primary orientation for the “Freedom to Learn” program, while also being promoted through the National Literacy Movement. However, fostering these two skills in a coherent and integrated manner within a single learning process is not a simple task and requires innovative educational models. Previous studies have shown that Project-Based Learning (PjBL) encourages creative, communicative, independent, and collaborative thinking [16, 17]. Meanwhile, the ethnoscience approach provides students with a comprehensive understanding of their own culture [18-20]. Despite these advancements, the coherent development of students' creative thinking and cultural literacy remains a challenge that can be addressed through the integration of ethnoscience and PjBL.

The integration of ethnoscience and PjBL, represents an ideal combination as it allows students to engage in hands-on learning experiences that connect scientific concepts with local wisdom. This model aligns with the holistic learning principles outlined in Indonesia's Higher Education Standards, promoting comprehensive thinking through the internalization of local wisdom, which characterizes ethnoscience-based learning [21, 22]. The integration of ethnoscience and PjBL also fosters an integrative approach to science education, encouraging interdisciplinary understanding rather than mere knowledge acquisition [23]. Additionally, the integration of ethnoscience and PjBL promotes interactive and collaborative learning, characterized by creative and innovative project-based activities and enhances students' creative thinking and cultural literacy through projects that are integrated with real-world issues and practices [17].

Project-based learning grounded in local wisdom creates a contextual and meaningful learning environment, fostering a love for one's culture [24]. This learning process enhances creative performance as students design and execute projects [25] while the ethnoscience content strengthens students' cultural literacy [26]. The urgency of developing creative thinking skills and cultural literacy in today's globalized world underscores the need for innovative learning models to foster these competencies coherently within a single educational process. Previous research has explored the individual development of creative thinking [6] and cultural literacy [10]. Findings show that creative thinking skills can be improved through direct experiences in project-based work [27, 28]. PjBL facilitates meaningful and constructive learning experiences in science, allowing students to approach problems with creative solutions [29]. In PjBL, students are placed at the center of the learning process, engaging in projects rooted in real-world challenges [30]. This makes PjBL highly relevant for integration with local wisdom (ethnoscience) to strengthen cultural literacy. This innovation enhances both creative thinking and cultural literacy within a coherent learning process.

1.1. Study Objectives

This study aims to develop and evaluate the validity and effectiveness of the Ethnosains Integrated Project-Based Learning (PjBL) model as a tool for enhancing students' creative thinking skills and cultural literacy. Specifically, the research employs a developmental methodology to assess the model's content and construct validity through expert perspectives. Furthermore, the study evaluates the model's effectiveness during preliminary field testing, providing insights into its practical application and potential impact in educational settings. The research questions based on the study objectives are as follows:

1. What is the validity level of the Ethnosains Integrated Project-Based Learning (PjBL) model in enhancing students' creative thinking skills and cultural literacy, as assessed through content and construct validity by experts?
2. How effective is the initial implementation (preliminary field testing) of the Ethnosains Integrated Project-Based Learning (PjBL) model in improving students' creative thinking skills and cultural literacy in educational settings?

2. Methodology

2.1. Research Design

This study employs the Research and Development (R&D) approach [31] to develop the Ethnosains Integrated Project-Based Learning (PjBL) model. The R&D methodology was chosen to systematically validate and implement an innovative educational model addressing the need for enhanced creative thinking and cultural literacy in higher education. The study focuses on designing, validating, and implementing the model to evaluate its validity and effectiveness. Validity assessments targeted content and construct dimensions, ensuring the model meets educational needs and is grounded in robust theoretical and empirical frameworks.

Content validity ensures the model aligns with the latest educational standards and addresses the critical areas of creative thinking and cultural literacy. Construct validity evaluates theoretical grounding, model syntax, expected outcomes, and the learning environment. This rigorous approach ensures a well-founded and adaptable model that meets contemporary educational demands.

2.2. Participants

The study involved five expert validators with specializations in educational models, creative thinking, and cultural literacy. These experts provided critical feedback during the validation process. For the preliminary field testing, 16 biology education students from Universitas Pendidikan Mandalika, Indonesia, participated. These students were selected based on their potential to benefit from enhanced creative thinking skills and cultural literacy, aligning with the study's goals. The small sample size for preliminary testing allowed for close observation and detailed assessment of the model's practical effectiveness. Participants were briefed on the study's objectives and provided informed consent prior to their involvement.

2.3. Procedures

The validation process was conducted through Focus Group Discussions (FGDs) with expert validators. Each session involved a detailed review of the model's components, with feedback recorded and integrated into subsequent iterations. The FGDs focused on refining the model's theoretical structure, syntax, and practical applications, ensuring its alignment with targeted educational outcomes. Following validation, the ethnoscience integrated PjBL model was implemented in a controlled environment using a one-group pretest-posttest design. Participants underwent an initial assessment (pretest-O_1) of creative thinking and cultural literacy, followed by instruction using the newly developed model. Post-intervention assessments (posttest-O_2) measured improvements in the target variables.

2.4. Instruments

Validation data were collected using a structured validation sheet designed to evaluate the content and construct validity of the model. Validators rated various aspects of the model on a five-point Likert scale, and the results were analyzed descriptively. Students' creative thinking skills were assessed through an essay test comprising eight items designed to measure fluency, flexibility, elaboration, and originality. Meanwhile, cultural literacy was evaluated using a questionnaire consisting of eighteen items across three indicators: understanding cultural diversity, cultural sensitivity, and interaction with cultures.

The instruments underwent a development and piloting process before the study to ensure their reliability and validity. The results of these tests demonstrated that the instruments were both valid and reliable, confirming their suitability for use in the research. This rigorous preparatory work ensured the accuracy and consistency of the data collected, supporting the study's objectives effectively.

2.5. Data Analysis

The data analysis involved both descriptive and inferential statistical methods to evaluate the validity and effectiveness of the ethnoscience integrated PjBL model. Validation data from expert evaluators were analyzed descriptively by averaging scores to determine whether the model met the predefined validity threshold. The effectiveness of the model was assessed through descriptive analysis, which categorized students' creative thinking skills and cultural literacy on a five-point scale ranging from "excellent" to "poor." Pre- and post-intervention data were analyzed using JASP software (version 0.19) to evaluate significant improvements. Analysis of Variance (ANOVA) was employed to statistically compare pretest and posttest scores, providing detailed insights into the model’s impact on enhancing the target competencies.

2.6. Ethical Considerations

This study adhered to ethical research practices, including obtaining informed consent from all participants. Participants were assured of their right to withdraw at any time without penalty. Data confidentiality was strictly maintained, and the study received approval from the Institutional Review Board of Universitas Pendidikan Mandalika. Throughout the research process, transparency and respect for participants' autonomy were prioritized, ensuring compliance with ethical standards for educational research.

3. Results and Discussion

The development of the Ethnosains integrated PjBL model resulted in a structured model comprising six key phases designed to enhance students' creative thinking skills and cultural literacy. The first phase, ethno-orientation, serves as the introductory stage where students are introduced to local cultural contexts relevant to the project. This phase is essential for fostering an understanding of indigenous knowledge, which forms the foundation for the subsequent learning activities. During this stage, students are encouraged to explore and engage with local cultural elements, providing a meaningful context for the learning process.

In the second phase, ethno-problem, students are tasked with identifying and defining problems related to the cultural context explored in the previous phase. This phase emphasizes problem-solving within a cultural framework, challenging students to think critically and creatively about issues that arise from local traditions, practices, or knowledge. The focus on real-world problems allows students to connect their learning to tangible cultural experiences, promoting a deeper understanding of both the content and the cultural implications of the problem at hand.

The third phase, ethno-project design, involves students collaborating to develop projects aimed at solving the identified cultural problems. In this phase, students employ their creative thinking skills to design innovative projects that integrate scientific principles with local cultural knowledge. The process of project design encourages students to think outside the box and develop original solutions that are culturally relevant and scientifically sound. This phase emphasizes collaboration, creativity, and critical thinking as students work together to create actionable and meaningful project plans.

In the subsequent phases, ethno-project investigation and ethno-presentation, students conduct research and investigations to test their project designs and ultimately present their findings. The investigation phase allows students to engage in hands-on exploration, collecting data and insights that validate their project hypotheses. This practical engagement deepens their understanding of both cultural and scientific concepts. The final presentation phase provides an opportunity for students to showcase their projects to their peers and educators, fostering an environment of knowledge sharing and cultural appreciation. Finally, in the sixth phase, ethno-reflection, students reflect on their learning experiences, the success of their projects, and the cultural insights they have gained. This phase is critical for consolidating their understanding and encouraging continuous personal and academic growth in creative thinking and cultural literacy.

The Ethnosains integrated PjBL model was validated by five expert validators to assess its content and construct validity. The results of the validation process, which include evaluations of the model's relevance, structure, and effectiveness, are presented in Table 1.

Table 1.
The Validation Results of Ethnosains Integrated PjBL Model.

Validator	Aspect	N*	Mean	SD	Criteria
Validator 1	Content - Needs	5	4.000	0.000	Valid
	Content - State-of-the-Art	4	4.000	0.000	Valid
	Construct	11	4.000	0.000	Valid
Validator 2	Content - Needs	5	4.000	0.000	Valid
	Content - State-of-the-Art	4	3.750	0.500	Valid
	Construct	11	3.818	0.405	Valid
Validator 3	Content - Needs	5	4.000	0.000	Valid
	Content - State-of-the-Art	4	3.750	0.500	Valid
	Construct	11	3.818	0.405	Valid
Validator 4	Content - Needs	5	3.600	0.548	Valid
	Content - State-of-the-Art	4	4.000	0.000	Valid
	Construct	11	3.727	0.467	Valid
Validator 5	Content - Needs	5	4.000	0.000	Valid
	Content - State-of-the-Art	4	4.000	0.000	Valid
	Construct	11	4.000	0.000	Valid
Average	Content - Needs	5	3.920	0.110	Valid
	Content - State-of-the-Art	4	3.900	0.200	Valid
	Construct	11	3.873	0.162	Valid

**N = Validation Item Number*

The validation results presented in Table 1 reflect the rigorous evaluation of the Ethnosains integrated PjBL model by five expert validators. This validation process aimed to assess both the content and construct validity of the model, ensuring that it aligns with the goal of enhancing students' creative thinking skills and cultural literacy. Table 1 outlines the key aspects

evaluated by the validators, including the necessity for developing the Ethnosains integrated PjBL (content validity), its alignment with state-of-the-art educational research, and the model's construct validity, which encompasses its theoretical and empirical foundations, structure, and educational objectives. The results demonstrate that the Ethnosains integrated PjBL model met the threshold for validity across all parameters.

The necessity for the Ethnosains integrated PjBL model was evaluated as a key aspect of content validity, receiving an average score of 3.92 out of 4.00 from the validators. This indicates a strong consensus among the experts that the development of such a model is essential, particularly in addressing the increasing demand for innovative learning approaches that foster creative thinking and cultural literacy. As highlighted by Ah-Nam and Osman [1], the globalized world demands that students develop creative, innovative, and competitive skills to navigate complex challenges. The Ethnosains integrated PjBL model addresses this by combining project-based learning with ethnoscience, providing a holistic educational framework that encourages students to engage with local culture while solving real-world problems creatively.

Furthermore, the model's alignment with the latest educational research and practices (state-of-the-art) also received high scores from the validators, with an average rating of 3.90. This reflects the model's grounding in contemporary educational theories, including those related to PjBL [17, 18] and the ethnoscience approach [20, 32]. The Ethnosains integrated PjBL model integrates these approaches to offer a comprehensive learning experience that not only enhances students' problem-solving abilities but also deepens their understanding of their cultural heritage. This alignment with cutting-edge educational practices ensures that the model is both relevant and effective in achieving its intended outcomes.

In terms of construct validity, the Ethnosains integrated PjBL model was evaluated across various dimensions, including its theoretical and empirical foundations, the syntax of the model, and the learning environment it creates. The validators gave an average score of 3.87 for the construct validity aspect, indicating that the model is well-supported by existing educational research and theory. The integration of project-based learning, which fosters creative thinking and problem-solving [29], with ethnoscience, which strengthens cultural literacy [14], ensures that the model effectively promotes both competencies. Moreover, the model's design emphasizes an interactive and collaborative learning environment, where students engage in meaningful, real-world projects that connect scientific concepts with local wisdom.

The high ratings for the construct validity of the Ethnosains integrated PjBL model suggest that the model's structure and components are well aligned with its educational objectives. The six-phase structure of the model—ethno-orientation, ethno-problem, ethno-project design, ethno-project investigation, ethno-presentation, and ethno-reflection—provides a clear and coherent framework for fostering both creative thinking and cultural literacy. Each phase is designed to build upon the previous one, ensuring that students are continuously developing their skills through hands-on, culturally relevant projects. This iterative process of learning, investigation, and reflection aligns with the principles of project-based learning, which has been shown to enhance students' ability to approach problems creatively and constructively [28].

The feedback provided by the validators also highlighted the importance of the model's learning environment and social system, which received positive evaluations. The Ethnosains integrated PjBL model creates a learning environment that encourages collaboration, creativity, and critical thinking, as students work together to design and implement projects that are grounded in their cultural context. This aligns with the findings of Nusi et al. [17], who noted that project-based learning fosters communicative, independent, and collaborative skills among students. Furthermore, the model's emphasis on the integration of local cultural knowledge into the learning process helps to strengthen students' cultural literacy, as they engage with and reflect on their cultural heritage throughout the project.

Based on the objectives of this study, the Ethnosains Integrated Project-Based Learning (PjBL) model, having been validated, was subsequently implemented in a preliminary field testing phase with prospective biology teacher students. This implementation aimed to evaluate the model's effectiveness in enhancing students' creative thinking skills and cultural literacy. The results of the data analysis on students' creative thinking are presented in Table 2, followed by descriptive plots (raincloud plots) in Figure 1, and group ANOVA results in Table 3.

Table 2.
The descriptive analysis results of students' creative thinking.

Indicator	Group	N	Mean	Std. Error	Std. Dev.	Coef. of var.
Fluency	Pretest	16	1.875	0.107	0.428	0.228
	Posttest	16	3.344	0.099	0.397	0.119
Flexibility	Pretest	16	1.750	0.112	0.447	0.256
	Posttest	16	3.250	0.065	0.258	0.079
Elaboration	Pretest	16	1.813	0.111	0.443	0.244
	Posttest	16	3.281	0.079	0.315	0.096
Originality	Pretest	16	3.688	0.151	0.602	0.163
	Posttest	16	3.250	0.065	0.258	0.079
Average	Pretest	16	2.284	0.080	0.320	0.140
	Posttest	16	3.282	0.042	0.166	0.051

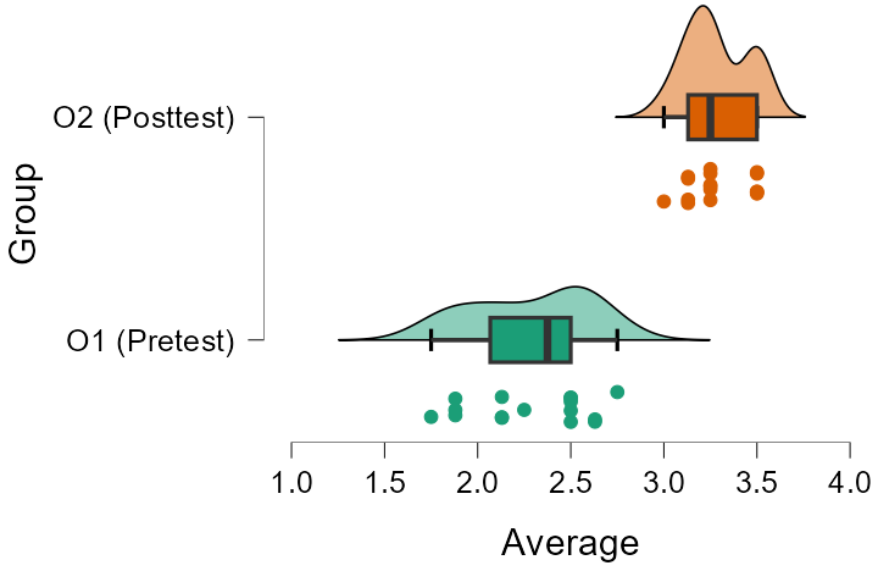

Figure 1.
Descriptive plots (raincloud plots) of students' creative thinking average scores

The descriptive analysis presented in Table 2 indicates a significant improvement in students' creative thinking skills following the implementation of the Ethnosains Integrated PjBL model. All indicators, including fluency, flexibility, elaboration, and originality, demonstrate an increase in mean scores from the pretest to the posttest. Specifically, the average score rose from 2.284 in the pretest, categorized as "less creative," to 3.282 in the posttest, categorized as "creative," with a notable reduction in variability as indicated by lower coefficients of variation. This suggests enhanced consistency in students' creative thinking performance after the intervention.

The descriptive visualization shown in Figure 1 (raincloud plots) further supports the findings of Table 2. The plot illustrates a clear upward shift in the distribution of scores from the pretest to the posttest. Posttest scores are clustered around higher average values with reduced dispersion, highlighting the positive effect of the Ethnosains Integrated PjBL model on students' creative thinking skills.

Table 3.
The results of ANOVA for students' creative thinking

Indicator	Case	Sum of Squares	df	Mean Square	F	p	η^2
Fluency	Group	17.258	1	17.258	101.330	< .001	0.772
	Residuals	5.109	30	0.170	-	-	-
Flexibility	Group	18.000	1	18.000	135.000	< .001	0.818
	Residuals	4.000	30	0.133	-	-	-
Elaboration	Group	17.258	1	17.258	117.085	< .001	0.796
	Residuals	4.422	30	0.147	-	-	-
Originality	Group	1.531	1	1.531	7.136	0.012	0.192
	Residuals	6.437	30	0.215	-	-	-
Average	Group	7.980	1	7.980	122.601	< .001	0.803
	Residuals	1.953	30	0.065	-	-	-

The results of the ANOVA analysis, as shown in Table 3, reveal significant differences between pretest and posttest scores across all creative thinking indicators. Fluency, flexibility, elaboration, and the overall average score exhibit highly significant improvements ($p < .001$), with η^2 values ranging from 0.772 to 0.818, indicating strong effect sizes. While originality also shows a significant improvement ($p = .012$), its effect size ($\eta^2 = 0.192$) is moderate. These findings confirm the effectiveness of the Ethnosains Integrated PjBL model in enhancing students' creative thinking skills across multiple dimensions.

The findings of this study demonstrate the successful integration of PjBL with an ethnoscience context in enhancing students' creative thinking skills. These results align with previous studies highlighting that PjBL facilitates knowledge construction through discussion, projects, and problem-solving activities, thereby improving students' creative thinking abilities [33]. PjBL optimally fosters student creativity, emphasizing its significance as a critical competency in modern education [34]. The integration of ethnoscience into PjBL further enriches the learning experience by connecting scientific concepts with students' local environments and cultural practices. Prior studies have also shown that ethnoscience-based PjBL enhances students' critical thinking skills, closely related to creative thinking [35].

The significant impact of the ethnoscience-integrated PjBL model on improving students' creative thinking is further supported by evidence indicating that linking science education with local wisdom through ethnoscience fosters creativity among students [36]. This contextual approach not only makes learning more relevant but also encourages students to apply

their knowledge in real-world scenarios, thereby promoting innovative thinking. As highlighted in previous research, PjBL effectively influences students' creative thinking by incorporating elements that support creativity within the PjBL framework itself [37] as demonstrated in this study through the integration of an ethnoscience context.

Subsequently, the results of the data analysis on students' cultural literacy are presented in Table 4, followed by descriptive plots (raincloud plots) shown in Figure 2, and group ANOVA results detailed in Table 5.

Table 4.
The descriptive analysis results of students' cultural literacy.

Indicator	Group	N	Mean	Std. Error	Std. Dev.	Coef. of var.
Understanding cultural diversity	Pretest	16	2.792	0.081	0.325	0.116
	Posttest	16	4.344	0.083	0.330	0.076
Cultural sensitivity	Pretest	16	2.223	0.064	0.255	0.115
	Posttest	16	4.018	0.072	0.290	0.072
Interaction with cultures	Pretest	16	2.212	0.056	0.225	0.102
	Posttest	16	3.913	0.080	0.318	0.081
Average	Pretest	16	2.409	0.056	0.226	0.094
	Posttest	16	4.091	0.062	0.249	0.061

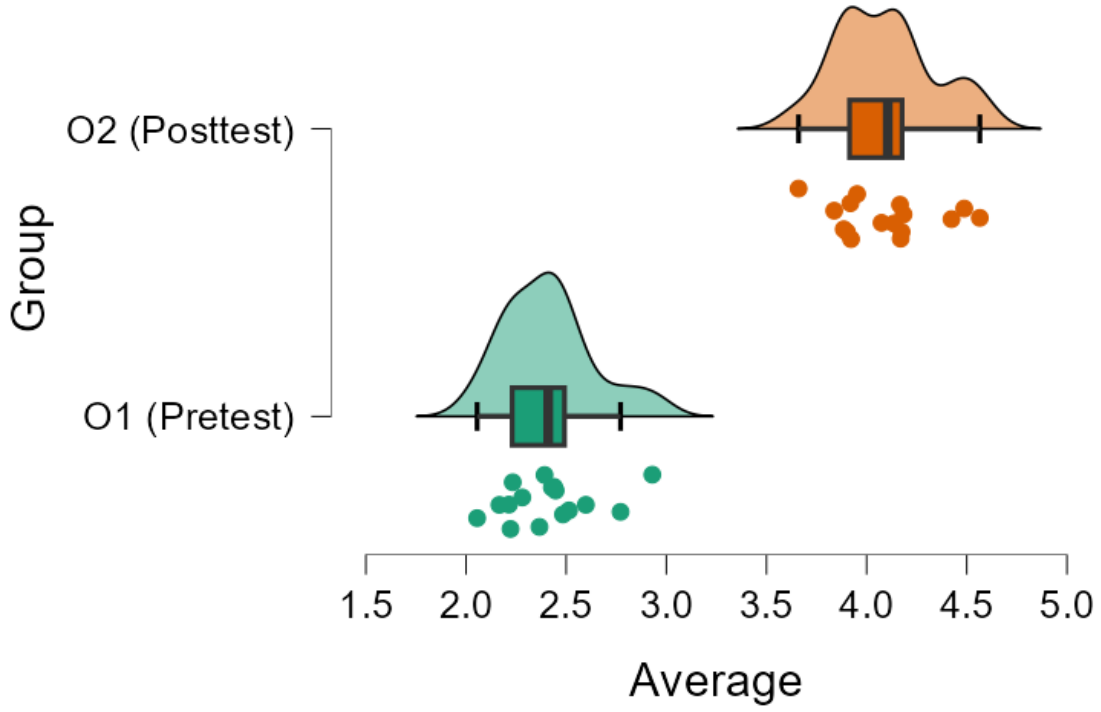

Figure 2.
Descriptive plots (raincloud plots) of students' cultural literacy average scores.

The descriptive analysis results in Table 4 show a notable improvement in students' cultural literacy following the implementation of the Ethnosains Integrated PjBL model. The average score increased from 2.409 in the pretest to 4.091 in the posttest, with the pretest categorized as "moderately literate" and the posttest as "highly literate." All indicators, including understanding cultural diversity, cultural sensitivity, and interaction with cultures, demonstrated significant gains, with the most substantial increase observed in understanding cultural diversity. The lower coefficients of variation in the posttest indicate greater consistency in cultural literacy scores among students.

The descriptive raincloud plot in Figure 2 provides a visual representation of the improvement in cultural literacy scores. The posttest distribution is shifted significantly to the right compared to the pretest, with a higher concentration of scores near the maximum range. This reinforces the substantial impact of the Ethnosains Integrated PjBL model in enhancing students' cultural literacy.

Table 5.
The results of ANOVA for students' cultural literacy.

Indicator	Case	Sum of Squares	df	Mean Square	F	P	η^2
Understanding cultural diversity	Group	19.272	1	19.272	179.523	< 0.001	0.857
	Residuals	3.220	30	0.107	-	-	-
Cultural sensitivity	Group	25.766	1	25.766	345.308	< 0.001	0.920
	Residuals	2.239	30	0.075	-	-	-
Interaction with cultures	Group	23.120	1	23.120	304.879	< 0.001	0.910
	Residuals	2.275	30	0.076	-	-	-
Average	Group	22.640	1	22.640	401.549	< .001	0.930
	Residuals	1.691	30	0.056	-	-	-

The ANOVA results in Table 5 reveal significant differences between pretest and posttest scores across all cultural literacy indicators. The F-values for understanding cultural diversity ($F = 179.523$), cultural sensitivity ($F = 345.308$), and interaction with cultures ($F = 304.879$) are all highly significant ($p < .001$), with η^2 values above 0.85, indicating large effect sizes. The overall cultural literacy average also demonstrates a significant improvement ($F = 401.549$, $p < .001$, $\eta^2 = 0.930$). These results confirm that the Ethnosains Integrated PjBL model effectively enhances students' cultural literacy across all measured dimensions.

The ethnoscience-integrated PjBL model has been proven to significantly enhance students' cultural literacy by incorporating local knowledge and cultural contexts into the learning process. This model not only fosters a deeper understanding of scientific concepts but also encourages appreciation and respect for cultural diversity. The findings of this study are supported by previous research showing that integrating local wisdom into teaching practices improves students' thinking skills and scientific literacy while instilling cultural values through the learning process [38, 39]. Other studies have reported that ethnoscience-based learning actively engages students in discovering new concepts, thereby enhancing their cultural literacy [40].

By involving students in projects related to their cultural heritage, educators can create more relevant and meaningful learning experiences. Moreover, implementing ethnoscience in PjBL encourages students to explore their local environment and cultural practices, fostering a sense of identity and belonging. The findings of the current study are further supported by Ginting et al. [41], who noted that strong cultural literacy is developed through project-based learning that integrates scientific principles. This aligns with the findings of Wahyudi et al. [42], which highlight that context-based learning rooted in cultural entities improves students' thinking skills and cultural literacy. By engaging with local cultures and traditions, students are better prepared to understand and appreciate the diversity of knowledge systems.

Overall, the findings of this study underscore the significant potential of the ethnoscience-integrated PjBL model in enhancing students' creative thinking skills and cultural literacy. The model successfully integrates PjBL with ethnoscience to create a holistic educational framework that fosters creativity and an appreciation for cultural diversity. Through engaging in culturally contextualized projects, students not only develop innovative solutions to real-world problems but also deepen their understanding of local wisdom and cultural heritage. This dual impact aligns with contemporary educational goals of equipping students with competencies essential for global competitiveness while preserving their cultural identity. These results affirm that the ethnoscience-integrated PjBL model provides a meaningful and effective approach to addressing the intertwined challenges of fostering creative thinking and cultural literacy in higher education.

6. Conclusion

The Ethnosains Integrated Project-Based Learning (PjBL) model was developed with a structured six-phase learning process: ethno-orientation, ethno-problem, ethno-project design, ethno-project investigation, ethno-presentation, and ethno-reflection. This structured model was validated by expert evaluators, confirming its content and construct validity. Expert validation results showed high average scores across aspects such as educational relevance (3.92 out of 4.00), alignment with state-of-the-art research (3.90), and theoretical coherence (3.87).

The initial implementation during preliminary field testing demonstrated significant improvements in students' creative thinking, with an average score increase from 2.28 (categorized as "less creative") in the pretest to 3.28 ("creative") in the posttest. All creative thinking indicators—fluency, flexibility, elaboration, and originality—showed marked gains, particularly fluency and flexibility, with effect sizes (η^2) exceeding 0.77. These findings highlight the model's ability to cultivate creativity through culturally contextualized, collaborative, and problem-solving-based learning processes.

Similarly, the model proved highly effective in enhancing students' cultural literacy, as indicated by an increase in the average score from 2.41 ("moderately literate") to 4.09 ("highly literate") across all indicators. Understanding cultural diversity saw the highest improvement, followed by cultural sensitivity and interaction with cultures, with effect sizes (η^2) consistently exceeding 0.85. These results reflect the model's success in integrating local wisdom and cultural contexts into the learning process, thereby fostering a stronger sense of cultural identity and appreciation among students.

The findings suggest that this model addresses the intertwined educational challenges of enhancing creative thinking and cultural literacy in a coherent and impactful manner. Future studies could expand the scope of application across diverse educational levels and cultural contexts to further validate its versatility and long-term effectiveness.

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