




INCREASING HIGH SCHOOL STUDENTS' CREATIVITY IN LOCAL WISDOM-BASED ENVIRONMENTAL STUDIES THROUGH THE PROJECT-BASED LEARNING MODEL

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ARTICLE INFO	ABSTRACT
<p>Keywords: PjBL model; local wisdom; student creativity</p> <p><i>Article History:</i> Received: 2024-02-14 Accepted: 2024-04-21 Published: 2024-04-25 *Corresponding Author Email: aganihaji@usk.ac.id doi:10.20961/jkpk.v9i1.85224</p>  <p>© 2024 The Authors. This open-access article is distributed under a (CC-BY-SA License)</p>	<p>Enhancing creativity through education enriched with local wisdom is essential, allowing students to delve into new ideas and information about chemical concepts through everyday phenomena. This research investigates the impact of a Project-Based Learning (PjBL) model infused with local wisdom on student creativity. A quasi-experimental design with pretest-posttest control groups was utilized. The participants were eleventh-grade students selected via purposive sampling. The study employed questionnaires and observation sheets as instruments. The procedure demonstrated that PjBL, enriched with local wisdom, significantly fosters student creativity by supporting authentic learning experiences and encouraging innovative ideas. In contrast, direct instruction predominantly centers on teacher-led activities, with minimal direct student engagement. The data analysis included average difference tests, N-gain, and percentage analysis. Results indicated a notable improvement in student creativity within the PjBL group compared to the control, with statistical significance at $0.000 < 0.05$. N-gain scores were medium (0.44) for the experimental group and low (0.25) for the control. Creativity scores in the experimental group were high across all indicators—preparation, person, process, product, and press—ranging from 93.6 to 96.8. In contrast, the control group scored in the medium range from 66.7 to 72.6. This evidence suggests that the PjBL model effectively enhances student creativity by contextually integrating hydrocarbon chemical concepts with local wisdom. Therefore, this approach achieves curriculum goals and motivates educators and students to embrace and apply local wisdom creatively in their learning processes.</p>
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INTRODUCTION

In the 21st-century educational landscape, students are expected to develop competencies across four key areas, one of which is creativity [1]. Creativity is increasingly recognized as crucial for preparing students to effectively navigate complex changes and global challenges. This

educational focus extends beyond the mere transfer of technical knowledge and skills, aiming also to cultivate resilience, social skills, and adaptability to evolving contexts.

From an educational standpoint, creativity is characterized by generating novel and unconventional products intended to be beneficial [2], [3]. A significant method

of fostering creativity involves integrating local wisdom into learning processes. Strategies incorporating local wisdom into science education include identifying and utilizing local resources and strengths that schools can leverage [4]. This approach enriches learning experiences and ensures that education remains contextually relevant and deeply interconnected with students' cultural backgrounds.

Local wisdom encompasses knowledge that communities develop through experience and adaptation to their local environments [5], [6], [7]. In educational settings, fostering students' creative thinking becomes essential, particularly in subjects like chemistry, which enhances the ability to interpret representations [8]. Additionally, creativity enables students to use their imagination for problem-solving, applying innovative and inventive approaches [9], [10]. Local wisdom may include various aspects such as knowledge, skills, intelligence, resources, social processes, values, norms, and customs [11].

Observations in several high schools in Aceh Province—a region known for its rich local wisdom—reveal that many students lack creativity in linking educational material to real-life phenomena. Traditionally, instruction in these schools has been predominantly teacher-centered, relying heavily on lectures, standard discussions, and demonstrations. Such conventional methods are increasingly inadequate due to the dynamic nature of the 21st-century educational landscape, which demands innovative approaches. Project-Based Learning (PjBL) emerges as a promising

instructional innovation designed to better engage students in learning by integrating knowledge acquisition with developing essential skills [12]. This approach encourages active student participation and makes learning more relevant by connecting it with local wisdom and real-world problems.

Aceh is a province rich in diverse local wisdom that permeates the general society. Various elements of this wisdom can be integrated into chemistry education. For example, the production of shrimp paste, which involves colloidal properties, or the coconut oil extraction from fermented coconut (minyruk simple and minyruk like u) involving concepts such as water content's role, free fatty acids, iodine values, peroxide values, hydrolysis, and oxidation processes. Other examples include the dehydration process in dried starfruit (suntan acid), vinegar usage in processed meats (sie robot), and the preservation of dried fish (keumamah) through the addition of kitchen ash, as well as the traditional production of banana sale.

This study explores the Malamang tradition, where sticky rice is cooked using bamboo and burning coals from local waste materials like coconut husks, shells, or palm fronds before significant Islamic holidays. This tradition remains preserved, utilizing these natural and locally sourced materials instead of modern fuels like kerosene or gas. Integrating such traditions into the curriculum ensures they are preserved over time while providing students with a contextual learning experience that enriches their understanding of chemistry. Incorporating local wisdom into education enhances students' engagement

and poses various challenges for educators, including resource limitations, specific teacher training, and curriculum inflexibility [13-14].

Project-based learning (PjBL) integrated with local wisdom offers a pathway to meaningful and engaging educational experiences. This approach not only cultivates creativity and innovation among students but also enhances their problem-solving skills. PjBL is recognized for its potential to make learning more engaging and relevant, significantly improving students' scientific understanding and performance in chemistry [15]. It also promotes maximum creativity [16], fosters teamwork [17-18], and provides students with extensive hands-on experience [19], [20].

Integrating environmentally friendly practices with local wisdom in chemistry education is vital to natural sustainability, emphasizing the relevance of traditional knowledge in contemporary education. The primary objective of this research is to investigate the impact of a PjBL model that incorporates local wisdom on student creativity within chemistry courses. This study aligns with the goals of the 2013 curriculum, which emphasizes contextual learning and encourages students to develop independent problem-solving skills.

METHODS

1. Research Design

This study employs a quantitative approach using a quasi-experimental design with a pretest-posttest control group format. This design was chosen to compare the effects of a local wisdom-based Project Based Learning (PjBL) model against

traditional direct instruction (DI) methods in enhancing students' creativity.

2. Participants

The population for this study comprised all eleventh-grade students at a high school. The school selected for this research has a B accreditation and follows the 2013 curriculum. Purposive sampling was utilized to select the sample, driven by specific characteristics, including the results of a homogeneity test, which indicated a significance value of $0.783 > 0.05$. This value suggests that the sample groups are drawn from a population with equivalent variance, affirming their homogeneity regarding initial student capabilities. Consequently, the sample consisted of two groups from the science program, labeled Science Program A and Science Program B, comprising 26 students.

3. Instruments

The instruments used in this research were questionnaires and observation sheets. In developing the instrument, testing it on a small sample is carried out first, then testing its validity and reliability. The type of questions used uses a Likert scale in the form of an open questionnaire. The instrument testing activities carried out aim to ensure clarity and relevance.

4. Data collection methods

The data collection procedure begins with instrument testing on a small sample of 15 students. The trial was carried out for one week. After the instrument was declared valid

and reliable, the researcher conducted the research process in the experimental class through the local wisdom-based PjBL model and in the class through the DI model. In the initial stage, the researcher conducted the research by distributing a pretest (questionnaire) to both classes, then providing learning treatment to the experimental class through the PjBL model containing local wisdom and the DI model control class where during the treatment direct observations were made of the level of creativity of students in both classes. The final stage is conducting a posttest by giving a questionnaire.

5. Data analysis

The data analysis technique is to conduct a t-test to determine the average level of difference in students' creativity in the experimental and control classes before and after implementing the learning treatment. N-Gain analysis will determine the increase in student creativity before and after implementing the learning treatment—percentage analysis to determine the increase in students' creative abilities.

RESULTS AND DISCUSSION

Student creativity is essential for integrating theoretical knowledge with real-world phenomena. It manifests as the ability to generate new ideas and innovative solutions [21]. Recognizing this, educational strategies that foster creativity through direct experience are crucial. Project-based learning (PjBL), in particular, empowers students to take ownership of their learning

by developing and realizing their ideas through project execution.

This study assessed student creativity using two primary instruments: questionnaires and observation sheets. These tools helped evaluate the creativity levels among students engaging with a PjBL model incorporating local wisdom. The findings from this research indicate a significant enhancement in students' creative abilities. This improvement is attributed to the opportunity provided by the PjBL approach for students to deeply explore and innovate upon the local wisdom and cultural values present in their environment, linking them creatively with chemical concepts. This method reinforces their understanding and encourages a practical application of academic theories, demonstrating the effectiveness of integrating PjBL with elements of local wisdom in educational settings.

1. Results of Analysis of Student Creativity Through Questionnaire Answers

An analysis of student creativity was conducted to test the hypothesis that implementing the Project-based Learning (PjBL) model, infused with local wisdom, influences student creativity in chemistry classes. This analysis was facilitated through a questionnaire comprising 20 questions, which included both positive and negative statements. The purpose of this creativity questionnaire was to gauge student responses before and after the instructional interventions in both the experimental and control classes. The experimental group employed the PjBL model enriched with local

wisdom, while the control group utilized the Direct Instruction (DI) model. When discussing specific outcomes, such as creativity scores or the impact of PjBL, it is essential to relate these findings to the

original hypothesis or research question to maintain coherence. Detailed results concerning the average increase in student creativity in both the experimental and control groups are presented [Figure 1](#).

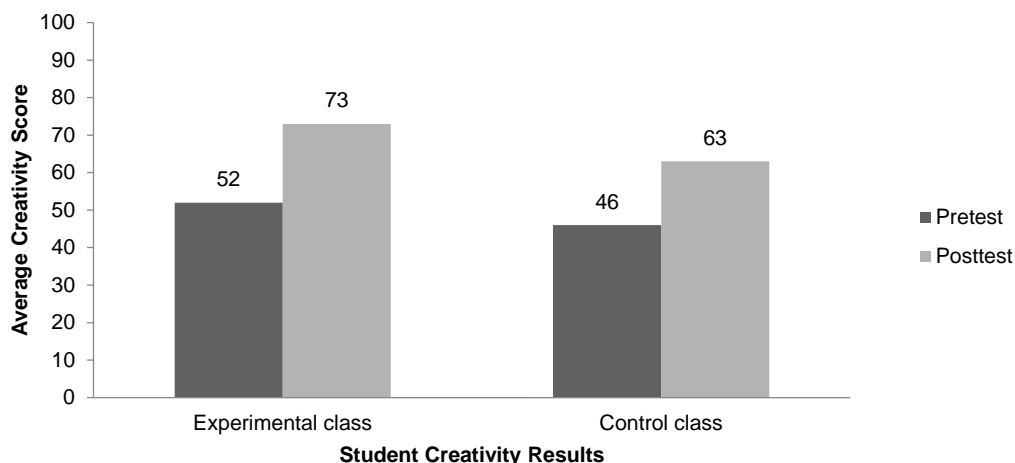


Figure 1. Average Results of Student Creativity

[Figure 1](#) shows the average creativity of students after implementing the learning treatment. The analysis of students' creativity in the experimental class obtained an average of 73.0, higher than the control class of 63.0. The findings prove that the average creativity of students in the experimental class using the wisdom-based PjBL model is higher than that of the control class using the DI model. The low creativity of students in the control class is because the implementation of learning does not involve students directly in expressing various new ideas from their learning experiences. Therefore, the PjBL model is considered more suitable for integrating learning that focuses on students and increasing learning experiences that innovate scientifically. This aligns with previous research that the PjBL model can be used as an alternative learning modality to improve students' creative thinking, critical

thinking, communication, and collaboration skills [22].

Higher creativity scores in the experimental group indicate an enhanced ability among students to design projects from the initial preparation stage through to the generation of innovative ideas and the production process. Consistent with the findings of [23], the use of the Project-based Learning (PjBL) model is deemed effective because learning is inherently linked to project work. Thus, project-based learning fosters creativity and innovation, grounded in achievements documented in students' learning outcomes. This enhancement in creativity is evident from students' improved knowledge and their ability to discern connections between diverse concepts, forming a robust foundation for creative thinking [24].

The findings indicate that the high creativity scores in the experimental class can be attributed to the pivotal role of the PjBL model in enhancing student learning. This effectiveness stems from the students' ability to contextually integrate local wisdom into chemistry material. Students have utilized local waste materials such as palm fronds and shells as substitutes for conventional hydrocarbon fuels, exploiting the inherent value of local wisdom as an alternative to depleting resources like gas or petroleum. Through project learning, students are actively involved in repurposing waste from their surroundings. Integrating project-based learning with local wisdom yields meaningful, creative, and innovative educational experiences because it compels students to construct "bridges" connecting various material objects [14]. By employing a PjBL framework rooted in local wisdom, students are equipped to harness natural resources such as waste to enhance the cultural values and traditions of their communities.

The creativity exhibited by students in utilizing local waste products like coconut

shells, palm shells, coconut fronds, and palm fronds as fuel showcases the values of local wisdom. In particular regions, such as Aceh, the *melemang* tradition—a method of using charcoal as fuel—is a deeply entrenched cultural practice. This utilization of natural products as eco-friendly hydrocarbon fuels underscores the PjBL model's effectiveness in fostering student creativity. The PjBL model promotes contextual learning through complex activities that grant students autonomy to explore, plan educational activities, engage in collaborative projects, and ultimately produce tangible outcomes [25]. Therefore, PjBL grounded in local wisdom not only enhances students' chemistry learning outcomes but also provides them opportunities to leverage natural resources and sustain local cultural and environmental practices. Additionally, the increase in students' creativity, as measured by the N-Gain, further elucidates the methodological strengths of this approach. Detailed results of this analysis are depicted in Figure 2.

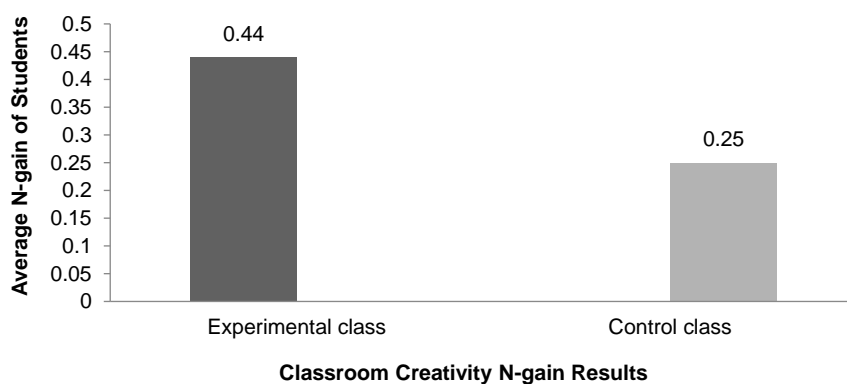


Figure 2. Average N-gain Results for Student Creativity

Figure 2 illustrates the enhancement in student creativity as evidenced by the results from the N-gain analysis. According to the data, the average N-gain score for the experimental class was 0.44, categorized as medium, whereas the control class scored 0.25, categorized as low. This data analysis confirms that the results of creativity assessment through N-gain in the experimental class, which employs the PjBL model, surpass those of the control class using the Direct Instruction (DI) model. The necessity for creative learning in classrooms is underscored by the presence of various innovative practices [26]. Additionally, the integration of a local wisdom approach positively impacts communal living [27]. Consistent with [28], the integration of material related to local wisdom enhances understanding among students unfamiliar with their regional traditions. Therefore, linking chemistry education with local wisdom not only motivates students to learn independently but also enables them to utilize local waste resources effectively.

This research also sheds light on the importance of motivation and educational resources that contribute to product

development through the exploitation of local wisdom. The aim is to foster the creativity of educators and students by incorporating experiential learning and promoting innovation in scientific education.

Further findings demonstrate an increase in students' creativity, particularly in their ability to use natural products such as palm frond waste as alternative materials for creating substitutes for gas and oil. Students have successfully linked hydrocarbon chemical materials with local wisdom values, enhancing learning outcomes through collaborative problem-solving within their study groups. This approach aligns with the PjBL model's goal of fostering 21st-century skills [29]. Moreover, fostering student creativity is paramount in the rapidly evolving educational landscape [30].

To determine the variance in student creativity before and after the educational interventions, an independent sample t-test was conducted to examine the differences in mean creativity scores. The results of this analysis, detailing the differences in students' creativity before and after the learning interventions, are presented in Tables 1 and 2.

Table 1. Average Difference Test Results for Students' Creativity Before Treatment

Class	Normality	Homogeneity	Significance
Experimental	0,082 > 0,05 (normally distributed)	0,306 > 0,05 (homogeneous)	0,017 > 0,05 (there are significant differences)
Control	0,200 > 0,05 (normally distributed)		

Table 1 presents the results from the analysis of differences in average creativity among students. Prior to the learning interventions, the Kolmogorov-Smirnov normality test for both the experimental and

control classes showed significance values (Sig) for all data > 0.05, indicating that the research data were normally distributed. The homogeneity test yielded a Sig Based on Mean value of 0.306 > 0.05, confirming that

the variances in the experimental and control class data were equal or homogeneous.

The independent sample t-test on students' creativity before the implementation of the learning treatments in both the experimental and control classes yielded a Sig. (2-tailed) value of 0.017. A Sig. (2-tailed) value < 0.05 would indicate a significant difference between the creativity levels of the experimental and control classes; however, this was not the case here. Initial creativity abilities of students were relatively low, likely

due to insufficient exposure to supportive learning models or methods. The observed increase in creativity not only underscores the effectiveness of the Project-Based Learning (PjBL) approach but also highlights the potential of students to leverage local wisdom values in their learning. The potential of students to utilize the local wisdom values surrounding them is evident. For the analysis of hypothesis testing in both the experimental and control classes after the learning treatment, refer to [Table 2](#).

Table 2. Average Difference Test Results for Student Creativity After Treatment

Class	Normality	Homogeneity	Significance
Experimental	0,144 $> 0,05$ (normally distributed)	0,863 $> 0,05$ (homogeneous)	0,000 $< 0,05$ (there are significant differences)
Control	0,200 $> 0,05$ (normally distributed)		

[Table 2](#) displays the results of hypothesis testing in the experimental and control classes after the implementation of the learning treatments. The Kolmogorov-Smirnov normality test yielded significance values (Sig) of 0.144 and 0.200 for the experimental and control classes, respectively, both exceeding 0.05, indicating that the data were normally distributed. The homogeneity tests for these classes showed a Sig Based on Mean value of $0.863 > 0.05$, confirming that the data variances in the experimental and control classes were homogeneous.

The independent sample t-test between the experimental and control classes revealed a Sig (2-tailed) value of 0.000. A Sig (2-tailed) value < 0.05 indicates a significant difference in creativity between students in the experimental and control classes. This significant difference

underscores the impact of integrating local wisdom into the Project-Based Learning (PjBL) model, enhancing students' creativity in developing products imbued with local cultural values, such as those demonstrated through the traditional "melamang" practice in Aceh. Here, the community leverages local wisdom, transforming waste into useful hydrocarbon compounds. Consistent with prior studies, PjBL rooted in local wisdom significantly boosts student creativity by fostering active engagement in analyzing and resolving specific project challenges [31].

The research findings further demonstrate that, compared to the control group, the experimental group exhibited enhanced creativity. This enhancement aligns with findings by [32], where the PjBL model, augmented by local wisdom, not only increased student enthusiasm and activity but also deepened their understanding of

local culture, thereby facilitating effective learning through PjBL supported by local wisdom.

2. Results of Analysis of Student Creativity Through Observation Sheets

The analysis of student creativity was conducted through observations from the onset of learning implementation to the evaluation stage, covering four stages:

preparation, person, process, product, and press. The involvement of Project-based Learning (PjBL) and local wisdom significantly influences student participation and creativity in chemistry lessons. Figure 3 depicts the average results of student creativity indicators as observed by three different observers.

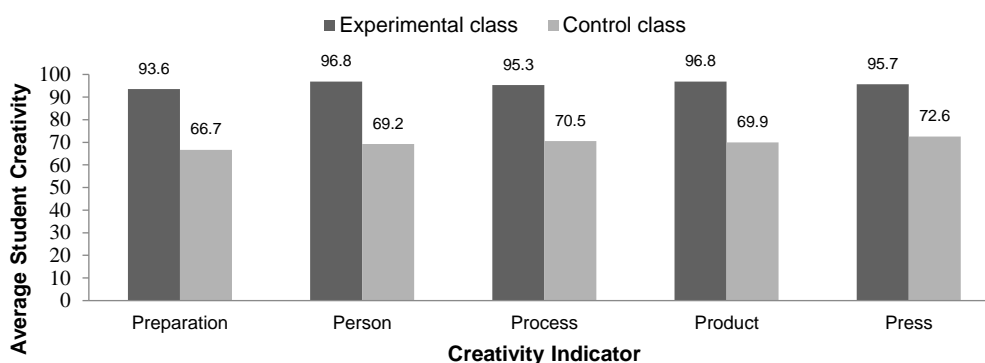


Figure 3. Average Percentage of Student Creativity Perindicator

According to Figure 3, the analysis of the average percentage of student creativity indicators shows that the experimental class achieved an average percentage of over 90, while the control class scored less than 80. These results suggest that student involvement in the PjBL model greatly exceeds that in the Direct Instruction (DI) model in fostering creativity. The PjBL model enriched with local wisdom evidently enhances student creativity across all stages—preparation, person, process, product, and press. This aligns with [33], which posits that the assessment of students' creativity encompasses four dimensions—person, process, press, product—collectively known as the four P's of creativity, and has not been comprehensively executed, particularly in chemistry education.

Furthermore, as highlighted by [34], a scientifically literate individual is one who (a) possesses an understanding of scientific knowledge and its interrelationships with technology, society, and the environment; (b) engages in cognitive processes to explore knowledge; and (c) adopts scientific thinking as a lifelong habit. According to [35], humans require a structured life system based on their unique culture, which facilitates organizing their experiences through intellectual processes known as local wisdom. Therefore, these findings advocate for the integration of PjBL into the curriculum and emphasize the necessity for educational resources to enhance students' ability to creatively apply and innovate material concepts by

embedding local wisdom in chemistry lessons.

Data analysis revealed that the average creativity indicator for students in the experimental class was categorized as high, while it was medium for the control class. This substantiates that the implementation of the PjBL model incorporating local wisdom significantly boosts students' creativity compared to the control class. As noted by [36], local wisdom encompasses both traditional and contemporary forms, allowing local communities to evolve their wisdom through life experiences and adapt to global influences.

Despite the contributions of this study, it also identifies limitations, such as the need for more educator resources, enhanced educator training, and adequate time allocations for project implementation, paving the way for future research on developing skills to utilize natural products as environmentally friendly and marketable resources. This notion is supported by [13], who asserts that creativity emerges from existing elements and is founded on three main factors: novelty, resolution, and style [37]. In conclusion, this research demonstrates the profound impact of combining PjBL with local wisdom on enhancing student creativity, offering a promising avenue for future educational strategies.

CONCLUSION

The research results indicate that project-based learning (PjBL), integrated with local wisdom, positively impacts student creativity in the context of hydrocarbon compound studies in chemistry education.

This approach facilitates understanding, innovation, and the application of local wisdom values, providing tangible illustrations of chemical concepts through natural products found in the surrounding environment. The findings show a significant difference in student creativity between the experimental and control classes, with a significance value of $0.000 < 0.05$. Analysis of creativity indicators across the stages of preparation, person, process, product, and press reveals that scores in the experimental class ranged from 93.6 to 96.8, categorized as high. In contrast, the control class scores ranged from 66.7 to 72.6, categorized as medium. This research underscores the importance of embedding local wisdom into the curriculum to enhance creativity and student engagement, potentially transforming chemistry education into a more meaningful experience. Integrating PjBL with local wisdom emerges as an innovative approach to nurturing creativity and deeper learning in chemistry education, suggesting a promising direction for future educational strategies.

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