MaPan : Jurnal Matematika dan Pembelajaran
p-ISSN: 2354-6883 ; e-ISSN: 2581-172X
Volume 11, No 1, June 2023 (53-71)
DOI: https://doi.org/10.24252/mapan.2023v11n1a14

DEVELOPMENT OF PDF FLIP-BASED E-MODULE FOR MATHEMATICS LEARNING

Alimuddin Tampa[1)], Nasrullah[2)], Khairil Amry[3)]
[1,2,3]The Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar
[1,2,3]Jl. Daeng Tata Raya, Parang Tambung, Makassar, Indonesia
Email: alimuddin@unm.ac.id[1)], nasrullah@unm.ac.id[2)], kamry.4th@gmail.com[3)]

Received April 06, 2023; Revised May 28, 2023; Accepted June 04, 2023

Abstract:
This research of development aims to develop an e-module based on Flip PDF with valid, practical, and effective integer and fraction material. This research conducted in R&D (Research and Development) design with ADDIE's development model which included 5 stages, those are analysis, design, development, implementation, and evaluation. Respondents of the product development trial were grade VII students of SMP Negeri 25 Bulukumba with 64 students. The research instrument was a media assessment sheet by media experts and material experts to measure the validity and then questionnaires for teacher and student responses to measure the practicality of the mathematics e-module. The results showed that the mathematics e-module fulfilled the validity and practical criteria. The product meets the criteria of validity based on the assessment by the material expert with an average score of 3.88 and the assessment by the media expert with an average score of 3.33. The product meets the practicality criteria based on student responses with an average score of response at 3.72, categorized as practical, and teacher responses with an average score of response at 3.7, categorized as very practical. Based on the data criteria above, it can be concluded that the mathematics e-module can be used in learning activities. Further research can be done by developing learning media on specific abilities.

Keywords: Development, E-module, Mathematics

PENGEMBANGAN E-MODULE BERBASIS FLIP PDF UNTUK PEMBELAJARAN MATEMATIKA

Abstrak:
Penelitian pengembangan ini bertujuan untuk mengembangkan e-module berbasis Flip PDF dengan materi bilangan bulat dan pecahan yang valid, praktis, dan efektif. Penelitian ini menggunakan jenis penelitian R&D (Research and Development) dengan model pengembangan ADDIE yang meliputi 5 tahapan yaitu analysis, design, development implementation, dan evaluation. Responsden uji coba produk pengembangan adalah siswa kelas VII SMP Negeri 25 Bulukumba dengan jumlah siswa 21 orang. Instrumen penelitian berupa lembar penilaian media oleh ahli media dan ahli materi untuk mengukur kevalidan dan angket respons guru dan respons siswa untuk mengukur kepraktisan e-module matematika. Hasil penelitian menunjukkan bahwa e-modul matematika memenuhi kriteria valid dan praktis.

Produk memenuhi kriteria kevalidan berdasarkan penilaian oleh ahli materi dengan skor rata-rata 3,88 dan penilaian oleh ahli media dengan skor rata-rata 3,33. Produk memenuhi kriteria kepraktisan berdasarkan respons siswa yang dikategorikan praktis dengan respons rata-rata 3,72 dan respons guru yang dikategorikan sangat praktis dengan respons rata-rata 3,7. Berdasarkan kriteria data di atas, dapat disimpulkan bahwa e-modul matematika dapat digunakan dalam kegiatan pembelajaran. Penelitian selanjutnya dapat dilakukan dengan mengembangkan media pembelajaran pada kemampuan yang spesifik.

Kata Kunci: Pengembangan, E-modul, Matematika

How to Cite: Tampa, A., Nasrullah, & Amry, K. (2023). Development of PDF Flip-Based E-Module for Mathematics Learning. *MaPan : Jurnal Matematika dan Pembelajaran*, *11*(1), 53-71. https://doi.org/10.24252/mapan.2023v11n1a4.

INTRODUCTION

Mathematics is a universal science that underlies the development of modern technology, has a role in various disciplines, and advances human thought (Aisyah, Hawa, Somakin, Purwoko, & Hartono, 2007; Roof & Chimuma, 2022; Sanchal & Sharma, 2017). Therefore, mathematics subjects need to be given to all students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to work together (Broza, Biberman-Shalev, & Chamo, 2023; Depdiknas, 2006; Dulun & Lane, 2023).

One of the mathematics materials in the 2013 curriculum that is taught in junior high school class VII in the odd semester is whole numbers and fractions. In the material on integers and fractions, there is a subject of discussion of number arithmetic operations which consist of addition, subtraction, multiplication, and division operations. Integers and fractions are materials in mathematics that are widely applied in everyday life and are often used in other materials such as algebraic fractions, comparisons, and other mathematical materials. Therefore, students need to master and understand integers and fractions well, including fractional arithmetic operations, so that students have no difficulty applying integer and fractional material in the field of mathematics and everyday life to avoid making mistakes. experienced by students when solving questions related to material arithmetic operations on integers and fractions. One of them is the success of junior high school students in solving math problems and related disciplines.

In achieving learning outcomes, appropriate methods and teaching materials greatly affect the learning completeness of students. However, the teaching methods are less attractive and are the cause of the difficulties students feel in learning mathematics (Sutrisno, 2019). To overcome students' difficulties in learning mathematics, educators must use appropriate methods and teaching materials so that students can master number material. The use of appropriate teaching materials can stimulate active students in participating in the learning process (Sagita, 2016).

One alternative that can be done is to use technology in the learning process, such as computer applications. By utilizing computer applications students can understand material easily, because students will see visuals that are displayed clearly, and students can repeat material that cannot be understood properly independently (Somayasa, Natajaya, & Candiasa, 2013). What's more, students in the 21st century are already computer literate and related to it such as the internet, cellphones, computers, laptops, tablets, and other devices that can be used to communicate with other people. A digital environment like this supports students in the process of learning mathematics.

In addition, learning tools that support the learning process need to be mastered by the teacher, such as the mathematics learning module (Nasrullah, Upu, & Syahrullah, 2017). Mulyasa (2009) and Sutrisno (2008) interpret the module as a form of printed information that is designed sequentially. The module also uses language that is easy to understand, this will help students achieve learning goals. With modules, students can also measure their level of understanding and mastery of the material discussed in each module unit, if they have mastered it, then they can continue to the next level module unit (Prastowo, 2011). In addition to the definitions above, according to Sabri (2010), the module is a complete device consisting of a series of learning activities designed to assist students in achieving learning objectives. However, the teacher's ability to develop teaching materials by utilizing technology is still low (Sahelatua, Vitoria, & Mislinawati, 2018).

Therefore, the use of technology in the development of teaching materials needs to be done. The use of electronic teaching materials in learning is very necessary so that students can understand mathematics subject matter more deeply. Teaching materials in the form of electronic modules (e-modules) provide an advantage over printed books because students are allowed to

repeat subject matter independently according to their needs via a student's smartphone/laptop wherever and whenever.

From this, teaching materials were developed to support learning activities by utilizing smartphones which facilitate the delivery of mathematics material to students. The teaching materials developed are teaching materials that can make students active and not feel bored in learning activities. The teaching material in question is e-module. E-module (electronic module) is an electronic version of a printed module that can be read on a computer and designed with the required software (Wiyoko, Sarwanto, & Rahardjo, 2014).

Mathematics e-module can help students understand the material with visualization in the form of pictures and videos. The e-module is a learning resource that can independently build students' mathematical knowledge. In addition, e-modules are very well used to increase student participation during the learning process. This is because the e-module is a learning tool that contains material, limitations, methods, and ways of evaluating that are arranged regularly and interestingly to achieve the desired competency according to the level of complexity electronically (Maryam, Masykur, & Andriani, 2019).

Several previous studies have also developed e-modules namely Astalini, Darmaji, Kurniawan, and Chen (2021), Aulia and Prahmana (2022), Hadiyanti, Hobri, Prihandoko, Susanto, Murtikusuma, Khasanah, and Maharani (2021), Kurniawan, Astalini, Darmaji, Tanti, and Maryani (2022), Patri and Heswari (2021). However, in this study, the PDF flip software was used. Flip PDF is an application that can be used for the learning process. The advantage of this software is that Interactive Publishing is not only in the form of text but can insert images, videos, music/voice, hyperlinks, and others to make the e-module interactive with users. With this e-module, students can have a variety of learning experiences, and can eliminate student boredom, because the media used is more varied. Thus the e-module using Flip PDF software is very well used to increase students' understanding in the learning process. Based on this description, the researcher intends to develop teaching materials in the form of e-module mathematics on whole numbers and fractions that meet valid and practical criteria so that they can be used as learning resources specifically for class VII junior high school students.

METHODS

The type of research used is research and development or Research and Development (R&D). The product produced in this study is an electronic module (e-module) mathematics based on Flip PDF on valid and practical integers and fractions. The research and development design used is the ADDIE development model. The ADDIE research model has five stages consisting of analysis, design, development, implement, and evaluate (Allen, 2006).

This research was conducted at a junior high school in Bulukumba Regency in the odd semester of the 2022/2023 school year. The subjects in this study were class VII students with one class trial participant selected by random sampling of 21 students.

Data collection techniques used to develop the e-module are interviews and questionnaires (questionnaires). Interviews were conducted before the creation of the Flip PDF-based e-module. Questionnaires (questionnaires) are used to collect information or data in research including e-module validity questionnaires for validation experts and student and teacher input response questionnaires to the e-module.

The instruments used in this study were questionnaires for validation tests consisting of media validation questionnaires, material validation questionnaires, and instrument validation questionnaires. Instruments were given to expert validators to assess the validity of the material, layout and also the readiness of teaching materials in the form of electronic modules (e-modules) for use in schools. Questionnaires for practicality trials consisting of teacher response questionnaires to find out teacher responses and assessments of electronic teaching materials that have been used in research as well as student response questionnaires to determine students' responses and assessments of electronic teaching materials after using them in the teaching and learning process.

The data analysis technique used to process data resulting from the Flip PDF-based e-module development research for mathematics learning, namely the quantitative data analysis technique of the data obtained from the validation questionnaire of media experts and material experts as well as the responses of students and teachers. The analysis was carried out to see the validity and practicality of the e-module.

Table 1. Expert Validation Assessment Score

Score	Choice of Eligibility Answers
4	Very Valid
3	Valid
2	Less Valid
1	Invalid

The total rating score can be found using the following formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (1)$$

Explanation:
$\bar{x}$: average media and material validation scores
x_i : the value of each item
n : the number of items

Converting scores into assessment questions can be seen in table 2 below.

Table 2. Criteria for Validity and Description

Score	Validation Criteria	Description
$3.26 < \bar{x} \leq 4$	Valid	Not revision
$2.51 < \bar{x} \leq 3.26$	Valid Enough	Partial revision
$1.76 \leq \bar{x} < 2.51$	Less Valid	Partial revision and review of material
$1.00 \leq \bar{x} < 1.76$	Invalid	Total revision

Table 3. Practicality Test Score

Score	Eligibility Answer Options
4	Strongly agree
3	Agree
2	Less Agreed
1	Disagree

The instrument used has 4 answers, so the total rating score can be found using the following formula.

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (2)$$

Description:
$\bar{x}$: average practicality score
x_i : the value of each item
n : the number of items

Converting scores into assessment questions can be seen in table 4 below.

Table 4. Criteria for Evaluating Practicality Trials

Quality Score	Description
$3.26 < \bar{x} \leq 4$	Practical
$2.51 < \bar{x} \leq 3.26$	Practical enough
$1.76 \leq \bar{x} < 2.51$	Less practical
$1.00 \leq \bar{x} < 1.76$	Not practical

RESULTS AND DISCUSSION

The results of this Flip PDF-based mathematics e-module development research are as follows:

1. Analysis

At this stage, the researcher conducted interviews with the mathematics teacher and the principal of SMPN 25 Bulukumba which aimed to find out the problems in learning activities. Interviews with math teachers to find out how to teach and interviews with school principals to find out the facilities available at the school.

Based on the results of interviews with the mathematics teacher at SMP 25 Bulukumba, information was obtained that the learning took place only using the Ministry of Education and Culture's mathematics books as learning resources and utilizing blackboards and markers as media for introducing learning material. It is also known that all students have their smartphones. Where students spend more time using smartphones than opening textbooks.

From these interviews, it is necessary to develop teaching materials to support understanding of the material and facilitate the delivery of mathematics material to students using smartphones. The teaching materials developed are teaching materials that can make students active, learn independently, and not feel bored in learning activities.

The teaching material in question is in the form of a mathematics e-module that can be operated via a smartphone and helps students understand the material with visualization in the form of pictures and videos. The e-module is a learning resource that can independently build students' mathematical knowledge.

Based on the description above, an outline is obtained in the analysis stage, namely:

a. Student Needs Analysis

In learning activities, students only take notes on the material in printed books provided with a little explanation from the teacher in class. This happens because in learning many teachers use the lecture method and only use whiteboards and markers as a medium of introduction to learning material. Many of the students still do not understand the subject matter in class and only rely on book notes. Therefore, the researcher concluded that students need learning activities that do not only use the lecture method, teaching materials or learning media are needed that are interesting and can make it easier for students to study material again both in class and outside the classroom. This becomes the rationale for researchers in compiling and developing electronic modules (e-modules).

b. Curriculum Analysis

In the curriculum analysis phase, it is known that the curriculum used is the 2013 curriculum which uses a scientific approach. The general steps of the scientific approach in learning activities include observing, asking, reasoning, processing, and communicating or better known as 5M. In the 2013 curriculum, whole numbers and fractions consist of two basic competencies and six learning objectives.

Table 5. Analysis of Curriculum Material on Integers and Fractions

	Basic competencies
3.1	Explain and determine the sequence of integers (positive and negative) and fractions (ordinary, mixed, decimal, percent)
3.2	Explain and perform arithmetic operations on integers and fractions by utilizing various properties of operations
	Achievement Indicator
3.2.1	State the properties of integer arithmetic operations
3.2.2	Describe the various properties of arithmetic operations involving integers
3.2.3	Determine the result of an integer arithmetic operation by utilizing various properties of the operation
3.2.4	State the properties of arithmetic fraction operations
3.2.5	Explain the various properties of arithmetic operations involving fractional numbers
3.2.6	Determine the results of arithmetic fraction operations by utilizing various properties of operations

2. Design

The design phase is an advanced stage of the analysis phase. The steps taken by the researcher at this stage are:

a. Product Design Drafting

The mathematics e-module is designed based on the components in the module. The sections in the mathematics e-module are covers, preface, descriptions, concept maps, material descriptions, practice questions, formative tests, answer keys, bibliography, and glossary.

b. Preparation of Research Instruments

Research instruments as tools used by researchers to collect research data. The preparation of the instrument begins with the preparation of a grid and is compiled into an instrument which is consulted by the supervisor and then submitted to the instrument validator for validation. If the research instrument is declared valid, then the instrument can be used for data collection.

3. Development

a. Making E-Module

The first step in making this e-module is to make the contents of the module with its design in the Microsoft Word 2010 application in the form of e-module identity, basic competencies, learning objectives, concept maps, learning activities, material descriptions, practice questions, answer keys, bibliography, and glossary.

E-Module cover Concept maps Learning Videos

Figure 1. Design E-Module Initial View

Learning Activities Exercise and Summary Formative Test

Figure 3. Design E-module

b. E-Module Validation

After making the e-module, the validation stage is carried out with competent validators in their field, and revisions are carried out according to the advice of expert validators until the e-module is declared valid and can be tested on students.

Table 6. Results of Mathematical E-module Validation Analysis by Material Experts

No	Aspects	Analysis	Nilai Validator
1	Content eligibility	$\sum_{i=1}^{n} x_i$	46
		n	12
		$\bar{x}$	3.83
		Criteria	Valid
2	Language	$\sum_{i=1}^{n} x_i$	24
		n	6
		$\bar{x}$	4
		Criteria	Valid
3	Presentation	$\sum_{i=1}^{n} x_i$	35
		n	9
		$\bar{x}$	3.888
		Criteria	Valid
4	Overall	$\sum_{i=1}^{n} x_i$	105
		n	27
		$\bar{x}$	3.88
		Criteria	Valid

Based on the recapitulation of the validation results in table 6, the average value of each aspect of the assessment is at an interval of $3.26 < \bar{x} \leq 4$. In general, the conclusion of the assessment of the validator states that which means the criteria are valid. The average value of the total assessment is 3.88, it can be concluded that this value is included in the Valid category of developed math e-modules that can be used with revisions.

Table 7. Results of Analysis of Mathematical E-module Validation by Media Experts

No	Aspects	Analysis	Validator Value
1	Display screen design	$\sum_{i=1}^{n} x_i$	22
		n	7
		$\bar{x}$	3.14
		Criteria	Valid Enough
2	Ease of use	$\sum_{i=1}^{n} x_i$	24
		n	7
		$\bar{x}$	3.42
		Criteria	Valid
3	Consistency	$\sum_{i=1}^{n} x_i$	11
		n	3
		$\bar{x}$	3.66
		Criteria	Valid
4	Benefits	$\sum_{i=1}^{n} x_i$	20
		n	6
		$\bar{x}$	3.33
		Criteria	Valid
5	Graphics	$\sum_{i=1}^{n} x_i$	23
		n	7
		$\bar{x}$	3.285
		Criteria	Valid
6	**Overall**	$\sum_{i=1}^{n} x_i$	100
		n	30
		$\bar{x}$	3.33
		Criteria	Valid

Based on the recapitulation of the validation results in table 8, the average value of each aspect of the assessment is at an interval of $3.26 < \bar{x} \leq 4$. In general, the conclusion of the assessment of the validator states that which means the criteria are valid. The average value of the total assessment is 3.33, it can be concluded that this value is included in the valid category of developed math e-modules that can be used with revisions.

4. Implementation

The math e-module that has been developed and revised is tested in real conditions, namely in class. However, at this stage, the researcher only carried out a limited trial of limited products to see the response from the teacher and students' responses to the mathematics e-module that had been developed. The trial is intended to see the level of practicality of the e-module. This e-module was tested on 21 class VII.1 student and 1 math teacher from SMPN 25 Bulukumba.

During the limited trial implementation, the researcher/developer explained what was contained in the mathematics e-module. This is done by the developer so that students are more enthusiastic when learning the material in the e-module.

At the first meeting, students were directed to install the e-module application on their respective cell phones. Then students are directed to operate the e-module and read the instructions for using the available e-module. After the teacher and students have finished paying attention to the e-module, on the last day of the trial, a questionnaire was given by the developer. This questionnaire aims to see how far the response of teachers and students is to the mathematics e-module that has been developed.

a. Student Response Questionnaire Analysis

The five aspects assessed are in the practical category with an average score of 3.79 for the pleasure aspect, and 3.57 for the curiosity aspect. 3.74 for the liveliness aspect, 3.63 for the attention aspect, and 3.75 for the interest aspect. As for the overall value of the student response questionnaire to this e-module, the average is 3.72 in the range $3.26 < \bar{x} < 4.00$ so that it is included in the practical criteria.

b. Teacher Response Questionnaire Analysis

The two aspects assessed are in the practical category with an average score of 3.8 for the assistance aspect and 3.7 for the convenience aspect respectively. As for the overall score of the student's response questionnaire to

this e-module, the average is 3.70 in the range $3.26 < \bar{x} \leq 4.0$ so that equation that in the practical criteria.

5. Evaluation

Evaluation is a process to see whether the product being developed is successful and in line with initial expectations or not. The evaluation stage is carried out at each of the four previous stages. Evaluation that occurs at each of the four stages is called formative evaluation because its purpose is for revision needs. The formative evaluations carried out included (1) instrument tests by validators, (2) media and material tests, and (3) limited trials by subject teachers and students. After knowing the validity and practicality of the e-module, the evaluation of this development research is that there is a need for further experimental research on e-modules with a larger population to determine the effectiveness of the e-module. Following student learning outcomes.

Table 8. Recapitulation of Student Mathematics Learning Outcomes

Statistics	***Pre-test***	***Post-test***
Sample size	21	21
Mean	24.0428	76.4461
Median	24.4	69.43
Mode	23.4	64.41
Variance	46.886	60.622
Standard deviation	6.82682	6.86442
Maximum score	36.60	86.86
Min score	12.20	48.16
Range	26.60	36.66

Based on data on mathematics learning outcomes in the pretest, it can be seen that the highest score was 36.6 and the lowest score was 12.20 out of 21 students. The average value is 24.0429. This indicates that the score for learning mathematics is still centered on a score of 25.0429. The median is 24.4 which means that about 50% of students have a score of less than 24.4. The mode is 23.4 which means that the highest score obtained by students in the Tryout class is 23.4. Because mode < median < mean, the size of the slope of the distribution is positive. The standard deviation of 6.82782 indicates that the size of the data deviation from the average value is 6.82782. While in the posttest it can be seen that the highest score was 86.86 and the lowest score was 48.16 from 21 students. The average value is 76.4461, this indicates that the

score for learning mathematics is still centered on a score of 76.4461. The median is 69.43 which means that around 50% of students have a score of less than 69.43. The mode is 64.41 which means that the highest score obtained by students in the Test class is 64.41. Because mode < median < mean, the slope of a distribution is positive. The standard deviation of 6.86442 indicates that the size of the deviation of the data from the average value is 6.86442. From the overall pretest and posttest scores obtained by students, if they are categorized into very high, high, medium, low, and very low categories, then the frequency distribution, presentations, and categories of students' mathematics learning outcomes in Flip Pdf Based E-Module learning can be seen in table 9 below.

Table 9. Frequency Distribution of Students' Mathematics Learning Outcomes with Flip PDF-Based E-Module Learning

Score Intervals	**Category**	***Pre-test***		***Post-test***	
		Frequency	Percentage (%)	Frequency	Percentage (%)
90-100	Very high	0	0.00	5	14.29
80-89	High	0	0.00	9	25.71
65-79	Medium	0	0.00	17	47.57
55-64	Low	0	0.00	4	11.43
0-54	Very low	21	100.00	0	0.00
Total		21	100.00	21	100.00

Table 9 above shows that the pretest average score of mathematics learning outcomes before being given treatment using Flip Pdf Based E-Module learning is in the very low category. This means that before the Flip PDF-Based E-Module Learning had a low understanding of integers and fractions. While the average post-test score of students is in the medium category. This means that students' understanding of integer and fraction material after learning Flip Pdf Based E-Module learning increases. The gain recapitulation on students' mathematics learning outcomes is presented in table 10 below.

Table 10. Normalized Gain Classification of Students' Mathematics Learning Outcomes with the Flip PDF-Based E-Module Learning Method

Gain Normalization Coefficient	Classification	Frequency	Percentage (%)
g ≥ 0,7	High	12	57.14
0,3 ≤ g < 0,7	Medium	8	38.10
g < 0,3	Low	1	4.76
Total		21	100.00

Based on table 9 it appears that the increase in students' mathematics learning outcomes after being taught with Flip Pdf Based E-Module learning with an average of 0.7203 is in the high classification. Based on the minimum completeness criteria (KKM) that apply in class VII SMP Negeri 25 Bulukumba, namely 74.9, the level of achievement of classical mathematics learning outcomes with Flip PDF-Based E-Module learning can be achieved. The learning results show that e-module learning based on flip PDF is effective.

Scores of validity, practicality, and learning outcomes show that the e-module is feasible to use in learning mathematics. This is in line with research conducted by Hidayat, Rohaeti, , Ginanjar, and Putri (2022) show that the developed e-module can improve students' mathematical reasoning abilities. E-modules that can be accessed anytime and anywhere help students learn the material (Rahman, Wibawa, & Sumantri, 2022). E-modules will make it easier for teachers to convey material and make it more interesting because it is to technological developments (Delita, Berutu, & Nofrion, 2022). By using e-modules students can learn independently so they can understand concepts better and make the learning process fun (Serevina, Sunaryo, Raihanati, Astra, & Sari, 2018). E-modules can facilitate students to learn more interactively so that planned learning outcomes can be achieved (Rahmawati, Vahlia, Mustika, Yunarti, & Nurhanurawati, 2022).

CONCLUSION

The Flip PDF-based math e-module is categorized as valid and practical with a validity score of 3.88 for material validation and 3.33 for media validation, a practicality score of 3.72 for student responses, and 3.70 for teacher responses in the range of $3{,}26 < \bar{x} \leq 4{,}00$, so that the e-module is valid and practical and feasible to use in learning. Besides that, concerning the KKM, the average learning result is 76.45 so the e-module is said to be effective because the average student score is above the KKM.

The results of the e-module product developed in this study can be viewed online by accessing the link https://bit.ly/emodul-7mtk or can be downloaded and installed on an Android smartphone (apk) via the link https://bit.ly/File-emodul.

REFERENCES

Aisyah, N., Hawa, S., Somakin, Purwoko, & Hartono, Y. (2007). *Pengembangan pembelajaran matematika SD*. Jakarta: Dekdiknas.

Allen, W. C. (2006). Overview and evolution of the ADDIE training system. *Advances in Developing Human Resources*, *8*(4), 430–441. https://doi.org/10.1177/1523422306292942.

Astalini, Darmaji, Kurniawan, D. A., & Chen, D. (2021). Students' perceptions of mathematical physics e-module on multiple integral material. *Journal of Education Technology*, *5*(4), 531–538. https://doi.org/10.23887/jet.v5i4.33600.

Aulia, E. T., & Prahmana, R. C. I. (2022). Developing interactive e-module based on realistic mathematics education approach and mathematical literacy ability. *Jurnal Elemen*, *8*(1), 321–249. https://doi.org/10.29408/jel.v8i1.4569.

Broza, O., Biberman-Shalev, L., & Chamo, N. (2023). "Start from scratch": Integrating computational thinking skills in teacher education program. *Thinking Skills and Creativity*, *48*(101285). https://doi.org/10.1016/j.tsc.2023.101285.

Delita, F., Berutu, N., & Nofrion. (2022). Online learning: The Effects of using e-modules on self-efficacy, motivation, and learning outcomes. *Turkish Online Journal of Distance Education-TOJDE*, *23*(4), 93–107.

Depdiknas. (2006). *Kurikulum tingkat satuan pendidikan (KTSP)*. Jakarta: Depdiknas.

Dulun, O., & Lane, J. F. (2023). Supporting critical thinking skills needed for the international baccalaureate diploma programme: A content analysis of a national and two international education programs in Turkey. *Thinking Skills and Creativity*, *47*(101211). https://doi.org/10.1016/j.tsc.2022.101211.

Hadiyanti, N. F. D., Hobri, Prihandoko, A. C., Susanto, Murtikusuma, R. P., Khasanah, N., & Maharani, P. (2021). Development of mathematics e-

module with stem-collaborative project-based learning to improve mathematical literacy ability of vocational high school students. *Journal of Physics: Conference Series*, *1839*, 1–7. https://doi.org/10.1088/1742-6596/1839/1/012031.

Hidayat, W., Rohaeti, E. E., Ginanjar, A., & Putri, R. I. I. (2022). An epub learning module and students' mathematical reasoning ability: A development study. *Journal on Mathematics Education*, *12*(1), 103–118. https://doi.org/10.22342/jme.v13i1.pp103-118.

Kurniawan, D. A., Astalini, Darmaji, Tanti, & Maryani, S. (2022). Innovative learning: Gender perception of e-module linear equations in mathematics and physics. *Indonesian Journal on Learning and Advanced Education*, *4*(2), 92–106. https://doi.org/10.23917/ijolae.v4i2.16610.

Maryam, Masykur, R., & Andriani, S. (2019). Pengembangan e-modul matematika berbasis open ended pada materi sistem persamaan linear dua variabel kelas VIII. *AKSIOMA: Jurnal Matematika Dan Pendidikan Matematika*, *10*(1), 1–12. https://doi.org/10.26877/aks.v10i1.3059.

Mulyasa, E. (2009). *Menjadi guru profesional*. Bandung: PT Remaja Rosdakarya.

Nasrullah, Upu, H., & Syahrullah. (2017). Model pembelajaran STTP bagi mahasiswa dalam penyusunan modul pembelajaran matematika berbasis exelearning. *Jurnal Matematika Dan Pembelajaran*, *5*(2), 112–120. https://doi.org/10.33477/mp.v5i2.172.

Patri, S. F. D., & Heswari, S. (2021). Development of ethnomathematic-based on mathematics e-module to improve students' logical thinking skills. *AIP Conference Proceedings*. https://doi.org/10.1063/5.0043250.

Prastowo, A. (2011). *Metode penelitian kualitatif dalam perspektif rancangan penelitian*. Yogyakarta: Ar Ruzz Media.

Rahman, A., Wibawa, B., & Sumantri, S. (2022). Develop english electronic module for tourism through analysis of learners and context. *The Asian Institute of Research Education Quarterly Reviews*, *5*(1), 48–57. https://doi.org/10.31014/aior.1993.05.01.417.

Rahmawati, D., Vahlia, I., Mustika, Yunarti, T., & Nurhanurawati. (2022). Validity analysis of development of socrates-based linear algebra e-modules. *Education Quarterly Reviews*, *5*(2), 357–364. https://doi.org/10.31014/aior.1993.05.02.495.

Roof, H., & Chimuma, L. (2022). The relationship among reading, math and

science achievement: exploring the growth trajectories over three time points. *Educational Research: Theory and Practice*, *33*(2), 32–49.

Sabri, A. (2010). *Strategi belajar mengajar micro teaching*. Jakarta: PT Ciputat Press.

Sagita, D. (2016). Peran bahan ajar LKS untuk meningkatkan prestasi belajar matematika. *Seminar Nasional Pendidikan Matematika Ahmad Dahlan*, 37–44. Retrieved from http://seminar.uad.ac.id/index.php/sendikmad/article/view/10.

Sahelatua, L. S., Vitoria, L., & Mislinawati. (2018). Kendala guru memanfaatkan media IT dalam pembelajaran di SDN 1 Pagar Air Aceh Besar. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *3*(2), 131–140.

Sanchal, A., & Sharma, S. (2017). Students attitudes towards learning mathematics: impact of teaching in a sporting context. *Teachers and Curriculum*, *17*(1), 89–99.

Serevina, V., Sunaryo, Raihanati, Astra, I. M., & Sari, I. J. (2018). Development of e-module based on problem-based learning (PBL) on heat and temperature to improve students' science process skills. *TOJET: The Turkish Online Journal of Educational Technology*, *17*(3), 26–36.

Somayasa, W., Natajaya, N., & Candiasa, M. (2013). Pengembangan modul matematika realistik disertai asesmen otentik untuk meningkatkan hasil belajar matematika peserta didik kelas X di SMK Negeri 3 Singaraja. *Jurnal Penelitian Dan Evaluasi Pendidikan Indonesia*, *3*(1). Retrieved from https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ep/article/view/625/410.

Sutrisno, E. (2019). *Pengembangan e-modul matematika interaktif menggunakan visual studio* [UIN Raden Intan Lampung]. Retrieved from http://repository.radenintan.ac.id/7186/.

Sutrisno, J. (2008). *Teknik penyusunan modul*. Jakarta: Direktorat Pembinaan Sekolah Menengah Kejuruan.

Wiyoko, T., Sarwanto, & Rahardjo, D. T. (2014). Pengembangan Media Pembelajaran Fisika Modul Elektronik Animasi Interaktif untuk Kelas XI SMA ditinjau dari Motivasi Belajar Siswa. *Jurnal Pendidikan Fisika*, *2*(2), 16–19. Retrieved from https://jurnal.fkip.uns.ac.id/index.php/pfisika/article/view/4670.