ENHANCING SEVENTH-GRADE STUDENTS' SCIENTIFIC LITERACY THROUGH THE SCIENCE-POLY GAME

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Abstract

This study aims to improve seventh-grade junior high school students' scientific literacy through the use of the science-poly game on the topic of motion. The learning process was implemented using the lesson study approach, which consists of three stages: plan, do, and see. In the planning stage, teachers collaboratively designed learning activities and literacy-based questions integrated into the science-poly game. During the implementation stage, students participated in the game while engaging with scientific problems that required them to analyze questions, identify key scientific terms, and formulate conclusions. In the reflection stage, teachers discussed the learning outcomes and evaluated the effectiveness of the learning process. The science-poly game was designed as an interactive learning medium that integrates game-based activities with scientific literacy tasks. The results show that all stages of the lesson study were successfully carried out and supported collaborative teacher reflection. The implementation of the science-poly game helped facilitate students' engagement and supported the development of their scientific literacy skills. This is indicated by students' ability to understand scientific questions (56%), identify key scientific terms (59%), and connect these key terms to construct scientific conclusions (44%). Based on these findings, the science-poly game can be considered an alternative learning medium that supports the development of scientific literacy among seventh-grade junior high school students, particularly in learning the concept of motion.

Introduction

Scientific literacy refers to the ability to understand, evaluate, and apply scientific concepts and processes in everyday life. It involves how individuals process scientific facts and concepts, interpret scientific data, and how communities collectively engage with scientific knowledge and practices (Kelp et al., 2023). Scientific literacy is essential for understanding global issues such as climate change, health, and technological development, as well as for participating actively in science-related discussions and decision-making in society (Toole et al., 2020).

Developing scientific literacy requires systematic efforts, particularly at the junior high school level. For seventh-grade students, scientific literacy can be fostered through science learning activities in the classroom (Alves et al., 2020). Scientific literacy consists of several components that are translated into specific indicators. One key component is identifying scientific

issues, which includes recognizing issues that can be investigated scientifically, identifying key scientific terms, and understanding the main characteristics of scientific inquiry (OECD, 2019). Teachers' understanding of these indicators is a fundamental prerequisite for designing learning activities that effectively promote students' scientific literacy skills (Setiawan et al., 2022).

However, scientific literacy cannot be optimally developed through conventional instructional media alone. Teachers are encouraged to design engaging and meaningful learning experiences that motivate students to actively participate in the learning process. One approach to creating enjoyable learning environments is through the use of game-based learning media. Educational games have been shown to increase students' learning motivation and support the development of targeted competencies in classroom learning (McGuire et al., 2023). Game-based media also provide positive learning experiences, enhance motivation, and facilitate deeper conceptual understanding, as demonstrated in previous studies using role-playing and interactive games (Zahrah et al., 2024). Among the commonly used game-based learning media in schools is the monopoly game.

The monopoly game can be modified into an educational learning medium to train specific skills in an enjoyable manner. Previous studies have reported that the use of monopoly-based games can improve students' understanding of science and mathematics concepts at the secondary school level (Hazril, 2021). Other studies have shown that monopoly-based learning media can enhance students' collaboration skills in ecology learning (Ulfa, 2024) and increase motivation and learning outcomes in biology topics such as the digestive system at the junior high school level (Hayati, 2022). These findings suggest that monopoly-based games have strong potential to be adapted into learning media that support scientific literacy development. One such adaptation is the *science-poly* game.

Seventh-grade junior high school students learn integrated science topics that include both biology and physics. While all science topics can potentially be used to develop scientific literacy, post-pandemic learning conditions have led to a decline in students' abilities to comprehend scientific texts and perform numerical reasoning (Buban, 2023). This decline has resulted in difficulties in understanding science materials that involve mathematical calculations, particularly in physics. This challenge is supported by Wangchuk (2023), who found that students often struggle with physics due to the extensive use of formulas and its strong connection to basic mathematical operations. Several physics topics at the junior high school level are considered difficult, including electricity, waves, energy transformation, force, and motion (Shrestha, 2023). Among these topics, motion is taught in Grade 7 and requires both conceptual understanding and mathematical reasoning, making it highly suitable for training scientific literacy skills.

To address these challenges, motion concepts can be delivered through engaging and interactive learning activities using modified game-based media. The *science-poly* game is an educational board game specifically designed for junior high school students to make science learning more enjoyable and interactive. In this game, certain spaces on the board direct players to question cards containing scientific literacy-based problems related to motion. Players who answer correctly earn points, creating a learning atmosphere that is both competitive and collaborative. This game-based approach supports students in practicing scientific literacy skills in a meaningful context. The development of scientific literacy-oriented learning media is crucial for fostering students' literacy-oriented character and competencies (Chasanah et al., 2022). Therefore, this study aims to develop seventh-grade students' scientific literacy through the use of the *science-poly* game on the topic of motion.

Method

This study employed the Lesson Study approach, which consists of three systematic stages: Plan, Do, and See (Sari et al., 2023). Lesson Study was selected to ensure collaborative planning, reflective teaching practice, and continuous improvement in learning implementation.

During the Plan stage, the model teacher analyzed students' characteristics and learning needs through classroom observation and non-cognitive diagnostic assessment. Based on this analysis, a learning module on motion was designed and integrated with the science-poly game as a learning medium. In addition, an observation sheet focusing on students' scientific literacy skills was developed to support data collection during the learning process.

The Do stage involved the implementation of the learning activities according to the prepared lesson plan. The model teacher facilitated learning using the science-poly game, while peer teachers and a mentor teacher acted as observers. Observations focused on students' engagement and the manifestation of scientific literacy indicators during the gameplay.

Finally, the See stage consisted of a reflective discussion between the model teacher and observers. This reflection aimed to evaluate the learning process, identify strengths and weaknesses of the science-poly implementation, and analyze the extent to which scientific literacy indicators were achieved through the game-based learning activity.

Table 1. Stages of Lesson Study Implementation

Lesson Study Stage	Activities Conducted	Output
Plan	Analysis of students' characteristics and needs; development of a motion learning module integrated with the science-poly game; preparation of scientific literacy observation sheets	Lesson plan, science-poly media, observation instruments
Do	Implementation of learning using the science-poly game; observation of students' scientific literacy skills by peer teachers and mentor teacher	Observation data on scientific literacy indicators
See	Reflective discussion between model teacher and observers regarding learning implementation and achieved indicators	Reflection notes and recommendations for improvement

Results

This learning implementation was conducted using the Lesson Study method and involved a supervisor lecturer, a mentor teacher, a model teacher, peer teachers, and seventh-grade junior high school students. The results and discussion are presented based on the three stages of Lesson Study: Plan, Do, and See.

Plan Stage (Learning Planning)

The initial step in the planning stage was analyzing students' characteristics and learning needs through classroom observation and non-cognitive diagnostic assessment. These activities were conducted during the final meeting of the previous topic, temperature and heat, in Grade 7. The results indicated that most students exhibited kinesthetic learning styles and required enjoyable learning activities, particularly those involving collaboration with classmates. Based on these findings, the model teacher decided to employ game-based learning media, as educational games are considered effective in accommodating kinesthetic learners and creating an engaging learning atmosphere.

The second step involved determining the learning material to be used in this study. This process was carried out through discussions with the mentor teacher and peer teachers, accompanied by a review of relevant research articles to identify science topics commonly perceived as difficult by Grade 7 students. The discussion aimed to select material that was appropriate for training scientific literacy skills while aligning with students' characteristics and learning needs. The outcome of this process was the selection of motion as the learning topic and science-poly as the learning media.

The third step was the development of learning tools for the Grade 7 motion topic, which included a learning module, the science-poly game, student worksheets, scientific literacy reading articles, and observation sheets. The learning module was designed for three meetings, with the final meeting integrating the science-poly game. After the learning tools were completed, they were discussed with the supervisor lecturer, mentor teacher, and peer teachers to obtain constructive feedback. One key suggestion was to increase the number of reading articles to enrich students' background knowledge related to motion concepts. This recommendation aligns with Rejeki (2024), who stated that reading materials can broaden students' information and support deeper conceptual understanding.

Do Stage (Learning Implementation)

The implementation of learning on the motion topic was conducted over three meetings. The first meeting focused on introducing motion concepts using interactive PowerPoint presentations and reading articles. Students were asked to read the articles to enrich their understanding and identify important information. To assess students' comprehension, they were instructed to write ten key sentences derived from the reading materials and respond to teacher-generated questions based on those sentences.

The second meeting emphasized motion concepts involving formulas and mathematical calculations. A scientific literacy-based student worksheet (LKPD) was used as the primary learning medium. Students were required to read, understand, and complete the worksheet by filling in missing sections. Through the activities in the first and second meetings, students became accustomed to reading scientific texts and extracting relevant information, thereby progressively training their scientific literacy skills.

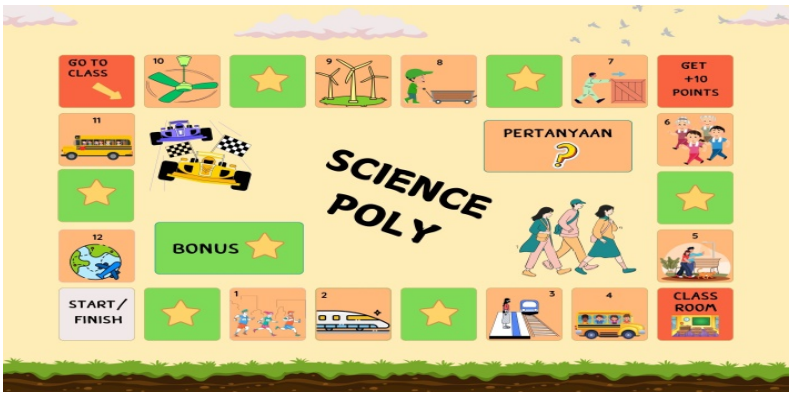

Figure 1. Science-poly Board Game

The third meeting involved learning activities using the science-poly game. The science-poly learning media consisted of a large board game (4 × 3 meters), question cards, bonus cards, and a soft dice. The game was played in groups, with each group consisting of three to four students. One student in each group acted as a game piece and moved across the board. The science-poly game incorporated scientific literacy-based questions related to motion concepts, which

students were required to answer during gameplay. Throughout the activity, the mentor teacher and peer teachers observed students' scientific literacy skills as they emerged during the game. The observations were systematically recorded using the prepared observation sheets.

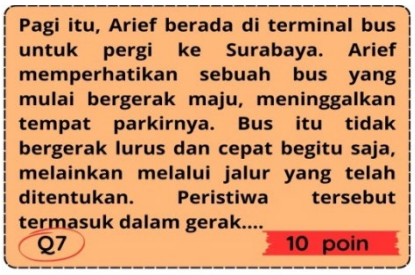

Figure 2. Question Cards

Figure 3. Learning Activities Using the Science-poly Game

See Stage (Learning Evaluation)

The **See** stage was conducted through a reflective discussion involving the supervisor lecturer, mentor teacher, and peer teachers. The discussion began with the presentation of observation results by the mentor teacher and peer observers. Based on these observations, the learning implementation was found to be consistent with the designed lesson plan. Students demonstrated high levels of enthusiasm and engagement during the learning activities using the science-poly game.

Figure 4. Reflective Discussion during the See Stage with the Supervisor Lecturer, Mentor Teacher, and Peer Teachers

However, the reflection also identified an aspect of the science-poly game that required improvement, specifically the content of the bonus cards. Some bonus cards allowed players to take points from other groups, which was perceived as potentially unfair to groups that had earned points through sustained effort. To address this issue, the observers suggested revising the bonus cards so that they only provide additional points, rather than deducting points from

other groups. This revision was considered important to maintain fairness and support positive competition among students.

In addition to evaluating the learning process, the mentor teacher and peer teachers observed several scientific **literacy indicators** that emerged during the science-poly gameplay. The observed indicators and their corresponding percentages are presented in Table 2.

Table 2. Percentage of Scientific Literacy Indicators Achieved

No.	Scientific Literacy Indicator	Number of Students	Percentage (%)
1	Understanding the given scientific questions	18	56
2	Identifying scientific keywords from the questions	19	59
3	Connecting keywords to form scientific conclusions	14	44

The observation results indicate that the science-poly game was able to train three indicators of scientific literacy. Specifically, 56% of students were able to understand the scientific questions presented during the game, suggesting that the science-poly media encouraged students to read scientific questions more carefully. Furthermore, 59% of students successfully identified scientific keywords from the questions, indicating that the game supported students in recognizing and selecting relevant information from scientific statements.

However, the indicator related to connecting keywords to form scientific conclusions showed a lower achievement rate of 44%. This finding suggests that students still experienced difficulty in synthesizing information and constructing scientific conclusions. Such results are reasonable, as higher-order scientific reasoning and information synthesis typically require more intensive and sustained practice.

Overall, the science-poly game proved to be an instructional medium that is not only engaging but also effective in training two out of three scientific literacy indicators, particularly in the aspects of understanding and identifying scientific information. These findings are consistent with Twiningsih (2021), who reported that the use of instructional media can positively influence students' scientific literacy skills. Similarly, Fatih (2024) demonstrated that an augmented reality–based science learning game significantly improved students' scientific literacy, with post-test achievement reaching 92.14%. In addition, Usman (2024) found a positive relationship between the use of learning media and students' scientific literacy, showing that socio-scientific issues (SSI)–based media effectively enhanced the competency dimension of scientific literacy.

Discussion

The findings of this study demonstrate that the implementation of the Lesson Study approach, integrated with the science-poly game, was effective in facilitating students' scientific literacy skills, particularly within the competency of identifying scientific issues. The structured stages of Lesson Study—Plan, Do, and See—enabled systematic planning, reflective teaching practice, and collaborative evaluation, which contributed to the quality of the learning process. This result is consistent with previous studies highlighting Lesson Study as an effective framework for improving instructional quality through collaborative reflection and continuous professional development (Zanaton et al., 2014; Wardani et al., 2023; Keliat et al., 2025).

The use of the science-poly game created an engaging learning environment that supported students' active participation and motivation. More than half of the students were able to understand scientific questions (56%) and identify scientific keywords (59%) during gameplay. These

findings indicate that game-based learning media can support students in processing scientific information, particularly in reading comprehension and identifying essential elements of scientific problems. Prior research has shown that educational games enhance motivation, engagement, and conceptual understanding by providing interactive and contextualized learning experiences (Twiningsih & Elisanti, 2021; Fatih et al., 2024; McGuire, 2023). In addition, game-based learning environments allow students to actively interact with scientific content, which is essential for developing foundational scientific literacy skills (Kelp et al., 2023).

However, the achievement of the indicator related to connecting keywords into scientific conclusions remained relatively low (44%). This suggests that while the science-poly game effectively supports lower to mid-level scientific literacy skills—such as comprehension and identification—it is less effective in fostering higher-order skills, including synthesis and scientific reasoning. According to the PISA scientific literacy framework, the ability to construct scientific explanations and conclusions requires advanced reasoning, repeated practice, and sustained engagement with evidence-based tasks (OECD, 2023). Such competencies are typically developed through explicit instructional scaffolding and opportunities for scientific argumentation (Usman et al., 2024).

To clarify the contribution of the science-poly game to each scientific literacy indicator, Table 3 presents a summary of the achieved indicators along with their pedagogical implications.

Table 3. Scientific Literacy Indicators Achieved through the Science-poly Game

Scientific Literacy Indicator	Achievement (%)	Interpretation
Understanding scientific questions	56	Indicates that the science-poly game encourages careful reading and comprehension of scientific problems
Identifying scientific keywords	59	Shows that the game supports students in recognizing and selecting relevant scientific information
Connecting keywords into scientific conclusions	44	Suggests that higher-order reasoning and synthesis skills require further instructional support

Based on these findings, the science-poly game can be considered an introductory and reinforcing medium for scientific literacy training, particularly in the early stages of literacy development. To maximize its impact on higher-order scientific literacy skills, the science-poly game should be complemented with additional instructional strategies, such as inquiry-based learning, guided discussion, or problem-based learning activities that explicitly target reasoning and conclusion-drawing processes.

Overall, this discussion highlights that the science-poly game, when implemented within the Lesson Study framework, contributes meaningfully to the development of scientific literacy among junior high school students. The integration of game-based learning and collaborative teaching practices not only enhances student engagement but also provides a foundation for further development of advanced scientific reasoning skills.

Research Limitations

This study has several limitations that should be considered when interpreting the results. First, the learning implementation was conducted in only one class (Grade 7E) at SMP Laboratorium UM, which limits the generalizability of the findings to other classes or schools. Second, the study focused solely on one competency aspect of scientific literacy, namely identifying

scientific issues, while the other scientific literacy competencies—such as explaining scientific phenomena and using scientific evidence—were not examined.

Additionally, the observation of scientific literacy indicators relied on qualitative observation data without pre-test and post-test comparisons, which may limit the depth of quantitative measurement of students' learning gains. Finally, the duration of the intervention was relatively short, as the science-poly game was implemented only in the final meeting, which may not be sufficient to fully develop higher-order scientific literacy skills.

Conclusion

The results of this study indicate that the Lesson Study stages—Plan, Do, and See—were implemented effectively and systematically. The Plan stage involved student observation, diagnostic assessment, and the preparation of learning materials. The Do stage focused on the implementation of learning activities based on the designed lesson plan, with the final meeting integrating the science-poly game into the learning process. The See stage was carried out through reflective discussions involving the supervisor lecturer, mentor teacher, and peer teachers to evaluate the learning process and analyze the scientific literacy indicators achieved by students.

Based on the observers' findings, the science-poly game was able to support the development of several scientific literacy indicators, including understanding scientific questions (56%), identifying scientific keywords (59%), and connecting keywords to construct scientific conclusions (44%). These results suggest that the science-poly game can serve as an effective learning medium for supporting the development of scientific literacy skills among seventh-grade junior high school students.

However, considering the limitations of this study, further research is recommended to implement the science-poly game in multiple classes at the same grade level and to examine all competency aspects of scientific literacy. Such studies would provide a more comprehensive understanding of the effectiveness of the science-poly game as a game-based learning medium in science education.

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