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ORIGINAL

Integrating Local Wisdom of Penti: A Novel Strategy to Enhance Students' Creative Thinking Skills in Biology Education

Integrar la sabiduría local de Penti: una nueva estrategia para mejorar las habilidades de pensamiento creativo de los estudiantes en el aprendizaje de biología

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ABSTRACT

Introduction: *Penti*, a traditional Manggarai ceremony, embodies gratitude, reconciliation, and values of cooperation and mutual assistance. These values inspire the PENTI learning model, designed to create contextual learning experiences and improve students' creative thinking skills. This study investigates the model's effectiveness in enhancing high school students' creative thinking.
Method: this study employed a pretest-posttest non-equivalent control group design, involving 337 tenth-grade students in Manggarai Barat, Indonesia. Participants were divided into experimental (PENTI), positive control (STAD), and negative control (conventional) groups. Creative thinking skills were assessed using an essay test rubric based on relevant indicators, with data analyzed via ANCOVA at a 0,05 significance level.
Results: the results showed that the PENTI model was significantly more effective than STAD and conventional learning in improving students' creative thinking skills. The LSD test further confirmed significant differences among the groups. Students in the PENTI class achieved an average score of 85,92, which was higher than those in the other groups.
Conclusion: the PENTI learning model, which integrates the values of cooperation and mutual assistance from the *Penti* traditional ceremony, has proven to be effective in enhancing students' creative thinking skills. This model provides contextual and meaningful learning experiences, making it a recommended innovative approach for modern education.

Keywords: Learning Design; Learning Development; Culturally Integrated Learning; PENTI; Creative Thinking Skills.

RESUMEN

Introducción: el *Penti*, una ceremonia tradicional de los Manggarai, representa gratitud, reconciliación y valores de cooperación y ayuda mutua. Estos valores inspiran el modelo de aprendizaje PENTI, diseñado para crear experiencias de aprendizaje contextual y mejorar las habilidades de pensamiento creativo de los estudiantes. Este estudio investiga la efectividad de este modelo en estudiantes de secundaria.
Método: este estudio utilizó un diseño pretest-posttest con grupos de control no equivalentes, involucrando a 337 estudiantes de décimo grado en Manggarai Barat, Indonesia. Los participantes se dividieron en grupo experimental (PENTI), grupo control positivo (STAD) y grupo control negativo (aprendizaje convencional). Las habilidades de pensamiento creativo se evaluaron mediante pruebas de ensayo con un rúbrica basada en indicadores específicos. Los datos fueron analizados mediante ANCOVA con un nivel de significancia de 0,05.

Resultados: los resultados mostraron que el modelo PENTI fue significativamente más efectivo que el STAD y el aprendizaje convencional para mejorar las habilidades de pensamiento creativo de los estudiantes. La prueba LSD confirmó además diferencias significativas entre los grupos. Los estudiantes en la clase PENTI lograron una puntuación promedio de 85,92, que fue más alta que la de los otros grupos.
Conclusión: el modelo de aprendizaje PENTI, que integra los valores de cooperación y ayuda mutua de la ceremonia tradicional *Penti*, ha demostrado ser efectivo para mejorar las habilidades de pensamiento creativo de los estudiantes. Este modelo proporciona experiencias de aprendizaje contextuales y significativas, por lo que se recomienda como un enfoque innovador para la educación moderna.

Palabras clave: Diseño de Aprendizaje; Desarrollo de Aprendizaje; Aprendizaje Integrado Culturalmente; PENTI; Habilidades de Pensamiento Creativo.

INTRODUCTION

Creative thinking includes the ability to generate novelty, apply new ideas, and transform existing elements into more valuable forms.[1] These skills are widely recognized as essential elements in a knowledge-based society and technological innovation because they help individuals solve problems innovatively and develop new solutions that are relevant to the ever-evolving world.[2,3,4,5] In a world full of 21st-century challenges, such as climate change, global migration, socio-economic inequality, and the need for lifelong learning, creative thinking is one of the main skills that society must have to face the complexity of these problems.[6,7]

Creative thinking skills must be developed through quality education, either through independent learning or as part of a series of 21st-century skills.[8,9] Education that focuses on developing these skills enables students to adapt to new methods and perspectives, create innovative solutions, and become globally competitive human resources.[9] Thus, creative thinking skills are not only important for productivity and competitiveness but also key to shaping a generation that is able to address future challenges with a creative and adaptive approach.[10]

Creative thinking skills are also a key element in successful learning, particularly in sciences such as biology.[11] These skills not only enable students to engage actively and think critically but also support the development of creative thinking, as well as cognitive and affective abilities, which are crucial for building a positive self-concept.[12,13] Additionally, creative thinking skills are formed through continuous learning experiences that gradually direct students' interests and competencies in specific fields.[14] Creative thinking skills are crucial in the context of science education for tackling complex challenges,[15] making it essential to understand students' attitudes toward science.[16] Creative thinking is a unique expression of self, and the integration of positive attitudes and creativity in education fosters an adaptive generation ready to contribute to a continuously evolving world.[17]

In 2022, PISA measured students' creative thinking skills for the first time across 64 OECD member countries OECD.[18] The results showed that the average OECD score for creative thinking skills was 33 out of a total of 60 points. Singapore emerged as the top-performing country, achieving a creative thinking skills score of 41 points, higher than all other OECD member countries.[19] Meanwhile, Indonesian students' creative thinking skills were below average, with a score of 19 points, categorized as low.[20] Previous studies have also indicated the low level of creative thinking skills among Indonesian students.[21,22,23]

Biology education in Indonesia is generally still focused on rote memorization of concepts.[24] Ideally, biology learning should place greater emphasis on student activities that involve direct interaction with the environment and local culture, which has been proven effective in enhancing student engagement and developing creative thinking skills.[25] This local wisdom-based approach allows students to develop creativity while understanding material relevant to everyday life and fostering appreciation for local culture.[26] Additionally, this approach has been shown to effectively enhance students' creative thinking skills by connecting academic knowledge with real-life contexts, encouraging them to think creatively in practical situations.[27]

This study integrates the local wisdom of Penti, a tradition of the Manggarai community in Indonesia, which is rich in values of togetherness and respect for nature.[29] The Penti tradition reflects a harmonious relationship between humans, nature, and the Creator, as embodied in the philosophy and behaviors of the Manggarai community.[30] This tradition serves as a moment to express gratitude for harvest yields and natural resource management, while also preparing for the next planting season.[31] The harmony between living with nature, fellow humans, and the Creator is evident in the stages of the Penti tradition, which include preparation, core, and conclusion, representing the life cycle of an agrarian community reliant on nature.[32,33]

The integration of local wisdom, such as *Penti*, a cultural tradition of the Manggarai community, not only strengthens spiritual and ecological connections but also opens opportunities for its application in education. Through this application, a learning model that connects local culture with scientific concepts can provide a more meaningful learning experience. One of the learning models frequently used by teachers is the Student

Teams Achievement Divisions (STAD) model, as it is effective in enhancing group cooperation and student achievement through healthy competition.[34] The *Penti*-based local wisdom learning model offers a more contextual and relevant learning experience through the exploration of local culture.[35,36] This model also enables students to deeplay and meaningfully understand biological concepts.[37,38] Furthermore, it engages students emotionally and meaningfully understand biological concepts.[39] Through direct interaction with local culture, students have the opportunity to understand scientific concepts better through personal experiences and collaborative activities.[40]

Penti is a traditional ceremony of the Manggarai community, rich in the values of gratitude, peace, and harmony. These noble values serve as the foundation for developing the PENTI learning model, which consists of five stages: Preview to spark students' curiosity, Exploration to seek alternative solutions, Narrative for collaborative discussion transfer to apply concepts in new contexts, and Inference for validation and self-reflection. This model is designed to gradually enhance students' creative thinking skills by connecting academic material to everyday life, making it relevant for biology learning in schools.[41,42] This approach encourages exploration, meaning-making, and the development of creative solutions applicable in the students' cultural context.[43,44] The PENTI model is thus a unique approach that supports 21st-century skills, such as problem-solving, communication, and adaptability.[45]

The stages of this learning model are based on relevant learning theories. The Preview stage is grounded in cognitive theory, which emphasizes the importance of activating prior knowledge.[46] Exploration draws on social cognitive theory, highlighting the role of exploration in building understanding.[47] Narrative refers to socio-cultural theory, emphasizing the importance of social interaction in learning.[48] Transfer strengthens students' ability to apply concepts in new situations, in line with social cognitive theory.[49] Inference adopts a constructivist approach, encouraging reflection to reinforce understanding.[50]

Several aspects of the PENTI model require further attention. The adaptation and implementation of this model in other local cultural contexts in Indonesia have not been widely explored, despite the country's cultural diversity offering significant opportunities for further research.[51] Long-term evaluation of the impact of this model on students' creative thinking skills is also necessary to ensure its sustained benefits.[52] Additionally, integrating technology into the PENTI model remains an untapped potential to enhance its effectiveness in the digital era. The relationship between ecological values in the *Penti* tradition and the development of students' creative thinking skills, particularly in the context of biology education, has not been thoroughly examined. Furthermore, the model's applicability in schools with different socio-cultural characteristics and resources requires further investigation.[53]

Given these needs, this study aims to develop and test the PENTI learning model in enhancing students' creative thinking skills. It also seeks to contribute to education that is more culturally relevant and aligned with global needs in the 21st century. Based on these arguments, the research hypothesis is that the implementation of the PENTI learning model has a significant influence on improving students' creative thinking skills.

METHOD

Research Design

This study is a quasi-experimental research with a pretest-posttest non-equivalent control group design,[54] involving three sample groups: the experimental group, positive control group, and negative control group. The independent variable in this study is the learning model, which includes the PENTI learning model (experimental group), the STAD learning model (positive control group), and conventional learning (negative control group). The dependent variable is creative thinking skills. The research design is presented in table 1.

Table 1. Quasi-Experimental Research Design

Pretest	Treatment Group	Number of Students	Posttest
O1	PENTI	114	O4
O2	STAD	112	O5
O3	Conventional (direct learning)	111	O6

Research Samples

The population of this study comprises all 10th-grade students in a senior high school located in West Manggarai, East Nusa Tenggara, totaling X students across nine classes. The sample consists of 337 students selected randomly using the simple random sampling method to assign the experimental group, positive control group, and negative control group. Each learning model is represented by three classes: those employing the PENTI model, the STAD model, and conventional learning. A homogeneity test was conducted isure the variance among the sample groups was homogeneous, allowing the treatment in the study to be applied validly. Homogeneity analysis was performed using SPSS version 26.0 for Windows.

Instrument

The research instrument for assessing creative thinking skills was determined to be reliable, with a reliability coefficient of 0,84 calculated using Cronbach's Alpha. This calculation was based on student scores from 16 essay questions, assessed using a rubric based on CFOEIF (Curiosity, Fluency, Originality, Elaboration, Imagination, and Flexibility) indicators as proposed by [1]. Reliability indicates the consistency of the instrument in measuring students' creative thinking skills. The instrument's validity was previously confirmed with a validation score of 0,82, as evaluated by three experts in biology education and cultural studies.

Data collection began with the validation of the learning materials and research instruments. This validation was carried out by three experts in biology education and one cultural expert, who assessed the alignment of learning objectives, teaching modules, student worksheets, and research instruments. The validation results indicated that the learning materials were valid, with scores of 0,81, 0,86, 0,83, and 0,82, respectively.

Procedures

Each class was taught using a different learning model: PENTI, STAD, and Conventional. In the experimental class, the PENTI learning model was implemented with the following stages: connecting prior information, linking new information to existing knowledge, organizing information into stories in groups, applying knowledge to new situations, and giving and receiving feedback. In the positive control class, the STAD learning model was applied following the stages developed by [55]: delivering learning objectives, presenting information, organizing students into groups, conducting evaluations, and providing rewards. In the negative control class, the conventional learning model was used, consisting of the following stages: opening, material delivery, class discussion, independent practice, closing, and evaluation.[56] In this type of learning, the teacher has full control over the lesson, and students primarily act as active listeners.[57] The detailed learning process for all three models is fully presented in table 2.

Table 2. Learning Process for the Three Classes: PENTI, STAD, and Conventional

Class	Learning Model	Learning stages
Experiment	PENTI	(1) Connecting prior information: students gather initial information from various sources to understand the topic, supporting preparation, comprehension, and information retention, (2) linking new information to existing knowledge: students connect new information with existing knowledge to enhance understanding, motivation, and skills through data collection and problem-solving, (3) organizing information into stories in groups: Information is organized into stories in groups, helping students comprehend and recall the material in a structured manner, (4) applying knowledge to new situations: students apply knowledge to new situations, reinforcing understanding and the material's relevance to real-life contexts, and (5) giving and receiving feedback: feedback is provided to enhance understanding through decision-making, critical thinking skills development, and group appreciation.
Positive Control	STAD	(1) the teacher explains the objectives and benefits of learning to students, (2) the teacher delivers the main material to the entire class, (3) students are divided into heterogeneous groups to collaborate, (4) students work on tasks that encourage teamwork, (5) students' understanding is assessed both individually and as a group, and (6) the teacher gives rewards to motivate successful students or groups.
Negative Control	Conventional	((1) the teacher explains the learning objectives and provides an overview of the material to be covered, (2) the teacher delivers material through lectures or presentations, often using tools such as whiteboards or presentation slides, (3) The teacher provides opportunities for students to ask questions or discuss the material, and (4) The teacher summarizes the material, reinforces key points, and conducts evaluations to measure students' understanding.

Data analysis

The research data were analyzed using ANCOVA and LSD (Least Significant Difference) tests with SPSS version 26.0 for Windows. Differences in the effects of the three learning models were further examined through post hoc analysis using the Least Significant Difference (LSD) test. Prior to this, the Kolmogorov-Smirnov test and Levene's test were conducted to ensure the data met the assumptions of normality and homogeneity

Ethical Considerations

This study was conducted in adherence to the principles of research ethics, ensuring that participants' rights and the confidentiality of their information were protected throughout the research process. Informed consent was obtained from each participant, and the study was carried out in accordance with applicable

ethical guidelines.

RESULTS

Results of Normality and Homogeneity Tests for Students' Creative Thinking Scores

The prerequisite tests, including normality and homogeneity tests, indicated that students' creative thinking scores were both normal and homogeneous (table 3).

Table 3. Normality and Homogeneity Test of Students' Creative Thinking Scores

Treatment Group	N	Normality	Homogeneity
Creative Thinking Initial Test	337	0,093	0,394
Creative Thinking Final Test	337	0,095	0,738

Effect of the PENTI Learning Model on Students' Creative Thinking Skills

Table 4 presents the results of the analysis on the application of the PENTI learning model in improving creative thinking skills.

Table 4. Effect of Learning Models on Students' Creative Thinking Skills

Source	Type III Sum of Square	df	Mean Square	F	Sig.
Corrected Model	8313,715[a]	3	2771,238	110,055	0,000
Intercept	11314,794	1	11314,794	449,346	0,000
Pretest	3,864	1	3,864	0,153	0,695
Class	8308,088	2	4154,044	164,970	0,000
Error	8385,133	333	25,181		
Total	2119485,320	337			
Corrected Total	16698,848	336			

Table 4 provides information on the differences among the learning models used in this study, showing an F-value of 164,970 with a significance value (Sig.) of 0,000, which is smaller than a = 0,05. This indicates that the hypothesis "the PENTI learning model has an effect on students' creative thinking skills" is pported. Following the confirmation of the hypothesis, a post hoc LSD test was conducted, and the results are summarized in table 5.

Table 5. Summary of LSD Test Results Based on Learning Models

Class	Initial Test	Final Test	Change	Corrected Average	Increase (%)	LSD Notation
Conventional	67,19	75,08	75,07	75,07	11,8	a
STAD	67,91	75,81	75,81	75,81	11,6	b
PENTI	68,01	85,92	85,93	85,93	26,3	c

Students' creative thinking skills in classes using the PENTI learning model showed a significant difference compared to those in classes using the STAD and Conventional models, as evidenced by the differences in notations among the three learning models. Table 4 reveals difference in the adjusted mean scores among the models, with the PENTI model achieving the highest score (85,93), followed by the STAD model (75,81) and the Conventional model (75,07). Students taught using the PENTI model achieved better results than those taught using the STAD or Conventional models. Based on these findings, the PENTI learning model has the potential to serve as an alternative approach to improving students' creative thinking skills.

DISCUSSION

The statistical analysis results show that the PENTI learning model has a positive impact on students' creative thinking skills. The implementation of the PENTI model successfully fostered a significant improvement in creative thinking scores, as evidenced by the posttest results. This improvement is supported by the PENTI syntax, which emphasizes learning while valuing the cultural heritage of Manggarai.[58] Furthermore, the model effectively enhances students' learning interest and provides space for active engagement beyond merely receiving information. Previous studies support these findings, indicating that learning models based on local wisdom, such as PENTI, are effective in enhancing students' creative thinking skills through relevant problem-solving contexts.[59] The integration of ethnoscience and creative thinking stages has also been shown to create

meaningful learning experiences and strengthen appreciation for local culture.[60]

The PENTI learning model emphasizes collaboration and mutual cooperation in the learning process. This approach aligns with the principles of cooperative learning, which aim to increase student participation, facilitate leadership experiences, and develop the social skills needed for group work. According to [61], cooperative learning is effective in improving student participation, leadership skills, and social competencies for collaboration while also enhancing academic outcomes and interpersonal relationships. This idea is supported by research showing that cooperative learning improves academic performance, active participation, and student collaboration, aligning with the goals of the PENTI model.[62] Findings by [63] indicate that cooperative learning provides students with opportunities to act as leaders, make decisions, and develop social skills, all of which are integral to the PENTI model's emphasis on achieving shared learning goals.

In the first stage of the PENTI learning model, Preview, students are encouraged to build initial understanding through gathering and organizing information, reflecting the principle of *bantang sama* or "*sitting together*" in Manggarai culture. This principle underscores collective preparation to strengthen solidarity and cooperation. Through this stage, students learn to collaborate, build ideas collectively, and share understanding to achieve common learning objectives while embedding values of solidarity. The structured Preview stage has been shown to support the development of creative thinking skills through reflection and idea organization [64], yielding significant improvements in flexibility and originality of thought.[65] From a cognitive theory perspective, the Preview stage helps students connect new information to prior knowledge, strengthening mental schemas.[66] Meanwhile, social cognitive theory emphasizes that learning is influenced by the interaction between individuals and their environment.[67] Additionally, the Preview process aligns with information processing theory, which explains how informis absorbed, stored, and retrieved from memory.[68]

In the second stage of the PENTI learning model, Exploration, students are encouraged to gather, organize, and connect new information with their prior knowledge, resembling the process in the *barong boa* ritual during the *Penti* ceremony in Manggarai. Through *barong boa*, the Manggarai community deepens their understanding of cultural values by honoring their ancestors, strengthening communal bonds. Similarly, exploration in learning enriches students' knowledge, enabling them to discover new ideas, solve complex problems, and sharpen creative thinking skills.[69] This approach also fosters critical thinking and encourages innovation in the classroom.[70] Based on constructivist theory, knowledge is constructed through interactions with the environment and new information.[71] Discovery learning theory [72] highlights the importance of hands-on experiences in learning, while sociocultural theory [73] emphasizes the role of social interaction in the learning process.

The third stage of the PENTI learning model, Narrative, plays a vital role in enhancing students' creative thinking skills by organizing information into meaningful stories. This process reflects the *barong Lodok* ritual in the *Penti* tradition of Manggarai, where symbolic narratives such as lingko and haju teno strengthen the relationship between humans, nature, and ancestors, while internalizing cultural values and environmental preservation.[30] The narrative approach in learning helps students connect new knowledge with their experiences, formulate ideas reflectively, and solve complex problems logically.[74] This ritual aligns with constructivist and sociocultural theories, emphasizing the importance of experiential and social interactions in building knowledge.[71,73] By adapting the narrative values of *barong Lodok*, students can develop creative thinking skills and understand the logical and sustainable meanings of learning.[75]

The fourth stage of the PENTI learning model, Transfer, plays a crucial role in enhancing creative thinking skills by encouraging students to apply their knowledge in new situations. The transfer process involves applying learned concepts to different contexts, enabling students to think creatively and devise innovative solutions.[76,77] This process aligns with the *barong wae* ritual in the *Penti* tradition of the Manggarai community, where cultural and spiritual values are applied to honor the guardian spirits of water, strengthening the connection with nature and ancestors.[29] The *barong wae* reflects the transfer of intergenerational knowledge through collective practices of preserving water resources. Social cognitive theory supports this perspective by emphasizing the importance of social interaction in the learning process.[47] The *barong wae* ritual embodies this practice through collective processes that reinforce the community's symbolic understanding. By intering the values of *barong wae*, students can develop creative thinking skills through meaningful experiences relevant to their sociocultural.

The fifth stage of the PENTI learning model, Inference, is critical for improving students' creative thinking skills through the reinforcement of understanding, decision-making, and deeper cognitive processes. Inference enables students to develop more profound comprehension, supporting creative and adaptive thinking in tackling new tasks.[64,78] This process aligns with the *barong boa* ritual in the *Penti* tradition, which serves as an expression of gratitude to ancestors and a form of collective reflection. Reflection in *barong boa* parallels inference, where the community draws conclusions from experiences to make collective decisions that strengthen social solidarity. Constructivist theory supports the reinforcement of understanding through reflective conclusion-making,[50] while social cognitive theory highlights the importance of social interaction and feedback.[79] By adapting the values of *barong boa*, students can develop creative thinking skills through

meaningful and culturally relevant reflection. The *barong boa* ritual is an integral part of the *Penti* celebration, encompassing spiritual, ecological, and social dimensions to maintain harmony between humans, nature, and the spiritual world.[80]

The PENTI model, with its relevant and contextual approach, enhances students' motivation and engagement by encouraging them to apply concepts in familiar contexts. The integration of cultural values and local knowledge broadens problem-solving perspectives.[81] This approach fosters analytical and reflective thinking skills while promoting emotional engagement that motivates deeper reflection.[82] The creative thinking skills developed are more applicable because students learn in real-life contexts,[83] preparing them to address challenges in more creative and effective ways.[84]

On the other hand, the STAD cooperative model has also been proven to be more effective than the conventional model, despite the slight difference in the adjusted mean scores. This effectiveness is primarily due to its emphasis on teamwork and active interaction among students.[34] Through group discussions, students can share ideas, receive feedback, and engage in collaborative learning that enriches their perspectives.[40] This approach facilitates more dynamic learning and participation,[85] in contrast to the conventional model, which tends to be more passive and dominated by one-way lectures from the teacher.[86] As a result, the conventional model is often insufficient in stimulating creative thinking skills,[87] making the STAD cooperative model a better choice for developing these skills in educational settings.[34]

The differences in creative thinking scores among the PENTI, STAD, and conventional classes are also influenced by the variations in learning models applied in each class. The PENTI model, which emphasizes exploration and collaboration, aligns with constructivist learning theory, which posits that knowledge is built through active engagement and exploration. This model provides students with more opportunities to develop new ideas, as research indicates that constructivist-based methods significantly enhance creative thinking skills.[88] Meanwhile, the STAD model focuses on structured and collaborative teamwork, fostering social interaction and collective problem-solving, both of which are crucial for the development of creative thinking.[89] In contrast, conventional classes often rely on passive teaching methods such as lectures and rote memorization.[90] Studies have shown that such passive environments limit students' opportunities to engage in active processes, thereby reducing their potential for creative thinking compared to active and student-centered approaches.[91]

This study is limited to specific variables and subjects at the high school level. To gain a deeper understanding of the effectiveness of the PENTI model, further research could explore its application to other subjects at the higher education level.

CONCLUSION

The research results indicate that the PENTI learning model has a significant impact on enhancing students' creative thinking skills, with an average score of 85,92. These findings suggest that the implementation of the PENTI model can effectively improve high school students' creative thinking skills, making it a relevant and innovative learning model.

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