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The implementation of the problem-based learning model integrated with ethnoscience on students' critical thinking skills and learning motivation

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Abstract: Critical thinking skills and learning motivation exist in every student, but each individual possesses them at different levels. The aim of this study is to examine the correlation between the application of problem-based learning in science lessons, specifically on the topics of vibration, waves, and sound, and students' critical thinking skills and learning motivation. This research employed a one-shot case study design, which is a type of pre-experimental research. The sample consisted of 35 eighth-grade students from class VIII G at MTsN 1 Kota Serang. The sampling technique used was purposive sampling, and data were collected using tests. The result of the study indicate that: (1) based on the assessment of four aspects of students' critical thinking skills, 27 students were categorized as very high and 8 students as high; (2) based on six aspects of learning motivation, 1 student was categorized as moderate, 22 students as high, and 12 students as very high; (3) the correlation between critical thinking skills and learning motivation through the ethnoscience-integrated problem-based learning model was 70.1%, with the calculated r-value exceeding the table r-value at a significance level of 0.05.The conclusion of this study is that students' learning motivation and critical thinking skills through ethnoscience-integrated problem-based learning are strongly correlated.
Keywords: Critical Thinking Skills; Learning Motivation; Problem-Based Learning; Ethnoscience

INTRODUCTION

In facing increasingly complex global challenges, education must equip students with competencies relevant to the demands of the times. 21st-century education integrates skills, knowledge, abilities, and attitudes, along with mastery of information and communication technology (ICT). The competencies of the 21st century, also known as the 4Cs, can be realized in learning through: (1) critical thinking and problem-solving skills, (2) communication skills, (3) creativity and innovation skills, and (4) collaboration skills (Fitria et al., 2023). These 4C competencies are crucial for preparing students to face competition in the 21st century (Kim et al., 2019). These competencies help students become more skilled, flexible, and adaptive in dealing with the various challenges of modern society (Laar et al., 2017).

Sarwanto et al. (2020) stated that critical thinking is a thinking process that leads to making logical conclusions about what to believe and what actions to take. Critical thinking is not only about finding answers to problems or questions but, more impor-

tantly, about questioning the truth of answers, facts, and information (Fajari et al., 2020a). According to Abbasi and Izadpanah (2018), critical thinking is a systematic process that enables individuals to formulate and evaluate their own beliefs and opinions and is an organized process that allows one to evaluate evidence, assumptions, logic, and language underlying others' statements. The indicators of critical thinking skills used in this study are those developed by the Delphi research team, as stated in Facione's report (Fajari et al., 2020a), which explains that critical thinking is a cognitive skill comprising interpretation, analysis, evaluation, inference, explanation, and self-regulation.

Students who engage in learning integrated with 21st-century competencies are enabled to experience more meaningful and relevant learning in preparation for a constantly changing world. Students are expected to identify problems well and then offer a solution to solve them (Wahyuningtyas et al., 2023). The problem-solving model is highly effective in achieving competencies (Patricia et al., 2022). The Merdeka Curriculum requires contextual learning with authentic assessment, meaning the material presented must be linked to real-life situations (Nadiyah et al., 2022). Learning should connect problems in the classroom to real-world situations (Yerizon et al., 2022). The PBL model raises real problems in classroom learning, which makes students more engaged (Simanjuntak et al., 2021; Windiyani et al., 2023). Based on the learning outcomes in vibrations and waves during the 2022/2023 academic year at MTsN 1 Kota Serang, 60% of students had not yet achieved passing scores on daily tests. Therefore, an appropriate strategy using a specific learning model is needed to improve student learning outcomes.

PBL is highly suitable for discussing topics in science; it increases students' confidence and improves learning outcomes compared to traditional teaching methods (Khakim et al., 2022). A learning model that supports science- and culture-based education is the ethnoscience approach (Patricia et al., 2022). Ethnoscience is knowledge derived from a person's language and culture that can be verified and innovated in classroom science learning (Wahyu, 2017). The implementation of learning using the ethnoscience approach begins with a science learning theme that incorporates local wisdom. A learning theme infused with local wisdom will be developed into scientific knowledge covering science, technology, simple engineering, and mathematical calculations (Aza et al., 2020).

Learning is not only influenced by the model or media used. Students' psychological levels also play a role in influencing the learning process. One of these is students' level of motivation, which greatly affects their cognitive abilities (Lestari & Nugraheni, 2022). High motivation leads to maximum learning outcomes, while low motivation results in minimal outcomes (Xu et al., 2021). Low motivation can be observed when students do not complete assignments given by the teacher or submit them late (Jia et al., 2021). Motivation can also be enhanced by using engaging models and media. When students are more attracted to the learning, they become more motivated. Increased motivation positively impacts learning outcomes, while low motivation correlates with poor performance (Arias et al., 2022).

A study on critical thinking and communication skills by Samani et al. (2019) concluded that the SCT learning model can be a consideration for teachers to train students in critical thinking, communication skills, and self-efficacy. Research conducted by Hasyda and Arifin (2020) found that the use of the LMS Cloud Classroom (CCR) is more engaging, activates the discussion process, and improves students' communica-

tion and critical thinking skills. Another study by Fitriyah and Ramadani (2021) concluded that worksheets using the group investigation approach can optimize students' communication and critical thinking skills. However, none of these studies have examined the role of ethnoscience.

Based on these issues, it is necessary to implement the Problem-Based Learning model integrated with ethnoscience to improve students' critical thinking skills and learning motivation. This is important considering that the goal of 21st-century learning is for students to integrate skills, knowledge, attitudes, and ICT mastery. The characteristics of 21st-century learners can be realized through learning that hones critical thinking skills and enhances students' motivation, ultimately impacting their learning outcomes. So, the aim of this study is to examine the correlation between the application of problem-based learning in science lessons, specifically on the topics of vibration, waves, and sound, and students' critical thinking skills and learning motivation.

METHOD

The type of research used in this study is quantitative research. This pre-experimental research method is conducted on a single group, namely the experimental group, which receives treatment using the Problem-Based Learning model. The research design applied in this study is a one-shot case study. According to Sugiyono (2014), this research design involves a single treatment that is assumed to have an effect, followed by a post-test. The subjects of this study are all students of class VIII G at MTsN 1 Kota Serang. Class VIII G was chosen as the research subject based on the teacher's consideration. The class consists of 35 students. The sampling technique used is purposive sampling.

In this study, data collection was conducted using a test technique. The test method used was a written test in the form of multiple-choice questions to measure students' critical thinking skills. The test instrument consisted of 30 multiple-choice questions that were tested for validity, reliability, discriminating power, and difficulty level. The results of the test showed that 15 questions met the most ideal criteria—valid, reliable, with good to excellent discriminating power, and with varied and proportional difficulty levels. Questions that did not meet the criteria were eliminated, so only the 15 best questions were used in the study to optimally measure students' critical thinking skills.

The data analysis techniques in quantitative research are divided into two: descriptive data analysis and inferential data analysis (Creswell, 2014). Descriptive data analysis is used to describe or present the research data without concluding that it is applicable to the population. The data are presented through mean, median, mode, standard deviation, variance, maximum and minimum values, and percentages. This analysis provides a general picture of data trends or respondent characteristics. Meanwhile, inferential data analysis is used to test hypotheses and draw conclusions from the sample to the population. This analysis begins with prerequisite tests, including a normality test to determine whether the data are normally distributed and a homogeneity test to ensure that the variances between data groups are equal. After fulfilling the prerequisites, hypothesis testing is conducted, including a correlation test to determine whether there is a relationship between two variables, as well as the direction and strength of that relationship. Through the application of both techniques, researchers can gain an in-depth understanding of the data and draw valid conclusions based on empirical findings.

RESULT AND DISCUSSION

Profile of Critical Thinking Skills Using the Ethnoscience-Integrated Problem-Based Learning Model

After the learning process, nine students achieved high scores and 26 students achieved very high scores in critical thinking skills. Based on the data obtained from the student worksheets (LKPD) and critical thinking questions, the order of indicators from highest to lowest achievement varied. In the LKPD, the critical thinking indicators ranked from highest to lowest were: interpretation, explanation, analysis, and inference. Meanwhile, in the critical thinking test, the order from highest to lowest was: analysis, interpretation, inference, and explanation. The distribution of cognitive levels in the evaluation questions on critical thinking skills consisted of one question at level C1, two at C2, five at C3, three at C5, and four at C6.

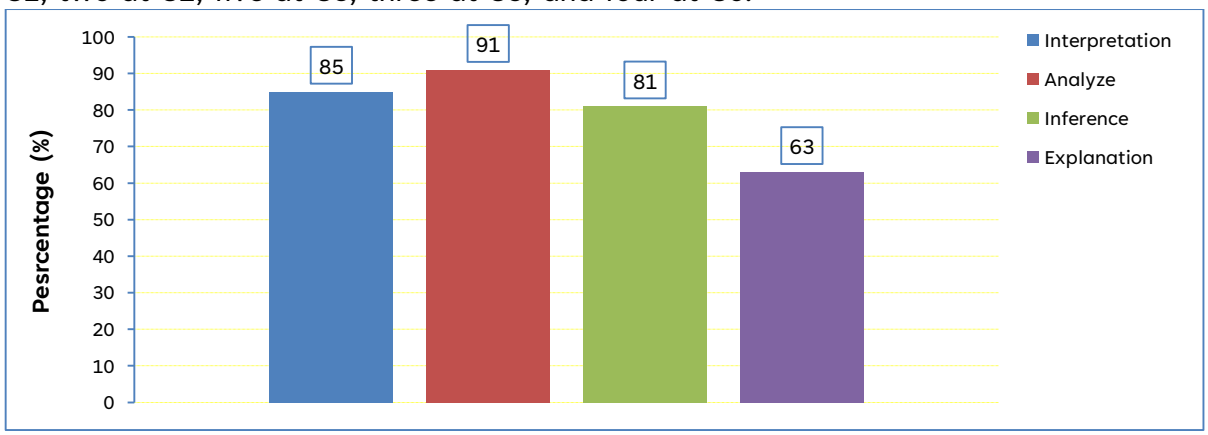

Figure 1. Achievement of Critical Thinking Skills

The percentage data was obtained by calculating the total score for each indicator, divided by the overall total score, and multiplied by 100 (Figure 1). As a result, the indicator with the highest achievement level was analysis at 91%, followed by interpretation at 85%, inference at 81%, and explanation at 63%.

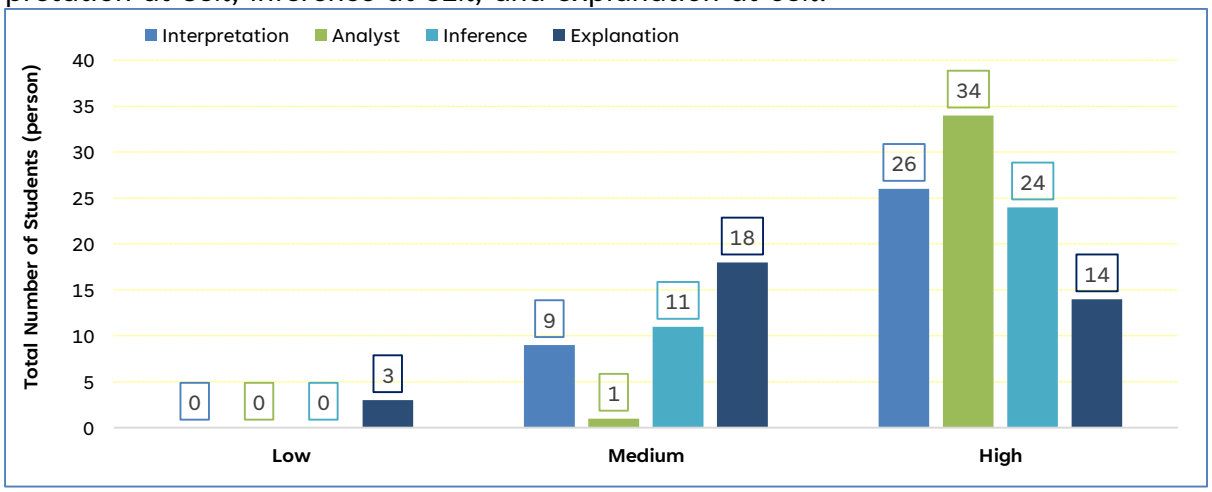

Figure 2. Students' Critical Thinking Skill Levels

Students' critical thinking skill levels were calculated based on score ranges obtained by each student. For the interpretation indicator with a maximum score of 9, students were categorized as follows: scores of 1–3 were considered low, 4–6 as moderate, and 7–9 as high. For the indicators of analysis, inference, and explanation, which have a

maximum score of 12, the categorizations were: scores of 1–4 as low, 5–8 as moderate, and 9–12 as high.

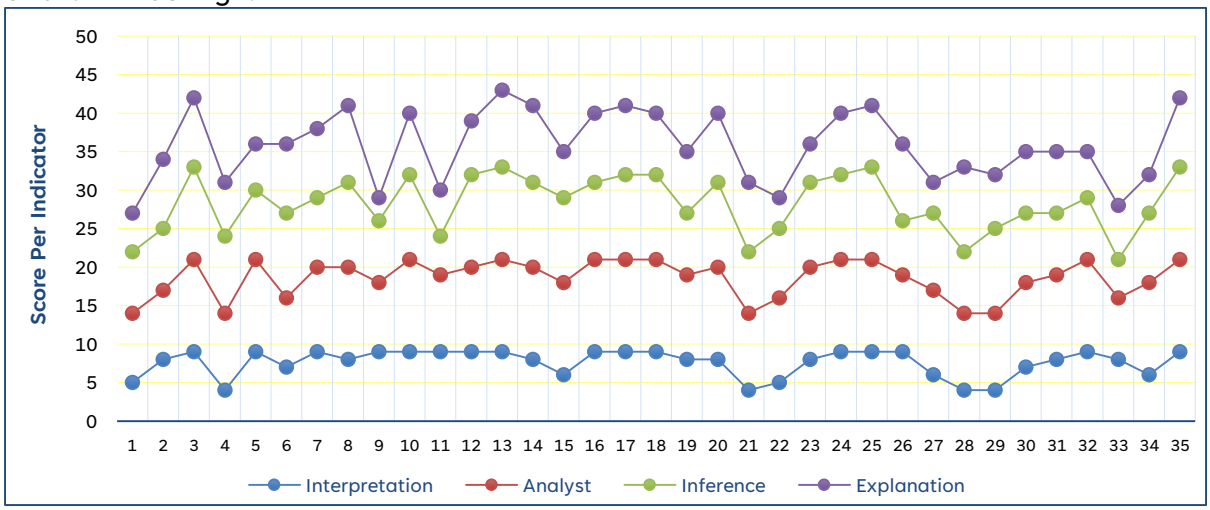

Figure 3. Individual Students' Critical Thinking Profiles

Each student had different strengths and weaknesses in the various indicators of critical thinking. To assess critical thinking, students were given multiple-choice reasoning questions. Many students answered the questions correctly but gave incorrect reasons. This indicates that if a student can answer both the question and the reason correctly, they demonstrate higher-order thinking and a deeper understanding beyond just the taught concept. In contrast, if students only choose the correct answer but give the wrong reason, it suggests they only understand what was taught without developing critical thinking skills. Based on the existing critical thinking profiles, three students who had low scores in explanation require special attention during the learning process. They should also be given similar types of questions to train and accustom them to thinking critically.

The high achievement in the analysis indicator indicates that students are relatively capable of breaking down information, identifying relationships between concepts, and evaluating evidence logically. This finding aligns with Narmaditya et al. (2018), who stated that analytical skills often develop first because they are frequently sharpened through problem-based learning. Meanwhile, the low achievement in the explanation indicator shows that students still struggle to present logical and systematic reasoning, which, according to Facione (Fajari et al., 2020b), is a key element of higher-order thinking skills.

This study also provides a concrete picture that some students tend to only recall information taught without actively developing critical thinking skills. These findings are consistent with Vygotsky's theory of the Zone of Proximal Development (ZPD), which emphasizes the need for appropriate guidance and stimulation to help students move from their actual development zone to their potential development zone (Jin, 2016). The three students with low explanatory abilities need special treatment in learning through scaffolding and repeated practice with reasoning-based questions.

Profile of Learning Motivation Using the Ethnoscience-Integrated Problem-Based Learning Model

After learning using the ethnoscience-integrated problem-based learning model, 22 students showed high learning motivation, while 13 students showed very high motiva-

tion. The learning motivation was assessed during the fourth meeting when students conducted experiments using various rampak bedug traditional musical instruments.

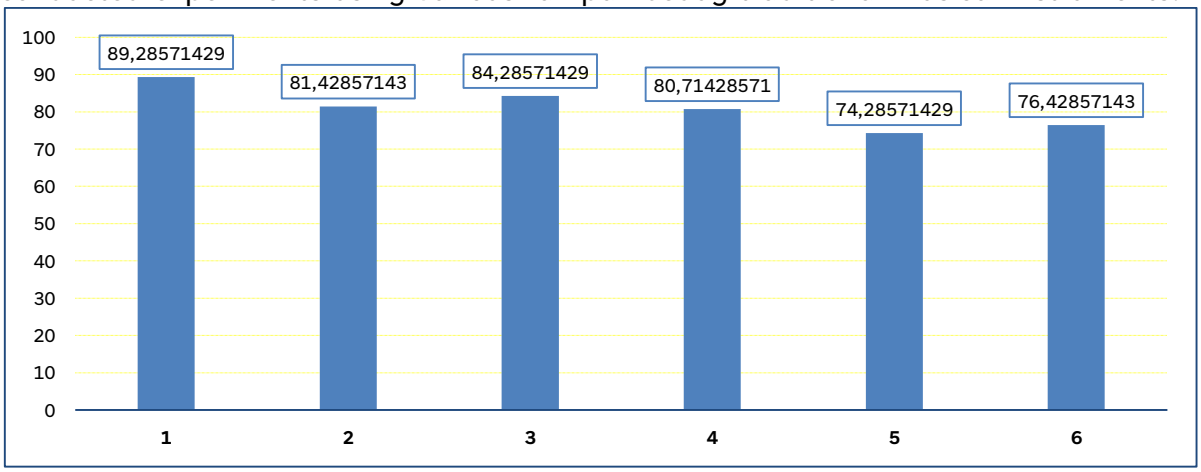

Figure 4. Percentage of Achievement for Learning Motivation Indicators

Based on Figure 4, it is found that the motivation indicator "not easily giving up on what is believed" had the lowest completion percentage at 74%, while the indicator "persevering in completing tasks" had the highest at 89%. The problem-based learning model requires students to actively engage in solving real-world problems. By integrating ethnoscience, students not only learn from theories but also from practices and local cultural experiences, making learning more relevant and engaging. Ethnoscience connects scientific knowledge with local wisdom and cultural practices. This can enhance student motivation as they can see a direct link between their lessons and their lives.

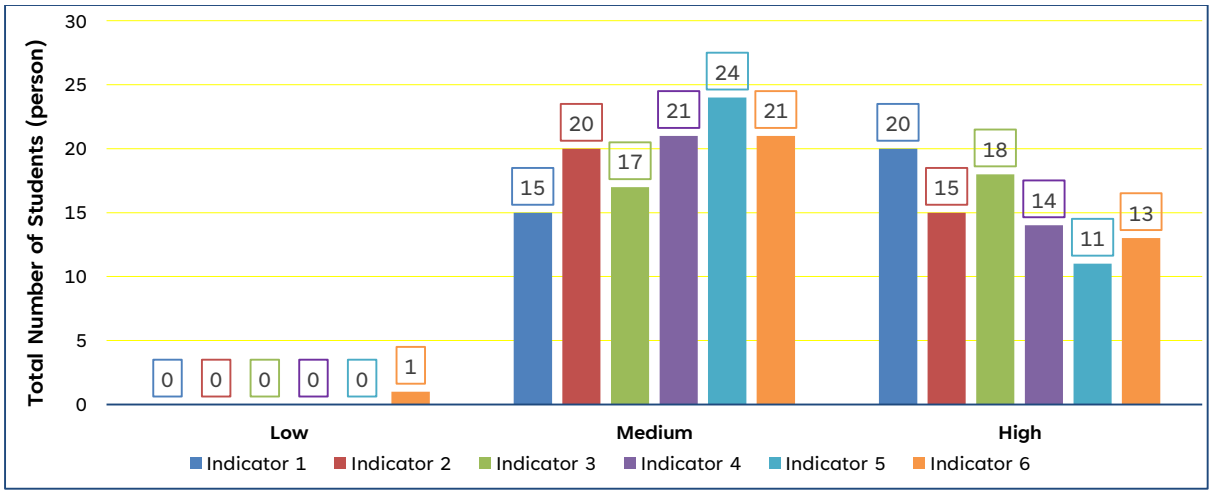

Figure 5. Students' Learning Motivation Level

The indicators of students' learning motivation have been explained in the previous points. The level of students' learning motivation was obtained through a calculation using a scoring range based on the scores received by the students. Each indicator has a maximum score of 4, so to group students into low, medium, and high categories, the scores are divided into three ranges. Scores ranging from 0–1 are categorized as low, 2–3 as medium, and a score of 4 as high. On the indicator of enjoying seeking and solving problems, there was one student who fell into the low category, as the student was only able to meet one out of the four criteria. Meanwhile, the indicator does not

easily give up on what they believe in; the medium category had the highest number of students.

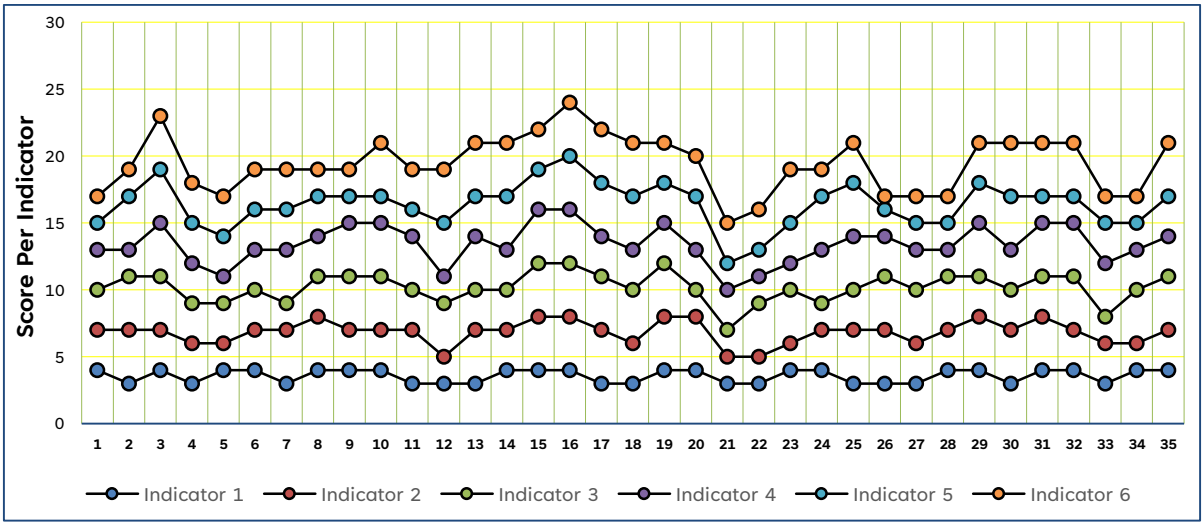

Figure 6. Learning Motivation Profile of Each Student

Each student has different strengths and weaknesses in each indicator of learning motivation. The variation in achievements across indicators suggests that even though students show persistence in completing tasks, they may not fully possess the confidence and commitment to the values or understandings they believe to be true. This finding is relevant to McClelland's motivation theory (Kusumaningsih & Hardi, 2022), which states that motivation is influenced by three main aspects: the need for achievement, affiliation, and power. High persistence in tasks indicates a strong need for achievement, but a lack of firm belief may reflect a lack of deep internalization of values.

The problem-based learning (PBL) model used in this study encouraged students to be active, collaborative, and responsible for their learning process. The integration of ethnoscience strengthened the contextual and cultural aspects, enabling students to feel closer to the learning material (Munawaroh, 2020). Research by Fajari et al. (2020b) stated that PBL can increase students' intrinsic motivation because they find the learning personally meaningful and relevant to real life. When students are able to relate science material to local cultural practices, as in the ethnoscience approach, they are more likely to understand and be motivated to solve problems related to their surrounding environment.

Correlation Between Critical Thinking Ability and Students' Learning Motivation

The prerequisite tests included a normality test to determine whether the data were normally distributed and a homogeneity test to ensure that the variance among data groups was equal. Based on the Kolmogorov-Smirnov normality test on students' critical thinking skills and learning motivation, both variables showed a significance value (p-value) of 0.200. This value is greater than the significance threshold of 0.05, indicating that the data for critical thinking skills and learning motivation is normally distributed.

Table 1. Normality Test Results

Variable	N	Kolmogorov-Smirnov Z	Sig. (p-value)	Distribution
Critical Thinking Skills	35	0,112	0,200	Normal
Learning Motivation	35	0,098	0,200	Normal

Furthermore, a homogeneity test was conducted to show that there was no significant difference in the spread of data across the groups, which means the homogeneity requirement was met for further analysis. The Table 2 shows the results of the homogeneity test in this study.

Table 2. Homogeneity Test Results

Variable	Levene Statistic	df1	df2	Sig. (p-value)	Conclusion
Critical Thinking Skills	1,024	1	68	0,315	Homogen
Learning Motivation	0,847	1	68	0,361	Homogen

Based on Levene's test for homogeneity on the data of students' critical thinking skills and learning motivation, the significance (p-value) for critical thinking skills was 0.315 and for learning motivation was 0.361. Both values are greater than the significance threshold of 0.05, indicating that the variances of the two variables are homogeneous or consistent across groups. After meeting the prerequisites, hypothesis testing was conducted, one of which was a correlation test to determine whether there is a relationship between the two variables, as well as the direction and strength of the relationship.

Table 3. Correlation Test Results

		Critical Thinking	Motivation
Critical Thinking	Pearson Correlation	1	.701**
	Sig. (2-tailed)		0.000
	N	35	35
Motivation	Pearson Correlation	.701**	1
	Sig. (2-tailed)	0.000	
	N	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation result between students' critical thinking skills and their learning motivation was 70.1%, with the calculated r value greater than the table value (0.7 > 0.3426), with an alpha of 0.05% and a 95% confidence level in education. This means there is a strong correlation between students' critical thinking and their learning motivation. This finding aligns with the study by Lestari and Nugraheni (2022), which stated that students with high learning motivation tend to demonstrate better critical thinking skills because they are driven to explore, analyze, and evaluate information deeply. Similar findings were also reported by Abdulah and Wangid (2021), who explained that motivated students are more active in learning, open to intellectual challenges, and better able to develop higher-order thinking skills.

Meanwhile, the integration of ethnoscience in problem-based learning provides real-life contexts that enhance students' engagement in learning. Ethnoscience connects scientific knowledge with local wisdom and relevant cultural practices, making learning not only more interesting but also more meaningful and relevant (Aza et al., 2020; Nadiyah et al., 2022). Students' motivation to learn increases because they can see the direct connection between the knowledge taught and their everyday lives. This is in line with Bandura's theory, which explains that relevant and meaningful experiences can strengthen students' self-efficacy and encourage them to think more critically (McLeod, 2016).

CONCLUSION

Based on the research results and discussion above, it can be concluded that: (1) the profile of students' critical thinking skills on material integrated with ethnoscience

using the problem-based learning model consists of 7 students with high critical thinking skills and 28 students with very high critical thinking skills; (2) the profile of students' learning motivation using the problem-based learning model integrated with ethnoscience consists of 1 student with moderate learning motivation, 22 students with high motivation, and 12 students with very high motivation; and (3) students' learning motivation and their critical thinking skills through ethnoscience-integrated problem-based learning are strongly correlated. The implication of this research shows that integrating ethnoscience into the problem-based learning model can effectively enhance students' critical thinking skills and learning motivation. Therefore, this learning model is worth implementing more broadly in science education to promote meaningful and contextual learning.

This study is limited to one school with a relatively small sample size, so the results cannot yet be generalized to more diverse educational contexts. Additionally, the study focuses only on the aspects of critical thinking skills and learning motivation, without examining the model's direct impact on academic achievement. Therefore, future researchers are encouraged to expand the scope of the study by involving more schools and considering other variables such as academic achievement and social skills. For teachers, the ethnoscience-integrated problem-based learning model can be adopted as an effective instructional strategy to improve students' critical thinking and motivation. Schools are expected to provide support in the form of training and facilities so that this model can be implemented sustainably. Meanwhile, for education policymakers, the integration of local content such as ethnoscience into the curriculum should be considered to strengthen the character and cultural relevance of learning in local contexts.

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