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Development of a science literacy-based e-module for elementary school students

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ABSTRACT

Students' understanding of science concepts often encounters difficulties due to their abstract nature, including the topic of the respiratory system, which impacts students' low interest in learning and their science literacy skills. To overcome these challenges, innovative, communicative, and child-friendly learning media are needed. This study aims to develop a science literacy-based e-module on the respiratory system that can serve as an alternative medium for science learning among fifth-grade elementary school students. The research method employed was a research and development approach, utilizing the ADDIE model, with a primary focus on the development stage. The research subjects consisted of a material expert, a language expert, a media expert, one teacher, and six students in a limited trial. Data collection instruments included validation sheets and response questionnaires. The analysis technique employed a descriptive approach, utilizing both qualitative and quantitative methods. The results showed that the developed science literacy-based e-module is feasible for use in learning. Teachers and students provided positive responses, stating that the e-module helped explain the concept of the respiratory system more clearly, systematically, and understandably. Thus, the science literacy-based e-module on the respiratory system is considered effective as a learning medium that supports the strengthening of science literacy while enhancing students' understanding of scientific concepts in elementary school.

ABSTRAK

Pemahaman murid terhadap materi sains seringkali menghadapi kendala karena sifatnya yang abstrak, termasuk pada materi sistem pernapasan, sehingga berdampak pada rendahnya minat belajar dan keterampilan literasi sains murid. Untuk mengatasi permasalahan tersebut, diperlukan media pembelajaran yang inovatif, komunikatif, dan sesuai dengan karakteristik anak. Penelitian ini bertujuan mengembangkan e-modul berbasis literasi sains pada materi sistem pernapasan yang dapat digunakan sebagai media alternatif dalam pembelajaran IPA di kelas V sekolah dasar. Metode penelitian yang digunakan adalah penelitian dan pengembangan dengan model ADDIE yang dibatasi sampai tahap pengembangan. Subjek penelitian terdiri atas ahli materi, ahli bahasa, ahli media, seorang guru, serta enam murid pada uji coba terbatas. Instrumen pengumpulan data berupa lembar validasi dan angket respons, sedangkan teknik analisis dilakukan secara deskriptif kualitatif dan kuantitatif. Hasil penelitian menunjukkan bahwa e-modul berbasis literasi sains yang dikembangkan layak digunakan dalam pembelajaran. Guru dan murid memberikan respons positif karena e-modul ini membantu menjelaskan konsep sistem pernapasan secara lebih jelas, sistematis, dan mudah dipahami. Dengan demikian, e-modul berbasis literasi sains pada materi sistem pernapasan dinyatakan efektif sebagai salah satu media pembelajaran yang mendukung penguatan literasi sains sekaligus meningkatkan pemahaman murid terhadap konsep-konsep sains di sekolah dasar.

Kata Kunci: *e-modul; literasi sains; sekolah dasar*

INTRODUCTION

Science learning (Ilmu Pengetahuan Alam, IPA) plays a strategic role in developing students' logical, critical, and scientific thinking skills from an early age. Through IPA, students are introduced to observable natural phenomena that they can analyse and understand using scientific principles. Therefore, IPA functions not only as a means of transferring information but also as a medium for developing essential science literacy skills in the digital era (Eryuni, 2023). According to the Organisation for Economic Co-operation and Development (OECD) in 2003, science literacy is defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence to understand and make decisions concerning nature and human activities (Fuadi *et al*., 2020). Indonesia's low PISA results in science literacy indicate the need for serious efforts to improve the quality of science (IPA) learning in elementary schools (Hewi & Shaleh, 2020).

OECD data from 2023 reinforce this finding, showing that in Indonesia, almost no students excel in science. Only about 7% of students reach Level 5 or 6, far below the OECD average. Students who excel should be able to apply their scientific knowledge creatively and independently across a range of situations, including those they have not previously encountered (Herlina & Abidin, 2024). To achieve this level of competence, meaningful science learning should be directed toward concrete, active experiences that are relevant to daily life. Implementing meaningful learning will help students understand concepts more deeply, rather than merely memorising them (Nuriana & Hotimah, 2023). Therefore, science learning in elementary schools should be designed to develop students' scientific skills, curiosity, and problem-solving abilities.

Science learning aims to help students recognise their environment and the natural world around them, as well as to understand the various natural potentials of the Indonesian archipelago (Herdiana *et al*., 2021). The respiratory system is an important topic in the fifth-grade science curriculum. This material covers the human respiratory system, the mechanisms of breathing, and disorders that may occur within it. Understanding the respiratory system requires more than rote memorisation of theory; it also demands that students grasp its function in daily life. Previous research indicates that learning about human body organs should be presented interactively to enable students to connect concepts to real-life experiences (Kurniawati *et al*., 2021). Similarly, other studies emphasise that literacy-based science learning can help students become more independent in mastering the material. However, in practice, this topic is often still taught through lectures and textbook use, which tends to make students passive (Safitri & Sari, 2023). This situation makes it difficult for students to understand the abstract concepts of the respiratory system, underscoring the need for innovations in how the material is presented in a more engaging, interactive manner that also supports the development of science literacy skills

This finding is reinforced by interviews with the fifth-grade teacher at SDN 014 Sialang Kayu Batu. According to the teacher, instructional learning resources remain dominated by textbooks and student worksheets. The most frequently used teaching method is lecturing, which tends to make students passive and less actively engaged in the learning process. This situation has implications for low reading interest and limited literacy among students, particularly in science, which requires analytical, critical-thinking, and problem-solving skills. The low literacy culture within the school has become a barrier to improving the quality of learning (Komara & Hadiapurwa, 2023). If this situation continues, students will have difficulty understanding scientific concepts in depth, resulting in suboptimal learning outcomes. Therefore, alternative solutions are needed to assist teachers in delivering the material while increasing students' engagement in the learning process.

A lack of literacy will confuse students. Students who are confused will certainly have difficulty solving the problems they face, whether those problems are related to science or everyday life. Schools and teachers need to strive for collaborative learning and education (Juliana *et al*., 2023; Khaira *et al*., 2023). One of the solutions that can be offered is the development of science literacy-based e-modules to support science learning, especially on the respiratory system material. E-modules are digital teaching materials that can be accessed flexibly and are designed to facilitate students' understanding through interactive formats. The use of science-literacy-based e-modules can foster students' independence in learning and enhance critical thinking skills. (Kristina *et al*., 2022). Additionally, Lastri's research emphasises that e-modules can be utilised as an alternative teaching material that is more engaging than conventional textbooks (Lastri, 2023). By integrating science literacy into the e-module, students are not only required to understand concepts but also encouraged to analyse, evaluate, and apply their knowledge in real-world contexts.

The development of science literacy-based e-modules is highly relevant for improving the quality of science learning in elementary schools. Science literacy skills, in addition to student motivation, also require teachers to consider appropriate teaching strategies that align with students' conditions and potential. The teaching process recommends providing direct experiences and applying the essence of science (Efendi & Filahanasari, 2024). Theoretically, the development of science literacy-based e-modules is an appropriate solution because science literacy not only emphasises mastery of concepts but also trains critical, analytical, and applicative thinking skills.

According to constructivist theory, students actively construct their understanding through real-world experiences and contexts, whereas Mayer's cognitive multimedia theory emphasises that integrating text, images, and interactivity in digital media can enhance conceptual understanding. Therefore, science literacy-based e-modules encourage students to understand, analyse, evaluate, and apply science knowledge in everyday life, making them highly relevant for improving the quality of science education in elementary schools. The novelty of this science literacy-based e-module lies in its approach, which emphasises active student engagement in the learning process, rather than just reading the material. Previous research has highlighted that the use of flipbook-based e-modules can increase students' motivation to learn due to their visually appealing and interactive design (Mahendri *et al*., 2023). In addition, the e-module that integrates problem-based learning with science literacy can encourage students to develop problem-solving skills. Therefore, the science literacy-based e-module to be developed in this study will not only serve as an additional learning resource but also as an innovative means to enhance students' understanding, interest in learning, and literacy skills.

This study aims to develop an e-module on respiratory system science literacy that can serve as an alternative medium for science learning for fifth-grade elementary school students. This research is important because there are still limited studies that develop teaching materials in the form of science literacy-based e-modules at the elementary school level, especially for respiratory system material. Therefore, this study is expected to make a meaningful contribution to improving the quality of science education in elementary schools, particularly by developing innovative digital teaching materials that are relevant to students' needs.

LITERATURE REVIEW

E-Modul

One important factor in supporting the learning process is the e-module. According to its etymology, "e-module" is derived from the combination of the terms *'electronic'* and *'module'* (Sidiq, 2020). E-modul is a learning unit called a module created to help students achieve their learning goals using resources designed to accommodate each individual's unique characteristics and learning pace (Bantani *et al*.,

2024). The main benefit of the e-module is its ability to transcend time and space constraints, allowing users to access it at any time and from any location (Ashary & Komara, 2022; Satriani *et al*., 2025). There are several benefits of using e-modules, among others (Laili, 2019): 1) The e-module can increase students' motivation to learn; 2) Evaluation facilities are available to help teachers and students identify the parts that have been mastered and those that still need to be learned; 3) Educational resources can be distributed evenly over one semester; 4) The creation of learning materials is adjusted to students' educational backgrounds; 5) Electronic modules are more dynamic and engaging compared to printed modules, which are often static; 6) E-modules can reduce dependence on text components in printed modules by incorporating multimedia components such as audio, video, and animations

Science Literacy

Science literacy is an important part that needs to be accommodated and improved through science learning in the classroom. Science literacy is not only about knowing scientific facts and concepts but also about critical thinking skills, problem-solving, and utilising scientific data to inform decisions in daily life (Latip, 2022). Literacy can be understood as the ability to read and write, whereas science refers to the body of knowledge. Science is the systematic use of the scientific method to understand the world. Therefore, scientific literacy encompasses more than gathering information and developing ideas; it emphasises students' capacity to learn new information by applying the scientific method, a fundamental aspect of the scientific approach (Abrori *et al*., 2023). Therefore, science literacy should be taught at the elementary school level to ensure that students develop more comprehensive 21st-century skills (Rani & Budiarso, 2025).

Scientific literacy entails the ability to identify, understand, and explain scientific issues, enabling informed decision-making based on scientific evidence. Science literacy helps students solve problems by enabling them to understand scientific concepts and communicate scientific information (Kristina *et al*., 2022). This skill encompasses critical thinking, problem-solving, and evidence-based decision-making. Therefore, gathering information and developing concepts are not the only topics discussed in science literacy; it also emphasises students' ability to learn new information by applying the scientific method, a fundamental aspect of the scientific approach. Science literacy applies scientific knowledge to solve problems, thereby fostering a high level of self-awareness and environmental sensitivity in decision-making informed by scientific evidence (Nuro *et al*., 2020).

Characteristics of Elementary School Students

Fifth-grade students are at the concrete operational stage, as their logical thinking is limited to concrete objects. Therefore, for abstract subjects, the material must be concretised before students can understand it. Teachers should consider the diverse characteristics of elementary school students, as these relate to the continuity of learning activities. Each student is a unique individual with different ability levels, understanding levels, and possibly different learning interests. As a result, to achieve effective learning, teachers cannot view students as the same objects that can be treated in the same way (Kem, 2022; Qorib, 2024).

Characteristics of fifth-grade elementary school students can be observed in their achievement of learning outcomes, including knowledge, skills, and attitudes. At ages 10–11 years, children are in the concrete operational stage, according to Piaget, during which logical thinking begins to develop but remains limited to tangible, observable phenomena (Kumbar *et al*., 2024). The purpose of education is divided into three main domains: cognitive, affective, and psychomotor, which serve as reference points for understanding the characteristics of fifth-grade students. The development of fifth-grade students who are still in their

growth phase is an important task for teachers, who must continually monitor and assist students in understanding each student's characteristics. The role of teachers is not limited to implementing the learning process; they must also continuously guide students so they can develop and understand their own characteristics (Azizah & Irianto, 2024).

METHODS

The research employed is development research (Research and Development, or R&D). The development procedure follows the ADDIE model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. However, this study is limited to the development stage, with the primary focus on producing a valid and feasible media prototype. This stage is considered important as an academic foundation for ensuring the quality of the e-module's content, design, and usability before broader implementation. Therefore, feasibility testing by experts and small-scale trials with teachers and students are deemed sufficient to address the research objectives at this stage.

The research subjects consist of six validators. The assessment results from two validators in each field (material, language, and media) are processed by calculating the average scores given. Thus, for each field, a single average score is obtained to represent the validation results of that field. Next, the three average scores are combined to obtain an overall validation score for the learning media. Additionally, a limited trial involves one teacher and six students as initial users. Validators are selected based on their academic background and experience in their respective fields, so the validation results are expected to be more accurate and comprehensive.

The data collection instruments include validation sheets completed by experts (material, language, and media) and response questionnaires for teachers and students. All instruments use a Likert scale ranging from 1 to 4 to facilitate assessment. Data analysis is conducted both qualitatively and quantitatively. Qualitative analysis is used to review input, comments, and suggestions from experts, which are then incorporated into product improvements. Meanwhile, quantitative analysis involves converting scores from the validation instruments into percentages, thereby enabling the determination of the feasibility of the developed media. The following is the formula used to calculate the quantitative analysis:

$$P\frac{f}{n} \; x \; 100\%$$

Description:
P = Percentage
n = Highest score
f = number of data scores used

After the data are analysed using the previously explained percentage formula, the result will be a percentage reflecting the quality of the learning media product. This percentage indicates the media's suitability and serves as a basis for revising the product, based on validation results from media and content experts, as presented in Table 1.

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Table 1. Product Validity Criteria

No	Percentage %	Viability
1	25,00% - 40,00%	Invalid
2	40,01% - 55,00%	Less Valid
3	55,01% - 70,00%	Sufficiently Valid
4	70,01% – 85,00%	Valid
5	85,01% - 100%	Highly Valid

Source: Lapebridinsi & Mustika (2025)

If the instructional material receives a score between 81% and 100%, it is considered highly valid and suitable for use without adjustment. However, if the evaluation findings fall outside that percentage range, the learning module must be modified until it meets the validity criteria, with a minimum percentage of 81%. The module must then be resubmitted for evaluation by the validators.

RESULTS AND DISCUSSION

This study aims to describe the development process, validity, and product responses to a science literacy-based e-module on the respiratory system for fifth-grade students at SDN 014 Sialang Kayu Batu. The results of the study from the three stages are as follows:

Analysis Stage

The results of the teacher and student analysis indicate that both teachers and students face several challenges in the science learning process. Teachers often struggle to present material in an engaging and applicable manner, whereas students often struggle to understand abstract concepts. This situation calls for learning media that connect concepts to real-life experiences, are easy for teachers to use, and attract students' interest. Therefore, the most effective and successful media are those that not only deliver information but also encourage active student involvement in the learning process.

Curriculum analysis shows that basic science competencies in elementary schools emphasise skills in observing, asking questions, experimenting, and drawing conclusions about simple phenomena. Therefore, the development of a science literacy-based e-module must be designed in alignment with the learning outcomes listed in the syllabus. Each section of the module's material, activities, and assessments is designed to support science literacy skills, ensuring that the learning objectives are not only academically achieved but also aligned with current curriculum needs.

The results of the learning environment analysis indicate that most elementary schools already have technological facilities, such as computers, projectors, and internet access, although the quality and availability are not consistently distributed. Teachers are generally quite prepared to utilise digital media, and students show a high interest in using technology in learning. However, the limitations of devices in some schools need to be considered in the design of e-modules. Therefore, e-modules are designed to be flexible and accessible both online and offline, so they remain suitable for the actual conditions in schools and can support the effectiveness of learning to the fullest.

Design Stage

In the design stage, the initial step is to conduct preliminary research to ensure that the e-module design aligns with the characteristics and needs of the primary users, namely, elementary school teachers and students. This is important so that the developed e-module is not only communicative but also practical for use in science learning activities. Next, the learning materials are determined based on curriculum analysis and students' learning needs. The selected materials closely align with basic science competencies in elementary schools and are supplemented by activities that reinforce science literacy. To clarify the flow, the e-module structure is systematically organised, comprising an introduction, main content, practice questions, and evaluation elements that assess achievement of the learning objectives.

During the design process, four main components of scientific literacy are integrated into the e-module content, namely understanding the scientific method, mastering scientific concepts, developing scientific thinking patterns, and applying science in real-life contexts. To enrich the material, the researcher gathers relevant references, such as texts, images, tables, and graphs, that can be scientifically verified, thereby enhancing the validity of the e-module content and supporting science literacy-based learning. During the implementation stage, Microsoft Word is used to draft content in accordance with the module framework, and Canva is used to design an attractive graphic layout. Writing in Microsoft Word includes the cover page, preface, table of contents, learning objectives, main information descriptions, science literacy exercises, assessment tasks, student reflections, and references. The language used is simple, communicative, and appropriate for the cognitive development of elementary school students.

Meanwhile, Canva is used to design the cover, which includes the title, the author's name, and appealing illustrations, as well as to create infographics, tables, and illustrations of scientific phenomena. The visual design results from Canva are formatted as JPG or PNG files and then inserted into the Word document according to the module sections. The layout is arranged consistently using tables, headings, bullet points, and harmonious background colours to make it look neater and more user-friendly. As the final step, the e-module is converted to a digital format by uploading it to the Flipbook platform, making it easily accessible to teachers and students as interactive, engaging, and simple learning media. The following presents a view of the science literacy-based e-module: cover page, preface, table of contents, learning objectives, main information, science literacy exercises (e.g., experiments or observations), assessment tasks and questions, and references, as shown in Figure 1.
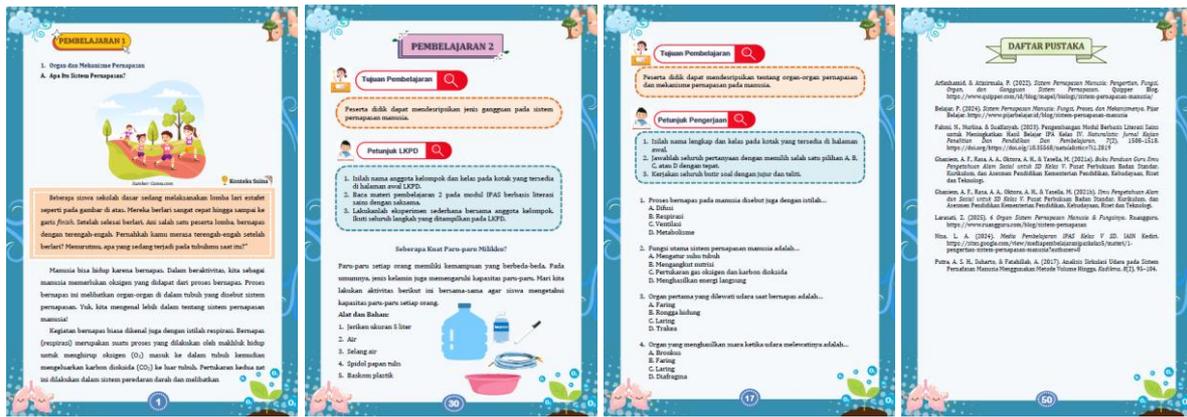
Figure 1. E-Module Display for Human Respiratory System Science Literacy Material
Source: Author's Documentation 2025

This interactive e-module, grounded in science literacy, begins with an engaging and communicative cover page. The cover displays the module title, a subtitle indicating the learning theme, which is the human respiratory system, and is complemented by an illustration of respiratory organs and relevant human activities. Placing the author's name at the bottom of the cover reinforces the module's identity and conveys a professional impression. In the preface, the author provides background on the module's development, expresses gratitude, and hopes that this e-module will help students understand scientific material more easily. The author also emphasises the importance of science literacy as a foundation for students to navigate developments in science and technology. The structure of the e-module is systematically organised, as shown in the table of contents. This section outlines the module's contents, including the preface, instructions for use, concept maps of the material, learning activities, exercises, and the bibliography.

Presenting a clear table of contents makes it easier for teachers and students to locate the relevant sections. Each learning unit in the e-module is equipped with clear and simple learning objectives. For example, students are expected to describe the respiratory organs, explain the mechanisms of breathing, and identify various disorders of the human respiratory system. Writing these objectives helps students understand what competencies they will achieve after studying the material. The main information is presented in a communicative and age-appropriate manner suitable for elementary school students. The material is complemented with illustrations, images, tables, and examples of phenomena from everyday life to facilitate understanding. This presentation not only focuses on theory but also emphasises the connection to real-world situations. Science literacy exercises are presented as simple experiments, observations, and questions about phenomena. Students are encouraged to think critically, analyse data, and draw conclusions from their observations.

This section is designed so that learning is not only passive but also encourages active student engagement. Additionally, assignments and assessment questions include multiple-choice, fill-in-the-blank, and short-answer formats. These questions not only measure conceptual understanding but also test students' ability to interpret information and solve contextual problems in accordance with principles of science literacy. To conclude, this e-module includes a bibliography of scientific sources used by the author in preparing the material. This section ensures that the information presented has a clear scientific basis, thereby enhancing the credibility of the e-module as a suitable learning medium.

Development Stage

After the science literacy-based e-module is developed, the next step is to validate it with subject-matter, language, and design experts, and to gather feedback from teachers and students. This validation process aims to ensure that the developed e-module aligns with learning objectives, the characteristics of elementary school students, and is pedagogically appropriate. The results of the experts' validation serve as the basis for revising the e-module. Revisions are made in response to suggestions and input to improve the product before conducting a limited trial with students.

The e-module assessment was conducted using a validation questionnaire sheet containing several statements regarding content feasibility, language clarity, and visual design quality. Each aspect was evaluated using a Likert scale ranging from 1 to 4 to determine the extent to which the e-module met the predetermined criteria. The data were then averaged for each aspect and expressed as percentages. These percentage results were then averaged again, with weights proportional to the number of validators or respondents. This process produced a final score that reflects the validity of the e-module and serves as a primary indicator of whether the science literacy-based e-module is suitable for use in elementary school science education or requires further improvement.

Expert Material Validation

Material expert validation aims to assess the suitability of the e-module content with respect to the basic competencies and learning objectives, and the accuracy of the scientific concepts presented. The material expert examines whether the content in the e-module aligns with the curriculum, is scientifically correct, and relevant to the everyday experiences of elementary school students. Input from the material expert is essential to ensure that the science literacy-based e-module content does not cause misconceptions, provides accurate explanations, and is systematically organised to support students' optimal achievement of science literacy.

Table 2. Expert Material Validation Results

No.	Indicator	Validator 1	Validator 2
1.	Self Instructional	97,2%	94,4%
2.	Self contained	91,6%	83,3%
3.	Stand Alone	100%	100%
4.	Adaptive	100%	100%
5.	Science Literacy Skills	100%	100%
	Average	**97,76%**	**95,54%**
	Total Average	**96,65%**	
	Criteria	**Highly Valid**	

Source: Research Data Results 2025

The validation results presented in Table 2 indicate that the science literacy-based e-module is highly feasible. Almost all aspects received scores above 90%, with some indicators, such as stand-alone, adaptive, and science literacy, earning perfect scores from both validators. These findings demonstrate that the e-module is well designed to be self-sufficient, flexible, and effective in integrating science literacy components. Although there were slight differences in scores between the validators, particularly on the self-contained aspect (91.6% and 83.3%), the overall results consistently show that the e-module is highly valid. An average total score of 96.65% indicates that this media is not only feasible but also of high

academic quality for instructional use. In other words, this e-module can be used without substantial revisions, while further improvements can focus on technical details informed by the validators' feedback.

Language Expert Validation

Language expert validation is conducted to assess the appropriateness of language use in the science literacy-based e-module. This assessment evaluates the suitability of language to students' cognitive development levels, text readability, and the clarity of information delivery. Language experts ensure that the language used in the e-module is simple, clear, and accessible to elementary school students. Additionally, this validation aims to avoid overly complex terminology, long sentences, or improper sentence structure. With input from language experts, the science literacy-based e-module is expected to convey learning materials clearly, effectively, and in accordance with students' characteristics, making it easy to understand and engaging to learn.

Table 3. Language Expert Validation Results

No.	Indicator	Validator 1	Validator 2
1.	Language appropriateness	89,2%	96,4%
2.	Communicative	100%	75%
3.	Appropriateness for student development	100%	100
	Average	**96,4%**	**90,46%**
	Total Average	**93,43%**	
	Criteria	**Highly Valid**	

Source: Research Data Results 2025

Based on Table 3, the validation results by two language experts indicate that the science literacy-based e-module falls into the 'very valid' category with an overall average score of 93.43%. The high score on the appropriateness indicator for students' development (100% from both validators) confirms that the language used is suitable for elementary school students' comprehension level. This is a significant finding because it ensures optimal readability and understanding of the material. However, there was a difference in assessment regarding the communicative aspect. Validator 1 received a perfect score (100%), whereas Validator 2 received only 75%. This discrepancy suggests that, although some experts consider the e-module's language communicative, there remains room to improve its consistency and ease of understanding for all parties. Overall, these results affirm that the language used in the e-module is highly appropriate for elementary school science instruction and has the potential to enhance communication style, thereby improving effectiveness.

Media Expert Validation

Media expert validation aims to assess the visual aspects, layout, and aesthetics of the science literacy-based e-module being developed. Media experts evaluate the cover design, content neatness, colour choices, typography, illustrations, and layout consistency to ensure alignment with the characteristics of elementary school students. Media experts' evaluation is crucial to ensure that the e-module has an attractive appearance, appropriate proportions, and the capacity to enhance students' motivation to learn.

Additionally, this validation also ensures that the e-module is practical to use, easily accessible, and comfortable to support learning activities.

Table 4. Media Expert Validation Results

No.	Indicator	Validator 1	Validator 2
1.	Module size	87,5%	87,5%
2.	Module cover design	95%	95%
3.	Module content design	89,6%	97,5%
	Average	**90,7%**	**93,3%**
	Total Average	**92%**	
	Criteria	**Highly Valid**	

Source: Research Data Results 2025

The validation results from two media experts in **Table 4** indicate that the science literacy-based e-module is categorised as 'very valid' with an overall average score of 92%. The high score on the cover design indicator (95% from both validators) confirms that the module's initial appearance is considered attractive and consistent with instructional design principles. Regarding content design, although there was some variation in assessments between Validator 1 (89.6%) and Validator 2 (97.5%), both still reflect good visual quality and readability of the content. Meanwhile, the module size indicator received a score of 87.5%, which, although lower than other aspects, still falls into the very valid category. Overall, these findings affirm that the e-module design meets the eligibility standards for size, aesthetics, and visual coherence. Therefore, the e-module is suitable for use in elementary school science education, with room for improvement through technical refinements to achieve a higher level of design quality.

Based on expert validation, the science literacy-based e-module is classified as highly valid and suitable for instructional use. The content was validated by experts, with an average total score of 96.65%, categorised as very valid. This indicates that the content of the e-module is aligned with the basic competencies and learning objectives and accurately presents the concepts required by students. Next, validation by language experts yielded an average total score of 93.43%, which is categorised as very valid. This proves that the language used in the e-module is appropriate for students' cognitive development levels, communicative, and easy to understand, thus preventing misconceptions or difficulties in understanding the material. Meanwhile, validation by media experts yielded an average total score of 92%, categorised as very valid. These findings suggest that the visual appearance, layout, and aesthetics of the e-module are attractive, proportionate, and suitable for elementary school students' characteristics. Overall, the validation results across these three aspects indicate that the science literacy-based e-module developed meets the standards of feasibility with respect to content, language, and design. Therefore, this e-module can be used as an effective learning medium to enhance science literacy among elementary school students, although minor revisions may be warranted based on suggestions and input from validators.

Teacher Response

The teacher's response was obtained via a questionnaire assessing ease of understanding, the presentation of the e-module, and usefulness. The analysis results indicate that teachers provided a highly positive assessment of the developed e-module. Teachers stated that this e-module helps present learning material more clearly, communicatively, and attractively, making it easier for students to understand abstract concepts. Additionally, teachers rated the e-module as in accordance with the curriculum, using simple, easy-to-understand language and supported by attractive visual displays that align with elementary school students' characteristics. Overall, the media are considered highly feasible and effective for classroom learning. Table 5 presents the teachers' response results.

Table 5. Teacher's Response Results

No.	Indicator	Score
1.	Ease of understanding	90%
2.	E-module presentation	90%
3.	Kemanfaatan	100%
	Average	**93,3%**
	Criteria	**Highly Valid**

Source: Research Data Results 2025

Teachers' responses to the science literacy–based e-module were collected via a questionnaire assessing ease of understanding, presentation, and usefulness. The analysis results showed that the average teacher rating was 93.3%, placing it in the "very valid" category. Teachers assessed that the e-module was easy to understand because the material was systematically organised and aligned with the basic competencies. Regarding presentation, teachers gave positive evaluations due to the e-module's attractive, communicative design, which is easy to use in teaching and learning activities. Furthermore, in terms of usefulness, the e-module was considered highly effective in explaining the learning material more clearly and contextually, thereby helping students grasp abstract concepts more easily. Overall, teachers' responses indicate that the science literacy–based e-module is suitable for use as a learning medium in elementary schools.

Student Response

Students' responses to the science literacy–based e-module were collected via a questionnaire that assessed several indicators, including the e-module's appearance, ease of understanding, presentation appeal, and learning interest. From the processed questionnaire data, the average scores indicated a "Very Good" category. Most students reported that the e-module was highly engaging, particularly because it included illustrations, bright colours, and a clear, communicative layout. Regarding ease of understanding, students reported that they better understood the concepts of the respiratory system after using the e-module, as the material was presented gradually and simply, supported by images and contextual examples. In addition, students appreciated the science literacy exercises and evaluation questions, which encouraged greater active engagement in learning. Overall, the students' responses indicate that the science literacy–based e-module is well-liked, easy to understand, and effective in increasing their learning motivation, particularly when studying abstract scientific topics such as the

respiratory system. Therefore, this e-module is considered an effective learning tool for IPAS in Grade V elementary school.

Table 6. Student Response Results

No.	Student Name	Score Obtained	Maximum Score	Percentage	Category
1.	SA	52	56	92,8%	Highly Valid
2.	AD	51	56	91,1%	Highly Valid
3.	H	53	56	94,6%	Highly Valid
4.	I	51	56	91,1%	Highly Valid
5.	EPS	53	56	94,6%	Highly Valid
6.	IAS	53	56	94,6%	Highly Valid
	Average		**93,13%**		
	Criteria		Highly Valid		

Source: Research Data Results 2025

Based on the questionnaire results for six students presented in Table 6, the students' response percentages to the science literacy–based e-module ranged from 91.1% to 94.6%, with an overall average of 93.13%. These results fall into the Very Valid category. All students reported that the e-module was easy to understand, presented engagingly, and helpful in supporting their understanding of respiratory system material. The high scores indicate that the e-module is not only feasible for use but also capable of attracting students' interest in learning and supporting the achievement of learning objectives. Therefore, the students' responses reinforce the finding that the science literacy–based e-module is an effective learning medium for fifth-grade students.

Discussion

The science literacy-based e-module on the respiratory system for elementary school students has been designed in accordance with students' needs and curriculum requirements, presenting material that is communicative, systematic, and supported by engaging visual illustrations. Teachers assess that this e-module is useful for facilitating learning, helping to explain abstract concepts, and incorporating innovative teaching media. Meanwhile, students report understanding the material more easily, greater interest in learning, and increased motivation to participate in lessons. This aligns with previous research indicating that digital-based science e-modules can be used in learning activities and improve students' science literacy (Humairah *et al*., 2024). In addition, according to other research, the electronic learning media developed can be applied more effectively in learning.

The use of e-modules has been shown to improve students' science literacy (Kaniyah *et al*., 2022). In addition, interactive e-modules can improve science literacy by being easy to use and featuring engaging features that help students understand the material (Ismaniati, 2023). The improvement in students' science literacy is attributable to the e-module's presentation, which often features contexts close to students, thereby stimulating their curiosity and encouraging them to search for, explore, and investigate information in the material they are learning (Muntari *et al*., 2024). The e-module is used as a teaching material to support independent learning, employing a communicative, two-way language approach, making it easier for students to study the lesson material. Its use involves electronic media, specifically e-

modules, to develop scientific literacy (Muzijah *et al*., 2020). Additionally, this e-module is a practical learning medium that can be accessed anywhere, facilitating independent learning and thinking, with various benefits. The e-module is the most practical medium and offers numerous advantages that facilitate learning for teachers and students. Therefore, science literacy-based e-modules are very beneficial for learning activities, especially for remote or in-person learning, because they are highly efficient (Sesanti & Wahyuningtyas, 2022).

The results of this study imply that the development of science literacy-based e-modules can serve as an effective alternative learning medium in elementary science education. E-modules help teachers deliver respiratory system material more clearly, interactively, and in ways that align with students' characteristics, thereby enhancing understanding of abstract concepts. Additionally, these e-modules strengthen students' science literacy by combining knowledge with activities such as observation and practice. Thus, this research supports the importance of integrating digital technology into learning to improve the quality of elementary education and provides an innovative model that can be applied to other subjects.

This research has several limitations that warrant mention. First, the trials conducted are still limited to a relatively small number of subjects, so the results cannot yet be generalized to a broader context. Second, the study focuses solely on the development stage of the ADDIE model; therefore, the long-term effectiveness of the e-module and its performance in more complex learning situations have not been fully tested. Therefore, further research with a larger sample size, full implementation across stages, and a more comprehensive evaluation is strongly recommended to ensure that this e-module can make an optimal contribution to improving the quality of science education in elementary schools.

CONCLUSION

This research developed an e-module on respiratory system science literacy for elementary school students. The developed e-module has been designed to meet students' needs and curriculum requirements, with content presented in a communicative, systematic manner and supported by engaging visual illustrations. The language is simple and easy to understand, and the material includes learning objectives, key information, science literacy exercises, and contextual assessments. Teachers assess that this e-module is useful for facilitating learning, helping to explain abstract concepts, and incorporating innovative teaching media. Meanwhile, students report that the material is easier to understand, that they are more interested in learning, and that they are more motivated to participate in lessons. Overall, this science literacy-based e-module on the respiratory system can serve as a viable alternative learning medium to support the strengthening of science literacy while also potentially enhancing students' conceptual understanding and interest in learning in elementary schools.

AUTHOR'S NOTE

The author declares that there are no conflicts of interest related to the publication of this article. The author affirms that the article's data and content are free of plagiarism.

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