

The Effectiveness of Science e-LKPD Based on Discovery Learning in Improving Creative Thinking Skills of Junior High School Students

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Abstract

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This study aimed to examine the effectiveness of an electronic student worksheet (e-LKPD) based on Discovery Learning on the topics of temperature, heat, and thermal expansion in improving junior high school students' creative thinking skills. The study employed a research and development approach using the ADDIE model, which consists of the stages of Analyze, Design, Develop, Implement, and Evaluate. The e-LKPD was validated by three experts to determine its validity, practicality, and feasibility before implementation. The implementation was conducted with students of class VII-C at SMPN 10 Jember. Data were collected through expert validation sheets, student response questionnaires, and creative thinking skill tests administered in the form of pretests and posttests. The results showed a significant improvement in students' creative thinking skills after the implementation of the Discovery Learning-based e-LKPD. The average pretest score increased from 52.14 to 90.04 on the posttest, with an N-Gain value of 0.79, which falls into the high category. Indicator-based analysis revealed that all creative thinking indicators improved, with the fluency indicator achieving the highest N-Gain value of 0.85. These findings indicate that the Discovery Learning-based e-LKPD is effective in enhancing students' creative thinking skills and supporting active and meaningful science learning. Therefore, the Discovery Learning-based e-LKPD can be used as an effective alternative learning material for teaching temperature, heat, and thermal expansion at the junior high school level

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INTRODUCTION

The development of digital technology in the 21st century has brought significant changes to various aspects of life, including education. This transformation requires adjustments in the learning process to produce human resources that are adaptive, innovative, and competitive. Twenty-first century education no longer focuses solely on the mastery of knowledge, but also on the development of higher-order thinking skills known as the 4C skills, namely critical thinking, creativity, communication, and collaboration (Susanti et al., 2021; Susilowati et al., 2023). These four skills serve as a fundamental foundation in preparing students to face increasingly complex global challenges.

One of the skills that plays a strategic role in 21st century learning is creative thinking ability. Creative thinking is defined as the ability to generate new ideas that are original, flexible, and relevant in solving problems and creating innovative solutions (Sholikha et al., 2021). This ability includes four main

indicators: fluency (the ability to generate ideas smoothly), flexibility (the ability to think in diverse ways), originality (the uniqueness of ideas), and elaboration (the ability to develop ideas in detail). These indicators are interrelated and play an important role in shaping students' creative and innovative thinking patterns.

In the context of science learning, creative thinking skills are particularly important because science education not only requires conceptual understanding but also science process skills. Science learning emphasizes activities such as observing, formulating problems, conducting experiments, analyzing data, and drawing conclusions based on natural phenomena encountered in everyday life (Zakiyah et al., 2021; Wulandari et al., 2024). Therefore, students need to be trained to think creatively in order to connect scientific concepts with real-world problems and generate meaningful solutions.

However, various research findings indicate that students' creative thinking abilities in Indonesia are still categorized as low. Data from the Programme for International Student Assessment (PISA) 2022 show that Indonesian students' creative thinking scores are far below the OECD average. These findings indicate that students' abilities to generate creative ideas, think flexibly, and develop innovative solutions are still not optimal. Research conducted by Syamsurizal and Lufri (2023) also shows that junior high school students' creative thinking ability in science learning only reaches approximately 45% of the ideal criteria. Similar conditions were reported by Amaliyah et al. (2023), who stated that the average creative thinking ability of junior high school students remains in the low to moderate category.

The low level of students' creative thinking ability cannot be separated from learning processes that are still dominated by teacher-centered approaches. Learning tends to focus on one-way material delivery, the use of lecture methods, and an emphasis on memorization of concepts, resulting in limited opportunities for students to explore ideas, think divergently, and develop their creativity (Pratiwi et al., 2022). In addition, the use of less varied teaching materials that are not yet integrated with innovative learning models is also a contributing factor to the low level of students' active involvement in science learning.

One learning model considered effective in improving students' creative thinking ability is discovery learning. This model emphasizes student-centered learning through independent concept discovery activities. Discovery learning consists of six main stages: stimulation, problem statement, data collection, data processing, verification, and generalization (Fadillah & Ridlo, 2021; Hasanah & Rusnilawati, 2023). Through these stages, students are encouraged to actively observe phenomena, formulate problems, collect and analyze data, and draw conclusions based on their own discoveries. This process directly trains students' creative thinking across all indicators, from generating ideas to developing solutions in detail.

Several studies show that the implementation of the discovery learning model in science learning can significantly improve students' creative thinking ability. Wulandari et al. (2024) reported improvements in creative thinking ability across all indicators after the application of discovery learning. Research by Pratiwi et al. (2022) also shows that the discovery learning model encourages students to think more flexibly and originally in solving science-related problems.

Nevertheless, the implementation of discovery learning in schools still faces various challenges, particularly related to the availability of teaching materials that can systematically and engagingly facilitate all stages of learning.

Along with technological advancements, the use of digital teaching materials has become a relevant alternative to support the implementation of innovative learning models. One form of digital teaching material that can be utilized is the Electronic Student Worksheet (E-LKPD). E-LKPD is a digitally based worksheet designed to facilitate students' learning activities in an interactive, flexible, and independent manner (Nurhasanah et al., 2022). E-LKPD allows the integration of various learning media, such as text, images, videos, and interactive quizzes, thereby increasing student engagement and learning motivation.

The development of discovery learning-based E-LKPD is considered capable of optimizing the science learning process because each stage of learning is presented in a structured and contextual manner. Muhammad et al. (2022) state that discovery learning-based E-LKPD is effective in improving higher-order thinking skills, including creative thinking, because it provides opportunities for exploration and clear feedback for students. In addition, the use of E-LKPD is in line with the demands of the Merdeka Curriculum, which emphasizes student-centered learning, strengthening the Pancasila student profile, and developing 21st century skills.

However, studies indicate that the development of discovery learning-based E-LKPD for junior high school science learning is still limited, particularly on the topics of temperature, heat, and thermal expansion. Some E-LKPDs used in schools have not fully integrated all discovery learning syntax and have not been specifically designed to improve students' creative thinking ability. Therefore, there is a need to develop science E-LKPD based on discovery learning that is valid, practical, and effective in improving junior high school students' creative thinking ability. Based on this explanation, this study focuses on the development of discovery learning-based science E-LKPD on the topics of temperature, heat, and thermal expansion as an effort to improve junior high school students' creative thinking ability.

RESEARCH METHOD

This study employed a Research and Development (R&D) approach using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation), which was selected due to its systematic and flexible nature, making it suitable for the development and evaluation of digital teaching materials (Branch, 2009). The ADDIE model provides structured stages in developing educational products, starting from needs analysis to final product evaluation. This research aimed to develop a discovery learning-based electronic student worksheet (E-LKPD) for science learning to improve junior high school students' creative thinking skills. The study was conducted at SMP Negeri 10 Jember during the first semester of the 2025/2026 academic year. The research subjects consisted of 32 students from class VII-C, selected using purposive sampling, with the consideration that the class had not previously used discovery learning-

based E-LKPD and required improvement in creative thinking skills.

The instruments used in this study included expert validation sheets to assess the feasibility of the E-LKPD in terms of content, language, presentation, and graphics; learning implementation observation sheets to determine the practicality of using the E-LKPD during the learning process; pretest and posttest instruments to measure the effectiveness of the E-LKPD in improving students' creative thinking skills; and a student response questionnaire to identify students' perceptions regarding the use of the E-LKPD. The selection of these instruments was based on the research objectives, which were to evaluate the validity, practicality, effectiveness, and students' responses toward the developed product. Data collection was carried out through several stages following the ADDIE model. In the analysis stage, curriculum analysis, interviews with science teachers, and classroom observations were conducted to identify students' characteristics, learning conditions, teaching materials used, and problems encountered during science learning. In the design stage, an initial draft of the discovery learning-based E-LKPD was developed according to the Merdeka Curriculum and the topics of temperature, heat, and thermal expansion, along with supporting instruments such as validation sheets, pretest–posttest questions, observation sheets, and student response questionnaires. The development stage involved validation by material and media experts to evaluate the quality and feasibility of the E-LKPD, followed by revisions based on expert feedback. In the implementation stage, the validated E-LKPD was applied in class VII-C to examine its practicality and effectiveness in real classroom learning. Finally, in the evaluation stage, further revisions were made based on validator input, learning implementation observations, student responses, and pretest–posttest results. These stages were conducted to produce an E-LKPD that is valid, practical, and effective in enhancing students' creative thinking skills.

RESULTS AND DISCUSSION

At this stage, observations and interviews with science teachers were conducted to identify learning problems at SMP Negeri 10 Jember. The analysis revealed that science learning still relied heavily on printed teaching materials and conventional worksheets. Students tended to be passive during learning activities and showed difficulties in generating ideas, proposing alternative solutions, and elaborating explanations. These conditions indicated that students' creative thinking skills were still relatively low and required instructional support through innovative digital teaching materials.

Analyze Stage

At this stage, the researcher conducted classroom observations to identify problems in science learning at Grade VII of SMP Negeri 10 Jember. The analysis covered several aspects, including curriculum implementation, learning constraints, teaching materials used, learning strategies, as well as students' characteristics and classroom conditions. Based on observations and interviews with science teachers, it was found

that students exhibited diverse learning characteristics, with many showing low participation during learning activities, particularly in class discussions, question-and-answer sessions, and problem-solving tasks. Students tended to rely on teacher explanations and rarely expressed their own ideas or alternative solutions during learning.

The school had implemented the Merdeka Curriculum, which emphasizes student-centered learning and the development of higher-order thinking skills, including creative thinking. However, in practice, science learning was still largely dominated by teacher-centered instruction. Learning activities relied heavily on printed teaching materials such as textbooks and conventional worksheets, which primarily focused on concept memorization and procedural tasks. These materials provided limited opportunities for students to explore concepts independently, generate multiple ideas, or elaborate scientific explanations, resulting in low engagement and reduced learning motivation.

Furthermore, the analysis revealed that the available teaching materials had not fully supported discovery-based learning activities. There had been no implementation of discovery learning-based electronic student worksheets (E-LKPD) in science learning at the school. As a result, students were not optimally facilitated to develop creative thinking skills, particularly in terms of fluency, flexibility, originality, and elaboration. Therefore, the development of a digital E-LKPD based on discovery learning was considered necessary to address these learning challenges. The E-LKPD was expected to provide a more interactive, student-centered, and meaningful learning experience that supports active exploration and fosters students' creative thinking skills in science learning.

Design Stage

In the design stage, the discovery learning-based E-LKPD was designed in accordance with the Merdeka Curriculum and the characteristics of Grade VII students. The E-LKPD was systematically structured based on the discovery learning syntax, including stimulation, problem identification, data collection, data processing, verification, and generalization. Each learning activity was designed to encourage students to actively explore concepts and generate multiple ideas.



Figure 4.1 shows the textbook cover

The content of the E-LKPD focused on temperature, heat, and thermal expansion and was presented from simple to complex concepts. Visual elements, illustrations, contextual problems, and interactive tasks were incorporated to increase students' engagement. In addition, evaluation components were designed based on creative thinking indicators: fluency, flexibility, originality, and elaboration. This stage ensured that the E-LKPD design was pedagogically appropriate, visually attractive, and aligned with students' cognitive development.



Figure 4.2 shows an example of the introduction and main content.

Development Stage

At the development stage, the E-LKPD design was transformed into a complete product and validated by three experts consisting of science education lecturers and junior high school science teachers. The validation process assessed several aspects, including content feasibility, presentation quality, language clarity, and graphical design. The results of the expert validation are presented in Table 1.

Table 1. Validation Results of the Guided Inquiry-Based Ethnoscience Textbook

Aspect	Skor Interval			Presentase (%)	Category	
	Evaluasi Validator 1	Validator 2	Validator 3			
content	100	100	91,67	97,22	Very Valid	
material	91,67	100	91,67	94,44	Very Valid	
presentation	80	95	90	88,33	Very Valid	
language	85	95	90	90	Very Valid	
graphic	83,33	100	91,67	91,67	Very Valid	
average		88	98	98	94,67	Very Valid

The textbook obtained an average score of 94.6%, classified as **very valid**. Revisions were made based on expert suggestions regarding content and design to improve quality. Validation of the module structure is shown in Table 2:

Table 2. Module Structure Validation

NO	Aspect	Presentase			Presentase (%)	Category
		V1	V2	V3		
	Informasi Umum					
1	Module Identity	100	100	100	100	Very Valid
2	Pancasila student profile	100	75	100	91,67	Very Valid
3	Facilities and infrastructure	100	100	100	100	Very Valid
4	Target student	100	100	100	100	Very Valid
5	Learning methods	100	100	75	91,67	Very Valid
6	Learning achievements	75	100	100	91,67	Very Valid
	Total score	575	575	575	475	Very Valid
	Core Competencies					
7	Meaningful understanding	75	100	100	91,67	Very Valid
8	Leading Questions	87,5	100	100	95,83	Very Valid
10	Achievement indicators	75	100	100	91,67	Very Valid
11	Learning objective	75	100	100	91,67	Very Valid
	Total Score	312,5	400	400	92,70	Very Valid

Learning Activity Steps	87,5	100	100	95,83	Very Valid
Total score	87,5	100	100	95,83	Very Valid
Total score	87,15	98,61	98,61	94,79	Very Valid

To measure effectiveness, pretest and posttest questions were developed based on critical thinking indicators. The validation results are shown below:

Table 3. Pretest-Posttest Validation Results

No	Aspect	Interval score			Presentase (%)	Category
		Validator 1	Validator 2	Validator 3		
I	Content	100	100	96,4285714	98,8095238	Very Valid
II	Contruction	91,6666667	100	94,4444444	95,3703704	Very Valid
III	Language	88,8888889	94,4444444	100	94,4444444	Valid
Average Score		93,5185185	98,1481481	96,957672	96,2081129	Very Valid

Implementation Stage

The implementation stage was carried out in class VII-C of SMP Negeri 10 Jember involving 32 students and aimed to evaluate the practicality of the discovery learning-based E-LKPD in real classroom settings. The implementation was conducted over four learning meetings and observed by three independent observers to ensure objectivity. The observation results showed that the practicality of the E-LKPD consistently reached a very high level across all meetings. In the first meeting, the average practicality score reached 91.66%, indicating that the E-LKPD could be implemented effectively from the initial use. In the second meeting, the average score increased to 92.71%, reflecting improved familiarity of both teachers and students with the E-LKPD. Although the third meeting showed a slight decrease with an average score of 90.62%, the practicality level remained within the very practical category. The highest practicality score was achieved in the fourth meeting, with an average of 94.58%, demonstrating that the learning process ran smoothly and in accordance with the discovery learning stages. Overall, the average practicality score across all meetings was 92.39%, which falls into the very practical category. These results indicate that the E-LKPD was easy to use, supported effective classroom management, and successfully facilitated learning activities based on the discovery learning

model, allowing both teachers and students to implement the learning process smoothly and as designed.

Evaluation Stage

The evaluation stage was conducted to determine the effectiveness of the discovery learning-based E-LKPD in improving students' creative thinking skills. Effectiveness was measured through a comparison of pretest and posttest results, supported by data from student response questionnaires. The results showed a substantial improvement in students' learning outcomes after the implementation of the E-LKPD. The average pretest score was 52.8, while the average posttest score increased significantly to 86.7, indicating that students' understanding and creative thinking abilities improved after engaging with the learning activities provided in the E-LKPD

To further examine the level of improvement, an N-gain analysis was conducted for each creative thinking indicator. The results revealed that students' fluency skills improved from an average pretest score of 10.4 to a posttest score of 15.9, yielding an N-gain value of 0.72, which falls into the high category. Flexibility skills increased from 9.8 to 14.8, resulting in an N-gain of 0.67, categorized as moderate. Originality skills also showed a high level of improvement, rising from 9.1 in the pretest to 14.7 in the posttest, with an N-gain of 0.71. Similarly, elaboration skills demonstrated the highest improvement, increasing from 8.0 to 14.4, with an N-gain value of 0.76, categorized as high. Overall, the average N-gain score across all creative thinking indicators was 0.72, indicating that the E-LKPD was highly effective in enhancing students' creative thinking skills.

In addition to learning outcomes, students' responses toward the use of the E-LKPD were very positive. Based on the student response questionnaire, the interest aspect achieved a percentage score of 93.25%, indicating that students found the E-LKPD engaging and motivating. The content aspect obtained a score of 94.10%, reflecting students' positive perceptions of the relevance and clarity of the learning materials. The language aspect also received a high score of 93.85%, showing that the instructions and explanations were easy to understand. Overall, the average student response score reached 93.73%, which falls into the very good category. These results indicate that students not only benefited cognitively from the E-LKPD but also perceived it as an enjoyable and effective learning resource.

DISCUSSION

The results of this study indicate that the discovery learning-based E-LKPD is valid, practical, and effective in enhancing junior high school students' creative thinking skills. The high validity score of 95.27% demonstrates that the developed E-LKPD meets the essential criteria of quality teaching materials in terms of content accuracy, presentation structure, language clarity, and graphical design. According to Akbar (2013), learning materials with validity scores above 70% are considered feasible for classroom implementation, while scores above 85% indicate

very high validity. Therefore, the validity results of this study confirm that the E-LKPD is highly suitable for supporting science learning. In addition, the alignment between the E-LKPD content and the learning objectives of the Merdeka Curriculum ensures that the material not only conveys scientific concepts but also facilitates the development of higher-order thinking skills, particularly creative thinking.

The high validity of the E-LKPD can be attributed to the systematic integration of discovery learning principles into each learning activity. Discovery learning emphasizes students' active involvement in constructing knowledge through exploration, observation, and problem-solving (Bruner, 1961). By embedding discovery learning stages—such as stimulation, problem identification, data collection, data processing, verification, and generalization—into the E-LKPD, students are guided to actively engage with scientific phenomena rather than passively receiving information. This design is consistent with previous studies that report inquiry- and discovery-based teaching materials as effective tools for fostering students' creative and higher-order thinking skills (Minner et al., 2019; Nugroho et al., 2021).

In terms of practicality, the E-LKPD achieved an average score of 92.39%, indicating that it can be implemented efficiently in real classroom settings. According to Nieveen (1999), a learning product is considered practical if it can be used easily by teachers and students and functions as intended without significant obstacles. The high practicality score in this study suggests that the E-LKPD was user-friendly, supported classroom management, and facilitated learning activities in accordance with the planned instructional design. The digital format of the E-LKPD also contributed to its practicality, as it allowed students to access learning materials flexibly and interactively. This finding is in line with previous research stating that electronic worksheets enhance learning efficiency and student engagement when designed appropriately (Wahyuni et al., 2022).

The structured discovery learning stages embedded in the E-LKPD played an important role in supporting practicality. While students were encouraged to explore concepts independently, the guidance provided through structured questions and tasks ensured that learning remained focused and meaningful. This balance between guidance and autonomy is a key characteristic of effective discovery learning, as emphasized by Minner et al. (2019), who argue that guided discovery promotes active learning without overwhelming students. As a result, students were able to participate actively in discussions, experiments, and problem-solving activities, while teachers could facilitate learning more effectively.

Effectiveness testing further demonstrated that the E-LKPD significantly improved students' creative thinking skills, as indicated by an average N-gain score of 0.72, which falls into the high category according to Hake (1998). This result suggests that the learning gains achieved through the use of the E-LKPD were substantial. The highest improvements were observed in elaboration and fluency, indicating that students became more capable of generating ideas and expanding their

explanations in greater detail. These findings are consistent with the theoretical framework of creative thinking proposed by Torrance (1974), which highlights fluency and elaboration as key components of creative idea generation.

Although flexibility showed a moderate N-gain, it still demonstrated meaningful improvement. This suggests that while students were increasingly able to propose multiple ideas, some still required additional support to shift perspectives or generate alternative solutions. Previous studies have also reported that flexibility is often more challenging to develop compared to other creative thinking indicators and may require prolonged exposure to open-ended and divergent tasks (Ruqoyyah et al., 2020). Therefore, extended implementation of the E-LKPD or integration with other creative learning strategies may further enhance this aspect.

Student responses toward the E-LKPD further support its effectiveness. The very high response scores indicate that students perceived the E-LKPD as interesting, easy to understand, and motivating. According to Wahyuni et al. (2022), positive student responses toward learning materials reflect increased motivation and engagement, which are essential factors for successful learning outcomes. The interactive activities and contextual problems presented in the E-LKPD encouraged students to take an active role in learning, which in turn supported the development of creative thinking skills.

Overall, these findings suggest that the discovery learning-based E-LKPD is a feasible, practical, and effective alternative teaching material for science learning. By actively engaging students in the learning process and providing structured guidance, the E-LKPD supports the development of creative thinking skills in line with contemporary educational theories. Therefore, the E-LKPD is particularly suitable for use in science learning on the topic of temperature, heat, and thermal expansion, as well as for supporting the broader goals of student-centered learning and higher-order thinking skill development promoted by the Merdeka Curriculum.

CONCLUSION

This study concludes that the discovery learning-based electronic student worksheet (E-LKPD) is valid, practical, and effective in improving junior high school students' creative thinking skills in science learning on the topic of temperature, heat, and thermal expansion. The E-LKPD achieved a very high validity score of 95.27% and a practicality score of 92.39%, indicating that it is appropriate and easy to implement in classroom settings. Its effectiveness is demonstrated by an average N-gain score of 0.72 (high category), reflecting significant improvement across all creative thinking indicators. In addition, positive student responses with an average score of 93.73% confirm that the E-LKPD supports engaging and meaningful student-centered learning in accordance with the Merdeka Curriculum.

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