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Effectiveness of Ethno-STEM-Based Science Teaching with the Project-Based Learning Model on Students' Scientific Literacy

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Abstract: The results of the OECD in 2019 showed that in 2012-2018, the acquisition of scientific literacy in Indonesia was still relatively low compared to other countries. The pretest results also showed that the average value of students' scientific literacy was 65 out of 100. Learning based on empowering thinking skills and using the context frequently encountered by students can help students relate scientific knowledge to everyday life, particularly in the aspect of interpreting data and evidence scientifically. From these problems, the study aims to (1) reveal the effect of ethno-STEM-based science teaching based on drums on vibration and wave material on the scientific literacy of junior high school students, and (2) identify the scientific literacy profile of junior high school students in Surakarta based on measurements using scientific literacy question instruments on vibration and wave material. This study was quasi-experimental. The population was all eighth-grade students from three junior high schools in Surakarta, totaling 864 students. The sample consisted of two classes from each school, selected as experimental classes and six control classes, determined using a cluster random sampling method. Data was collected using a science literacy test. The results showed: (1) there was an effect of the ethno-STEM approach with the PJBL learning model on students' scientific literacy in junior high school science learning on vibrations and waves, tested using the ANCVA test with a significance level of 0.047, and (2) in the experimental classes at junior high schools A, B, and C, there was an increase in all aspects of scientific literacy. In the control class, the highest increase was observed in the aspect of evaluating scientific investigations, while the lowest increase was noted in the aspect of explaining phenomena scientifically.
Keywords: drums, ethno-STEM, science learning tools, science literacy

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INTRODUCTION

The 21st century has witnessed rapid advancements in information and communication technologies. Consequently, the current educational system must prepare human resources capable of meeting the challenges of modern development. Essential competencies for students in this era include learning and innovation skills, mastery of media and information technology, and life and career skills (Abidin, 2014). Science literacy has become one of the key skills in addressing these challenges. It equips individuals with a fundamental understanding of science and technology necessary for solving daily problems (Council, 2012).

Based on the 2019 OECD PISA assessment, as well as data from 2012 and 2015, science literacy levels in Indonesia remain low. In 2012, Indonesia's average score was 382, significantly below the international average of 501, ranking 64th out of 70 countries. In 2015, Indonesia's score rose slightly to 403 but still fell short of the 493 international average score, ranking 62nd out of 70 countries. By 2018, Indonesia had an average score of 396, compared to a global average of 489, ranking 70th out of 78 countries (OECD, 2019c). In Southeast Asia, Indonesia's PISA scores in 2012 averaged 382, which was below the regional average of 427, placing it last among nine countries. In 2015, Indonesia's score improved to 403, compared to a regional average of 432, yet it remained in ninth place. In 2018, the average score decreased to 396, while the regional average was 431, with Indonesia still ranking ninth (OECD, 2019c). These PISA results indicate that Indonesian students' science literacy is left behind that of all other participating nations. In addition, some research from Indonesia also indicated that Indonesian students remain in the 1st and 2nd level of Science literacy based on PISA categories (Ashari et al., 2023; Nasor et al., 2023; Nur'Aini et al., 2018)

Science literacy is defined as the ability to understand science, communicate it, and apply it to solve problems in one's surroundings. Basic science literacy, or foundational science literacy, refers to the capability to address everyday challenges using scientific understanding (Dewantari & Singgih, 2020). The application of science literacy is tied to an individual's science literacy profile, which reflects the ability to comprehend and apply knowledge to resolve issues related to science and technology in daily life (OECD, 2016). Over time, science literacy has evolved to encompass scientific knowledge, scientific attitudes, scientific processes, and an understanding of the nature of science. According to Vo D and Simmie (Vo & Simmie, 2024) (Bugtai, 2024; OECD, 2018), science literacy includes the following.

a. Content Knowledge:
   This refers to knowledge of scientific theories, ideas, facts, and information. It is categorized into three systems: the physical system, the biological system, and the Earth and space system.
b. Procedural Knowledge:
   This includes concepts that support data authenticity, data collection, and the analysis of scientific data. Procedural knowledge covers concepts such as variables, measurement, techniques for assessing and minimizing uncertainty, mechanisms to ensure replication and accuracy, standard methods for abstracting and representing data, control of variables and their role in experimental design, the use of trials, and suitable design approaches for specific scientific questions.
c. Epistemic Knowledge:
   This involves understanding explanations and justifications that establish scientific truths. Epistemic knowledge includes the contributions and characteristics of scientific knowledge, as well as the role of constructions and features in justifying knowledge produced by science.

According to the (OECD, 2018), science literacy competencies include the following.

a. Explaining Phenomena Scientifically:
   This competency enables students to understand explanations related to natural and technological phenomena by applying scientific knowledge, identifying scientific phenomena, formulating hypotheses, and explaining the societal implications of scientific knowledge.
b. Evaluating and Designing Scientific Inquiry:
   Through this competency, students can assess and explain scientific investigations, making evidence-based decisions for problem-solving. It involves identifying questions explored in specific scientific studies, distinguishing questions suitable for scientific investigation, evaluating methods for scientifically exploring a given question, and understanding and assessing various approaches scientists use to ensure data accuracy, objectivity, and the generalizability of explanations.
c. Interpreting Data and Evidence Scientifically:
   This competency allows students to analyze and evaluate scientific data, claims, and arguments in various formats and to draw appropriate conclusions. It includes translating data across different representations, analyzing and interpreting data to reach conclusions, identifying assumptions, evidence, and reasoning in science-related texts, distinguishing evidence-based scientific arguments from unsupported claims, and evaluating scientific arguments and evidence from diverse sources (e.g., newspapers, the Internet, and journals).

Science literacy is crucial today, as information—both accurate and false—spreads easily through social media and other internet-connected platforms. Information holds the potential to be a powerful tool, but can also be a source of confusion within society (Ainiyah, 2017). Therefore, a sound understanding is necessary to critically assess the constant flow of information. When individuals can

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accurately interpret and evaluate information, it can be validated as true; conversely, without these skills, information can easily become misleading. Hoax news or misinformation can have significant negative impacts on both individuals and society. It can create panic, erode trust, and even incite harmful actions (Iswanto et al., 2019). For instance, during the COVID-19 pandemic, false information circulated claiming that the COVID-19 vaccine caused infertility (Hotez & Bottazzi, 2021), or that hydroxychloroquine was an effective treatment despite lacking strong scientific evidence (Suparya et al., 2022). In this era of rapid information dissemination, science literacy is important for students, who frequently engage with social media. Addressing misinformation requires a learning environment that fosters collaboration and discussion among students to strengthen their understanding of science and their skills in analyzing information, including building critical thinking from underlying concepts and evidence (Andriani et al., 2025). Group discussions on current scientific issues can support students in validating information (OECD, 2019a). Addressing misinformation requires a learning environment that fosters collaboration and discussion among students, thereby strengthening their understanding of science and their skills in analyzing information. Group discussions on current scientific issues can support students in validating information (OECD, 2019a).

According to Appendix IV of the Indonesian Ministry of Education and Culture Regulation Number 81A of 2013, elementary school education is developed thematically, integrating cross-disciplinary subjects to foster students' attitudes, skills, and knowledge while appreciating local cultural diversity. This approach incorporates local wisdom into learning to enhance students' sense of cultural awareness and preserve local traditions amid the pressures of globalization (Culture, 2013). Given the demands of modern development and the Industry 4.0 era, there is a concern that future generations may lose cultural values in their thinking, which underscores the need to integrate culture into education by combining ethnoscience with STEM (Idrus, 2022).

Incorporating ethnography into science learning with hands-on activities or direct learning in a real-world environment has been proven to enhance students' science literacy (Jufrida et al., 2024). This is because students can obtain a deeper understanding of scientific concepts, ecological literacy, enabling them to formulate questions, conduct their own experiment, and reflect on it in the context of human and ecology (Haraldsson et al., 2024) (Jufrida et al., 2024). Besides that, ethnography can be integrated into various learning models and approaches, and it is proven that it can support the main component of the subject (such as models or learning approaches) (Fitria et al., 2025; Mulyono et al., 2024); Jadallah & Ballard, 2024)

Furthermore, STEM can increase the students' science literacy (Supriyadi et al., 2023). Similar to ethnography, STEM can be combined with many learning models and activities in order to enhance science literacy (Grancharova, 2024; Hardinata & Siregar, 2021; Nilyani et al., 2023).

Applying an ethno-STEM approach can help students achieve learning outcomes, which include scientific understanding, technology and engineering skills, critical and creative thinking, environmental awareness, collaboration and communication, cultural appreciation, and project implementation (Lestari & Basuki, 2021). Integrating ethno-STEM into the curriculum enables teachers to employ contextual learning, helping students apply classroom knowledge to solve real-world problems. This approach also fosters logical thinking and allows students to relate culture and local wisdom in addressing everyday challenges (Nugraheni et al., 2022). Science learning that incorporates STEM through real-life problems enables students to engage with multiple STEM subjects, enhancing both their understanding and capabilities (Anggraini & Huzaifah, 2017).

This study applies sociocultural theory, which emphasizes learning through social interaction and collaboration with others. In ethno STEM-based science learning, collaboration between students, teachers, and local communities allows the exchange of knowledge and experiences that help students develop a deep understanding of the science concepts learned (Rahmawati et al., 2020). According to Vygotsky, students' cognitive development is influenced by social and cultural interactions around them. Integrating local wisdom into ethno STEM-based science learning can help students understand science concepts in the context of regional culture, thus making learning more meaningful (Yasir & Hartiningsih, 2023). Thus, the application of sociocultural theory in ethno STEM-based science learning can improve students' science literacy while strengthening regional cultural identity (Nurhasnah et al., 2022).

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Integrating local wisdom into learning is considered essential due to its scientific relevance. For example, the topic of vibrations and sound waves in middle school science can be connected to traditional musical instruments like the Gamelan, fostering a link between science and local culture (Erlangga et al., 2022). Local wisdom refers to traditional elements rooted in a community's culture, reflecting Indonesia's island geography through physical structures, such as buildings and urban spaces. Thus, local wisdom is a vital component of regional culture that should be preserved, particularly through school education (Khusniati, 2014). For students in Java island, *kendang* in Gamelan is widely recognized since it always plays an important role in Javanese culture (Walton, 2007).

Science education that relies solely on memorization has proven less effective in revealing scientific principles and does not reflect the essence of science (Chiappetta & Koballa, 2010). This study employs an ethno-STEM approach, integrating natural sciences with local wisdom alongside aspects of technology, engineering, and mathematics. Consequently, the ethno-STEM-based approach demonstrates significant potential in supporting science literacy development, which is crucial for preparing students to address 21st-century challenges. According to Jean Piaget's constructivist theory, knowledge acquired through direct activity, exploration, and discovery within an environment transforms a teacher-centered approach into a child-centered one (Piaget, 1952). Piaget asserts that each undergoes invariant, progressive, qualitative changes in cognitive, emotional, and behavioral development, which cannot be skipped or reversed (Piaget, 1988). In summary, Piaget's constructivist theory emphasizes learning through independent exploration to gain new knowledge.

The selection of competencies is based on the continuous development and evaluation of science literacy competencies by PISA (OECD) over the years. The science literacy competencies defined by (OECD, 2019b) reflect outcomes from these well-tested PISA assessments. The three science literacy competencies selected for this study are: explaining phenomena scientifically, evaluating and designing scientific inquiry, and interpreting data or evidence scientifically. In addition to competencies, science literacy encompasses the dimensions of context and various types of scientific knowledge. The context of science literacy is categorized into three levels: personal, local or international, and global (OECD, 2019b). The present study focused on the local or international context, incorporating both national context and local wisdom into assessment instruments. The knowledge dimension in science literacy is also divided into three types: content knowledge, procedural knowledge, and epistemic knowledge (OECD, 2019b), which were also incorporated into the science literacy assessment instruments in this study. Constructivist theory, which aligns with contextual learning, was used to support indicators of students' science literacy.

This study offers a solution in the form of a learning module aimed at enhancing students' science literacy through an ethno-STEM-based and project-based learning (PjBL) approach. Ethnoscience aligns with students' science literacy by guiding them to apply classroom knowledge to solve real-life problems in ways that respect the cultural context of their local regions. STEM complements this by training students in skills such as data analysis, interpretation, and inquiry, which are essential for addressing practical issues. Supported by project-based learning, this approach uses real-world problems as a starting point for gathering and integrating new knowledge through direct experiences (Rusman, 2017). The PjBL model focuses on both process and product, involving activities such as defining project themes, planning activities, and implementing projects (Kamaruddin et al., 2024).

Previous studies have demonstrated the effectiveness of ethno-STEM-based science modules in enhancing various student skills, including character development (Martawijaya, 2014), conceptual understanding (Safitri et al., 2018), communication skills (Inayah et al., 2022), creativity (Karim et al., 2022), and critical thinking (Sartika et al., 2022). However, there is no study documenting the implementation of ethno-STEM to improve science literacy. Combined with PjBL, which applies constructivist learning theory, this approach may promote an active, creative, cooperative, and engaging learning environment that enhances students' skills and cognitive abilities (Sinta et al., 2022). By choosing a culture, such as Javanese drums, that can be applied to ethno-STEM-based learning, students can learn about information related to drums and gain a deeper understanding. Using the PJBL learning model will enhance the student learning process by applying collaboration and cultural understanding that students possess, creating a learning experience with cultural value throughout the process. Assigning project tasks, such as creating alternative drums from Paralon, will train students' critical thinking skills in solving problems discussed in project assignments. The teacher is tasked with being

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both a facilitator and an observer in the learning process to ensure that students can acquire the culture and science literacy competencies being applied. The teacher is also responsible for evaluating and reflecting with students to identify areas that need improvement for enhanced learning in the future.

This study utilizes a learning module developed based on prior research by (Nursalsabila, 2023). However, further testing is necessary within this research to gather valid data on the impact of ethno-STEM-based learning on students' science literacy in the context of science education. The objectives of this study are: (1) to reveal the effect of ethno-STEM-based science learning on the topic of vibrations and waves on middle school students' science literacy, and (2) to identify the science literacy profile of middle school students in Surakarta using a science literacy assessment instrument focused on the topic of vibrations and waves.

METHOD

We selected junior high schools (SMP) in Surakarta using a cluster random sampling method. This research was conducted in three junior high schools, selected based on several criteria, including being accredited, located within the scope of the Surakarta Karesidenan area, implementing an independent curriculum, and the application of the lecture method by teachers in science classes. In order to measure the effectiveness of the developing learning set, it is necessary to test it in real classroom conditions (Fahmi et al., 2022).

This research utilized the pretest-posttest control-group design. Two classes from each school were chosen as sample groups using cluster random sampling. One class was taught using the PJBL learning model with a science literacy-based learning module, featuring a simple drum-making practicum as the experimental group, consisting of 96 students. The other class used the inquiry learning model with conventional learning materials, featuring a tuning fork and a pendulum practicum as the control group, with 96 students.

This research consisted of three stages as follows.

(1) Preparation Stage: This involved the development of research instruments, which included: (a) comparing literature review of kendang scientific knowledge and traditional knowledge; (b) science literacy test questions for the experimental group, applying three science literacy competencies (explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data or evidence scientifically), and applying three types of science knowledge (content, epistemic, and procedural); (c) teaching modules for the vibrations and waves material using the PJBL model with an ethno-STEM approach, and student worksheets focused on an alternative drum-making project; (d) for the control group, teaching modules for vibrations and waves using the inquiry model with a scientific approach, featuring pendulum and tuning fork practicum. The preparation also included submitting a research permit, instrument validation, and a focus group discussion (FGD) for instrument revision prior to the study's implementation.

(2) Implementation Stage: This stage involved classroom activities in the experimental group with the drum-making project, starting from the first meeting with a pretest, followed by studying the case and types of drums, the second meeting involving the creation of the first simple drum and frequency testing to match the case, the third meeting involved analyzing and evaluating data from the first drum, then creating the second drum, and the fourth meeting involved testing the second drum and writing a simple report on the drum project, followed by a posttest. The control group conducted a simple practicum on the pendulum and tuning fork, starting with a pretest, followed by the material on vibrations and waves. The second meeting involved a pendulum practicum, the third meeting involved a tuning fork practicum, and the fourth meeting concluded with a posttest. The implementation stage in the control class at the first meeting begins with a pretest followed by the application of the pendulum tool case on the teacher's desk as a practicum material applied by making a simple pendulum with an eraser and rope that students will analyze and calculate to get the waves that occur in the pendulum which will be written on the LKPD, The second meeting continues the material with the application of the case of speaker sound that makes the surface of the water in the glass vibrate as a practicum material applied by using three tuning forks that are vibrated in three glasses filled with full, half, and quarter water which students will analyze to find out which glass filled with water gets the loudest vibration and the smallest vibration, the third

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meeting continues the garputala practicum activities until the making of a simple report on the LKPD, and the fourth meeting does the posttest and provides additional material from the teacher.

(3) Completion Stage: This involved the preparation of reports, results, and data analysis, applying the following tests:

1. The reliability test was tested using Cronbach's Alpha with a significance level of 0.05 with the result of R count of 0.541 which is greater than R table which is 0.220 and got valid results, and the content validation test of learning devices using the Gregory method (2015) with the result of R count of 0.235 which is greater than R table which is 0.220 and got valid results.
2. Prerequisite tests included normality tests with Kolmogorov-Smirnov results: (experimental pretest: 0.195), (experimental posttest: 0.054), (control pretest: 0.164), (control posttest: 0.176), homogeneity tests using Levene's test results: (SMP A: 0.200), (SMP B: 0.821), (SMP C: 0.661), and hypothesis testing using ANCOVA with a result of 0.047. All tests were performed with a significant level of 0.05.
3. After ANOVA, the subsequent statistical test was done to determine how big the effect of using partial eta square (Richardson, 2011) compared to the Cohen criteria (Cohen, 1988).
4. The percentage improvement in test scores of science literacy based on a combination of content, procedural, and epistemic knowledge, combined with explaining phenomena scientifically, evaluating and designing scientific inquiry, and interpreting data and evidence scientifically. The total improvement in scores is calculated using the following equation:

$$\left(\frac{Total\ of\ improved\ students}{total\ of\ students} x\ 100\%\right)$$

The testing was conducted using the following test question grid:

Table 1. Science literacy test question grid

No.	Competency	Knowledge
1	Explaining phenomena scientifically	Content
2a	Explaining phenomena scientifically	Procedural
2b	Interpreting scientific data and evidence	Epistemic
2c	Evaluating and designing scientific investigations	Procedural
3a	Interpreting scientific data and evidence	Content
3b	Interpreting scientific data and evidence	Content
3c	Explaining phenomena scientifically	Epistemic
4a	Interpreting scientific data and evidence	Procedural
4b	Interpreting scientific data and evidence	Epistemic
5a,b,c,d	Evaluating and designing scientific investigations	Procedural
6	Explaining phenomena scientifically	Content
7a,b,c,d	Interpreting scientific data and evidence	Epistemic
8a,b,c,d	Evaluating and designing scientific investigations	Procedural
9	Interpreting scientific data and evidence	Epistemic
10a	Evaluating and designing scientific investigations	Epistemic
10b	Evaluating and designing scientific investigations	Procedural

RESULTS AND DISCUSSION

Based on the science literacy competencies measured in the science literacy test, a difference in average scores between the pretest and posttest results was found in both the experimental and control groups. The control group applied a scientific learning approach, while the experimental group used an ethno-STEM learning approach. The test data for science literacy are presented in Table 1.

Table 1. Science Literacy Test Scores Description

Statistical Results	*Pretest*		*Posttest*	
	Experimental Group	Control Group	Experimental Group	Control Group
N	96	96	96	96

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Average	64	64	76	74
Standard Deviation	7	7	7	6
Lowest Score	52	43	60	52
Highest Score	78	77	85	84

The data presented in Table 1 show that the experimental class had a higher average posttest score compared to the control class. This is reflected in the posttest mean scores, with the control class having an average of 73.30. while the experimental class had an average of 73.94. A comparison of the pretest and posttest mean scores obtained by the students is presented in Tables 2, 3, and 4.

The descriptive test results of the experimental and control classes showed a slight difference. This is because learning that only uses inquiry encourages students to focus on remembering theory in practical assignments by not reading the material provided in the LKPD. It is also included in students' habits during learning, making them less likely to use science literacy when reading and working on posttest questions.

Table 2. Comparison of Average Science Literacy Test Scores for Control and Experimental Classes in SMP A

Competency	No. of Questions	Maximum Score Based on the Number of Keywords in Answers	SMP A Control Class		SMP A Experimental Class		Percentage Increase in Score	
			Pretest	Posttest	Pretest	Posttest	Control Class	Experimental Class
Explaining Phenomena Scientifically.	1	8	2.91	3.97	3.38	4.19	37.5%	90.62%
	2a	4	3.63	3.66	3.44	3.72	0.75%	84.37%
	3c	3	1.59	1.94	1.28	1.91	31.25%	65.62%
	6	9	3.13	3.84	2.41	3.00	56.25%	59.37%
	7b	4	2.06	2.69	2.25	2.78	56.25%	53.12%
Interpreting Data and Evidence Scientifically.	3ab	11	10.81	10.09	9.91	9.91	62.50%	68.75%
	4a	9	1.63	3.19	2.06	5.13	40.62%	53.12%
	4b	1	0.34	0.72	0.34	0.75	68.75%	71.87%
	7a	3	2.47	2.31	2.28	2.59	50.00%	56.25%
Evaluating and Designing Scientific Inquiry.	2b	5	2.19	3.13	2.66	4.16	62.50%	71.87%
	2c	9	1.44	2.88	1.44	2.88	59.37%	43.75%
	5	21	9.66	11.28	10.59	11.63	90.62%	53.12%
	8ab	7	3.28	1.84	3.44	4.78	81.25%	68.75%
	8cd	15	4.44	8.22	5.59	8.19	65.62%	78.12%
	10	14	3.84	4.84	3.75	4.94	65.62%	56.25%

*: *There is an improvement in the average score between the pretest and the posttest*

The data presented in Table 2 indicate that science instruction using the ethno-STEM approach can enhance science literacy, as evidenced by the average scores of SMP A students on the science literacy test. The experimental class showed an improvement in the average score for items 1, 2a, 3c, 6, and 7b, which apply the competence of explaining phenomena scientifically; items 4a, 4b, and 7a, which apply the competence of interpreting data/evidence scientifically; and items 2b, 2c, 5, 8ab, 8cd, and 10. which apply the competence of evaluating and designing scientific investigations. The control class showed an improvement in the average score for items 1, 6, and 7b, which apply the competence of explaining phenomena scientifically; items 4a and 4b, which apply interpreting data/evidence scientifically; and items 2b, 2c, 5, 8ab, 8cd, and 10. which apply the competence of evaluating and designing scientific investigations.

The results of the calculation of the average test scores and the percentage increase in the scores of SMP A students in the experimental and control classes show a slight difference. The average value of the control class on the competency to explain phenomena scientifically is No. 2a and 3c did not increase in value from the pretest of 3.66 and 1.94 to the posttest of 3.63 and 1.59, because the question requires students to read carefully related to the information presented in the problem in the form of a case that requires students to understand in advance what problems need to be solved to work on the problem. However, most students in the control class of SMP A misinterpreted the problem, which led them to the wrong answer. Likewise, the question of the competency to interpret data/evidence scientifically is no. 7a did not experience an increase in scores from the pretest of 2.47 to the posttest of 2.31, because the question requires students to observe the data that has been presented in the problem table before starting to understand the problem in the problem. However, most students choose to immediately read the problem first and then view the data displayed, which can confuse the data in question. The percentage increase in student scores in the control class differs by 83.62% in question 2a, 34.37% in question 3c, and 6.25% in question 7a compared to the percentage increase in scores in the experimental class.

Table 3. Comparison of Average Science Literacy Test Scores for Control and Experimental Classes in SMP B.

Competency	No. of Questions	Maximum Score Based on the Number of Keywords in Answers	SMP B Control Class		SMP B Experimental Class		Percentage Increase in Score	
			Pretest	Posttest	Pretest	Posttest	Control Class	Experimental Class
Explaining Phenomena Scientifically.	1	8	3.09	3.56	3.34	3.78	84.37%	59.37%
	2a	4	3.53	3.75	3.50	3.72	78.12%	81.25%
	3c	3	1.78	1.66	1.34	2.16	62.50%	68.75%
	6	9	3.16	3.53	2.50	3.72	75.00%	65.62%
	7b	4	2.00	2.34	2.38	3.16	87.50%	75.00%
Interpreting Data and Evidence Scientifically.	3ab	11	10.88	10.50	9.81	9.94	71.87%	65.62%
	4a	9	2.31	2.78	1.78	5.59	37.50%	46.87%
	4b	1	0.38	0.72	0.19	0.69	68.75%	65.62%
	7a	3	2.44	2.41	2.34	2.34	81.25%	84.37%
Evaluating and Designing Scientific Inquiry.	2b	5	2.25	2.88	2.56	3.84	65.62%	65.62%
	2c	9	3.31	2.75	3.13	3.78	46.87%	59.37%
	5	21	9.63	11.59	10.97	10.94	50.00%	59.37%
	8ab	7	3.63	4.50	3.66	4.81	78.12%	50.00%
	8cd	15	5.00	8.25	5.66	7.31	65.62%	68.75%
	10	14	3.53	4.88	4.06	4.84	65.62%	50.00%

*: *There is an improvement in the average score between the pretest and the posttest*

The data presented in Table 3 indicate that science instruction using the ethno-STEM approach can enhance science literacy, as evidenced by the average scores of SMP B students on the science literacy test. The experimental class showed an improvement in the average score for items 1, 2a, 3c, 6, and 7b, which apply the competence of explaining phenomena scientifically; items 4a and 4b, which apply the competence of interpreting data/evidence scientifically; and items 2b, 2c, 8ab, 8cd, and 10. which apply the competence of evaluating and designing scientific investigations. The control class showed an improvement in the average score for items 1, which applies the competence of explaining phenomena scientifically; items 4a and 4b, which apply interpreting data/evidence scientifically; and items 2b, 5, 8cd, and 10. which apply the competence of evaluating and designing scientific investigations.

The results of the calculation of the average test scores and the percentage increase in the scores of SMP B students in the experimental and control classes show little difference. The average value of the control class on the competency of explaining scientific phenomena 2a, 3c, 6, and 7b did not increase in value from the pretest of 3.75, 1.78, 3.53, and 2.34 to the posttest of 3.53, 1.66, 3.16, and 2.00 because the question occurred in the same case as students from SMP A, namely students misunderstood the problem presented in the problem. In the competency of interpreting data / scientific evidence, no. 3ab, there was no increase in scores from the pretest of 10.88 to the posttest of 10.50 because, in the question, the same case occurred: students did not understand the data displayed in the table before working on the problem. In the competency of evaluating and designing scientific investigations, no. 2c and 8ab did not increase from the pretest of 3.31 and 4.50 to the posttest of 2.75 and 3.63 because, in these questions, students did not read thoroughly related to the explanation of the case story in the problem, so many students were wrong in choosing the tools and materials used to solve the problem. The percentage increase in student scores in the control class is a difference of 3.13% in question 2a, 6.25% in question 3c, 9.38% in question 6, and 12.05% in question 7b compared to the percentage increase in scores in the experimental class.

Table 4. Comparison of Average Science Literacy Test Scores for Control and Experimental Classes in SMP C.

Competency	No. of Questions	Maximum Score Based on the Number of Keywords in Answers	SMP C Control Class		SMP C Experimental Class		Percentage Increase in Score	
			Pretest	Posttest	Pretest	Posttest	Control Class	Experimental Class
Explaining Phenomena Scientifically.	1	8	2.41	3.97	3.19	4.00	59.37%	78.12%
	2a	4	3.84	3.47	3.34	3.22	78.12%	68.75%
	3c	3	2.41	2.50	1.44	1.97	59.37%	65.62%
	6	9	2.97	2.75	2.59	4.09	50.00%	68.75%
	7b	4	3.22	3.22	2.06	3.09	81.25%	71.87%
Interpreting Data and Evidence Scientifically.	3ab	11	10.38	10.19	10.16	10.00	71.87%	65.62%
	4a	9	2.16	6.28	3.38	5.69	65.62%	59.37%
	4b	1	0.91	0.78	0.19	0.97	75.00%	93.75%
	7a	3	2.81	2.69	2.22	2.53	68.75%	59.37%
Evaluating and Designing Scientific Inquiry.	2b	5	2.25	4.06	2.50	4.25	75.00%	78.12%
	2c	9	1.16	2.22	2.69	4.13	75.00%	75.00%
	5	21	12.06	11.47	10.78	12.56	62.50%	53.12%
	8ab	7	2.91	4.38	3.19	4.06	56.25%	62.50%
	8cd	15	6.16	8.31	5.69	7.00	62.5%	50.00%
	10	14	4.38	5.28	4.16	3.66	62.50%	40.62%

*: *There is an improvement in the average score between the pretest and posttest*

Table 4 shows that science instruction using the ethno-STEM approach can improve science literacy, as observed from the average scores of SMP C students on the science literacy test. The experimental class showed an improvement in the average score for items 1, 3c, 6, and 7b, which apply the competence of explaining phenomena scientifically; items 4a, 4b, and 7a, which apply the competence of interpreting data/evidence scientifically; and items 2b, 2c, 5, 8ab, and 8cd, which apply the competence of evaluating and designing scientific investigations. The control class showed an improvement in the average score for Items 1 and 3c, which apply the competence of explaining phenomena scientifically; Item 4a, which applies interpreting data/evidence scientifically; and items 2b, 2c, 8ab, 8cd, and 10. which apply the competence of evaluating and designing scientific investigations.

The results of the calculation of the average test scores and the percentage increase in the scores of SMP C students in the experimental and control classes show little difference. The average value of the control class on the competency of explaining scientific phenomena, nos 6 and 7b, did not increase in value from the pretest of 2.97 and 3.22 to the posttest of 2.75 and 3.22 because the question presented the same error as SMP A and B students, namely, students misunderstood the problem presented in the problem. In the competency of interpreting data/evidence scientifically, no. 4b and 7a did not experience an increase in scores from the pretest of 0.91 and 2.81 to the posttest of 0.78 and 2.69 because the same error occurred, namely, not understanding the data presented in the problem. And in the competency of

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evaluating and designing scientific investigations, No. 5 did not increase in value from the pretest of 12.06 to the posttest of 11.47 because of the same mistake as SMP B students, namely, not reading the explanation of the story in the question thoroughly. The percentage of increase in student scores in the control class has a difference of 18.75% in Question 6; 7.62% in Question 7b; 18.75% in Question 4b; 9.38% in Question 7a; and 9.38% in Question 5, compared to the percentage of increase in scores in the experimental class.

This indicates that students' science literacy in the competence of evaluating and designing scientific investigations has improved from before to after the implementation of the ethno-STEM approach. However, for Item 10. there was no improvement in the average score, as many students ignored the information presented before answering the question. Overall, the average test scores indicate an increase in science literacy, particularly in the application of science literacy profiles to solve problems related to science and technology, as discussed in the previous paragraphs.

As shown in Tables 2, 3, and 4, there is a noticeable change in the scores of most students, as indicated by the increased average test scores. The score changes indicate an improvement in students' understanding of the science literacy competencies of explaining phenomena scientifically, interpreting data/evidence scientifically, and evaluating and designing scientific investigations, as well as the application of content, epistemic, and procedural science literacy knowledge in the test items. These data suggest the emergence of science literacy profiles for each student in both the experimental and control classes, as explained in Table 5.

Table 5. Science Literacy Profile of Three Junior High Schools in Experimental and Control Classes

Science Literacy Knowledge	**Student Percentage SMP A**		**Student Percentage SMP B**		**Student Percentage SMP C**	
	***KRL**	***1EKS**	***KRL**	***1EKS**	***KRL**	***1EKS**
Content	68.75%	71.87%	53.12%	71.87%	50.00%	75.00%
Epistemic	50.00%	59.37%	46.87%	62.5%	43.75%	53.12%
Procedural	65.62%	59.37%	56.25%	68.75%	56.25%	68.75%
Science Literacy Competency						
Explaining Phenomena Scientifically.	65.62%	87.50%	75.00%	87.50%	78.12%	84.37%
Interpreting Data and Evidence	53.12%	59.37%	65.62%	68.75%	62.50%	87.50%
Evaluating and Designing Scientific Investigations	65.62%	78.12%	62.50%	62.50%	59.37%	68.75%

**KRL = Control Class* **1EKS = Experimental Class*

The data presented in Table 5 shows the percentage of knowledge and science literacy competencies exhibited by students across three middle schools. Starting with SMP A, the percentage of content knowledge is 79.68%, epistemic knowledge is 46.87%, and procedural knowledge is 51.56%. For competencies, the percentages are 64.06% for explaining scientific phenomena, 65.62% for interpreting data, and 67.18% for evaluating. At SMP B, the percentage of content knowledge is 71.87%, epistemic knowledge is 42.18%, and procedural knowledge is 53.12%. For competencies, the percentages are 71.87% for explaining scientific phenomena, 68.75% for interpreting data, and 65.62% for evaluating. At SMP C, the percentage of content knowledge is 68.75%, epistemic knowledge is 62.5%, and procedural knowledge is 57.81%. For competencies, the percentages are as follows: explaining scientific phenomena is 68.75%, interpreting data is 68.75%, and evaluating is 76.56%. These data indicate the emergence of science literacy profiles from students, reflected in the improvement of scores on items assessing science literacy competencies and knowledge.

As shown in Table 5, content knowledge is the highest score reached by students in the experimental class, as 71.87% to 75% of students can answer the questions correctly. In this type of knowledge, students answer questions on the same topic and exhibit good retention due to the constructed activities conducted during class (Brendel et al., 2024) and their prior knowledge, resulting from high exposure to the information (Bae et al., 2023). On the other hand, in the experimental class, only 53.12%-62.5 % of students can answer the questions in epistemic knowledge. The questions in the epistemic knowledge were designed to analyze the concept understanding (Hidayat et al., 2025) and all underlying scientific reasoning (Urbanek et al., 2023). It takes several cognitive loads to understand and

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answer the questions (Hsieh & Tsai, 2014). In addition, the procedural knowledge falls into the middle category because, during the teaching and learning process, class experiments were replicated. This activity builds fluency in procedural knowledge (Hidayat et al., 2025).

Furthermore, Table 5 indicates that explaining phenomena scientifically is the most common competency mastered by students due to their high understanding of the content knowledge (OECD, 2016) . The second is interpreting data, and the rarest is evaluating and designing scientific investigation. The second and third competencies are less common than the first because they require scientific knowledge and an understanding of how science works. Additionally, high confidence is also required.

In the traditional lecture-based teaching class, the teacher remains the most active participant in the classroom, with limited student involvement in the learning process. Moreover, the teacher did not introduce scientific phenomena at the beginning of lessons, making it difficult for students to connect the concepts being taught with real-life phenomena, thus hindering their mastery of science literacy (Hidayah et al., 2019). Additionally, the test items were still limited to those requiring rote memorization and basic conceptual understanding. This resulted in students often memorizing concepts from theory without truly understanding them or being able to apply them effectively. Students' science literacy skills are influenced by several factors, such as the instructional materials used, the types of questions given, and the teaching models employed by the teacher (Suparya et al., 2022). Furthermore, science literacy profiles encompass both competencies and knowledge, as outlined by (OECD, 2019b). The emergence of science literacy profiles can be supported by teaching methods that reference scientific phenomena in everyday life, applying problem-based learning that encourages students to solve problems in their surroundings. This approach helps students grasp the concepts taught. However, due to the habitual use of the lecture method by teachers, students have become reliant on memorization rather than truly understanding the concepts presented in the lessons.

The improvement in science literacy and the emergence of science literacy profile indicators were supported by the implementation of learning syntax that aimed to apply science literacy competencies. For example, in the starting with essential question syntax, the competency of explaining scientific phenomena was applied by guiding students to understand the case of a missing drum belonging to a music group. In the exploration syntax, the competencies of explaining scientific phenomena and interpreting data or evidence scientifically were applied by directing students to analyze data from a traditional drum experiment and compare it with the data obtained from the simple drum they created. In assessing the outcome syntax, the competencies of evaluating and designing scientific investigations, as well as interpreting data or evidence scientifically, were applied by guiding students to analyze and evaluate data from both the initial and final simple drum models, which were used in preparing a simple group report. The pretest responses indicated that students had not yet fully understood the science literacy competencies applied in the test questions, which included: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data or evidence scientifically. However, the posttest responses showed improvement, as students demonstrated a better understanding of the science literacy competencies applied in the test.

The results from the normality test, homogeneity test, hypothesis test, observation of the implementation of learning syntax, and validation through the focus group discussion (FGD) yielded the following results.

Table 6. Results of Normality Test for Posttest-Pretest Science Literacy Test Scores

Class	Sig.	Criteria	Conclusion
Experimental (Pretest)	0.195	Sig > 0.05	Normal
Experimental (Posttest)	0.054	Sig > 0.05	Normal
Control (Pretest)	0.164	Sig > 0.05	Normal
Control (Posttest)	0.176	Sig > 0.05	Normal

The significance value of the pretest scores from the experimental class was 0.195 (0.195 > 0.05), indicating a normal distribution, and the posttest significance value from the experimental class was 0.054 (0.054 > 0.05), indicating a normal distribution as well. For the control class, the significance value of the pretest was 0.164 (0.164 > 0.05), showing a normal distribution, and the posttest

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significance value was 0.176 (0.176 > 0.05), also indicating a normal distribution.

Tests of Between-Subjects Effects

Dependent Variable: Nilai Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	244.175a	2	122.088	4.370	.014	.044
Intercept	11862.414	1	11862.414	424.635	<,001	.692
Pretest	130.092	1	130.092	4.657	.032	.024
Kelas	111.340	1	111.340	3.986	.047	.021
Error	5279.825	189	27.936			
Total	1136512.000	192				
Corrected Total	5524.000	191				

a. R Squared = .044 (Adjusted R Squared = .034)

Image 1. Calculation of Hypothesis Test Using ANOVA Test with Significance Level 0.05

The results of the hypothesis test calculation using ANCOVA show that the significance number for the average student test score is 0.047 (0.047 < 0.05), so there is a difference or influence from the ethno-STEM approach treatment in the experimental class, which means that the results of the hypothesis test show that the hypothesis used can be accepted, this happens because the ethno-STEM learning approach involving the STEM process has encouraged students in the experimental class to use science literacy in learning. These results also indicate that the effect size is large, based on a partial eta squared of 0.21. The effect size results obtained fall within the large effect category, as defined by Cohen (1988), indicating that the treatment of the ethno-STEM-based science literacy approach has a strong and meaningful impact on the science literacy test results. Based on this result, 21% of the students' performance in scientific literacy is directly related to ethno-STEM learning. This learning set has potential for classroom use.

The hypothesis test calculation yielded a result of 0.047, indicating a statistically significant difference or effect resulting from the implementation of the ethno-STEM approach in the experimental class. This means that the hypothesis tested can be accepted.

The result of the homogeneity test was 0.741, suggesting that the experimental and control classes come from a homogeneous population. Based on the hypothesis test result of 0.047, it can be concluded that there is a difference or effect from the application of the ethno-STEM approach in the experimental class, supporting the acceptance of the hypothesis.

Observation data on the implementation of learning syntax were collected through observation sheets completed by observers during teaching sessions using the ethno-STEM approach. The observed aspects focused on the implementation of the teaching and learning activities conducted by the teachers at the three selected junior high schools. The data from the observations were analyzed in terms of percentages and criteria, as shown in Table 7 below.

Table 7. Implementation Analysis of the Ethno-STEM Approach Syntax

Class	Implementation Percentage	Criteria
Experimental Group SMP A	96.05%	Excellent
Control Group SMP A	90.16%	Excellent
Experimental Group SMP B	85.52%	Excellent
Control Group SMP B	90.16%	Excellent
Experimental Group SMP C	100.00%	Excellent
Control Group SMP C	91.80%	Excellent

The analysis results indicate the implementation of the ethno-STEM approach syntax based on the teaching and learning activities conducted by the teachers in the three junior high schools as follows: At SMP A Surakarta, the experimental class did not conduct activities in the "karawitan" room during the exploration syntax, resulting in an execution rate of 95.05%. In the control class, the teacher did not implement the aperception syntax by displaying a PowerPoint presentation for the initial explanation of

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the material, with an execution rate of 90.16%. At SMP B Surakarta, in the experimental class, the teacher failed to connect the previous material with the upcoming material during the aperception syntax. Additionally, the teacher did not conduct presentations and discussions during the "monitoring the students and progress of the project" syntax, resulting in an execution rate of 85.52%. In the control class, the teacher did not connect the previous material to the upcoming material during the aperception syntax, and he did not assign any tasks during the closing activity, resulting in an execution rate of 90.16%. At SMP C Surakarta, the experimental class achieved a 100% execution rate. However, in the control class, the teacher did not connect the previous material with the upcoming material during the aperception syntax and did not display a PowerPoint presentation for the initial material discussion, resulting in an execution rate of 91.80%. Based on the syntax implementation criteria, both the ethno-STEM approach in the experimental class and the scientific approach in the control class were implemented effectively.

The FGD validation data was obtained through validation sheets filled out by validators during the FGD process. The FGD data were analyzed in terms of percentages and criteria—the FGD validation involved six science teachers from junior high schools in Surakarta. The results of the FGD validation indicate that the learning materials to be used in the research are suitable for implementation. The learning materials received a "excellent" rating from all six validators, with several suggestions and feedback provided, as follows: Validator 1 suggested changing the term "kerja sama" (cooperation) to "gotong royong" (cooperation) in the Pancasila student profile section of the experimental and control class modules. Additionally, in the control class student worksheets, they recommended adding reading sources. Validator 2 made similar suggestions to Validator 1 regarding both the experimental and control class modules and recommended adding reading sources to the control class LKPD. Validator 3 provided similar feedback to Validator 1 for the experimental and control class modules; however, he did not complete four items on the validation sheet for the experimental class module. For the control class LKPD, they suggested adding reading sources and changing the color selection. Validator 4 recommended changing "kerja sama" to "gotong royong" in the Pancasila student profile in the control class module and adding reading sources. Validator 5 provided the same suggestion for the control class module as Validator 4. Validator 6 suggested changes similar to Validator 1 for both the experimental and control class modules, and recommended adding reading materials and adjusting the color selection in the control class LKPD.

Science learning using science teaching materials applies the project-based learning (PjBL) model with the following learning syntax: starting with an essential question, making a project design, creating a schedule, monitoring the students and progress of the project, assessing the outcome, and evaluating the experience. The first syntax, starting with an essential question, begins the lesson with an open-ended question that triggers deep discussion. Students are encouraged to explore ideas and concepts more broadly, allowing them to build a more solid understanding (Richhart & Perkins, 2019). In this study, students were instructed to understand the given case, which involved the missing kendang, formulate research questions, develop hypotheses, and study concepts related to vibration, waves, sound, and their applications. These activities incorporate two key components of ethno-STEM: ethnoscience and science in the learning process. The use of essential questions in PjBL not only increases student engagement but also deepens their understanding of scientific literacy through understanding concepts related to phenomena in their surroundings (Fernandez & Lopez, 2023).

In the project design phase, students plan the project by setting objectives, identifying desired outcomes, and determining the necessary steps and resources required for its completion (Mergendollar & Thomas, 2019). In this study, the researcher guided students in determining and creating a product design based on the criteria to be measured, aligning it with the concepts they had already learned. This phase includes two components of ethno-STEM, namely: science and engineering, as the application of science concepts learned was integrated into the design of the kendang product as a solution to the presented case. The use of an appropriate project design in PjBL can enhance students' understanding and science literacy skills by applying conceptual understanding based on hands-on project experience (Rizvi & Gupita, 2023).

The learning steps of creating a schedule and monitoring the students' progress of the project involve the teacher guiding students to plan a schedule. Students collaborate with the teacher to determine the time required for each phase of the project, from research to presentation, and the teacher

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conducts periodic assessments to monitor students' progress. This can be done through meetings and group discussions (Krajcik & Shin, 2020). In this study, the researcher guided students in developing schedules and project implementation plans, creating products, and discussing each development in the project's progress. These activities trained students to evaluate and design scientific investigations. This step includes a component of ethno-STEM, namely engineering, as it involves planning project work and product creation. By providing treatment through schedules, support, and monitoring, students can better understand science concepts and apply them in real-world situations, which is the primary goal of scientific literacy (Liu & Chang, 2021). The implementation of monitoring enables teachers to evaluate students' progress regularly. In this way, timely interventions can be made if students encounter difficulties, helping them understand science concepts more effectively (Smith & Anderson, 2023).

In the assessing the outcome phase, the teacher evaluates the project results and assesses students' content knowledge, teamwork skills, and communication abilities (Vann & Williams, 2021). In this study, the researcher guided students to test the products they created, analyze the data obtained, reflect on the product, discuss the project plan, make improvements based on the data from the product reflection, and make decisions regarding the best product for the project outcome. This phase encourages students to explain scientific phenomena, evaluate and design scientific investigations, and interpret data scientifically, incorporating all four components of STEM. During this process, students are required to transform problems in an ill-defined task into a well-defined outcome through group collaboration (Han et al., 2014). Through presentations and project result discussions, students can refine their skills in communicating scientific information clearly and effectively (Garcia & Martinez, 2024).

The final learning step, evaluating the experience, involves the teacher assessing the final project product and engaging the class in discussions to reflect on their experiences and discuss what they learned while working on the project (Blumenfeld & Krajcik, 2021). In this study, the researcher guided students in creating a final report using the data obtained during the project process, analyzing it scientifically to produce results and enrich their understanding with input from the teacher. This activity encourages students to interpret data scientifically, incorporating three components of ethno-STEM: science, mathematics, and technology. The evaluation of learning experiences allows students to reflect on what they have learned, strengthening their understanding of science concepts (Huang & Chen, 2023).

The ethno-STEM-based science learning utilizes local wisdom by integrating technology, science, engineering, and mathematics in the science curriculum to help students understand the material being studied (Ahmad et al., 2023). Ethno-STEM-based learning applies elements other than ethnography and STEM, starting from local culture, which focuses on the cultural practices, values, and wisdom of local communities related to traditional science or technology (Amtonis et al., 2022); history, which is included in ethno STEM learning, to help students understand how local culture and technology developed over time, thus providing a historical perspective on STEM innovation (Sumarni & Kadarwati, 2020); creativity and art that are part of the ethno STEM approach to help students express the understanding gained from STEM concepts through creative means, such as culture-based product design (Marjanah et al., 2021); and 21st-century skills that include the development of problem-solving skills, collaboration, communication, critical thinking, and creativity, all of which are relevant in the modern global context (Ilyas & Ikram, 2021).

The integration of ethno-science and STEM has encouraged both teachers and students to utilize local knowledge as a learning resource, combined with technology to facilitate the process and create products that develop problem-solving, critical thinking, creativity, innovation, systematic thinking, and logical reasoning skills (Ahmad et al., 2023). Other studies applying ethno-STEM have shown that integrating project-based learning (PjBL) with ethno-STEM results in significant improvements in critical and creative thinking skills, with high achievement in both areas (Ariyatun, 2021). Furthermore, other research indicates that the integration of ethno-STEM in science learning improves students' collaborative skills by 38.5% (Qomaria & Wulandari, 2022). These findings demonstrate that integrating ethno-STEM into science learning can encourage students to develop analytical skills, critical thinking, and creativity by utilizing learning media within an environment that incorporates a science, technology, engineering, and mathematics (STEM) approach. However, this research was only conducted in schools with A accreditation; therefore, further research involving varied accreditation levels is necessary.

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CONCLUSION

The results of the study indicate that the ethno-STEM approach, combined with the Project-Based Learning (PJBL) model, affects students' science literacy in junior high school science education, specifically in the topics of vibration and waves. This influence was proven through an ANCOVA test, with a significance result of 0.047 and a partial eta square of 0.21 (indicating a significant effect). This learning set can be used in the class. Based on the research findings, the researcher suggested that future researchers pay more attention to school policy support, teacher understanding, and the availability of adequate resources, because the ethno STEM approach requires media and tools in the learning implementation process, so that the availability of tools and materials can affect the experience and meaning of teaching and learning obtained by students.

This study was limited to junior high schools with an A accreditation, which could potentially be expanded to include junior high schools from various cities with varying accreditations to obtain diverse results. The science literacy profiles of the three selected schools are as follows: starting with the percentage of science literacy knowledge, which includes content (SMP A: 79.68%, SMP B: 71.87%, SMP C: 68.75%), epistemic (SMP A: 46.87%, SMP B: 42.18%, SMP C: 62.5%), and procedural (SMP A: 51.56%, SMP B: 53.12%, SMP C: 57.81%), and science literacy competencies, which include explaining phenomena scientifically (SMP A: 64.06%, SMP B: 71.87%, SMP C: 68.75%), interpreting data/evidence scientifically (SMP A: 65.62%, SMP B: 68.75%, SMP C: 68.75%), and evaluating and designing scientific investigations (SMP A: 67.18%, SMP B: 65.62%, SMP C: 76.56%). These results show that in the knowledge aspect of science literacy, the highest percentage of content knowledge was found in SMP A, while the lowest was in SMP C; the highest epistemic knowledge percentage was in SMP C, and the lowest was in SMP B; and the highest procedural knowledge percentage was in SMP C, while the lowest was in SMP A.

In the competency aspect of science literacy, the highest percentage for explaining phenomena scientifically was found in SMP B, while the lowest was in SMP A; the percentage for interpreting data/evidence scientifically was the same for SMP B and SMP C, with the lowest being in SMP A; and the highest percentage for evaluating and designing scientific investigations was found in SMP C, with the lowest in SMP B. Based on the researcher's findings, the researcher analyzed that by implementing an ethno STEM learning approach that integrates local culture can increase student interest and motivation in learning, because learning becomes more relevant to everyday life, this approach also encourages students to be able to think critically and creatively with projects that provoke students to be able to solve problems in innovative ways, integrating cultural elements in learning can help preserve local cultural heritage and increase students' awareness of the importance of regional culture, and by improving the quality of ethno STEM-based learning in the future can help generations of students to be able to compete in facing global challenges with the skills to innovate, think critically, creatively and innovatively in solving problems.

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