



Development of a Basic Learning Module on Unit Conversion and Energy Based on Science Literacy

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Abstrak

Penelitian ini bertujuan untuk mengembangkan modul pembelajaran berbasis literasi sains pada materi konversi satuan dan energi serta menganalisis kelayakan dan respon peserta didik terhadap modul yang dikembangkan. Penelitian ini menggunakan metode Research and Development (R&D) dengan model ADDIE yang meliputi tahap analysis, design, development, implementation, dan evaluation. Subjek penelitian terdiri dari 45 peserta didik kelas X SMA/MA. Instrumen penelitian berupa lembar validasi ahli dan angket respon peserta didik. Hasil penelitian menunjukkan bahwa modul yang dikembangkan memperoleh nilai kelayakan sebesar 80,78% dengan kategori layak, yang mencakup aspek isi, bahasa, penyajian, dan literasi sains. Selain itu, respon peserta didik menunjukkan nilai rata-rata sebesar 99,17% dengan kategori sangat baik. Modul yang dikembangkan terbukti mampu meningkatkan pemahaman konsep, kemampuan analisis, serta penerapan konsep dalam kehidupan sehari-hari. Dengan demikian, modul pembelajaran berbasis literasi sains ini layak dan efektif digunakan sebagai bahan ajar dalam pembelajaran sains di tingkat SMA/MA.

Kata Kunci: literasi sains, modul pembelajaran, konversi satuan

Abstract

This study aims to develop a science literacy-based learning module on unit conversion and energy and to analyze its feasibility and students' responses. The research employed a Research and Development (R&D) method using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. The participants were 45 tenth-grade students of senior high school (SMA/MA). Data were collected through expert validation sheets and student response questionnaires. The results indicated that the developed module achieved a feasibility score of 80.78%, categorized as feasible, covering aspects of content, language, presentation, and scientific literacy. Furthermore, students' responses showed an average score of 99.17%, categorized as very good. The module was found to improve students' conceptual understanding, analytical skills, and ability to apply concepts in real-life contexts. Therefore, the science literacy-based learning module is considered both feasible and effective as instructional material for science learning at the senior high school level.

Keywords: scientific literacy, learning module, unit conversion

Introduction

Science education plays a strategic role in developing students' scientific thinking skills, particularly in addressing the challenges of the 21st century, which require critical thinking, creativity, and problem-solving abilities. In contemporary educational contexts, learning is no longer limited to conceptual understanding but extends to the application of knowledge in real-life situations. Scientific literacy has therefore emerged as a core competency that enables individuals to interpret scientific phenomena, evaluate evidence, and make informed decisions (Budiarti & Tanta, 2021; Syafitri & Syafriani, 2023). This competency is essential not only for academic success but also for preparing students to participate actively in a technology-driven and information-rich society (Setyowati et al., 2022).

From a global perspective, scientific literacy has been emphasized as a fundamental component of education policy frameworks, particularly through international assessments such as the Programme for International Student Assessment (PISA). Scientific literacy is defined as the ability to engage with science-related issues, explain phenomena scientifically, and interpret data and evidence (Park et al., 2024). This framework highlights the importance of integrating knowledge, scientific processes, and contextual understanding in science learning. Moreover, the distinction between PISA and curriculum-based assessments such as TIMSS underscores the need to focus on real-world application rather than rote memorization (Georgiou, 2023).

Despite its importance, numerous studies indicate that students' scientific literacy levels remain relatively low, particularly in developing countries, including Indonesia. This issue is influenced by multiple factors such as socio-economic status, school environment, and learning approaches (Borgonovi, 2022; Demir & Yıldırım, 2020). In addition, the gap between conceptual understanding and practical application often leads to difficulties in interpreting scientific concepts accurately. As a result, students struggle to apply their knowledge to real-life contexts, which ultimately affects their overall learning outcomes.

One of the fundamental competencies in science learning is the ability to perform unit and energy conversions. Unit conversion is a basic yet essential skill that involves understanding quantities, measurement systems, and

dimensional analysis. Errors in unit conversion can lead to significant misinterpretations in scientific calculations and experimental results, thereby hindering students' conceptual understanding. In both physics and chemistry, accurate unit conversion serves as a foundational skill for mastering more complex scientific concepts, emphasizing its importance in secondary education.

To address these challenges, science learning must adopt approaches that promote meaningful understanding and real-world application. One such approach is science literacy-based learning, which integrates scientific concepts with contextual issues, including socio-scientific issues (SSI) and science-technology-society (STS) perspectives. Previous studies have shown that integrating SSI and STEAM approaches can significantly enhance students' scientific literacy, critical thinking, and problem-solving skills (Chansaengsee, 2023; Kurniah et al., 2023; Rahmawati et al., 2023). These approaches encourage students to connect scientific knowledge with real-world problems, making learning more relevant and engaging.

In this context, the use of learning modules as instructional materials plays a crucial role in supporting independent and structured learning. Modules designed based on scientific literacy principles can facilitate students in understanding concepts, conducting analysis, and applying knowledge in practical situations. Furthermore, the integration of digital elements and systematic instructional design models such as ADDIE has been proven to improve the validity, practicality, and effectiveness of learning materials (Dalaila et al., 2022; Yusuf et al., 2022). Such modules not only function as learning resources but also as tools to guide students through inquiry-based and contextual learning processes.

Based on the above considerations, this study aims to develop a science literacy-based learning module on unit conversion and energy using the ADDIE model for senior high school students (SMA/MA). This research is expected to contribute to improving students' conceptual understanding, analytical skills, and scientific literacy. Additionally, it addresses the gap between theoretical knowledge and practical application by providing a structured and context-based learning resource aligned with the demands of 21st-century education.

Method

This study employed a Research and Development (R&D) approach aimed at developing and evaluating a science literacy-based learning module on unit conversion and energy for senior high school (SMA/MA) students. The development process adopted the ADDIE instructional design model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The analysis phase involved identifying students' needs, learning difficulties, and curriculum requirements related to unit conversion and energy concepts. In the design phase, the module structure, learning objectives, and science literacy components were systematically planned. The development phase focused on producing the module, followed by

expert validation to assess its content, language, presentation, and scientific literacy aspects.

The implementation phase involved testing the developed module on 45 tenth-grade students to evaluate its practicality and effectiveness in real classroom settings. Data were collected using expert validation sheets and student response questionnaires. The evaluation phase was conducted to analyze the feasibility and quality of the module based on quantitative percentage scores. The feasibility criteria included content appropriateness, linguistic clarity, presentation quality, and integration of scientific literacy. Meanwhile, students' responses were analyzed to measure usability, attractiveness, conceptual understanding, and application of knowledge. The results were interpreted using descriptive statistical analysis to determine the overall validity and effectiveness of the developed module.

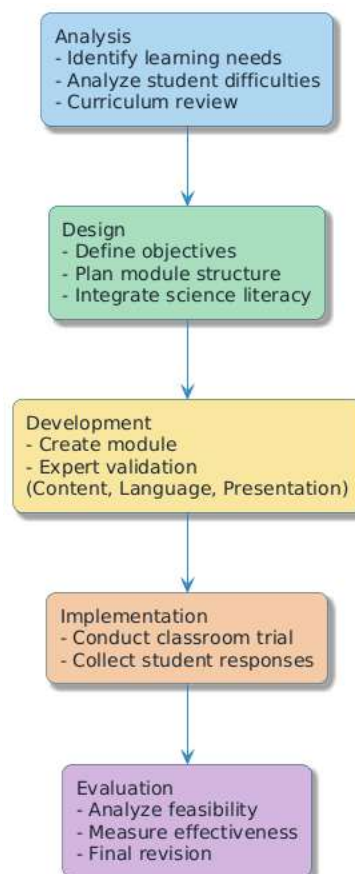


Figure 1. ADDIE Model for Learning Module Development

The diagram represents the ADDIE model as a systematic framework for developing learning modules. Each stage follows a sequential sequence, starting with needs analysis and ending with final evaluation to ensure product quality. This model emphasizes an

iterative process based on validation and field trials, ensuring that the resulting module is not only theoretically valid but also practically and effectively improves students' scientific literacy.

Result and Discussion

Result

Description of the Developed Learning Module

The developed learning module on unit conversion and energy was designed based on science literacy principles to enhance students' conceptual understanding and real-life application skills. The module integrates scientific concepts with contextual problems, allowing students to engage in analytical thinking and decision-making processes. It consists of several structured components, including learning objectives, concept explanations, worked examples, exercises, and evaluation sections. Each section was carefully aligned with science literacy indicators such as explaining phenomena, evaluating data, and applying concepts in real-life situations. This design ensures that students not only acquire knowledge but also develop higher-order thinking skills.

Furthermore, the module was structured to support independent learning, following the characteristics of self-instructional and user-friendly teaching materials. Clear instructions

and step-by-step explanations were provided to guide students through the learning process. The inclusion of contextual examples related to daily life enhances students' engagement and motivation. Additionally, visual elements such as diagrams and tables were incorporated to support better understanding of abstract concepts. The integration of these features aims to create a comprehensive and effective learning experience.

The development process also emphasized alignment with curriculum standards and students' cognitive levels. The content was adapted to meet the needs of senior high school students, ensuring relevance and accessibility. Scientific literacy elements were embedded throughout the module, encouraging students to connect scientific knowledge with societal and technological contexts. This approach supports the development of meaningful learning experiences that go beyond memorization. Overall, the module represents a structured and innovative learning resource.

Table 1. Structure of the Developed Module

Component	Description
Learning Objectives	Based on curriculum and literacy indicators
Concept Explanation	Clear and contextual explanations
Examples	Real-life related problems
Exercises	Analytical and application-based questions
Evaluation	Assessment aligned with literacy skills

The table illustrates the main components of the developed module, highlighting its structured and systematic design. Each component is aligned

with science literacy principles, ensuring that the module supports both conceptual understanding and practical application.

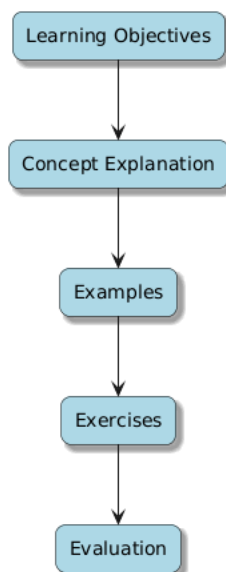


Figure 2. Module Structure

The diagram shows the logical flow of the module components, starting from objectives to evaluation. This sequence ensures a systematic learning process, guiding students from understanding concepts to applying and evaluating their knowledge.

Feasibility Analysis of the Learning Module

The feasibility of the developed module was evaluated through expert validation, focusing on four main aspects: content, language, presentation, and scientific literacy. The results indicate that the module achieved a high level of feasibility, with an overall score of 80.78%, categorized as “feasible.” The content aspect received the highest score, indicating strong alignment with curriculum standards and conceptual accuracy. This suggests that the material presented in the module is reliable and appropriate for instructional use. Additionally, the depth of content was considered sufficient to support students’ understanding.

The language aspect showed a slightly lower score compared to other aspects, although

it still fell within the feasible category. This indicates that while the module is generally clear and understandable, minor improvements in linguistic accuracy and readability could enhance its quality. The use of simple and communicative language was appreciated, as it supports student comprehension. However, further refinement in grammar and sentence structure is recommended. This highlights the importance of language clarity in educational materials.

The presentation aspect demonstrated a strong score, reflecting the module’s systematic organization and attractive layout. The inclusion of examples and structured content contributes to better understanding and learning efficiency. Visual elements such as diagrams and tables enhance engagement and support concept visualization. Meanwhile, the scientific literacy aspect also received a high score, indicating that the module effectively integrates literacy components. This confirms that the module supports analytical thinking and real-world application.

Table 2. Feasibility Results

Aspect	Score (%)
Content	82
Language	79
Presentation	81
Scientific Literacy	81
Total	80.78

The table summarizes the feasibility scores across different aspects, demonstrating that the module meets the required standards for

educational use. The high scores indicate strong validity and reliability.

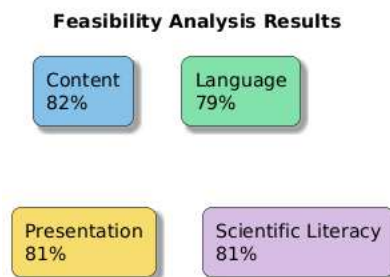


Figure 3. Feasibility Analysis

This diagram visually represents the comparison of feasibility scores across different aspects. It highlights that content and presentation achieved slightly higher scores than language, indicating areas of strength and improvement.

Students’ Responses to the Learning Module

The implementation phase involved collecting students’ responses to evaluate the

practicality and effectiveness of the developed module. The results indicate a very positive response, with an average score of 99.17%, categorized as “very good.” Students reported that the module was easy to use and understand, which supports independent learning. The clear instructions and structured content helped students navigate the material efficiently. This

suggests that the module successfully meets usability criteria.

In terms of visual appearance, students expressed high satisfaction with the design and layout of the module. The use of colors, diagrams, and organized content contributed to a more engaging learning experience. Attractive visual design plays a significant role in maintaining students' attention and motivation. Furthermore, students found the examples and exercises helpful in reinforcing their understanding. This indicates that the module effectively supports both cognitive and affective aspects of learning.

Students also reported improvements in their ability to understand and apply scientific concepts. The integration of real-life examples allowed them to connect theoretical knowledge with practical situations. This aligns with the principles of scientific literacy, which emphasize application and reasoning. The high response score demonstrates that the module is not only valid but also highly practical and effective in classroom settings. Overall, the results confirm the positive impact of the module on students' learning experiences.

Table 3. Students' Responses

Aspect	Score (%)
Ease of Use	98
Appearance	100
Understanding	99
Application	99

The table shows students' responses across different aspects, indicating very high

satisfaction levels. This suggests that the module is practical, engaging, and effective.

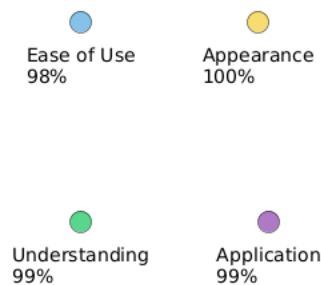


Figure 4. Students Response

The diagram illustrates the distribution of students' responses across different aspects. It highlights the high level of satisfaction, particularly in appearance and understanding.

Effectiveness of the Module in Enhancing Scientific Literacy

The developed module demonstrated significant effectiveness in enhancing students' scientific literacy. Students showed improved abilities in explaining scientific phenomena, analyzing data, and applying concepts in real-life contexts. This improvement is attributed to the integration of contextual learning and problem-solving activities within the module. The science literacy approach encourages students to think critically and make evidence-based decisions. As a result, students become more actively engaged in the learning process.

The effectiveness of the module is also reflected in students' improved analytical skills.

The exercises provided in the module require students to interpret data and solve real-world problems. This promotes higher-order thinking skills, which are essential for 21st-century learning. Additionally, the module supports the development of independent learning habits. Students are encouraged to explore concepts on their own, which enhances their learning autonomy.

Furthermore, the module facilitates the connection between theoretical knowledge and practical application. Students are able to relate scientific concepts to everyday life situations, making learning more meaningful. This aligns with the goals of science literacy, which emphasize relevance and application. The positive results indicate that the module is an effective instructional tool. It not only improves academic performance but also prepares students for real-world challenges.

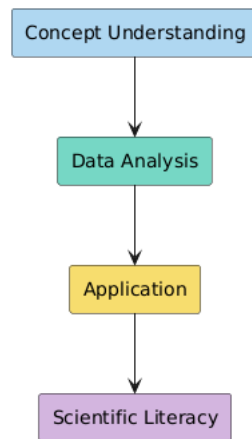


Figure 5. Literacy Improvement Process

The diagram illustrates the progression of students' learning from conceptual understanding to scientific literacy. It shows how different cognitive processes contribute to overall literacy development.

Discussion

The findings of this study indicate that the developed science literacy-based learning module achieved a high level of feasibility, with an overall score categorized as “feasible.” This result confirms that the integration of scientific literacy components into instructional materials can enhance the quality of learning resources. The high score in the content aspect demonstrates that the module aligns well with curriculum standards and supports conceptual accuracy. This finding is consistent with previous studies which emphasize that well-structured instructional materials significantly contribute to effective learning outcomes (Coppola & Pontrello, 2020; Dalaila et al., 2022; Madunić & Sovulj, 2024; Safitri & Dafit, 2025; Yusuf et al., 2022). Moreover, the integration of real-life contexts into the module supports meaningful learning, as suggested by constructivist approaches that promote active knowledge construction.

The relatively lower score in the language aspect, although still within the feasible category, suggests that clarity and readability remain critical factors in instructional design. This aligns with research indicating that linguistic simplicity

and clarity directly influence students' comprehension and engagement (Kholiq et al., 2022). Even when content quality is high, ineffective language can hinder understanding and reduce learning efficiency. Therefore, improving language accuracy and readability is essential to maximize the effectiveness of learning modules. This finding reinforces the importance of combining pedagogical, linguistic, and technological considerations in instructional material development.

The results also reveal that students' responses toward the module were extremely positive, with an average score categorized as “very good.” This indicates that the module is highly practical and user-friendly, supporting independent learning. Previous studies have similarly found that science literacy-based modules enhance student engagement and motivation, particularly when they incorporate contextual and interactive elements (Chansaengsee, 2023; Rahmawati et al., 2023). The attractive design and structured content of the module contribute to increased student interest and participation in the learning process. This suggests that visual and organizational aspects play a crucial role in supporting effective learning experiences.

Furthermore, the effectiveness of the module in improving students' understanding and application abilities highlights the importance of integrating scientific literacy into

science education. Students demonstrated improved skills in analyzing concepts and applying them in real-life contexts, which are key indicators of scientific literacy. This finding is supported by previous research showing that approaches such as STEAM and socio-scientific issues (SSI) significantly enhance students' critical thinking and problem-solving abilities (Kurniah et al., 2023; Wulandari & Putri, 2024). By connecting theoretical knowledge with practical applications, the module helps bridge the gap between abstract concepts and real-world situations.

Finally, this study confirms that the use of the ADDIE model provides a systematic and effective framework for developing high-quality instructional materials. The structured stages of analysis, design, development, implementation, and evaluation ensure that the resulting product is valid, practical, and effective. This is in line with previous studies highlighting the effectiveness of ADDIE in producing well-designed educational resources (Dalaila et al., 2022; Li et al., 2025; Spatioti et al., 2022; Yusuf et al., 2022). Overall, the findings suggest that science literacy-based modules developed through systematic instructional design can significantly improve students' learning outcomes and better prepare them for the demands of 21st-century education.

Conclusion

This study concludes that the development of a science literacy-based learning module on unit conversion and energy using the ADDIE model has been successfully carried out and meets the criteria of a feasible instructional product. The module demonstrated a high level of validity across content, language, presentation, and scientific literacy aspects, indicating its appropriateness for use in senior high school learning. The structured design, integration of real-life contexts, and alignment with scientific literacy principles contribute to its effectiveness in supporting students' conceptual understanding. These findings confirm that a well-designed module can serve as an effective learning resource that facilitates both knowledge acquisition and the development of higher-order thinking skills.

Furthermore, the results show that the module is highly practical and effective, as reflected in the very positive responses from students. The module not only enhances students' understanding of unit conversion and energy

concepts but also improves their ability to analyze and apply scientific knowledge in real-life situations. This indicates that integrating scientific literacy into instructional materials can significantly improve learning outcomes and student engagement. Therefore, this study recommends the use of science literacy-based modules as an innovative approach in science education, while future research may focus on digital module development and broader implementation to further enhance its impact in diverse educational contexts.

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