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Development of e-module to improve students' science learning outcomes

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Abstract: Today, teaching materials are not optimal for supporting students' conceptual understanding, and students easily become bored if the learning process is unengaging or monotonous, ultimately leading to low learning outcomes. This research aims to improve students' science learning outcomes by developing e-modules. The study followed the ADDIE research and development process. Individual trials involved 3 students, small-group trials involved 9 students, and implementation involved 30 students. Data were collected through observation, interviews, questionnaires, and tests. Data analysis included descriptions of interview results, calculations of student and teacher response percentages, pretest and posttest averages, and n-gain values. The results of the needs analysis show that teachers and students need science learning resources that they can use independently and can access flexibly. The average validation score for the material expert was 86%, and for media experts was 87%, indicating that the e-module was valid. The results of practicality tests with teachers and students showed that the e-module was practical for learning because it was easy to access and helped with understanding the material. The n-gain calculation showed a significant increase in students' science learning outcomes (n-gain = 0.72). The developed e-module met students' needs, was validated by experts, was practical to use, and effectively improved students' science learning outcomes. The e-module offered easy-to-access features, accurate information, and support for independent learning.

Keywords: Digital resources, learning outcome, science learning problem

Abstrak: Saat ini, bahan ajar belum optimal untuk mendukung pemahaman konseptual siswa, dan siswa mudah bosan jika proses pembelajaran tidak menarik atau monoton, yang pada akhirnya menyebabkan hasil belajar yang rendah. Penelitian ini bertujuan untuk meningkatkan hasil belajar sains siswa dengan mengembangkan e-modul. Studi ini mengikuti proses penelitian dan pengembangan ADDIE. Uji coba individual melibatkan 3 siswa, uji coba kelompok kecil melibatkan 9 siswa, dan implementasi melibatkan 30 siswa. Data dikumpulkan melalui observasi, wawancara, kuesioner, dan tes. Analisis data meliputi deskripsi hasil wawancara, perhitungan persentase respons siswa dan guru, rata-rata pretest dan posttest, dan nilai n-gain. Hasil analisis kebutuhan menunjukkan bahwa guru dan siswa membutuhkan sumber belajar sains yang dapat mereka gunakan secara mandiri dan dapat diakses secara fleksibel. Skor validasi rata-rata untuk ahli materi adalah 86%, dan untuk ahli media adalah 87%, menunjukkan bahwa e-modul tersebut valid. Hasil uji kepraktisan dengan guru dan siswa menunjukkan bahwa e-modul tersebut praktis untuk pembelajaran karena mudah diakses dan membantu pemahaman materi. Perhitungan n-gain menunjukkan peningkatan signifikan dalam hasil belajar sains siswa (n-gain = 0,72). E-modul yang dikembangkan memenuhi kebutuhan siswa, telah divalidasi oleh para ahli, praktis digunakan, dan secara efektif meningkatkan hasil belajar sains siswa. E-modul ini menawarkan fitur yang mudah diakses, informasi yang akurat, dan dukungan untuk pembelajaran mandiri.

Kata kunci: Sumber daya digital, hasil pembelajaran, masalah pembelajaran sains

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INTRODUCTION

Effective classroom management is a prerequisite for effective teaching. Likewise, a teacher's teaching style also influences learning effectiveness (Burroughs et al., 2019). Teachers certainly possess knowledge and skills that directly address core educational

issues, namely how to foster and direct the growth that occurs in students during the educational process (Desimone, 2023; Yurida et al., 2021). Teachers are the individuals authorized and responsible for students' education, both individually and in class settings. In carrying out their role, teachers must provide the necessary facilities for interaction in the teaching and learning. The facilities provided by teachers must be linked to current needs, namely, technology-based learning resources.

Technology will influence the future, with hybrid learning (a combination of online and face-to-face learning) set to grow (McPherron et al., 2020). Technology will enable greater flexibility, allowing students to access materials anytime, anywhere, and overcoming time and location barriers. Technology serves as a tool to assist teachers in creating digitally based learning that is relevant to the times, interactive, and that encourages active learning (Lewohl, 2023). Technological developments have led to the adaptation of learning system technology, with the availability of learning support features and applications on computers and smartphones (Ahmad et al., 2026). The urgency of using technology in learning has a significant impact on shaping the future of education.

The use of technology in learning activities must be carried out as wisely as possible to maximize interaction between teachers and students. A student's future success or failure can be seen in their ability to utilize technology (Sabri et al., 2022). Therefore, teachers need to implement a learning approach that maximizes the use of technology in teaching and learning activities to teach students digital literacy skills from an early age (Wicaksono et al., 2026). This aims to develop students' abilities to use digital technology. The use of technology in learning takes various forms, including digitally based teaching materials (Dita et al., 2023). The digital educational materials are learning resources in electronic form for delivering instruction. The delivery of material uses digital tools, such as the internet, computers, smartphones, and other digital media.

An e-module is a digital learning material developed systematically and interactively to provide students with independent learning experiences through electronic media such as smartphones, tablets, and computers (Nurzahra et al., 2025; Pratiwi et al., 2024). An electronic module (e-module) is an electronic version of a module, implemented as software, that can be used on a computer and accessed online (Yomaki et al., 2023). Develop of e-modules in learning activities can encourage independent learning, because they can be carried anywhere and used anytime. In this context, an e-module is a learning material developed and designed using technological devices. The development of this e-module for science subjects uses the principles of constructivist learning theory and a holistic approach. The constructivist theoretical approach is a cutting-edge learning theory that explains how internet technology creates opportunities for individuals to learn online (Pribadi, 2023). Meanwhile, the holistic approach views a complete unity, helping students develop critical thinking and analytical skills by inviting them to understand the relationships between concepts and see the big picture of the topic being studied.

Based on preliminary research conducted in the even semester in November 2024 at SMPN 1 Soppeng, one of the eighth-grade science teachers stated that science learning at the junior high school level often encounters obstacles because the previously used teaching materials are not optimal in supporting students' conceptual understanding. Printed teaching materials, such as textbooks and student worksheets, tend to be static, less interactive, and limited in visualization. Meanwhile, the characteristics of science subjects

are both concrete and conceptual, such as connecting concepts in force, energy, and cell biology processes with tactile conditions, so that visualization or simulation is required for easier understanding. In addition, science requires science process skills such as observing, inferring, and evaluating, which cannot be optimally developed only through text-based teaching materials. On the other hand, the traits of junior high school students who are part of the digital native generation demand a more modern learning approach. Today's students are accustomed to technology and tend to prefer interactive, visual digital learning media. They also have diverse learning styles (visual, auditory, kinesthetic), not all of which are well supported by conventional teaching materials. In addition, teenage students easily get bored if the learning process is not engaging or monotonous, which ultimately leads to low learning outcomes.

Based on the data obtained, there are 180 seventh-grade students, divided into six classes. Each class consists of 30 students, so the school's printed books cannot facilitate all eighth-grade students, as the number of books is still relatively limited. The development of e-modules as alternative teaching materials is the right solution to overcome the limitations of technology-based learning resources. E-modules can combine text, images, videos, animations, and interactive quizzes into a single medium that is easily accessible anytime, anywhere (Pratiwi et al., 2024; Setyantoko et al., 2023). This medium allows the presentation of scientific material in a contextual, visual, and fun way and supports both independent and collaborative learning (Azizah et al., 2022). With these features, e-modules are not only able to adapt to the characteristics of the material and students, but also has the capacity to significantly enhance student motivation and learning outcomes.

Several previous studies have found that e-modules can improve science learning results. The use of e-modules impacts science learning outcomes because they can be used independently, are easy to use, are engaging, and provide a variety of information students need (Dita et al., 2024). E-modules make them easier for students to access, promote active thinking, and serve as a platform for confirming previously acquired information (Wang, 2020). E-modules are available online and can be accessed via smartphones, providing students with convenience and flexibility and improving learning outcomes (Redhana et al., 2024). When science teachers use e-modules, students become more enthusiastic and their engagement increases, ultimately impacting learning outcomes (Eginuranda & Widiansyah, 2026). Thus, developing e-modules to support successful science learning is crucial.

The E-Module was developed and equipped with learning materials, images, audio, learning videos, and practice questions in accordance with the steps for compiling the module (Lestari et al., 2025). The E-Module was developed in accordance with the characteristics of grade VIII science students at SMPN 1 Soppeng, where three learning styles are dominant: visual, audio-visual, and kinesthetic. This can make it easier for teachers to understand students' learning styles, enabling them to develop more varied and interesting teaching materials. Then, the results of initial interviews conducted with grade VIII science teachers indicated that teachers considered science subjects very important to study several fundamental reasons, such as learning science helps students understand natural phenomena and their environment, thereby increasing students' curiosity and interest in learning. This research aims to improve students' science learning outcomes through the development of e-modules.

METHOD

The research employed a research and development (R&D) approach using the ADDIE model (Branch, 2009). The subjects were 180 eighth-grade students at SMPN 1 Soppeng in the Lalabata District during the 2025/2026 academic year. Students used for the trial were determined through purposive sampling. The initial stage involved analyzing student needs related to the e-module. Teacher needs were also assessed during this stage. The results of the needs analysis then served as the basis for the prototype design and storyboard for the e-module. The next stage was expert validation for the developed e-module, involving material experts and media experts. Individual trials involved 3 students, small-group trials involved 9 students, and implementation involved 30 students.

Data were collected through observation, interviews, questionnaires, and tests. These observations were conducted using observation sheets prepared by the researchers, which included indicators. The observation guidelines were used to evaluate student behavior during classroom learning activities. Interviews were conducted with e-module users, namely students and teachers. The questionnaire targeted eighth-grade students and inquired about the accessibility of educational resources, the curriculum used, and the classroom learning process. The questionnaire was used to gather data to substantiate the examination of the e-module's practicality and effectiveness. The questionnaire was administered to students and teachers to obtain positive feedback scores on the ease of use of the digital textbooks provided during the evaluation phase after the product trial. Tests were used to obtain data to support the analysis of the e-module's effectiveness.

Data analysis included descriptions of interview results, calculations of student and teacher response percentages, pretest and posttest averages, and n-gain values. Validation results were categorized based on research by Kasman et al. (2026), and n-gain categories were adapted from Hake (1998).

RESULTS AND DISCUSSION

A needs analysis was conducted during school observations by identifying needs based on the conditions at the school being studied. An interview with a science teacher revealed that the learning resources provided to students were teaching modules and printed science textbooks published by the Ministry. Further explanation was provided for the teaching modules, which lacked references to the science subject matter itself. Furthermore, the teaching modules provided were limited to teacher-provided resources, leaving students without their own learning resources to use in the learning process. The school implements the Independent Curriculum, an educational policy that provides schools with flexibility and autonomy in developing their curricula. According to Dita et al. (2023), the unavailability of e-modules is due to teachers still using government-provided learning resources.

Science educators indicated a need for autonomous learning tools that students might use to engage with scientific topics. E-modules serve as an alternate option due to their independent accessibility for users at any time and from any location. A study of student needs was conducted using a questionnaire to ascertain students' requirements and evaluate the need to develop e-modules in the learning process. The questionnaire was distributed via Google Form, as described in Table 1.

Table 1. Results of student needs analysis

No	Question	Yes	Sometimes	No
1	Have you ever experienced difficulties in science class?	8	19	3
2	Is the content in the instructional materials suitable?	5	23	2
3	Are the teaching materials and learning media used so far able to be used independently?	23	7	0
4	Are students able to use the existing teaching materials and learning media without teacher assistance?	29	0	1
5	Is the content of the textbook comprehensive or just the main points?	16	13	1
6	Have you ever experienced difficulties learning sub-topics in a lesson, especially in science, from the printed textbook you used? (For example, the completeness of the material, the explanation techniques, and the format)	12	16	2
7	Do you need alternative teaching materials that can be used in learning, especially in science, that are easier and more engaging?	18	9	3
8	Have you heard of e-modules?	17	7	6
9	Would you be interested in using E-Modules in science? (e-modules will be equipped with engaging learning materials, images, and videos)	24	6	0
10	Does the utilization of instructional videos facilitate your comprehension of particular scientific concepts?	17	5	8
11	Do you agree with the use of e-modules in science?	25	0	5
	Total score	194	105	31
	Percentage	58%	31%	9%

The results of the needs identification questionnaire with the e-module product, which scored 11 points, indicate that, in general, 58% of respondents answered affirmatively with a total score of 194, 31% answered sometimes with a total score of 105, and 9% answered no with a total score of 31. The conclusions that can be drawn from the requirements analysis conducted are that the significance of the development of e-modules to facilitate the learning process, particularly in science subjects, is acknowledged by both instructors and students. This endeavor is anticipated to enhance the efficacy of science education in the classroom, thereby enhancing the learning experiences of students and facilitating the attainment of learning objectives. The learning objectives sequence was followed in the development of the e-modules product. Developing e-modules that prioritize factors such as visibility, attractiveness, simplicity, usability, accuracy of information, coherence, and organization can address the paucity of variety in learning materials used by teachers (Nurzahra et al., 2025).

Student characteristics analysis was also conducted during the preliminary study of this research by administering visual, auditory, and kinesthetic learning style tests via a Google Form distributed to 30 students. The results of the student questionnaire analysis showed that the visual category accounted for 35%, audio-visual for 40%, and kinesthetic for 25%. The analysis of student characteristics showed the need for different learning approaches. The characteristics of the e-module must be aligned with students' stage of cognitive development. According to Jean Piaget, students' cognitive development occurs in stages, depending on age and level of cognitive maturity (Oogarah-Pratap et al., 2025). Among junior high school students, cognitive development is in a transitional stage from concrete operations to formal operations, so students' way of thinking begins to shift from understanding concrete things to abstract, logical thinking. This cognitive development directly influences students' learning styles and their ability to use digital modules.

Based on the needs analysis conducted, the use of e-modules in science learning can improve learning effectiveness by presenting complex concepts in an easier-to-understand way and by increasing student engagement and understanding. This is in line with research conducted by Kasman et al. (2026) and Pratiwi et al. (2024),where, in this study, there is a similarity in the development of e-modules with the aim of providing broad insights to users that have been developed according to the needs of students and teachers in the learning process.

Table 2. Initial design/prototype of e-module for science

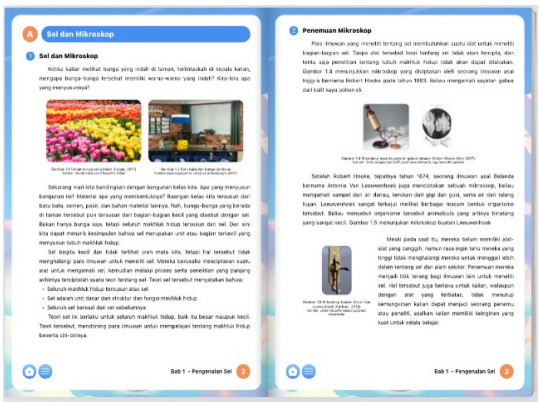
No	Components	Description
1	Specifications	Heyzine application software is used to produce electronic modules
2	Design	A template is first made using Canva before extracting the information into the Heyzine program
3	Material Design	The material has been exported to PDF. The PDF file is then published to the Heyzine application. Next, researchers use the Website 2 Apk Builder tool to convert digital instructional materials into Android apps for smartphones and computers
4	Visuals	Canva is used to develop an appealing visual design for digital learning materials
5	Body of e-module	Consists of a cover, foreword, table of contents, learning objectives, learning videos, appendices, and a bibliography
6	Content	The digital learning materials consist of two learning activities: soft-material crafts and processing vegetables into healthy foods and drinks

Cover Content

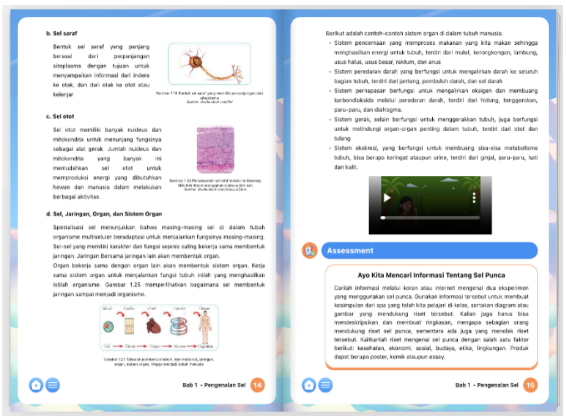
Fig. 1. Storyboard of e-module

a. Front cover view of e-module

b. Table of contents view



c. Material and content



d. Learning video display and content

Fig. 2. Developed e-module products

After producing the prototype and storyboard, the next step was to design the e-module in Canva. The design was based on the previously prepared prototype. This process involved using Canva's creative features and design tools to produce layouts and other visual elements that aligned with the storyboard concepts. Furthermore, the design was tailored to participants' needs and preferences while also considering principles that facilitate understanding and enhance the e-module's appearance. Using the prototype and storyboard as guides, the design served as the foundation for subsequent implementation,

ensuring the final result met the stated expectations and objectives. Several displays were designed in Canva and converted into the Heyzine Flipbook format (Figure 2). The product design was adapted to the prototype and storyboard prepared by the researcher (Ahmad et al., 2026; Nasrul et al., 2024; Yani et al., 2024).

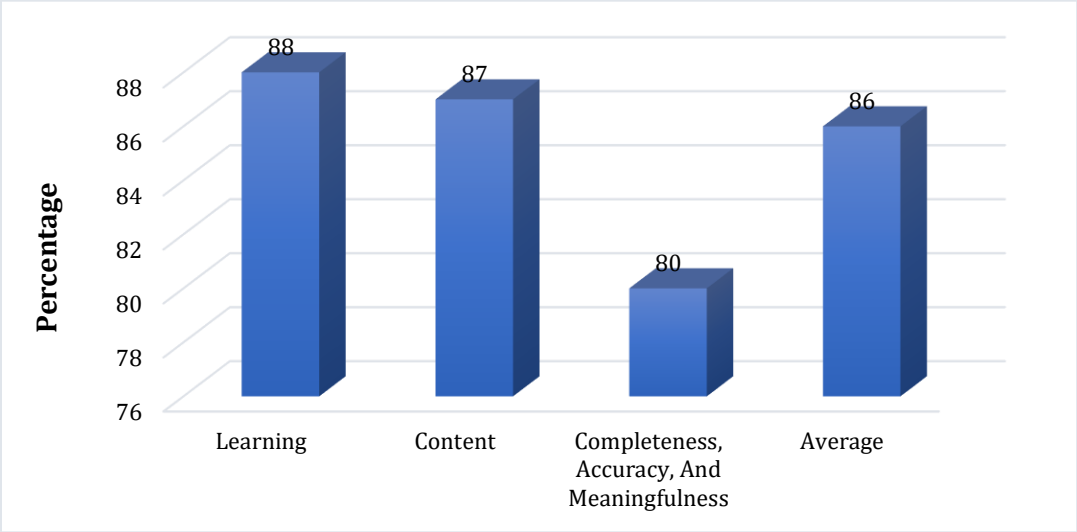


Fig. 3. Results of validation by material experts

The validation findings from material experts (Figure 3) indicate that the constructed e-module attained an average score of 86%, demonstrating its excellent validity as teaching material in the educational process. The e-module design phase involves compiling learning objectives, creating digital teaching materials, and considering elements such as interactivity, media integration (images, videos, etc.), and navigational ease to ensure the content is both informative and engaging. Digital teaching materials are crafted to be visually appealing, enhancing student comprehension and elevating the quality of learning in accordance with learning goals (Dita et al., 2023; Pratiwi et al., 2024).

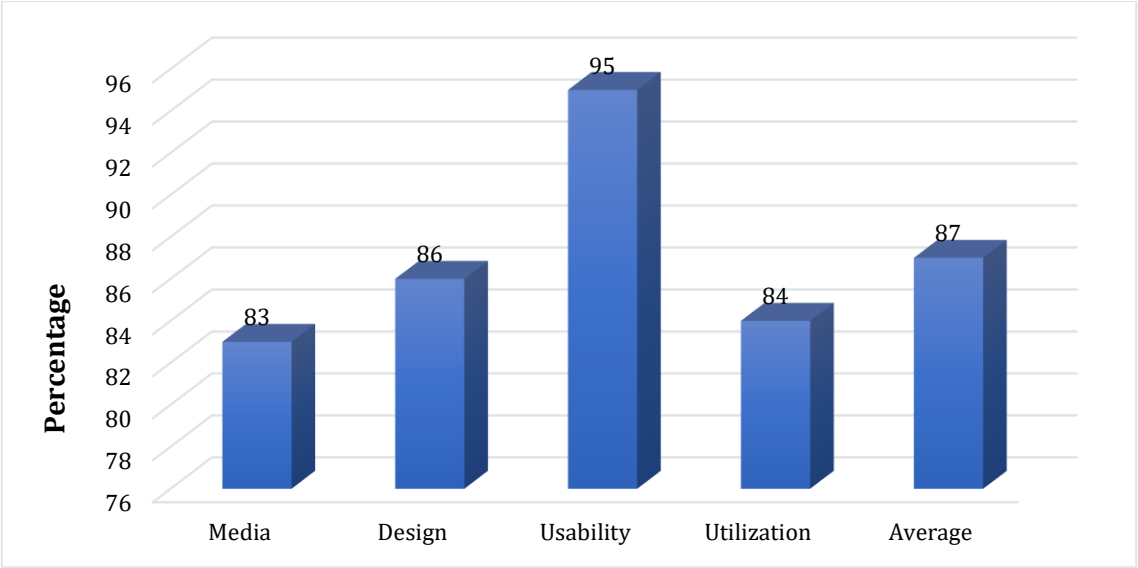


Fig. 4. Media expert validation results

The validation results from design/media experts (Figure 4) show that the e-module is categorized as highly valid with a total percentage of 87%. In terms of media, a score of 83% indicates that the e-module meets the principles of self-paced learning, self-instruction, and modular chunking. In terms of design, a score of 86% indicates good visual quality, particularly in terms of the cover, color proportions, and image legibility. In terms of usability, the highest score of 95% indicates that the e-module is highly accessible, has effective navigation, and directly supports the learning process. Meanwhile, the usability aspect achieved 84%, indicating that the e-module is valid in supporting learning, saving time, and reducing misconceptions, although its visual appeal and strengthening of the learning experience can still be improved. Overall, the e-module is considered highly valid in terms of design and media. Product development must be designed as attractively as possible to encourage users to use it and add information (Damopolii, 2025; Wambrauw et al., 2025; Yomaki et al., 2023).

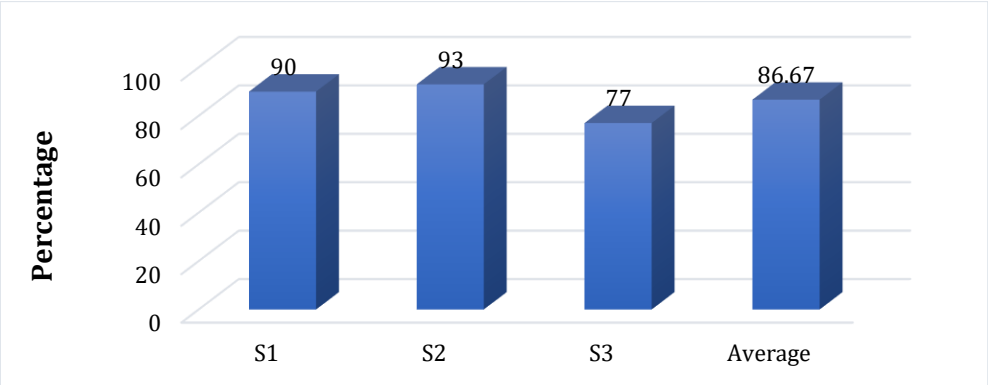


Fig. 5. Individual trial results

The results of the individual trials (Figure 5) show that the e-module is in the very practical category, with 90% of undergraduate students, 93% of postgraduate students, and 77% of postgraduate students, for a total average of 86.7%. Overall, the e-module was rated highly for its appearance, readability, material structure, and ease of use, thereby fulfilling its basic function as a medium for independent science learning. The results of the individual trials serve as the basis for further development in small groups (Horota et al., 2023; Runniarsiti et al., 2025).

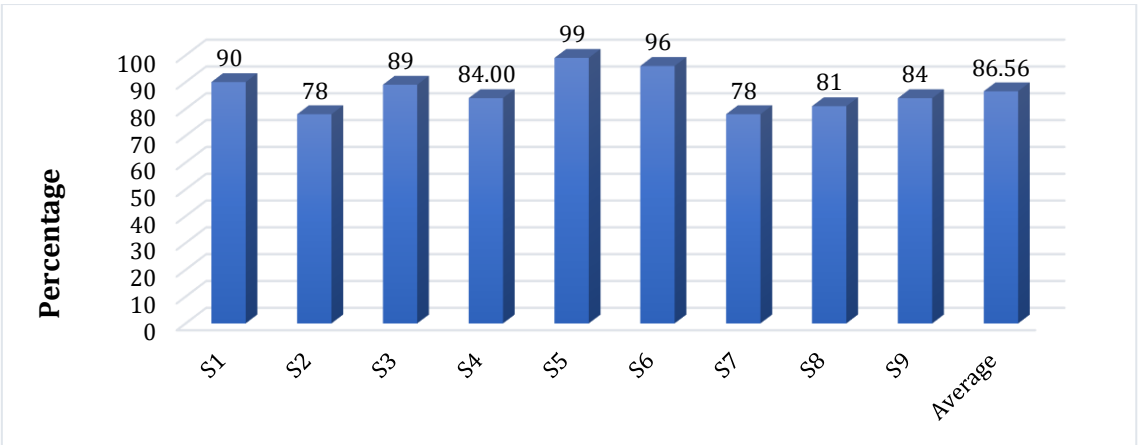


Fig. 6. Small group trials

Based on the results of a small-group trial (Figure 6) involving 9 students, the assessment percentages were 90%, 78%, 89%, 84%, 99%, 96%, 78%, 81%, and 84%, with an average of 86.56%. These results fall into the very practical category, indicating that the developed e-module was well received by students. Students gave positive assessments of the e-module's attractive appearance, easy-to-understand, well-structured material, and ease of use in supporting independent learning (Damopolii et al., 2022; Kobak et al., 2026; Pratiwi et al., 2024).

Table 3. Teacher response questionnaire results

No	Aspects	**Score**
1.	The e-module cover has an appealing color and aesthetic	5
2.	The e-module's layout and view are structured	5
3.	The font color is suitable	5
4.	The font size is suitable	4
5.	The font style is suitable	5
6.	The text in the material, instructions, and questions is clear	5
7.	There were no problems using the e-module	4
8.	The guidelines for using the e-module are clear	5
9.	The material in the e-module aligns with the learning objectives	4
10.	The images and animations presented in the e-module attract students' prefer and encourage learning	5
11.	The questions in the e-module may serve as practice both in and out of school	4
12.	The words and phrasing of the e-module are comprehensible to students	4
13.	The selection of learning videos in the e-module strengthens students' understanding	4
14.	Each learning activity presented in the e-module has objectives that align with the learning outcomes	4
15.	The types of learning media in the e-Module vary	4
16.	The e-module trains students to enrich their knowledge	5
17.	The e-module makes it easier for students to access learning materials	5
18.	E-modules improve students' comprehension of educational information	5
19.	E-modules capture students' attention	5
20.	E-modules facilitate learning	5
21.	E-modules are easy to use	5
22.	E-modules streamline student learning	4
23.	E-modules enhance the effectiveness and efficiency of the learning process in the classroom	5
24.	E-modules provide clarity to learning materials	4
	Percentage	91%

The teacher response questionnaire indicated that the designed e-module received a 91% rating, categorizing it as very practical. The findings reveal that educators provided very favorable feedback on the quality of the e-module. Teachers assessed that the e-module has an attractive appearance, materials aligned with learning objectives, is easy to use, and helps students understand the material and improve the effectiveness of the learning process. Thus, the e-module is considered suitable for use as a learning medium in the classroom with improvements based on the feedback provided.

Table 4. Effectiveness test results

Mean			
Pretest	Posttest	Gain	N-gain
76.53	93.50	16.97	0.72

Based on the results of the effectiveness test, the average pretest score was 76.53, and the posttest score was 93.50, resulting in a 16.97-point increase in learning outcomes after students used the e-module in science learning. Furthermore, the N-gain analysis result of 0.72 was categorized as high. These results indicate that the use of the e-module significantly and effectively improved student learning outcomes. This improvement in learning outcomes indicates that the developed e-module helps students better understand scientific concepts. The organized delivery of content, the use of accessible language, and the incorporation of educational media such as photos, videos, and practice questions enhance the engagement and interactivity of the learning experience. To make learning media more effective at helping students become interested in learning, improve understanding, and engage in interactive learning, it is necessary to integrate videos, images, and practice questions (Damopolii, 2025; Damopolii & Kurniadi, 2019; Dita et al., 2024). In addition, the characteristics of e-modules that can be accessed independently allow students to relearn the material at their own pace, so that their understanding of the material becomes more optimal.

The findings of the effectiveness test indicate that the use of e-modules in scientific education enhances student learning outcomes. This is seen by a rise in the average pretest score from 76.53 to 93.50 on the posttest, a difference of 16.97 points. The N-gain score of 0.72 is into the high category, indicating that the e-module is successful in enhancing students' conceptual comprehension. This conclusion is corroborated by the product's quality, which has been assessed as viable by expert validation. The validation percentage for material experts was 86%, and for media/design experts, 87%, both of which fall in the very feasible category. This feasibility indicates that the e-module has met the aspects of content, language, presentation, and learning media design. Good learning resources must have a systematic structure, use clear language, and facilitate students' independent learning (Mustofa et al., 2024; Nurzahra et al., 2025; Ramadani & Anwar, 2025). This is in line with the characteristics of the e-module developed in this research.

The findings of this study align with those of several previous studies, which have shown that the use of digital-based e-modules can improve student learning outcomes. Research by Dita et al. (2024) demonstrated that interactive e-modules can improve conceptual understanding by providing students with opportunities for independent and iterative learning. Similarly, research by Pratiwi et al. (2024), and Setyantoko et al., 2023)

found that e-module-based learning media are effective in improving learning outcomes because they present material systematically, include multimedia, and support independent learning.

User responses also supported the findings of this study. Teacher responses were categorized as excellent at 91%, indicating that the e-module was practical to use, aligned with learning objectives, and contributed to classroom learning efficiency. Meanwhile, student responses in individual trials (86.67%) and small group trials (86.56%) were excellent. This demonstrates that the e-module can increase motivation and interest in learning, as well as support independent learning. Good learning media should increase student engagement and provide meaningful learning experiences (Pratiwi et al., 2026; Wicaksono et al., 2026) while taking into account students' motivation during learning (Nasir et al., 2023). Overall, the results of expert validation, teacher responses, student responses, and effectiveness testing were mutually reinforcing and consistent. Thus, the developed e-module has been proven to be feasible and effective for science learning and relevant to the demands of 21st-century learning, which emphasizes independence, digital literacy, and improved learning outcomes.

The findings in the e-module development research are findings on 1) the language aspect, 2) increasing conceptual understanding, where the e-module product is equipped with learning videos that can help students better understand abstract concepts, 3) accessibility and involvement, where students can access the e-module anywhere and anytime, 5) improving student learning results. The advantages of this e-module are that the table of contents includes automatic hyperlinks to each desired page, assessment hyperlinks to Google Forms, teacher and student reflection hyperlinks to Google Forms, and learning video hyperlinks directly to YouTube. The advantages of this e-module are: (1) it can be accessed via computers, laptops, tablets, and smartphones in the form of applications or in web form; (2) the use of text, images, videos and animations in the e-module is adjusted to student needs; (3) it is equipped with text, images, and learning videos; and (4) it can increase the effectiveness of student learning outcomes in the learning process.

CONCLUSION

This research concludes that the developed e-module aligns with students' needs, meets validity and practicality criteria for teachers and students, and is effective in improving students' science learning outcomes. The results of the needs analysis show that teachers and students need science learning resources that they can use independently and can access flexibly. The average validation score for the material and media experts indicates that the e-module was valid. The results of practicality tests with teachers and students showed that the e-module was practical for learning because it was easy to access and helped with understanding the material. The n-gain calculation showed a high increase in students' science learning outcomes. The e-module offered easy-to-access features, accurate information, and support for independent learning.

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