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Article

Enhancing Students' Scientific Literacy Through A Discovery Learning Model Assisted by Science Modules on Madurese Batik

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ABSTRACT

Students' scientific literacy in Indonesia, especially at the junior high school level, is still low, thus requiring an innovative learning approach. Integrating local wisdom, such as Madurese batik, into science learning makes learning more contextual. This research aimed to analyze the effect of discovery learning assisted by a Madurese Batik science module on students' scientific literacy improvement. A one-group pretest-posttest design was utilized for this study, involving a sample of 31 students from class 7 at SMPN 2 Bangkalan. The research instrument used an essay test on scientific literacy competency. The analysis technique used the Wilcoxon and the N-Gain tests. The findings indicated a significant improvement in students' scientific literacy (Wilcoxon sig. = 0.000), with a moderate N-Gain of 0.65. This study implies that integrating local wisdom into discovery learning can be an effective strategy to enhance students' scientific literacy.

INTRODUCTION

The Society 5.0 era is marked by technological and information developments that require students to think critically, creatively, and adaptively in solving life's problems. This challenge can be addressed by developing students' scientific literacy skills through science learning (D'Agostino, 2020; Oktaviani & Faizah, 2024). Scientific literacy refers to an individual's skills to understand and apply scientific information to solve problems and make decisions (Shaffer et al., 2019; Safrizal et al., 2022). Students with good scientific literacy skills are capable of explaining scientific phenomena, interpreting data, and evaluating scientific investigations (Suryanti et al., 2021). Therefore, strengthening scientific literacy is an important aspect in science learning in Indonesia so that students are ready to face the dynamics of life in the Society 5.0 era.

However, in reality, the scientific literacy skills of Indonesian students, according to the PISA 2022 findings, remain quite low (OECD, 2023). These results are also supported by several previous researchers who have analyzed students' science literacy abilities. For example, research by Budiarti et al. (2021) found that students' scientific literacy skills on temperature

and heat were still low. Furthermore, Nuryanti et al. (2023) also revealed low scientific literacy in climate change, and research by Adnan et al. (2021) showed low scores in understanding biology concepts at the junior high school level. This situation demonstrates a gap between the demands of the Society 5.0 era and students' scientific literacy skills. Scientific literacy skills are crucial for students in applying their learning to address challenges, which require strong critical thinking skills (Susilowati, 2023). Scientific literacy is also crucial for preparing students to address global issues such as the environmental crisis and technological advancements. Although various studies have highlighted the low level of scientific literacy, efforts to develop contextual solutions based on the integration of local culture and technology remain rare.

The problem of low student scientific literacy has attracted the attention of several previous researchers to develop effective learning strategies. Several studies have shown improvements in scientific literacy through the application of specific learning models. Research by Wen et al. (2020), shows that guided inquiry learning can improve students' scientific literacy skills. Research by Prastika et al. (2019) has proven that problem-based learning models effectively enhance students' scientific literacy abilities. Research by Aulia & Hardinata (2024) found that implementing the discovery learning model positively impacts students' scientific literacy skills.

These three models (guided inquiry, problem-based learning, and discovery learning) share a common emphasis on developing scientific thinking and problem-solving skills through hands-on experience. However, most of these studies have not yet linked the application of these learning models to the cultural context and local wisdom relevant to students' lives. Yet, integrating local context into science learning has the potential to enhance students' understanding and motivation. Therefore, innovations in science learning are needed that not only focus on effective models but also consider the cultural context as a means of strengthening scientific literacy.

In this study, to enhance students' scientific literacy, a collaborative discovery learning model was applied with a science module integrated with the local wisdom of Madurese Batik. The discovery learning model was chosen because this model may be a model that is set up to find the concept and knowledge based on students' experiences (Syawaludin et al., 2022). This learning model includes multiple stages, namely stimulation, problem statement, data collection, data processing, verification, and generalizations (Nadjamuddin et al., 2022). Discovery learning makes students think inventively to discover the concepts being learned (Jaapar et al., 2021). The integration of Madurese batik into science learning was chosen because its production process, tools, and materials incorporate concepts from physics, chemistry, and biology, creating a real-life context relevant to students' lives. Several scientific concepts can be studied using the context of Madurese batik, such as the concepts of temperature and heat, elements, compounds, and mixtures, and the classification of living things (Sulastri et al., 2025; Darmawati et al., 2025; Wijaya et al., 2024; Wulandari & Harsiwi, 2025). In addition to its scientific value, Madurese batik also represents local cultural identity, so its use in learning not only strengthens understanding of scientific concepts but also fosters an appreciation for local wisdom.

Several previous studies have applied learning with a local wisdom approach to improve students' scientific literacy. According to Hadi et al. (2020), applying an ethnoscience approach within the discovery learning framework can enhance students' scientific literacy, achieving an average score of 67.93. A study by Dewi et al. (2021) states that contextual learning combined with ethnoscience has the potential to increase students' scientific literacy into the moderate range. A study conducted by Dewi et al. (2020), states that the implementation of the ethnoscience module successfully improves students' scientific literacy. Previous research has used ethnoscience, but has not specifically developed a discovery learning module based on Madurese batik and integrated with technologies such as augmented reality and games. Based

on the theoretical and empirical foundations, this research develops innovation in the form of implementing a discovery learning model using an integrated Madurese batik science module in collaboration with augmented reality and games.

Based on the description above, there is still a research gap related to the application of discovery learning integrated with the local cultural context in an effort to improve students' scientific literacy. Most previous studies only highlight the effectiveness of the discovery or ethnoscience model separately, without combining them in a complete learning framework. Previous studies also have not specifically developed a science module integrated with Madurese batik in discovery learning. Therefore, this study aims to analyze the improvement of students' scientific literacy through the application of the discovery learning model assisted by the science module integrated with Madurese batik. The novelty of this research lies in the development of discovery learning using the science module integrated with Madurese batik in collaboration with technologies such as augmented reality and games as a science learning innovation that is contextual, meaningful, and relevant to students' lives.

METHODS

A one-group pretest-posttest design was utilized for this study (Pongsapan & Patak, 2021). This design was chosen because it aimed to determine changes in students' scientific literacy skills before and after treatment in the form of discovery learning-based learning using a Madurese batik science module. The Madurese batik science module is equipped with trigger questions to train students' scientific literacy, and is equipped with augmented reality and games to check students' understanding after learning using the Madurese batik science module.

The research sample was 31 students of class 7A SMPN 2 Bangkalan, consisting of 12 male students and 19 female students. Participants were selected through a purposive sampling method. The research was conducted in 4 meetings. The research procedure began with a scientific literacy pretest, followed by the implementation of a discovery learning model using an integrated Madurese batik science module. After the learning was completed, students were given a scientific literacy posttest using the same instrument.

The scientific literacy test instrument consists of six essay questions. The questions were developed based on scientific literacy competency indicators according to the PISA framework, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically (Istyadji & Sauqina, 2023). All questions are designed in the context of Madurese batik making to emphasize the integration of local wisdom in science learning. The validity of the science literacy test was calculated through Pearson product-moment, and reliability was assessed through Cronbach alpha (Wijaya & Kloping, 2021; Hidayati et al., 2023). The findings can be found in Table 1 and Table 2. The literacy test instrument used has been declared valid because the significance is <0.05 and reliable because the Cronbach alpha value is> 0.6 (Hidayati et al., 2023).

Table 1. The Validity of Scientific Literacy Tests

Items	Pearson Correlation	Sig. (2-tailed)	Criteria
1	0.407	0.023	Valid
2	0.499	0.004	Valid
3	0.776	0.000	Valid
4	0.691	0.000	Valid
5	0.562	0.001	Valid
6	0.673	0.000	Valid

Table 2. The Reliability of Scientific Literacy Tests

Cronbach's Alpha	Criteria	N of Items
0.661	Reliable	6

The analytical method involved the use of the Wilcoxon test and the N-Gain test. The Wilcoxon test aims to determine the differences in students' scientific literacy before and after the application of the discovery learning model assisted by the science module on Madurese Batik. The Wilcoxon test was chosen because the pretest data on students' scientific literacy were not normal. The N-gain test was employed to assess the degree to which students' scientific literacy increased after applying discovery learning supported by the Madurese batik integrated science module. The findings from the N-Gain computation were categorized using the criteria in Table 3 (Jumadi et al., 2021).

Table 3. N-Gain Score Criteria

N-Gain Score	Criteria
$G \geq 0.70$	High
$0.30 \leq G < 0.70$	Medium
$G < 0.30$	Low

RESULTS AND DISCUSSION

Students' scientific literacy data were obtained from the results of the scientific literacy test conducted before and after the implementation of the discovery learning model assisted by the science module on Madurese batik using essay questions. The data were then tested for hypotheses using the Wilcoxon test because the students' scientific literacy pretest data were not normally distributed. The findings from the normality assessment of the scientific literacy data among students are presented in Table 4. Meanwhile, the findings of the Wilcoxon test can be seen in Table 5.

Table 4. The Normality Test Result

	Statistic	df	Sig.	Conclusion
Pretest	0.871	31	0.001	Not normally distributed
Posttest	0.954	31	0.207	Normally distributed

Table 5. Wilcoxon Test Result

Statistics	Posttest - Pretest
Z	-4.864
Asymp. Sig. (2-tailed)	0.000

From the information in Table 5, it is observed that the significance value obtained from the Wilcoxon test is 0.000, indicating it is below 0.05, thereby leading to the rejection of the null hypothesis. The null hypothesis of this study states that there is no difference in students' scientific literacy before and after the application of the discovery learning model assisted by science modules on Madurese batik. Conversely, the alternative hypothesis states that there is a difference in students' scientific literacy before and after the application of the discovery learning model assisted by science modules on Madurese batik. From the results of the Wilcoxon test, we can infer that there is a difference in students' scientific literacy scores before and after the application of the discovery learning model assisted by science modules on Madurese batik. Figure 1 illustrates the difference in scientific literacy scores.

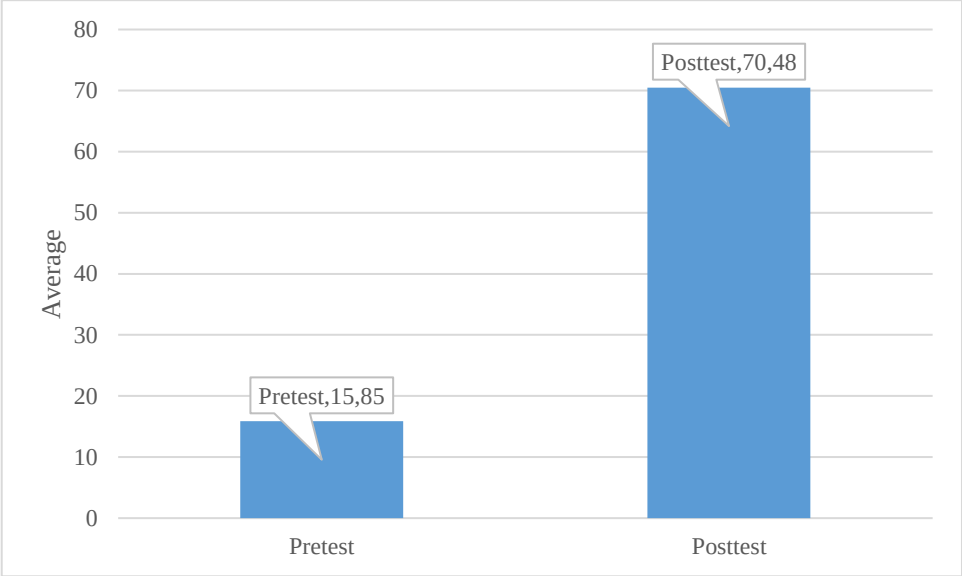

Figure 1. The Average Pretest and Posttest of Students' Scientific Literacy

From Figure 1, the average post-test score was higher than the pre-test score, confirming the effectiveness of discovery learning assisted by the Madurese Batik module. Discovery learning, which begins with stimulus questions that students are required to solve, encourages critical thinking and problem-solving skills (Arifin & Irawan, 2021; Nadjamuddin et al., 2022). In this study, trigger questions were used as a stimulus to open students' thinking patterns and stimulate their scientific literacy. Students used the Madurese batik module to collect and process data, helping them find solutions to the given problems. In the verification stage, educational games were used to check students' understanding and the accuracy of their answers, thereby improving their scientific literacy (Suryanti et al., 2021). These findings indicate that combining discovery learning with culturally relevant materials and interactive activities can significantly improve students' engagement.

The improvement in students' scientific literacy observed in this study is consistent with previous research indicating that discovery learning can enhance scientific literacy (Dewi et al., 2017; Berliana et al., 2023; Aulia & Hardinata, 2024). However, previous research has not linked the application of the discovery learning model to local cultural contexts such as Madurese batik. Unlike conventional approaches, this study integrates the Madurese batik science module into a culturally relevant context, enabling students to engage more meaningfully with the material. By using the Madurese batik module, students are encouraged to explore concepts independently, develop problem-solving skills, and think critically. The science module on Madurese batik can facilitate students to learn independently, contextually, and train students' scientific literacy. The contextuality of science learning can be achieved by linking scientific concepts and local wisdom that exist around students (Herdiana et al., 2022). As stated by Dewi et al., (2021), combining contextual learning with ethnoscience has the potential to enhance the scientific literacy of students. Thus, integrating local culture, such as Madurese batik, provides contextual learning that supports scientific literacy more effectively than conventional approaches

The N-Gain value of students' scientific literacy was 0.65, indicating a moderate level of improvement. Per indicator, explaining phenomena was high (0.73), while interpreting data (0.57) and evaluating investigations (0.65) were moderate. These results indicate that discovery learning supported by the Madurese batik science module effectively improves students' scientific literacy, with the greatest improvement in the indicator of explaining phenomena, although some skills, such as interpreting data and evaluating investigations, still require further strengthening.

Table 6. N-Gain Score Indicator of Scientific Literacy

Indicator	Pretest	Posttest	N-Gain	Criteria
Explaining scientific phenomena	17.2	77.4	0.73	High
Interpreting data and evidence scientifically	17.7	64.8	0.57	Medium
Evaluating and designing scientific investigations	10.9	68.5	0.65	Medium

From Table 6, we can see that every indicator of scientific literacy has shown improvement. Learning science through discovery learning, supported by the science module on Madurese batik, positively influences the enhancement of students' scientific literacy because the way students learn science will affect their scientific literacy abilities (Widiyanti & Susilayati, 2023). The most significant gains were observed in explaining scientific phenomena facilitated by the module's integration of real phenomena from the Madurese batik-making process. Students can recognize and provide explanations for various phenomena using the scientific concepts they possess (Waki'a & Sunarti, 2021). Moderate improvement was observed in interpreting data and evaluating investigations, which indicates that students still experience difficulties in these indicators due to students' lack of critical thinking skills and students only relying on memorizing concepts. To address this, additional strategies such as data analysis exercises and experiment-based learning are recommended. These findings suggest that integrating ethnoscience-based modules with discovery learning enhances students' scientific literacy, but further emphasis on data interpretation and investigation design is required.

CONCLUSION

This study demonstrates that linking the discovery learning model with local wisdom, through the Madurese batik science module, effectively enhances students' scientific literacy, with a moderate improvement (N-Gain 0.65). Indicators of scientific phenomena are most easily developed with contextual learning, while interpreting data and evaluating investigations are still weak and require additional strategies. Discovery learning supported by the Madurese batik module has a real impact on improving scientific literacy. The use of science modules on Madurese batik in discovery learning makes learning more contextual and supports students' ability to connect science with daily life. Future studies are recommended to integrate local wisdom with other learning models or media to further enhance scientific literacy. Additionally, targeted interventions are needed to strengthen students' skills in interpreting data and evaluating investigations, as these indicators still require special attention

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