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A Problem-Based Biology E-Module Integrating Riau Local Medicinal Plants for Respiratory System Learning

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Abstract

The limited diversity of biology teaching materials and the insufficient integration of Riau's local knowledge of medicinal plants into classroom instruction underscore the need for contextually relevant learning resources. This study aimed to develop a Problem-Based Learning (PBL)-based biology e-module integrating Riau medicinal plants into the respiratory system topic for Grade XI SMA/MA students and to assess its validity and student responses. The study employed a Research and Development design based on the ADDIE model, limited to the Analyze, Design, and Development stages. Product trials involved Grade XI students from SMAN 11 Pekanbaru and SMAN 3 Siak Hulu. Data were collected through interviews, needs-analysis questionnaires, expert validation sheets, and student response questionnaires. The e-module was evaluated by subject-matter, media, and instructional experts, and the resulting qualitative and quantitative data were analyzed descriptively. The e-module met the highly valid criterion, receiving validation scores of 94% from subject-matter experts, 96% from media experts, and 92% from instructional experts. Students also responded positively, with an average score of 92%, categorized as excellent. These findings indicate that the developed e-module offers a valid and well-

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received alternative biology teaching resource that is contextual, engaging, and student-centered. By connecting respiratory system concepts with community knowledge of Riau medicinal plants, the e-module contributes a locally grounded approach to integrating regional wisdom into PBL-based biology instruction.

Keywords: Biology E-Module; Local Medicinal Plants; Problem-Based Learning; Respiratory System; Riau Local Wisdom

INTRODUCTION

Education is a conscious effort to pass on values and culture from one generation to the next. Through education, the younger generation can learn from the experiences of previous generations, thereby becoming role models for those who follow. Education is understood as a human endeavor to shape personality in accordance with the values and culture prevailing in society (Rosanawati et al., 2023). In its development, education aims to shape learners so they can grow in alignment with the demands of life and their social environment.

Research and Development (R&D) is a structured approach in both academic and industrial fields aimed at creating innovations such as new products, systems, or models that have practical application (Rahayu, 2025). In the field of education, R&D can be used to produce instructional materials tailored to learning needs. Instructional materials are a crucial component of education, serving as tools to support the learning process and capable of being systematically designed to meet learners' requirements (Lubis & Albina, 2025).

An e-module is a type of instructional material used in learning activities. It incorporates various components such as content, learning activities, and assessments to help learners understand and master the subject matter. The use of technology-supported electronic modules is increasingly growing as a more interactive and efficient learning method, particularly in biology education (L. Rahmawati et al., 2025). Given these characteristics, e-modules serve as an alternative to print materials, overcoming the limitations of the latter while providing a more engaging learning experience.

The Problem-Based Learning (PBL) model is an instructional approach that utilizes real-world problems as a context for learners to develop critical thinking skills, solve problems, and acquire new knowledge (Darwati & Purana, 2021). PBL places problems at the core of learning activities, ensuring active learner engagement throughout the process.

The implementation of PBL has proven effective in enhancing the understanding of biological concepts, as learners do not merely receive information passively but actively construct knowledge through meaningful learning experiences and by connecting concepts to everyday life phenomena (Sari et al., 2024). The topic of the respiratory system is a biological subject requiring an understanding of organ structures, functions, and mechanisms. Instruction on this topic can be made more contextual by utilizing the environment and knowledge relevant to the students' daily lives (Walangitan et al., 2025). Learning materials derived from the local Riau-Malay culture play a role in shaping student character by instilling values such as religiosity, honesty, discipline, social awareness, responsibility, independence, environmental concern, and appreciation for regional potential.

Medicinal plants are types of flora used by the community to help treat various ailments. Traditional medicinal plants found in the Pekanbaru region represent a form of local wisdom with the potential to be utilized in biology education. Knowledge regarding the use of medicinal plants can provide real-world, relevant context for students. Integrating ethnobotany into education can bridge the gap between biological concepts and local cultural wisdom, ensuring the material is understood not merely as theory but also in connection with community practices (Bowaire & Sriyati, 2025).

Preliminary observations indicate a significant need for more innovative teaching materials. Specifically, 74.40% of students desire engaging and interactive biology materials, 80.00% favor the integration of local Riau medicinal plants, 86.53% require e-modules featuring attractive designs and functions, and 85.73% prefer a contextual learning approach. Interviews with teachers and students further reveal that existing teaching materials particularly printed textbooks and student worksheets are limited and lack variety, while schools have yet to implement e-modules that integrate local wisdom regarding medicinal plants.

Previous studies indicate that the development of e-modules and the integration of local wisdom can support learning. Haerani et al., (2026) developed a Science e-module for vocational high schools (STM) that integrated Malay Kompang local wisdom to boost motivation for preserving local traditions. Supratman et al., (2025) developed a Biology e-module using the ADDIE model, yielding results that demonstrated the product's feasibility. Witra et al., (2026) also developed teaching materials on medicinal plants that incorporated local wisdom. While these studies highlight the potential of digital teaching materials and

local wisdom, the present study focuses specifically on developing a Problem-Based Learning (PBL) Biology e-module that integrates local medicinal plants from Riau into the respiratory system curriculum for Grade XI high school (SMA/MA) students.

Based on the identified issues, student needs, and prior research, the novelty of this study lies in the development of a PBL-based e-module that combines respiratory system content with local medicinal plants from Riau. The development process utilized the ADDIE model, limited to the Analyze, Design, and Development stages, as the study focused on the creation, validation, revision, and limited trial of the product. Consequently, this study aims to validate the PBL based respiratory system e-module integrated with Riau's local medicinal plants and to assess student responses to the developed e-module.

METHODS

This study employs the Research and Development (R&D) method, utilizing both quantitative and qualitative data. The development research aims to produce a biology e-module based on Problem-Based Learning (PBL) that integrates local medicinal plants from Riau, specifically covering the respiratory system topic (Amalina et al., 2024). The ADDIE development model comprising Analyze, Design, Development, Implementation, and Evaluation was adopted; however, the scope of this study was limited to the Analyze, Design, and Development stages.

The study was conducted with Grade XI students at SMAN 11 Pekanbaru and SMAN 03 Siak Hulu. The research population consisted of Grade XI students from both schools. Trial samples were selected using purposive sampling, based on the criteria that the students had already studied the respiratory system material and aligned with the characteristics of the product being developed. Trials were carried out in one class at each school.

The research data consisted of both quantitative and qualitative information. Quantitative data included results from validation sheets completed by subject matter experts, media experts, and instructional experts, as well as student response questionnaires. Qualitative data comprised observations, interviews, criticisms, suggestions, and feedback from validators and students. Primary data sources were the validators and students, while

secondary sources included relevant research, journals, and books serving as the foundation for development.

Data collection procedures involved questionnaires, interviews, documentation, and validation sheets. Questionnaires were used to assess product validity and gather student responses. Interviews were conducted during the initial stage to identify the problems and needs of both teachers and students. Documentation served as evidence of research activities, while validation sheets were used to evaluate the feasibility of the e-module.

Product development was carried out in three stages. The Analyze stage involved analyzing the curriculum, needs, student characteristics, and tasks. The Design stage encompassed gathering references, structuring the e-module framework, designing the layout using Canva, and developing assessment instruments. The Development stage encompasses validation by subject matter, media, and instructional design experts; revisions based on validator feedback; and a limited trial involving students who had already studied the respiratory system (Rama et al., 2022).

Validation involved subject matter, media, and instructional design experts. Validation was conducted using assessment sheets developed based on product suitability aspects and indicators. Product revisions were made based on the experts' suggestions and feedback. A response test was administered after the revisions, allowing students to evaluate the product following the validation process.

Data analysis employed both descriptive qualitative and descriptive quantitative methods. Qualitative analysis was used to process suggestions, criticisms, and feedback from validators and students to inform product refinement. Quantitative analysis was used to calculate validity percentages and student response rates. Validation percentages were compared against suitability criteria, while student response questionnaire results were categorized based on the percentage criteria established for the study. The research was conducted in 2026 and was limited to the Development stage due to time and budget constraints.

RESULTS

The research findings are presented based on the ADDIE development model, covering stages up to the Development phase: needs analysis, product design, development

and validation, and learner response testing. The final product is a Problem-Based Learning (PBL)-based Biology e-module for Grade XI (SMA/MA) covering the respiratory system, which integrates local medicinal plants from Riau.

In the needs analysis stage, all indicators regarding learner needs fell into the "needed" category. The highest priority needs related to an engaging e-module design and features, followed by the need for a contextual learning approach and the integration of local medicinal plants from Riau. Interview results also indicated that existing teaching materials were limited to printed textbooks and student worksheets (LKPD), and there were no e-modules that integrated PBL with local medicinal plants from Riau.

Table 1. Results Of The Learner Needs Analysis

Requirement component	Percentage	Category
Engaging and interactive biology content	74.40%	Required
Integration of local medicinal plants from Riau	80.00%	Required
Attractive e-module design and features	86.53%	Highly required
Contextual learning approach	85.73%	Highly required

Based on Table 1 Results of the Student Needs Analysis, it is evident that all analyzed components fall into categories ranging from needed to highly needed. The need for engaging and interactive biology material received a score of 74.40% categorized as needed, while the need to integrate local medicinal plants from Riau received 80.00% also categorized as needed. Furthermore, an engaging e-module design and features ranked second highest at 86.53% categorized as highly needed, followed by a contextual learning approach at 85.73% also highly needed. The results in Table 1 indicate that students require teaching materials that not only present content but also feature an attractive, interactive, and contextual design that integrates Riau's local potential. These findings serve as the basis for determining the characteristics of the e-module being developed.

The product was designed using Canva in A4 format, structured around the respiratory system curriculum, and incorporates supporting images, references, the Problem-Based Learning (PBL) framework, and information on local medicinal plants from Riau. It is saved as a PDF and includes supporting elements such as barcodes for accessing specific sections of the e-module. The final product comprises instructional content, problem-based activities, scientific information, supporting videos or articles, references to the Quran and Hadith regarding the respiratory system and medicinal plants, as well as concluding and evaluation sections.

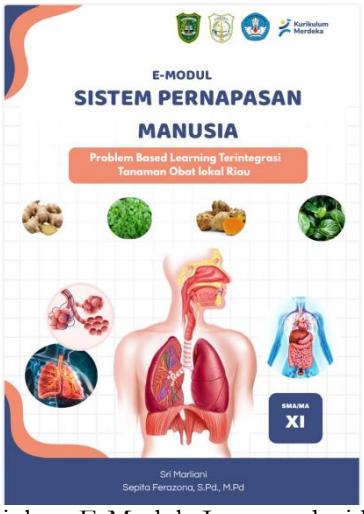


Figure 1. Cover of the PBL-based Biology E-Module Integrated with Local Medicinal Plants from Riau

Figure 1, which displays the cover of the PBL-based Biology e-module integrated with Riau's local medicinal plants, shows the initial visual of the product designed to establish its identity and provide an overview of its content. The cover features the respiratory system topic while highlighting Riau's local medicinal plants as a distinctive characteristic of the product. Its design aims to capture students' attention while illustrating the connection between the Biology subject matter and the local wisdom incorporated into the e-module.

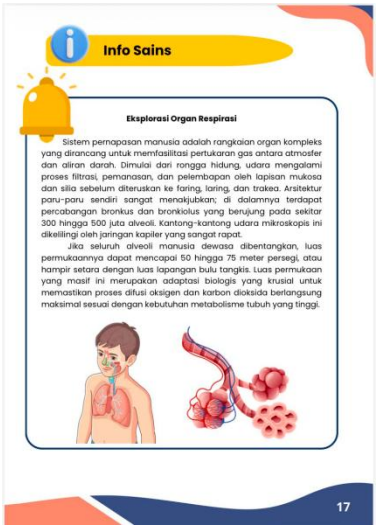


Figure 2. Example Of A Science Information Page In The E-Module

As shown in Figure 2. example of a science information page in the e-module, the page presents supplementary information related to the concept of the respiratory system. This science information serves to broaden learners' knowledge and connect the concepts being studied to relevant phenomena or knowledge from everyday life. The inclusion of this science information section is also a result of revisions made based on feedback from subject matter experts, intended to make the e-module's content more comprehensive and better support learners' understanding.

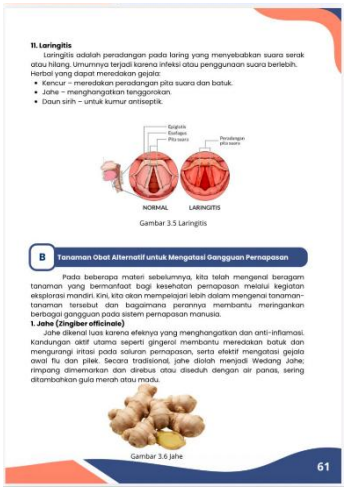


Figure 3. Example of material presentation integrating local medicinal plants from Riau

As shown in Figure 3. example of material presentation integrating riau's local medicinal plants, the respiratory system material is presented by linking it to medicinal plants known and utilized by the people of Riau. This integration provides a local context for learning, enabling students to connect biological concepts with their surrounding environment and local knowledge. This approach serves as a key characteristic of the e-module, as it combines respiratory system content, the Problem-Based Learning (PBL) approach, and local wisdom regarding Riau's medicinal plants.

Product validation was conducted by subject matter experts, media experts, and instructional experts. The validation results indicate that the product meets the criteria for being highly valid. The average validation scores were 94% from subject matter experts, 96% from media experts, and 92% from instructional experts. Consequently, the product was deemed suitable for use following revisions based on the validators' feedback.

Table 2. E-Module Validation Results

Validator	Percentage	Category
Subject matter expert	94%	Highly valid
Media expert	96%	Highly valid
Instructional expert	92%	Highly valid

Based on Table 2. e-module validation results, the e-module received a highly valid rating from all validators. The subject matter expert assigned a score of 94% highly valid, the media expert assigned 96% highly valid, and the instructional expert assigned 92% highly valid. These results indicate that the e-module meets the criteria for content, media, and

instructional suitability. Consequently, the e-module is deemed suitable for use following revisions based on the validators' suggestions and feedback.

During the subject matter expert validation, the content suitability aspect achieved an average score of 94%. Validator feedback included suggestions to add scientific information, videos, and articles regarding the respiratory system, as well as references from the Quran and Hadith concerning the respiratory system and medicinal plants. In the media expert validation, the visual design aspect scored 92% and the programming aspect 100%, resulting in an overall average of 96%. Media-related feedback primarily focused on adding images of medicinal plants to the cover and clarifying the content regarding medicinal plants. The instructional design expert validation assessed layout, language, and readability, yielding an overall average of 92%.

Student response testing was conducted in one class each at SMAN 11 Pekanbaru and SMAN 3 Siak Hulu following the use of the e-module. Questionnaire results indicated that student responses fell into the "very good" category, with an average score of 92%. The aspects evaluated included visual design, readability, language, content, and presentation. These data serve as supporting evidence that the product was positively received by the students.

Table 3. Students' Responses to the E-Module

Response Aspect	Percentage	Category
Visuals	91%	Excellent
Readability	91%	Excellent
Language	93%	Excellent
Content	93%	Excellent
Presentation/Motivation	94%	Excellent

Based on Table 3. student responses to the e-module, it is evident that all assessed aspects fell into the very good category. The aspects of visual design and readability each received a score of 91%, while the language and content aspects each scored 93%. The presentation/motivation aspect achieved the highest score at 94%. Overall, Table 3 shows that the average student response to the e-module reached 92%, placing it in the very good category. These results indicate that students responded positively to the e-module regarding its visual design, readability, language, content, and presentation.

Data indicating areas requiring further refinement also emerged during the validation process. According to the subject matter experts, the depth or complexity of the material in the initial assessment did not yet reach the highly valid category. Feedback from media

experts indicated that cover design and interactivity received lower ratings compared to other indicators. Instructional experts noted that linguistic aspects and certain elements regarding ease of understanding also required improvement. This feedback was incorporated into the product revision prior to the learner response trial.

DISCUSSION

The research results indicate that a PBL-based e-module integrating local medicinal plants from Riau was successfully developed to meet the learning needs identified during the analysis phase. The high demand for engaging, interactive, and contextual teaching materials demonstrates an alignment between real-world needs and the characteristics of the developed product. The product not only presents material on the respiratory system but also connects these concepts to medicinal plants familiar to the people of Riau. This integration brings the teaching material closer to the students' own context and fosters meaningful learning.

The product's "highly valid" rating indicates that the e-module successfully met criteria regarding content, media, and instructional design following the validation and revision process. Regarding content, the material's logical flow and accuracy were strong points, although the initial assessment suggested room for improvement regarding the depth of the material. This aligns with Widagdo, (2025), who argues that material depth is crucial for helping students build a broader, deeper, and more structured understanding. Aligning the material with learning objectives is also vital, as curriculum-aligned teaching materials facilitate the achievement of student competencies.

In terms of media, the visual presentation and programming quality demonstrate that the e-module possesses characteristics conducive to digital learning materials. Features such as a systematic layout, text readability, visual appeal, and ease of use help students focus on the content. These findings align with Silvia et al., (2024), who state that visual presentation is a critical component in digital teaching material development, as it can boost learning interest and motivation. The ease of access and usability also supports the views of Ramadhan, (2026) regarding how interactive e-modules can foster student motivation and engagement.

Regarding the instructional aspect, the product received a "highly valid" rating after an evaluation of learning objectives, alignment with learning outcomes, structural organization, PBL syntax, language use, and readability. These findings demonstrate that the

e-module not only meets visual standards but also features an appropriate instructional structure. This aligns with Dari & Sudatha, (2022), who state that e-modules featuring a systematic and engaging design, along with appropriate typography and imagery, can help learners comprehend material and improve their focus. The ease of reading also supports the findings of Luthfia et al., (2025), indicating that e-modules with high usability and readability are practical and effective tools for supporting learning.

The highly positive learner response demonstrates the product's acceptability regarding its visual design, readability, language, content, and presentation. This outcome supports the characteristics of Problem-Based Learning (PBL), which positions problems as the learning context and encourages learners to engage in the problem-solving process. Shaar & Syamsurizal, (2026) explain that PBL can enhance conceptual understanding through meaningful learning experiences and by linking concepts to real-life phenomena. These results also align with research by Zulfikar & Fauzi, (2025), showing that PBL-based e-modules can boost learner engagement through problem-solving activities.

The integration of local medicinal plants from Riau represents a significant contribution of the product, as it connects Biology instruction with local wisdom. Ethnobotany can serve as a bridge between abstract biological concepts and the learners' cultural and environmental experiences D. N. Rahmawati & Sriyati, (2024). This finding also aligns with Harmelayati et al., (2026), who examined the integration of ethnoecology in learning and demonstrated its potential to support learner literacy and understanding. Thus, the product's novelty lies not merely in its digital format, but in the combination of PBL, respiratory system content, and local Riau medicinal plants within a single instructional resource.

From a scientific perspective, this study reinforces the development of Biology instructional materials that integrate a problem-based learning approach with the context of local wisdom. Practically, the e-module offers an alternative teaching resource, enabling teachers to present respiratory system material in a manner that is more contextual, engaging, and learner-centered. Integrating medicinal plants can also help introduce students to the potential of biodiversity and local knowledge. Methodologically, employing the ADDIE model up to the Development stage demonstrates a systematic development process involving needs analysis, design, validation, revision, and limited trials.

This study has limitations as the development process was carried out only up to the Analyze, Design, and Development stages. The implementation and evaluation phases of the ADDIE model were not extensively conducted; consequently, no conclusions could be drawn regarding the e-module's effectiveness in enhancing learning outcomes, critical thinking abilities, or problem-solving skills. Furthermore, the trials involved a limited scope of schools and students. These limitations provide a basis for future research to test the product on a broader scale and to proceed with the implementation and evaluation stages.

CONCLUSION

This study resulted in the creation of a Problem-Based Learning (PBL)-based Biology e-module on the respiratory system for Grade XI SMA/MA students, integrating local medicinal plants from Riau. The product was developed using the ADDIE model, specifically covering the Analyze, Design, and Development stages.

The developed e-module met the criteria for high validity based on assessments by subject matter, media, and instructional experts, and it elicited a highly positive response from students. Thus, the research objectivesto produce and validate a PBL-based e-module integrating Riau's local medicinal plants and to gauge student response were successfully achieved.

The study's contribution lies in the provision of digital teaching materials that combine problem-based learning with the context of Riau's local medicinal plants; this allows the respiratory system topic to be presented in a more contextual and meaningful way while simultaneously introducing local wisdom to students. For future development, the e-module project should proceed to the implementation and evaluation stages, undergo testing with a broader range of schools and students, and be enriched with interactive features such as videos, animations, simulations, or digital quizzes.

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