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Development of a PjBL-Based E-Booklet on Temperature and Heat Integrated with the Local Wisdom of Magelang Pottery to Equip Students with Creative Thinking Skills

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Keywords

E-Booklet; temperature and heat; project based learning; local wisdom of pottery; creative thinking skills

Abstract

Problem: the integration of local wisdom in junior secondary science learning remains limited, contributing to low students' creative thinking skills. Furthermore, the use of digital teaching materials that support project-based learning is not yet optimal, resulting in less contextual and engaging learning. Objective: this study aimed to develop and examine the feasibility and effectiveness of a Project-Based Learning (PjBL)-based e-booklet on temperature and heat integrated with the local wisdom of Magelang pottery. Method: this research employed a Research and Development (R&D) approach using the ADDIE model and involved an experimental and a control class. The evaluation focused on feasibility (validity, readability, and practicality) and efeftiviness (product and process performance, as well as learning outcomes). Results: the developed e-booklet was found to be valid, practical, and received positive responses from students. Conclusion: the e-booklet was sufficiently effective in enhanving student engagement and creative thinking skills, making it a feasible contextual teaching material for junior secondary science learning.

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INTRODUCTION

Indonesia possesses rich cultural heritage and local wisdom distributed across various regions, one of which is pottery craftsmanship that embodies cultural, social, and educational values (Anisa, 2017; Suharson, 2024). This form of local wisdom has the potential to be utilized as a contextual learning resource in science education, as it enables the connection between scientific concepts and real-life phenomena in students' surroundings. However, the rapid development of globalization and digital technology presents significant challenges to the sustainability of local culture. The influx of external cultural influences may gradually shift local values if not accompanied by systematic preservation efforts (Larasati, 2018). In the educational context, the preservation of local culture can be realized through the integration of local content into curricula at primary and secondary levels, aligned with regional policy priorities, thereby fostering more relevant and meaningful learning experiences (Faiz, et al. 2023).

The integration of local wisdom into classroom instruction serves not only as a cultural preservation strategy but also as a means of developing 21st-century skills, including critical thinking, communication, collaboration, and creativity, through culturally responsive pedagogy (Fitrianto, & Farisi, 2025). These competencies are essential, as contemporary educational demads require students not only to master conceptual knowledge but also to think creatively in solving real-world problems. Nevertheless, the 2022 PISA survey conducted by the Organization for Economic Cooperation and Develompment (OECD) indicates that Indonesian students' creative thinking skills remain relatively low, ranking 19th out of 60 participating countries and below the OECD average.

Theoretically, the integration of local wisdom in junior secondary science learning has not been optimally implemented (Putra, & Wahyuni, 2025). Interview and observational finding with science teachers further reveal that students' creative thinking skills remain limited, particularly in upper-grade classes. Science instruction has also not fully incorporated local wisdom due to time constraints and the limited use of electronic-based teaching materials. This situation highlights a gap between the potential of local wisdom as a learning resource and its practical implementation in school science education.

These challenges call for innovation in science instruction that emphasizes not only conceptual mastery but also the development of creative thinking and the ability to relate scientific concepts to everyday phenomena. One potential approach is the Project-Based Learning (PjBL) model. Nurhikmayati, & Sunendar (2020) reported that PjBL enhances students' active engagement, independence, and responsibility in learning. This finding is supported by Azizah, et al. (2024), who demonstrated that local widom-based PjBL positively contributes to the improvement of fluency, flexibility, originality, and elaboration in creative thinking.

The use of instructional media also plays a crucial role in supporting learning outcomes. Syarifa, et al. (2024) suggested that digital e-booklets offer a concise, visually engaging, and accessible learning medium for students. Similarly, Marcellina, et al. (2023) found that local wisdom-based e-booklets assist students in understanding science concepts in a more contextual manner. Efforts to address these needs were undertaken through the development of instructional materials integrating the PjBL model with a digital e-booklet designed in accordance with the characteristics of junior secondary students. The development process focused not only on presenting the concepts of temperature and heat but also on linking them to the pottery-making process as a real-life representation of heat application. Through structured project stages, students are guided to observe, analyze, and reflect on scientific phenomena occurring during the firing and heating processes of pottery, thereby promoting more contextual and meaningful learning.

Previous studies have also indicated that project-based instructional materials integrated with local wisdom can enhance meaningful learning and strengthen higher-order thinking skills (Faiz, et al. 2023; Fitrianto, & Farisi, 2025). The integration of local contexts in science instruction reinforces the connection between scientific concepts and everyday life. Therefore, the development of a PjBL-based e-booklet integrated with local pottery wisdom possesses strong theoretical and empirical foundations and is relevant for implementation in junior secondary science learning.

METHOD

This study employed is a Research and Development (R&D) approach using the ADDIE development model. The ADDIE model developed by Branch (2009), consists of five stages ADDIE (Analysis, Design, Development, Implementation, Evaluation). The research procedures are presented in Table 1.

Table 1. Research Procedures Based on the ADDIE Development Model

ADDIE Stage	Main Activities	Output
Analyze	Analysis of media needs, student characteristics, temperature and heat material, and local pottery wisdom	Development specification requirements
Design	Designing e-booklets based on PjBL, learning objectives, and assessment instruments	Initial design of the e-booklet
Develop	Development of the e-booklet and validation	Validated e-booklet product
Implement	Implementation of learning trials and data collection	Data on readability, practicality, and effectiveness
Evaluat	Product analysis and revision	Final version of the e-booklet

The research involved both subjects and objects of study. The subjects were 64 seventh-grade students from classes VII E and VII F at SMP N 1 Borobudur, divided into two groups. The experimental class used the developed e-booklet as instructional material, while the control class received convetional instruction. The research design employed was a nonequivalent control group design.

The research instruments consisted of four types: (1) a validation sheet for product characteristics assessed by material and media experts; (2) a feasibility validation sheet covering expert validity (media and material experts), teacher and student readability, and teacher and student practicality; (3) an effectivinnes sheet including a creative thinking test, project assessment rubic, and process assessment rubic; and (4) a student response questionnaire for feedback on the use of the e-booklet.

Data analysis was conducted using several product evaluation criteria and formulas. For the analysis of the e-booklet's characteristics and feasibility, particularly validity, Aiken's V formula was used. Meanwhile, readability and practicality were analyzed using the Respondent Assessment Percentage (PPR) and Statement Indicator Score (SIP) (Sudjana, & Rivai, 2007).

The effectiveness of the e-booklet was analyzed using pretest and posttest instruments containing questions aligned with cognitive levels and creative thinking aspects. Students' pretest and posttest scores were subjected to prerequisite tests and hypothesis testing. In addition, the effectiveness of the e-booklet was evaluated through students' products and project performance as an implementation of Project-Based Learning (PjBL). The assessment criteria are presented in Table 2.

Table 2. Criteria for Students' Product and Process Creativity

Score Range	Creativity Criteria	Description
80.1 – 100	Very Creative	Students demonstrate a high level of creativity in both product and perfomance
60.1 – 80	Creative	Students demonstrate good creativity in both product and performance process
40.1 – 60	Moderately Creative	Students demonstrate moderate creativity in both product and performance process
20.1 – 40	Less Creative	Students demonstrate low creativity in both product and performance process
0.0 – 20	Not Creative	Students do not demonstrate creativity in both product and performance process

Source: Adapted from Solehah, & Carolina, (2022).

Tabel 2 presents the criteria for students' creativity levels assessed from their product and performance processes as part of the PjBL implementation. A score range of 80.1 – 100 indicates a very high level of creativity, while lower scores reflect lower levels of creativity, categorized as not creative. The student response questionnaire contained students' opinions regarding the use of the e-booklet. The feedback scores were calculated and categorized according to the criteria presented in Table 3.

Table 3. Criteria for Students' Responses

Precentage (%)	Criteria	Description
$81.50 \leq V \leq 100$	Very Good	Students provide very highly positive responses toward the e-booklet
$62.50 \leq V \leq 81.50$	Good	Students provide highly positive responses toward the e-booklet
$43.75 \leq V \leq 62.50$	Fair	Students provide moderate responses; improvements are need in certain aspects
$25 \leq V \leq 43.75$	Poor	Students provide low responses; many aspects require improvement

Source: Adapted from Ukiasriadi, & Hadi, (2025).

Table 3 presents the criteria for students' feedback responses toward the use of the e-booklet. The higher the percentage obtained, the more positive the response. Conversely, lower percentages indicate the need for improvements in several aspects.

RESULTS AND DISCUSSION

Implementation Results of the PjBL-Based E-Booklet Integrated with Local Wisdom

The results of this study include the development of a PjBL-based e-booklet on temperature and heat integrated with the local wisdom of Magelang pottery to foster creative thinking skills among seventh-grade students at SMP N 1 Borobudur. The study was conducted over several meetings to identify the product characteristics, determine its feasibility, examine its effectiveness, and obtain user feedback. The study was conducted over several meetings to identify the product characteristics, determine its feasibility, examine its effectiveness, and obtain user feedback. The detailed findings are presented as follows.

The developed e-booklet is a digital instructional material integrating the Projecr-Based Learning (PjBL) model with the local wisdom of pottery in the topic of temperature and heat. The media was designed with visual elements reflecting local cultural nuances, equipped with user guidelines, project-based activities, and open-ended questions aimed at enhacing students' creative thinking skills. The materials were presented contextually by linking temperature and heat concepts to the pottery-making process, making learning more meaningful. These characteristics are consistent with the findings of Rahayu, et al. (2025) and Maulida, et al. (2024), which indicate that digital instructional materials based on local wisdom and supported by visual and multimedia elements can enhace learning motivation, conceptual understanding, and student engagement.

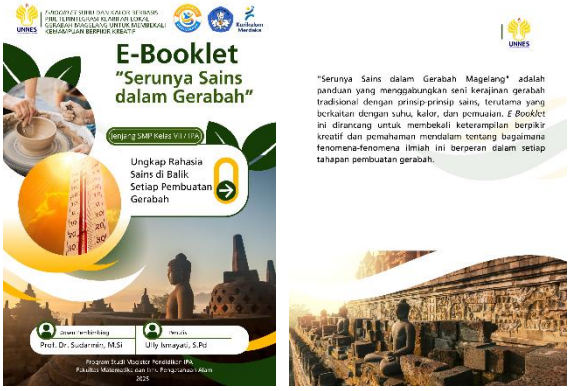

Figure 1. Front and Back Cover of the E-Booklet

Figure 2. Content Display of the Temperature and Heat E-Booklet

In terms of content, the e-booklet integrates temperature and heat concepts with the local wisdom of Magelang pottery, enabling students to understand abstract science concepts through real-life phenomena in their surroundings. Putra, et al. (2021) stated that integrating local wisdom into science learning enhaces meaningful learning and conceptual understanding. This finding is reinforced by Setiawan, et al. (2017), who emphasized that culturally contextualized science learning promotes better scientific literacy. Aikenhead, (2017) also highlighted the importance of connecting school science with students' cultural backgrounds to ensure relevance. Furthermore, the integration of the PjBL approach strengthens the e-booklet by encouraging active engagement and creativity in contextual project activites (Sari, et al. 2021). To ensure product quality, the feasibility of the e-booklet was evaluated in terms of validity, readability, and practicality.

Validity of the E-Booklet

The validity of the temperature and heat e-booklet integrated with local wisdom wes assessed using Aiken's V index, evaluated by media and material experts. The results are presented in Table 4.

Table 4. Validity Results of the E-Booklet

Validator	Aspect	Aiken's V Score	Decision
Media Expert	Presentation Feasibility	0.86	
	Language Feasibility	0.92	
	Graphic Feasibility	0.96	
Material Expert	Content Feasibility	0.94	High Validity
	Presentation Feasibility	0.93	
	Language Feasibility	0.91	
	E-booklet Characteristic Component	0.93	
Overall Average		**0,92**	**High Validity**

Table 4 shows that all aspects fall within the high validity category, indicating that the e-booklet is suitable for instructional use. The high validity reflects the alignment among content, media design, and instructional construction, including systematic material presentation, coherent PjBL syntax, and the integration of local wisdom. These findings align with Rahmadini, et al. (2024) and Sari, & Widodo, (2021), who stated that well-designed PjBL-based instructional materials tend to demonstrate high validity and effectively facilitate active and independent learning.

Readability and Practicality of the E-Booklet

Readability was evaluated to determine the clarity of presentation, content, and language from both teachers' and students' perspective. The results are presented in Table 5.

Table 5. Recapitulation of Teachers' and Students' Readability Results

Aspect	Teacher (%)	Student (%)	Aspect Average	Criteria
Appearance	86.1	76.2	81.15	Very Good
Content	88.3	75.0	81.65	Very Good
Language	71.7	78.1	74.9	Good
Overall Average	**82.03**	**76.3**	**79.17**	**Good**

The differences in ratings reflect variations in user perspectives influenced by experience and instructional needs (Sung, et al. 2016). Nevertheless, the e-booklet was considered readable and understandable, making it appropriate for classroom use. Practicality was evaluated to determine the ease, efficiency, relevance, and usefulness of the e-booklet. The results are presented in Table 6.

Table 6. Recapitulation of Teachers' and Students' Practicality Results

Aspect	Teacher (%)	Students (%)	Aspect Average	Criteria
Ease and Clarity	91.6	80.0	85.8	Very Practical
Efficiency and Attractiveness	87.5	79.4	83.45	Very Practical
Relevance and Usefulness	85.4	75.6	80.5	Very Practical
Overall Average	**88.17**	**78.33**	**83.25**	**Very Practical**

Overall, the e-booklet was categorized as very practical. This indicates that it is easy to use, systematically structured, and effectively integrates project activities. These findings align with Sari, & Widodo, (2021) and Wahyuni, & Suryadi, (2020), who reported that PjBL-based materials enhace interactivity, efficiency, and student engagement.

Effectiveness of the E-Booklet

The effectiveness of the e-booklet was examined through product outcomes, learning processes, and learning achievement. From the product perspective, students' pottery works were categorized as creative to very creative, characterized by visual quality, proportional form, and alignment with temperature and heat concepts, although some products required stronger scientific representation. In terms of process, students demonstrated active participation throught all project stages, both independently and collaboratively. Learning outcomes showed an improvement in students' creative thinking skills, as reflected in pretest-posttest score differces. The results are presented in Table 7.

Table 7. Effectivess Results of the E-Booklet

Class	Number of Students	Mean Pretest	Mean Posttest	N-Gain Score	Criteria
Experimental	32	59.63	83.06	0.30	Moderate
Control	32	40.00	50.43	0.22	Low

The N-Gain score of the experimental class falls within the moderate category, while the control class is categorized as low, indicating that the implementation of the e-booklet was sufficiently effective. Improvemnts were observed across four aspects of creative thinking: fluency, flexibility, originality, and elaboration. Fluency showed the most sifnificant improvement, followed by elaboration. These findings are consistent with Torrance (1996) and Mukaromah, & Inayah, (2025), who suggested that fluency is often the initial and more easily developed stage of creative thinking. However, originality and flexibility remained relatively limited, as students' ideas tended to be similar and lacked diverse perspectives. According to Torrance (1996), these higher-level aspects require sustained simulation and an open learning environment.

Overall, the findings indicate that the PjBL-based e-booklet integrated with Magelang pottery local wisdom is moderately effective in enhancing students' creative thinking skills through contextual, active, and meaningful learning.

Students' Feedback Responses

To obtain follow-up evaluation data, students in the experimental class were asked to provide feedback regarding the attractivenees, ease of use, usefulness, and relevance of the e-booklet. The results are presented in Table 8.

Table 8. Students' Responses in Each Aspect

Number of Students	Attractivenes (%)	Ease (%)	Usefulness (%)	Relevance (%)	Overall (%)	Criteria
32	78.3	79.5	79.4	79.2	79.1	Good

Students demonstrated positive responses in all aspects, categorized as good. The visual design, illustrations, and integration of local wisdom enhanced students' interest in learning. The e-booklet was also considered easy to acces and helpful in understanding temperature and heat concepts as well as in conducting project activities independently.

These findings support previous studies (Purnamasari, et al. 2025; Damayanti, et al. 2024) indicating that PjBL-based digital media integrated with local wisdom effectively facilitates creativity, engagement, and meaningful science learning.

CONCLUSION

This study developed a Project-Based Learning (PjBL)-based e-booklet on temperature and heat integrated with the local wisdom of Magelang pottery to enhance sventh-grade students' creative thinking skills. The findings indicate that the e-booklet achieved a high level of validity based on expert evaluation and was categorized as good to very good in terms of readability, as well as very pratical in its implementation. The use of the e-booklet was moderately effective in improving students' creative thinking skills, particularly in the aspects of fluency and elaboration, although originality and flexibility still require further enhancement. Overall, the PjBL-based e-booklet integrated with local wisdom is considered feasible, practical, and sufficiently effective in supporting contextual and meaningful science learning.

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