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Implementation of Guided Inquiry Learning Model Based on Local Wisdom of Tapai Jringkeng to Improve Students' Critical Thinking Skills

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Abstract: Higher-order thinking skills are essential for students in the twenty-first century, with critical thinking being one of the most important. Despite its significance, Indonesian students' critical thinking skills often fall short of international standards. This may be attributed to science education that frequently overlooks socio-cultural environments. By integrating guided inquiry learning models with local wisdom, specifically tapai jringkeng, this study aims to examine the improvement of critical thinking skills in the 9-B class at SMPN 1 Kotaanyar. The research utilized a one-group pretest-posttest design involving 23 students. Data were gathered using an essay-based test consisting of five questions and analyzed with the N-gain formula. The findings revealed an N-gain score of 0.77, categorized as a high level, indicating a significant improvement in students' critical thinking skills. The study suggests that incorporating local wisdom into inquiry-based learning can enhance cognitive engagement and foster a deeper understanding of the context. Additionally, this research contributes to science education by offering a culturally responsive teaching model that fosters critical thinking through the inclusion of local wisdom.

Keywords: *critical thinking; guided inquiry; local wisdom*

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INTRODUCTION

In the 21st century, students need to develop advanced skills that are crucial in facing a rapidly changing world (Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2016; Rivalina, 2020; Suharyat et al., 2022). These important skills include critical thinking and problem-solving, collaboration and teamwork, effective communication, and the development of creativity and innovation, collectively referred to as the 4Cs (Khasanah et al., 2019; Wardani & Budiatnya, 2023; Taufiqurrahman, 2023). One of the most significant higher-order thinking skills is critical thinking, which is increasingly important for students as they navigate technological advances and globalization in the Industry 4.0 era (Rahardhian, 2022; Nurfalah et al., 2025). Critical thinking skills are considered a vital cognitive skill due to their significant impact on the quality of students' learning experiences (Alsaleh, 2020). Students with strong critical thinking skills can effectively solve problems in context, making them more effective in dealing with complex situations. Therefore, this skill is the main objective in all subjects, including science education (Mulyanti & Gading, 2023). According to Ennis (2011), the components of critical thinking skills include several indicators, such as basic clarification, basic support, inference, further clarification, and formulation of strategies and tactics.

Recent assessments indicate that the critical thinking skills of Indonesian students still fall short of international standards, as reflected in the results of the Programme for International Student Assessment (PISA). PISA, organized by the Organisation for Economic Cooperation and Development (OECD), measures students' abilities in reading, mathematics, and science globally. Students need critical thinking skills to face PISA questions that contain real-world contexts and require high-level thinking skills (Suprayitno, 2019). The results of PISA 2022 indicate a decline in scores across all three areas compared to 2018. Specifically in science, only 35% of Indonesian students reached Level 2, which involves the ability to apply everyday knowledge and understand basic procedures in recognizing scientific explanations, interpreting data, and designing questions related to experiments. The OECD (2023) also reported that Indonesia is ranked 18th from the bottom in science, while 76% of students in OECD countries have reached Level 2.

Preliminary research at SMPN 1 Kotaanyar revealed that students' critical thinking skills remain low. Based on the test results, only 31.25% of students answered correctly on the basic clarification indicator, 41.25% on the advanced clarification indicator, and 25% of students demonstrated appropriate abilities on the strategy and tactics indicator. Based on the classification of competency levels by Rosmalinda et al. (2021) and Ermayanti and Dwi (2016), 78% of students fall into the low category ($x \leq 60$). This finding confirms the need to improve students' critical thinking skills. Interviews with teachers revealed that the learning methods employed were still conventional, consisting of simple questions and answers without activities that encourage

critical thinking. Additionally, students' learning motivation, particularly in understanding abstract concepts, was relatively low. The local wisdom-based learning approach has not been optimally utilized, as the local context is often used as an example without a thorough exploration of the relevant cultural values.

Students' low critical thinking skills are attributed to a learning approach that overlooks their socio-cultural environment (Temuningsih et al., 2017; Sari et al., 2021; Wahyuni et al., 2025). In addition, many students are more familiar with foreign cultures than their own local knowledge and traditions, thus reducing their sense of nationalism and love for their homeland (Nuralita, 2020). Another major cause is the monotonous teaching method, which often involves lecturing, note-taking, and memorization, making the learning process less engaging (Puspasari et al., 2019). Local wisdom-based education plays a crucial role in developing skills while preserving regional culture, as it enables students to understand knowledge within the context of their familiar culture (Suarningsih, 2019; Farid, 2023; Elvianasti et al., 2023).

Integrating culture into the curriculum is a crucial strategy for addressing the challenges of globalization while preserving national identity (Edi, 2021; Fahmi et al., 2022; Widiatmaka, 2022). Indonesia, with its rich ethnic and cultural diversity, has a great responsibility to protect these noble values through education (Hidayah, 2015). This is in accordance with Law No. 20 of 2003 concerning the National Education System, which emphasizes the importance of community-based education that reflects religious, social, and cultural values, as well as local aspirations and potential. Currently, students' critical thinking skills are still limited to recognizing and identifying basic phenomena. They often struggle to analyze or apply abstract concepts in real-life contexts. For example, although many students can memorize environmental theories, they struggle to apply these theories to real-world problems that occur around them. Therefore, educational innovation is needed, primarily through the integration of local cultural values in the science curriculum (Hadijah et al., 2019; Muyassaroh et al., 2024). The people of Probolinggo, especially in Kotaanyar District, have a variety of local wisdom, one of which is in the field of cassava-based culinary. The geographical conditions in the form of mountains make cassava plants grow well. One of the famous local products is tapai jringkeng, a traditional fermented cassava food typically made during the rainy season. As a simple biotechnology product, *tapai jringkeng* is closely related to the natural sciences and has excellent potential for use as a learning material. Science learning that integrates local wisdom must employ a model that aligns with the characteristics of science and curriculum demands. One suitable model is inquiry-based learning (Priadi et al., 2021; Ramadhan, 2021; Aprizanti, 2023).

Guided inquiry learning that emphasizes active student involvement in building knowledge is very suitable to be combined with local wisdom in science education (Priadi et al., 2021; Ramadhan, 2021; Aprizanti, 2023). This approach enables students to understand scientific concepts through the inquiry process, linking learning to cultural practices and thereby fostering critical thinking skills, creativity, and science literacy (Lestari, 2018; Yolida et al., 2021; Purnamasari et al., 2022). Inquiry learning is effective in improving critical thinking skills in science subjects (Parwati et al., 2020; Devi, 2022: Ramadani et al., 2025). However, there is still limited research that integrates specific local wisdom, such as tapai jringkeng fermentation, into a guided inquiry learning model.

By incorporating this traditional biotechnology process into inquiry-based learning, students can develop a deeper understanding of science through culturally relevant and practical learning experiences that are grounded in real-world applications. Therefore, this study aims to implement a guided inquiry learning model based on the local wisdom of tapai jringkeng fermentation to improve students' critical thinking skills in science learning. This study presents novelty by focusing on specific local cultural practices as the basis for biotechnology learning, thereby encouraging culturally responsive education and strengthening the relevance of science to the local context.

METHODS

The type of research employed in this study is quantitative, utilizing a pre-experimental design. This pre-experimental method is used to determine whether there is a change or not in a condition that is given treatment. The research design employed is a pretest-posttest design, which measures or observes not only after treatment is administered but also before treatment is given (Fraenkel et al., 2023). The pre-experimental research design, also known as the one-group pretest-posttest design, involves a single group that is either determined based on specific reasons or not selected randomly (Fraenkel et al., 2023). This research design has a value that is taken, namely the condition before being given treatment (pretest), then given treatment, namely the application of guided inquiry model learning, then compared with the condition after being given treatment (posttest) which then after the value is compared, the results are presented in the form of an increase in students' critical thinking skills. The one-group pretest-posttest design, as described by Creswell (2017), is outlined in Table 1.

Table 1. Research design

Pretest	Treatment	Posttest
O_1	X	O_2

Note :
O1: Pretest
X: Learning using guided inquiry based on local wisdom "tapai jringkeng"
O2: Posttest

The use of a pre-experimental design in this study is based on several considerations. First, this research is exploratory in nature and aims to obtain preliminary insights into the potential effects of the guided inquiry learning model on students' critical thinking skills. As such, this design serves as an initial step toward more rigorous experimental research. Second, a one-group pretest-posttest design was chosen due to practical limitations in the research context, such as limited class availability and institutional constraints, which made the use of a control group unfeasible. Third, this design offers a simplified yet informative approach to observing gains in critical thinking, particularly when researchers are working with limited time and resources. Lastly, while the design has limited internal validity due to the absence of a control group, it remains a useful approach for testing hypotheses in a specific educational setting. The findings are not intended to be generalized broadly but rather to provide contextual insights that can inform future studies using more robust research designs.

The objective of this study was to determine whether implementing a guided inquiry learning model based on local wisdom, specifically tapai jringkeng, can improve students' critical thinking skills. The research was conducted at SMPN 1 Kotaanyar in Probolinggo Regency, East Java Province. The population of this study consisted of all students in class 9-B. A purposive sampling technique was employed to select participants, with a focus on the 9-B students as the experimental group. This research was conducted in one class with a total of 23 students, representing the 9th grade at the school. Although the number of subjects is limited, this study does not aim for a broad population generalization, but rather to gain an initial understanding of the treatment effects in a specific context. The generalization of the results of this study must be done with caution and supported by further research in a broader context and with a larger sample.

These students received treatment through the application of the guided inquiry learning model integrated with local wisdom, specifically on the topic of food biotechnology. The learning treatment is conducted over two meetings. In the first meeting (3 learning hours), the syntax of the guided inquiry learning model is presented, which involves posing questions or problems, formulating hypotheses, designing experiments, and conducting experiments to obtain data. In the second meeting (2 learning hours), the syntax of the guided inquiry learning model involves collecting and analyzing data to conclude. This separation of syntax is done because students need time to carry out the fermentation of tapai jringkeng for two days. The researcher administered a critical thinking skills test during both the pretest and posttest sessions. The test consisted of six essay questions that reflected three critical thinking indicators proposed by Ennis (2011), namely: 1) Elementary Clarification; 2) Advanced Clarification; and 3) Strategy and Tactics. Students were given 40 minutes to complete the test. The critical thinking skills test sheet has undergone validity testing by three validators and has been declared valid for use in testing. This test is conducted at the end of the second meeting. Data processing in this study uses N-Gain analysis of pretest and posttest scores. The N-gain calculation is performed to determine the extent to which the students' learning outcomes have improved. The results of the calculation are then viewed in the N-Gain score interpretation category, as in Table 2 (Hake, 1998).

Table 2. Interpretation of N-Gain Score

N- Gain Score	Category
N – Gain >0,70	High
0,30 ≤ N – Gain ≥ 0,7	Medium
N – Gain < 0,30	Low

In addition to n-gain analysis, the researchers also conducted statistical analysis for significance testing (paired t-test). Before performing the significance test, the researchers also conducted a normality test of the data to ensure that the obtained data were normally distributed. The paired t-test is conducted to test the hypothesis and determine if there are statistically significant differences between the pretest and posttest scores. The paired T-test is performed using SPSS (Statistical Package for the Social Sciences).

RESULT AND DISCUSSION

The improvement in students' critical thinking skills was evaluated by analyzing the results of the pretest and posttest. The pretest was given before treatment, and the posttest was administered after implementing

the guided inquiry learning model based on local wisdom. The pretest and posttest scores are presented in Table 3.

Table 3. Pretest and Posttest Results of Critical Thinking Skills for Class 9-B

Name	Pretest	Category	Posttest	Category
ADD	38	NP	79	P
AMS	54	NP	92	P
APEA	33	NP	83	P
AAP	63	NP	100	P
DMI	63	NP	100	P
FYP	42	NP	79	P
MZS	33	NP	88	P
MFOD	21	NP	67	P
MIF	46	NP	88	P
MRF	63	NP	96	P
MAP	46	NP	83	P
MB	67	NP	92	P
MRU	42	NP	83	P
NH	58	NP	88	P
NDK	50	NP	92	P
REP	63	NP	96	P
RAJ	42	NP	83	P
RS	58	NP	92	P
SI	46	NP	92	P
SLP	42	NP	88	P
SWN	54	NP	96	P
VAZ	54	NP	92	P
VAR	58	NP	88	P

Note:
NP (Not Pass): If the score < 75
P (Pass): If the score ≥ 75

According to Table 3, none of the students had yet achieved mastery in the pretest results. However, in the posttest results, all students successfully met the established minimum competency standard or passing grade. The low pretest scores were attributed to students not having received prior instruction in the science material, which made it difficult for them to answer the questions (Hilal, 2021). Additionally, the test questions required critical thinking skills, which further contributed to students' difficulties (Dewi et al., 2019). The pretest and posttest scores were analyzed using the N-Gain test to determine whether there was an improvement in students' critical thinking skills before and after implementing the guided inquiry learning model based on the local wisdom of *tapai jringkeng*. The results are illustrated in Figure 1.

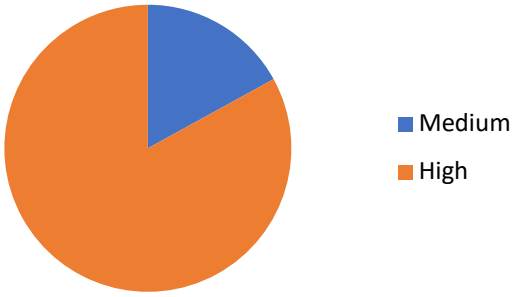

Figure 1. Students' N-Gain Score

According to Figure 1, 17% of students experienced a moderate increase, while 83% showed a high increase in critical thinking skills. Each student obtained a different N-Gain score due to variations in their intellectual development (Kristin, 2016). According to Wayudi et al. (2020), intellectual development is a key factor influencing differences in critical thinking abilities. The level of intelligence each student possesses plays a role in their intellectual growth. Students with higher intelligence tend to absorb information more easily and solve problems more effectively than those with lower intelligence (Sarifah & Nurita, 2023). The average N-gain scores of students are presented in Table 4.

Table 4. Average Results of N-gain Analysis of Critical Thinking Skills of Class 9-B Students

Critical Thinking Skills		N-Gain	Category
Pretest	Posttest		
49	89	0,77	High

Table 4 presents the average N-Gain test results obtained from students' pretest and posttest scores in critical thinking skills. The average pretest score was 49, while the average posttest score was 89. The data were analyzed using the N-Gain test, yielding a score of 0.77, which falls into the high category. These results indicate a significant improvement in students' critical thinking skills before and after implementing the guided inquiry learning model based on the local wisdom of tapai jringkeng, particularly in the conventional biotechnology topic. The results of the normality test on the research data show that the data are normally distributed. Thus, the data meet the assumptions for further analysis using the significance test. The normality test and paired t-test were carried out using SPSS software, and the results are presented in Tables 5 and 6.

Table 5. Normality test

	Number of Students (N)	Mean	Sig.
Pretest	23	49,39	0,292
Posttest	23	88,57	0,099

Table 6. Paired t-test

Paired Samples Test				
		t	df	sig. (2-tailed)
Pair 1	Pretest-posttest	-27,387	22	0,000

Based on Table 6, the significance value obtained is 0.000. This value is less than 0.05, so H0 is rejected and H1 is accepted. There is a significant increase in the average results of students' critical thinking skills between before (M = 49.39, SD = 11.80) and after the implementation of the guided inquiry learning model based on local wisdom "tapai jringkeng" (M = 76.57, SD = 15.54). The implementation of the guided inquiry learning model in this study effectively enhanced students' critical thinking skills. This finding aligns with Widiya and Radia (2023), Devi (2022), and Panggabeyan (2022), who stated that guided inquiry can improve students' critical thinking and academic achievement. Through guided inquiry, students are encouraged to think critically, actively participate in the learning process, and discover concepts with the support of their teachers' guidance. This guidance is provided in the form of directed questions, enabling students to think critically and creatively when analyzing and finding solutions to the given problems (Indawati & Sukarmin, 2021; Mulyanti & Gading, 2023).

The integration of local wisdom in the implementation of the guided inquiry model also plays a crucial role in enhancing students' critical thinking skills. This aligns with the study by Rakhmani et al. (2023), which found that the scientific knowledge of fermentation in making peuyeum has the potential to develop critical thinking skills in middle school students. The fermentation process in making peuyeum is similar to that of tapai jringkeng, which was used in this study. Additionally, using teaching materials that incorporate local wisdom in science education has been shown to significantly improve students' critical thinking skills (Irhasyuarna et al., 2022). The critical thinking skills employed in this study include elementary clarification, Advanced Clarification, and setting strategies and tactics. The results of the N-Gain Analysis for each indicator are presented in Table 7.

Table 7. Recapitulation of N-Gain Results for Each Critical Thinking Skills Indicator

CTS Indicator	Question number	Average		N-Gain	Category
		Pretest	Posttest		
Elementary Clarification	1,2	65	82	0,47	Medium
Advanced Clarification	3,4	40	98	0,96	High
Strategy and Tactics	5,6	43	86	0,75	High

Students received an average score of 65 on the pretest and 82 on the posttest for the first indicator, "Elementary Clarification" (questions 1 and 2). The N-Gain value of this indicator, which was 0.47, was classified as medium. The average pretest score for the second indicator, "Advanced Clarification" (questions 3 and 4), was 40, whereas the average posttest score was 98. This indicator's N-Gain value was 0.96, which is considered high. The average pretest score for the third indicator, "Developing Strategies and Tactics," was 43, whereas the average posttest score was 86. This indicator's N-Gain value was 0.75, which is likewise considered high.

The indicator of Elementary Clarification is practiced when students identify problems, formulate questions, and answer them based on theory. To strengthen their critical thinking skills, students are allowed to investigate and evaluate the problems presented at this stage (Falentina et al., 2020). The presentation of problems in learning can motivate students to think critically and find answers to the questions asked (Sarifah & Nurita, 2023). At this stage, students are allowed to develop their critical thinking skills through exploration and analysis of the problems presented (Falentina et al., 2020). The presentation of this problem will motivate students to think critically and provide answers to the questions posed in the problem (Sarifah & Nurita, 2023). The results of the analysis show that the N-Gain score for the simple explanation indicator is 0.47, which is the lowest score among all indicators and falls within the moderate improvement category. This low score is due to the lack of practice in formulating problems and hypotheses during observation activities. In the context of local wisdom, when facing problem literacy, students can identify factors that affect the quality of tapai jringkeng, such as the amount of yeast used. However, they still struggle to formulate problems and hypotheses correctly. This is due to students' limited understanding of the fundamental components of research, including independent variables, dependent variables, and the formulation of hypotheses. This condition indicates that, although students can recognize relevant phenomena, they still require additional guidance in transforming these observations into structured scientific problems and conjectures. Critical thinking skills do not develop instantly but require a long process and habituation (Sugiyarto & Karyanto, 2024). According to Kurniahtunnisa et al. (2016), critical thinking should be taught gradually and continuously through teacher guidance, so that students are accustomed to using it in the learning process. Furthermore, consistent and repeated practice can help improve students' critical thinking skills more effectively (Alsaleh, 2020).

The Advanced Clarification indicator is practiced during the data analysis stage to inform the formulation of conclusions. This is because students are required to design actions to test hypotheses and elaborate on the results obtained (Badi'ah et al., 2023). In this study, the indicators trained include the ability to construct or organize arguments, link various information logically, and formulate definitions. This indicator shows a high increase with an N-Gain score of 0.96. During the experimental activity of making tapai jringkeng with different yeast compositions, students were asked to reflect on the fermentation results obtained in relation to previously formulated hypotheses. This process allows them to reject incorrect or mistaken assumptions regarding the effect of the amount of yeast on the texture and taste of tapai. This activity helps students build arguments systematically and logically, enabling them to formulate definitions based on the concepts of fermentation they have learned. This aligns with Putri and Hindrasti (2019), who state that providing further explanation is part of the reflective process, enabling one to convince oneself, gain self-confidence, and make informed decisions.

The indicator of Strategy and Tactics is practiced from the experiment design stage to the experiment execution stage. At this stage, students are required to design actions to test the hypothesis (Badi'ah et al., 2023). The teacher provides a case study regarding the differences in the quality of two tapai jringkeng products, then guides students in determining the appropriate tools, materials, and observation procedures to answer the problem formulation. Students are asked to set strategies and tactics, both during and after the observation (Arfianawati et al., 2016). According to Khoirunnisa and Sabekti (2020), the ability to develop strategies and tactics can be enhanced if students can identify alternative solutions and determine the most effective actions to solve a problem. The increase in students' critical thinking skills, as indicated by this metric, shows an N-Gain value of 0.75 and is categorized as high.

Local wisdom-based guided inquiry learning is not only engaging and capable of developing students' critical thinking skills, but it also enhances their comprehension of the subject matter and introduces them to the local culture. This approach, which links science concepts with phenomena around students, not only increases their interest and understanding of the material but also serves as an effort to preserve local culture. In line with that, Dwiputra and Sundawa (2023) stated that integrating local wisdom in learning not only strengthens its existence but also internalizes the positive values contained therein. Similar research by Sari et al. (2025) suggests that local products that undergo a fermentation process can serve as learning resources that bridge the gap between indigenous knowledge and science, such as biotechnology, metabolism, and bacterial studies. Additionally, the use of guided inquiry-based learning devices is effective in enhancing students' understanding of concepts (Hidayat et al., 2022). The contribution of this research to science lies in its integration of scientific knowledge and local wisdom, thereby bridging theory and practice. It enriches science teaching methods through a culture-based approach. This model can be adapted to other science materials, thus encouraging innovation in learning and addressing the challenge of low critical thinking skills of students in Indonesia.

CONCLUSION

The application of guided inquiry grounded in local wisdom, such as *tapai jringkeng*, significantly enhanced students' critical thinking skills, as evidenced by improvements across three key indicators: Elementary Clarification (medium), Advanced Clarification (high), and Strategy and Tactics (high). The integration of culturally relevant materials made science learning more contextual and engaging, fostering not only cognitive

development but also appreciation for cultural diversity. However, since this study used a one-group pretest-posttest design without a control group, the findings should be interpreted with caution. Future research should apply this model to other scientific subjects and cultural contexts, using more rigorous experimental designs to better evaluate its broader applicability.

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