



Practicality of Local Wisdom-Based Science E-Modules Using Problem-Based Learning for Critical Thinking and Digital Literacy

Windiarti Pratiwi Putri¹, Muntari¹, Lalu Rudyat Telly Savalas¹

¹Master of Science in Education, Postgraduate Program, University of Mataram, Indonesia.

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*Corresponding Author

Windiarti Pratiwi Putri,

University of Mataram, Indonesia;

e-mail:

windiartipratiwip@gmail.com

Abstract

The integration of technology and local wisdom in science learning has become increasingly important to enhance student engagement and understanding. This study aimed to develop and evaluate the practicality of a Science E-Module based on Problem-Based Learning (PBL) and a local-wisdom approach for high school students. The study employed a development research design with limited trials, involving Classroom implementation observations, teacher and student response questionnaires, and data analyzed using descriptive quantitative techniques. The results showed that the Classroom implementation reached 92% (very well implemented), teacher responses averaged 93% (very practical), and student responses averaged 87% (very practical), indicating high engagement and usability. It can be concluded that the developed E-Module is practical and supports effective learning by promoting independent learning, critical thinking, and digital literacy. These findings suggest that integrating PBL and local wisdom through digital modules can be an innovative strategy to improve science learning and is recommended for broader implementation in similar educational contexts.

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INTRODUCTION

The rapid advancement of information and communication technology has significantly transformed educational practices, particularly in fostering digital literacy and higher-order thinking skills such as critical thinking. In the context of 21st-century education, critical thinking is considered a core competency that enables students to analyze problems, evaluate information, and make reasoned decisions (Alenezi & Akour, 2022; Wardat et al., 2023). The integration of digital learning media, including e-modules, plays a crucial role in facilitating interactive, flexible, and student-centered learning environments that support the development of these skills (Javaid et al., 2022; Budiyantri et al., 2025).

The relationship between Problem-Based Learning (PBL), digital learning media, and critical thinking skills has been widely discussed in science education. PBL encourages students to actively engage in solving real-world problems, thereby promoting analytical and reflective thinking (Ranggi et al., 2021; Jatmiko et al., 2023). Furthermore, the integration of local wisdom into learning materials enhances contextual understanding by linking scientific concepts with students' daily experiences, which can strengthen conceptual comprehension and critical thinking (Ivaningtias & Indana, 2024; Muntari et al., 2025). Therefore, combining PBL-based e-modules with a

local wisdom approach has strong theoretical potential to improve both cognitive and contextual learning outcomes.

However, previous studies show inconsistent findings regarding the implementation of digital learning media in classrooms. While several studies report that PBL-based e-modules effectively improve learning outcomes and student engagement, others highlight challenges such as limited usability, low practicality, and difficulties in classroom implementation (Ernawati & Sukardiyono, 2017; Arikunto, 2010). In practice, many digital learning tools fail to optimally support critical thinking because they are not user-friendly, lack interactive features, or are not aligned with real classroom conditions. This indicates a gap between theoretical effectiveness and practical applicability in educational settings.

Several recent studies have developed digital modules integrating PBL or local wisdom approaches; however, most of them primarily focus on validity and effectiveness aspects without comprehensively examining practicality in real Classroom contexts (Ranggi et al., 2021; Ivaningtias & Indana, 2024; Jatmiko et al., 2023; Muntari et al., 2025). In addition, limited studies explicitly link the practicality of such modules with their potential to support students' critical thinking skills. Therefore, this study offers novelty by focusing on the practicality of a PBL-based science e-module integrated with local wisdom, assessed through Classroom implementation, teacher responses, and student responses. This study aims to analyze the level of

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practicality of the developed e-module and its implications for supporting students' critical thinking skills and meaningful learning in real Classroom contexts.

MATERIALS AND METHODS

Time and Place

This study was conducted during the second semester of the 2024/2025 academic year at SMAN 1 Praya Barat, Central Lombok Regency, West Nusa Tenggara. The study period included the product development phase, expert validation, and a pilot test to evaluate the practicality of the e-module in science education.

Research Design

This study employs the Research and Development (R&D) method using the 4D development model, comprising the define, design, develop, and disseminate stages, developed by Thiagarajan et al. (1974). This model was selected because it involves systematic stages for producing a usable learning product. However, in this study, the testing focus is on the development stage, specifically the product's practicality through limited trials. This approach aligns with Sugiyono's (2017) view, who states that development research aims to produce a specific product while simultaneously testing its feasibility through systematic evaluation stages.

Population and Sample

The population of this study comprises all 10th-grade students at SMAN 1 Praya Barat. The research sample consisted of 25 students selected through purposive sampling, which involves selecting participants based on specific criteria relevant to the research objectives (Sugiyono, 2013). The research variables focused on the practicality of the Problem-Based Learning (PBL)-based science e-module using a local wisdom approach. Data were collected through observations of the implementation of learning as well as questionnaires completed by educators and students. The instruments used included an observation sheet for the implementation of learning and a Likert scale questionnaire to measure the level of practicality in terms of content, appearance, language, and benefits (Arikunto, 2010; Ernawati & Sukardiyono, 2017).

Research Procedure

The research procedure followed the 4D model. The Define phase involved needs analysis, analysis of learner characteristics, and analysis of the subject matter. The Design phase included developing PBL-based e-modules that incorporate local wisdom, as well as preparing research instruments. The development stage includes expert validation, product revision, and limited trials to assess the e-module's practicality for learning. The trials were conducted over three sessions by implementing the e-module in science learning activities. The dissemination stage was not carried out on a large scale because the research focused on testing the product's practicality on a limited scale, in accordance with the objectives of the initial development research.

Data Analysis Techniques

The analysis of practicality data was conducted using descriptive quantitative methods, based on the percentage scores derived from observations of instructional implementation and questionnaires completed

by educators and students. The data were analyzed using the percentage formula: $P = \frac{f}{N} \times 100\%$, where P is the percentage, f is the score obtained, and N is the maximum score (Arikunto, 2010). The percentage results were then categorized according to practicality criteria, namely very practical, practical, fairly practical, and less practical (Ernawati & Sukardiyono, 2017). The analysis was conducted using Microsoft Excel software to facilitate data calculation and presentation. This analytical technique was used to determine the ease of use, feasibility, and user response to the developed e-module.

RESULTS AND DISCUSSION

Result

The results of the practicality test were obtained during Classroom instruction through observations of lesson implementation and responses from both teachers and students to the PBL-based science e-module incorporating a local wisdom approach. The product developed in this study is a Problem-Based Learning (PBL)-based science e-module integrating a local-wisdom approach, designed to support students' critical thinking and digital literacy. The e-module is structured around problem-oriented learning scenarios that encourage students to analyze, investigate, and solve contextual scientific problems. The content is linked to local wisdom, enabling students to connect abstract science concepts with their real-life environment, thereby enhancing conceptual understanding and relevance.

In terms of design and functionality, the e-module is characterized by the integration of interactive multimedia elements, including videos, images, and audio, as well as user-friendly navigation that supports self-directed learning. It also includes self-instructional components, practice exercises, and immediate feedback to facilitate independent study and continuous evaluation. These features are intended to create an engaging, flexible, and accessible learning environment that not only improves learning effectiveness but also fosters higher-order thinking skills and students' ability to utilize digital technology in the learning process.

Feasibility of Learning

After undergoing validation and revisions based on feedback from expert validators, the PBL-based science e-module incorporating a local wisdom approach has been deemed ready for a limited pilot test. The purpose of this pilot test is to evaluate the module's practicality in Classroom learning activities, including its ease of use, student engagement, and teacher feedback as facilitators of the learning process.

A pilot study was conducted at SMAN 1 Praya Barat, involving 25 students. The researchers conducted intensive observations and recorded key aspects of the teaching process that could inform improvements to the module. Observations were conducted over three sessions, and the observers involved were science teachers at the school.

Classroom observations were used to assess the extent to which the module could be implemented as planned. Based on Table 1 below, the implementation of learning using the developed modules ranged from 89% to 95%, with an average of 93%, which falls into the "Very Well Implemented" category. This indicates that PBL-

based science e-modules incorporating a local wisdom approach can be effectively applied in practice and support the science learning process in the Classroom.

Table 1. Results of the Implementation of Learning Using PBL-Based Science E-Modules with a Local Wisdom Approach

No	P	P%	Categories
1	0,94	94%	Very Good
2	0,95	95%	Very Good
3	0,89	89%	Very Good
Average	0,93	93%	Very Good

Educators' Responses to the Use of PBL-Based Science E-Modules Incorporating a Local Wisdom Approach

Teachers' responses to the PBL-based science e-module incorporating a local-wisdom approach were collected via a questionnaire completed by chemistry teachers at SMAN 1 Praya Barat. The questionnaire assessed several aspects of the module, including its content, design, language, and effectiveness in supporting the learning process. The results of the teachers' responses are presented in Table 2 below.

Table 2. Percentage of Educators' Responses Regarding the Use of PBL-Based Science E-Modules Incorporating a Local Wisdom Approach at SMAN 1 Praya Barat

Aspect	P	P%	Categories
Materials	0,91	91%	Very Practical
Visualization	0,93	93%	Very Practical
Language	0,91	91%	Very Practical
Benefits	0,97	97%	Very Practical
Average	0,93	93%	Very Practical

Based on Table 2, educators' responses ranged from 91% to 97%, with an average score of 93%, which falls into the "Very Practical" category. Among the assessed aspects, the "benefits" component obtained the highest score (97%), indicating that teachers perceived the e-module as highly useful in facilitating the learning process, supporting instructional delivery, and enhancing student engagement. This suggests that integrating Problem-Based Learning (PBL) with local wisdom provides meaningful learning experiences that align with Classroom needs.

Furthermore, the "visualization" aspect achieved a high score (93%), indicating that the design and multimedia elements of the e-module were considered attractive and supportive of understanding the concept. The "materials" and "language" aspects, both scoring 91%, indicate that the content was relevant, well-structured, and easy to understand, enabling teachers to implement the module without significant difficulty. These findings demonstrate that the e-module meets key indicators of practicality, including ease of use, content clarity, and suitability for Classroom implementation.

Overall, the positive responses from educators indicate that the developed e-module is not only technically feasible but also pedagogically appropriate. The module supports teachers in delivering more interactive and contextualized learning, particularly through problem-based activities and the integration of local wisdom. This reinforces the role of practical digital learning media in bridging the gap between instructional design and real Classroom application, while also contributing to the

development of students' critical thinking and digital literacy skills.

Students' Responses to the Use of PBL-Based Science E-Modules Incorporating a Local Wisdom Approach

Student responses to the learning process were obtained through a questionnaire administered during the limited pilot phase, which assessed the practicality of the PBL-based science e-module incorporating a local wisdom approach. The questionnaire evaluated several aspects, including content, design, language, and student motivation during the learning process. The results of the student responses are presented in Table 3 below.

Table 3. Percentage of Student Responses Regarding the Use of PBL-Based Science E-Modules Incorporating a Local Wisdom Approach at SMAN 1 Praya Barat

Aspects	P	P%	Categories
Materials	0,88	88%	Very Practical
Visualization	0,88	88%	Very Practical
Language	0,81	81%	Very Practical
Motivation	0,92	92%	Very Practical
Average	0,87	87%	Very Practical

Based on Table 3, student responses ranged from 81% to 92%, with an overall average of 87%, which falls into the "Very Practical" category. Among the assessed aspects, the "motivation" component received the highest score (92%), indicating that the e-module effectively stimulated students' interest and engagement in learning activities. This suggests that integrating problem-based learning with local wisdom creates a more meaningful and relatable learning experience, encouraging active participation and curiosity.

The "materials" and "visualization" aspects both scored 88%, indicating that students perceived the content as relevant and the presentation as attractive and supportive of their understanding of scientific concepts. The use of multimedia elements, such as images and videos, likely helped make abstract concepts more concrete and easier to comprehend. Meanwhile, the "language" aspect received the lowest score (81%), yet it still falls within the "Very Practical" category, indicating that while the module is generally understandable, there is room for improvement in clarity, simplicity, or alignment with students' comprehension level.

These findings indicate that the developed e-module is well received by students and meets key criteria for practicality, particularly in usability, engagement, and learning support. The positive student responses also suggest that the module has the potential to facilitate independent learning and enhance students' critical thinking and digital literacy skills through interactive, contextual, and problem-oriented learning experiences.

Discussion

Characteristics of a PBL-Based Science E-Module Using a Local Wisdom Approach

The developed Science E-Module based on Problem-Based Learning (PBL) with a local wisdom approach has characteristics that support self-instruction, enabling students to access the material and complete practice exercises individually. This aligns with the findings of Sari & Octavia (2020), who reported that PBL-based modules are effective in enhancing students' learning

autonomy. This approach integrates technology with problem-based strategies, thereby supporting innovative, modern learning.

Additionally, the E-Module is self-contained and stand-alone, presenting atomic structure material comprehensively and allowing students to access it without additional media. These characteristics facilitate the achievement of learning objectives and improve students' understanding of the material (Siagian & Yasthophi, 2021; Sabila et al., 2022). The E-Module can be accessed through various electronic devices, including smartphones, laptops, and computers, thus facilitating remote learning and broadening students' access to the content.

The E-Module is also designed to be adaptive, tailored to the cognitive development of high school students at the formal operational stage (Ahmad et al., 2016; Lefa, 2014). The module includes interactive videos, images, text, audio, and practice exercises with direct feedback, enabling students to develop a deeper understanding of atomic structure concepts (Kamila et al., 2018). Its user-friendly design and communicative language facilitate comprehension, supporting effective learning (Hendri et al., 2021; Yastini et al., 2018; Sukirman, 2020).

Furthermore, the module demonstrates visual consistency through careful selection of fonts, spacing, color combinations, and an interactive design that is easy to read, which enhances reading interest and ensures content clarity (Syahrul, 2019; Mumpuni & Nurbaeti, 2019). Combined with module components such as learning outcomes, learning objectives, PBL syntax, guiding questions, discussion materials, instructional videos, exercises, glossary, references, and author profile, the Science E-Module based on PBL with a local wisdom approach serves as a practical, effective, and relevant learning medium that supports the development of students' critical thinking skills and digital literacy.

The Practicality of PBL-Based Science E-Modules Using a Local Wisdom Approach

The results of the Classroom implementation observation indicated that the Science E-Module, based on PBL with a local wisdom approach, can be consistently applied in the learning process, with an average implementation score of 92%, categorized as very well implemented. These findings confirm that the developed module supports teachers in managing the class and guiding student activities in line with PBL syntax, while facilitating the comprehensive and continuous use of atomic structure material. The high level of implementation aligns with the practicality principle in the Indonesian National Standard (SNI), which emphasizes that practical learning media should be effectively implementable in the Classroom.

Teacher responses to the module showed an average score of 93%, categorized as very practical, with the highest rating in usefulness (97%). This indicates that teachers perceive the E-Module as efficiently supporting teaching and learning activities, as easy to operate, and as relevant to the needs of high school science education. These findings are consistent with the literature suggesting that practical learning media must meet criteria of ease of use, alignment with learning objectives, and provide tangible benefits for the learning process (Sari & Octavia, 2020; Siagian & Yasthophi, 2021).

Student responses showed an average score of 87%, also categorized as very practical, with the highest score in motivation (92%). This demonstrates that the module increases student engagement, facilitates understanding of atomic structure concepts, and makes learning more interesting and contextual. Students were able to relate concepts to real phenomena, answer higher-order thinking questions, and interpret data scientifically. Student comments further support these findings, noting that the module was enjoyable, easy to understand, and relevant to daily life. These results align with 21st-century learning principles, which emphasize active student participation, independent learning, and the application of real-world contexts in learning (Hidayatullah et al., 2025).

Overall, the implementation of the Science E-Module based on PBL with a local-wisdom approach demonstrated a high level of practicality, both in Classroom practice and in responses from teachers and students. The module not only facilitates teaching and learning but also enhances student motivation and participation, making it an effective and applicable medium in modern high school science education.

CONCLUSION

The results of this study indicate that the Problem-Based Learning (PBL)-based science e-module incorporating a local wisdom approach demonstrates a high level of practicality, categorized as "very practical" based on Classroom implementation, teacher responses, and student responses. The implementation of learning was rated "very good," and both educators and students provided highly positive evaluations of the content, design, language, and benefits. These findings suggest that the developed e-module is easy to use, can be effectively implemented in real Classroom settings, and can enhance student engagement, thereby supporting the learning process.

From a scientific perspective, this study highlights the importance of practicality as a key component in the development of digital learning media, particularly in supporting Problem-Based Learning and fostering critical thinking and digital literacy. However, this study is limited to a small sample and a limited trial context, which may affect the generalizability of the findings. Therefore, future research is recommended to conduct broader implementation studies, examine the e-module's effectiveness on learning outcomes and critical thinking skills, and explore its application across different educational contexts to strengthen its empirical validity and scalability.

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AUTHOR'S CONTRIBUTION

Table of Author Contributions

Contribution Indicator	Author		
	1	2	3
Conceptualization	✓		
Literature Review	✓	✓	✓
Research Design / Methodology	✓	✓	✓
Instrument Development	✓		
Data Collection	✓		
Data Curation		✓	✓
Formal Analysis		✓	✓
Data Interpretation	✓		
Writing – Original Draft	✓		
Writing – Review & Editing	✓	✓	✓
Visualization / Tables	✓		
Supervision	✓	✓	✓

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