



Development of E-Modules to Improve the Learning Outcomes of Grade IV Students in Elementary Schools

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Abstract: This research aims to develop a valid, practical, and effective E-Module for mathematics learning for grade IV elementary school as a solution to increase the involvement of students who are less active due to less interesting teaching modules and the use of technology that is not optimal. This research uses a Research and Development (R&D) approach with a 4-D model, which consists of four stages: Define, Design, Develop, and Disseminate. Validation was carried out by four experts, namely experts in instruments, media, materials, and languages. The practicality test was carried out in two stages: trial I with two students and trial II with one educator and 12 students. The results of the study showed that the developed E-Modules had excellent validity, with the validity scores of media, materials, and language reaching 100%, 94%, and 81%, respectively. The practicality of the E-Module is also proven by the test results which show a percentage of 99.5% in trial I and 95.6% in trial II. In addition, students provided an average practicality of 99.1%. The level of effectiveness of the E-Module is reflected in the results of the pretest and posttest, where the average score of students increased from 65 in the pretest to 89.17 in the posttest, with an N-Gain score of 0.67 which indicates a significant increase in learning outcomes. Based on these results, the E-Module in the mathematics subject of grade IV elementary school can be declared valid, practical, and effective to be used in learning.

Keywords: Development; Elementary Schools; E-Modules

Introduction

The main goal of education is to develop the maximum potential of students, both intellectually, emotionally, and socially, so that they can become independent, responsible, and able to contribute positively to society. Education focuses not only on mastering knowledge, but also on building the character and life skills necessary to face global challenges (Erbaş, 2025; Hvalby et al., 2024; Jiabin et al., 2024). This goal is reflected in the National Education System Law No. 20 of 2003, chapter 1 article 1, which prioritizes efforts to create human beings who are intelligent, characterful, and have relevant skills.

The Industrial Revolution 4.0 has transformed various sectors, including education, by integrating digital technologies, IoT, and cyber-physical systems in learning (Fitrianti et al., 2024; Teknowijoyo & Marpelina, 2022; Yanti et al., 2024). Education is now faced with the challenge of adapting to the times and preparing a competent generation in the digital era (Dito & Pujiastuti, 2021; Jomezai et al., 2023; Sarva et al., 2023; Waligóra & Górski, 2025). In this context, educators play the role of facilitators who not only master the teaching materials, but also use technology to create innovative learning experiences (Afriani et al., 2025; Rahim et al., 2019; Skog et al., 2024). Changes in education

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management are urgently needed to accommodate these technological developments.

Education has a strategic role in developing qualified individuals with great potential. In addition to transferring knowledge, education also shapes students' character and critical thinking skills. The educational process provides opportunities for individuals to develop personally, which supports more responsible decision-making (Garrecht et al., 2018; Kazlauskienė et al., 2021; Utama et al., 2024; Wang et al., 2025). Therefore, the government must pay more attention to efforts to improve the quality of human resources and ensure that every student meets international standards.

Education reform has been carried out through the implementation of the Independent Curriculum, which aims to change the perspective in learning. The curriculum places more emphasis on the development of high-level thinking skills (HOTS), including creativity and critical skills, as well as skills relevant to the 21st century (Kemendikbud, 2020; Li et al., 2024; Lubis et al., 2023; Yanti & Thohir, 2024). With this approach, students are expected to be better prepared to face future challenges, replacing traditional learning methods that only prioritize memorization.

An effective learning approach is essential to improve student understanding. Therefore, the development of teaching materials and alternative learning media that can encourage students' creativity and innovation is indispensable. Teaching materials designed with various forms of media, both textbooks and digital resources, aim to create a dynamic learning experience and enrich students' understanding of the subject matter.

One of the alternative teaching materials that is in accordance with the demands of the Independent Curriculum and the Industrial Revolution 4.0 is the E-Module. The E-Module enables self-paced learning by using a variety of multimedia elements such as video, animation, images, and audio to facilitate student understanding (Elistiana et al., 2024; Sintawati & Margunayasa, 2021; Suci Ramanda et al., 2023). In mathematics learning, E-Modules help enrich the teaching and learning process and allow students to learn independently without direct guidance from the teacher (Maghfiroh et al., 2024; Rosyada et al., 2024).

E-modules have advantages in terms of two-way communication that supports distance learning, interactive nature and a more organized structure (Syahri et al., 2024). The use of E-Modules has a positive impact on student learning outcomes and allows educators to be more creative in developing effective teaching materials (Sofiah et al., 2025; Wulandari et al., 2021). In addition, E-modules provide constructive feedback from students, which can encourage educators to be more innovative.

Mathematics learning aims to develop critical and systematic thinking skills in solving problems (Hanan & Alim, 2023; Solikhah et al., 2024; Suryawan et al., 2023). However, mathematics is often considered a difficult and tedious field of study, which has an impact on students' low learning outcomes (Elfina, 2020; Yabashiru et al., 2025; Manalu et al., 2024; Sulistyani et al., 2021). This is reflected in the TIMSS data, which shows Indonesia's low ranking in mathematics learning, with an average score of 397 among 49 countries (Hadi & Novaliyosi, 2019). As a solution, it is necessary to develop interesting and innovative teaching materials, such as E-Modules, to improve student learning outcomes.

Method

This research uses research and development (R&D) methods with the aim of developing effective and efficient E-Module learning media. The study adopts a Four-D model consisting of four stages: definition, design, development, and deployment (Sugiyono, 2018). At the definition stage, an analysis of needs, students, tasks, and concepts is carried out to design media that is in accordance with learning objectives. Furthermore, at the design stage, the E-Module media is designed with the selection of appropriate media and formats, as well as the creation of the initial design. The development phase involves media validation by experts and practicality trials through small and large groups to assess the effectiveness and feasibility of the E-Module. Finally, at the deployment stage, E-Modules that have been validated and proven to be practical and effective are disseminated for use by users. The data analysis techniques used include qualitative and quantitative analysis, by measuring the validity, practicality, and effectiveness of the product using the N-gain formula and assessment criteria based on the percentage of scores.

Validation Test

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

Calculate the percentage of each sub variable with the formula:

$$P(s) = \frac{s}{N} \times 100\% \tag{2}$$

Practicality Test Analysis

$$\bar{x} = \frac{\sum x}{n} \tag{3}$$

Calculate the percentage of each sub variable with the formula:

$$P(s) = \frac{s}{N} \times 100\% \tag{4}$$

Determine the criteria for validity and practicality using the Likert scale. Based on the average score obtained, it can be interpreted with the following criteria:

Table 1. Score Interpretation Criteria

Percentage	Criterion
81 - 100	Very valid/very practical
61 - 80	Valid/practice
41 - 60	Quite valid/quite practical
21 - 40	Invalid/impractical
0 - 20	Very invalid/very impractical

E-Module Effectiveness Test

Analysis of E-Module Effectiveness Data (Pre-test and Post-test). Furthermore, the results of the calculation of the N-gain are interpreted according to the criteria as shown in the table 2.

$$g = \frac{Sf - Si}{100 - Si} \tag{5}$$

Table 2. N-Gain Classification Scale

Criteria (N-Gain)	Classification
(N-gain) ≥ 0.7	High
0.3 ≥ (N-gain) > 0.7	Keep
(N-gain) < 0.3	Low

The level of student learning outcomes is calculated using the following formula:

$$\text{Score} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\% \tag{6}$$

The categories of percentage of student learning outcomes are as follows:

Table 3. Category of Learning Outcome Percentage

Percentage	Criteria
81%-100%	Excellent
61%-80%	Good
41%-60%	Pretty good
21%-40%	Not good
0%-20%	Bad

Result and Discussion

The Process of Developing E-Modules in Mathematics Subjects in Grade IV Elementary School Stages of Definition

The definition stage aims to identify basic problems in mathematics learning that require the development of

E-Module teaching materials. This research includes several steps, namely: 1) Needs analysis, which focuses on classroom learning problems such as dependence on conventional media and educators' limitations in using technology. The results of observations at SD Negeri 19 Lurah Dalam show that learning is still teacher-centered and requires more interesting and interactive media. 2) Student analysis, which is carried out through observation and interviews to understand the characteristics of grade IV students who are less active and less motivated due to the lack of interesting learning media. 3) Task analysis, which aims to determine the ability of students to understand respiratory system material in grade IV mathematics learning based on the Independent curriculum. 4) Concept analysis, which is compiled based on learning outcomes and objectives to improve student learning outcomes.

Design Stage



Figure 1. E-module cover display

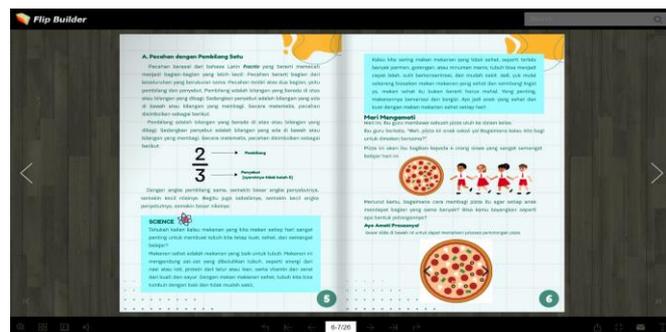


Figure 2. Activity page

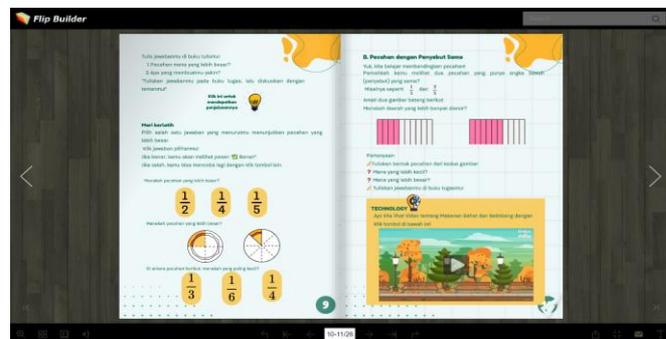


Figure 3. Learning videos

The design stages of the E-Module began with the preparation of test standards to measure students' abilities through pretests and posttests in accordance with the Mathematics Learning Outcomes (CP). The selection of E-Modules is done to select the modules that suit the material, using the Flipbuilder application that supports the integration of text, images, animations, and videos, and can be run on various devices. Furthermore, the selection of material formats is carried out by designing an E-Module containing learning outcomes, objectives, materials, and evaluations. The initial design included creating a flowchart that depicts the overall flow of the program and creating an E-Module using the Flipbuilder and Canva applications to support the design of the grade IV mathematics module for elementary school.

The Validity Level of the Development E-Module in Mathematics Subject Grade IV Elementary School.

*Development Stage
Validity Test*

Based on the recapitulation, the evaluation of the validator's questionnaire showed an excellent level of validity in all three aspects tested. The media validator questionnaire obtained the "Very Valid" category with a percentage rate of 89%. The material validator questionnaire was also categorized as "Very Valid" with a percentage rate of 94%. Meanwhile, the language validator questionnaire received the "Very Valid" category with a percentage level of 81%.

Table 4. Recapitulation of the Media, Material and Language Validity Test

Aspects	Percentage	Category
Media	89%	Highly valid
Material	94%	Highly valid
Language	81%	Highly valid

*The Level of Practicality of Developing E-modules in Mathematics Subjects in Grade IV Elementary School
Trial I*

The first trial phase was carried out by giving E-Modules to 2 students in grade IV of SD Negeri 19 Lurah Dalam. Based on the results of trial I, it shows that the assessment of 2 students for the E-Module is categorized as "Very Practical" with an average of 99.5%

Table 5. Results of Practical Trial I

Category Variable	Percentage	Category
User Convenience	100%	Very practical
Attractiveness of the Display	98%	Very practical
Material Understanding	100%	Very practical
Learning Independence	100%	Very practical
Learning Effectiveness	100%	Very practical
Average Trial	99.5%	Very practical

Trial 2

The second trial was carried out with grade IV educators of SD Negeri 19 Lurah Dalam and 12 students of grade IV elementary school. In the questionnaire the practicality of educators is categorized as "Very Practical" with a percentage level of 95.6%.

Table 6. Results of the Second Student Trial

Criterion Variable	Percentage	Category
User Convenience	100%	Very practical
Attractiveness of the Display	99%	Very practical
Material Understanding	99%	Very practical
Learning Independence	98%	Very practical
Learning Effectiveness	99%	Very practical
Average Trial	99.1%	Very Practical

Based on data from the table of the results of the students' practicality test, the test results were obtained with an average of 99.1%.

*The Level of Effectiveness of E-Modules in Mathematics Subjects in Grade IV Elementary School
Analysis of the Effectiveness of E-modules*

The effectiveness test of the E-Module can be seen from the learning outcomes of students. Learning outcomes are obtained through the results of knowledge tests by conducting pretest and posttest tests in the form of objective questions to determine the success of the E-Module developed in improving student learning outcomes.

Table 7. Recap of N-Gain Test Results

Class	Description	Meeting 1 Pre-Test	Meeting 2 Post-test
	Total	780	1070
	Average	65	89.17
IV	N-Gain		0.670833333
	N-Gain %		67%
	Category	"Medium" $0.3 \geq (0.67) > 0.7$	

Based on the calculation of the gain score from the comparison of the average score of the pretest and posttest class IV, a score of 0.67 was obtained which was included in the "Medium" category ($0.3 \geq 0.67 > 0.7$). This improvement shows that the E-Module is effective in increasing students' knowledge in mathematics subjects, especially fractional and decimal sub-materials. The average learning outcome of students after using the E-Module is 89.17, which is included in the "Very Good" category, so it can be concluded that there has been an increase in student knowledge.

Stages of Disseminate

This stage was carried out the dissemination of HTML links that were distributed to find out the practicality of using the E-Module for educators and the

response of educators for mathematics subjects grade IV elementary school.

Table 8. Recapitulation of Distribution Results

School	Percentage (%)	Category
SD 01 Batang Palupuh	95.3	Very practical
SD 09 Mudik Palupuh	94.3	Very practical
SDN 13 Muraro	94.7	Very practical

Based on the results of the stages of the deployment of the E-Module that was developed, it received positive responses and responses from elementary school teachers who have used it. This E-Module is very useful and easy to use, this E-Module is very interesting because it is equipped with interesting images, animations and learning videos and the arrangement of materials in the E-Module is very logical and systematic.

Conclusion

Based on data analysis, it can be concluded that the development of E-Modules in Mathematics class V through the stages of definition, planning, development, and dissemination has been successful with validation from instrumental, media, material, and language experts who show 100% "Very Valid" results for all aspects. The E-Module obtained a validity score of 89% for the media, 94% for the material, and 81% for the language. The trial showed that the E-Module was rated "Very Practical" with an average of 99.5% in the first trial and 95.6% in the second trial, with a high percentage for ease of use, attractive appearance, material understanding, and learning independence. The effectiveness of the E-Module is reflected in the improvement of student learning outcomes, with an average pretest of 65 and posttest of 89.17, as well as an N-Gain value of 0.67 which shows a significant improvement in learning.

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Author Contributions

Conceptualization, Y. and F.; methodology, F.; software, Y.; validation, M, R, A, A.; formal analysis, Y.; investigation, Y.; resources, Y.; data curation, Y.; writing—original draft preparation, Y.; writing—review and editing, Y, F, J, Z.; visualization, Y.; All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

No conflict interest.

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