ARITMATIKA
E-ISSN: 2723-1046; P-ISSN: 2723-0627
Volume : 5, Nomor : 1
Juni, 2024

DEVELOPMENT OF INTERACTIVE E-MODULE FOR VOCATIONAL STUDENTS IN LEARNING TRIGONOMETRY

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Abstract
In the current technological era, the utilization of media in learning is needed to support the learning process of students. This research aims to develop interactive e-module in the context of mathematics learning, especially on trigonometric material in right triangles. This research focuses on the involvement of technology to increase student motivation and learning outcomes. This research is a Research and Development (R&D) study or development research with a modified 4D (Define, Design, Develop, and Deseminate) research model into 3D. The research was conducted at SMKN 1 Gedangan in class X even semester. The results showed that the interactive e-module media was very valid as measured by the validity test of material and media experts by 87.5% or the value of Va-3.5, which means that the media is valid for use. The results of the practicality test obtained very practical criteria which amounted to 92.5%. The results of practicality by students obtained a result of 81.97% which means that the media is very practical to use. The results of the effectiveness test were obtained from the pretest and posttest results with a percentage increase of 84.615% and an N-gain value ≥0.7, which means that the media effectiveness level of the interactive e-module is very high. From the post-test results, it can be concluded that the interactive E-module is very effective in improving student learning outcomes through the use of appropriate and innovative technology.

Keywords: E-Module, Trigonometry

PENDAHULUAN

Mathematics is a compulsory subject that must be taught at the secondary level (Kemendikbud, 2014, 2016). Mathematics is one of the sciences that provide human convenience in everyday life (I. Wahyuni et al., 2023). As in buying and selling activities, measuring weight and length, counting activities etc (Handayani, 2023). Mathematics education is a structured effort that aims to direct students to gain a deep understanding, strong knowledge, and skills needed in the subject matter. The role of mathematics in shaping human intelligence is very important, especially in the era of modern society which increasingly appreciates its critical and innovative role in shaping the mindset and unique intelligence of each individual (Hendriana, 2014). Besides that, the purpose of learning mathematics is to empower students to face and solve real-world challenges with skilled analytical and creative abilities. Students' abilities when learning mathematics are also very diverse (Hermiati & Julianti, 2023). Therefore, it is appropriate that for the learning objectives to be achieved, mathematics learning in schools needs to be fully implemented to the maximum.

To achieve learning objectives, teachers must master a variety of skills, including managing the classroom effectively and using creative and unusual teaching methods,

strategies, models, and resources. The ability to choose and apply methods that are by predetermined educational objectives is the key to success in teaching (Maryana et al., 2019). Students find it difficult to understand mathematics, one of which is due to the lack of attractive learning media used (Kristiani et al., 2021). Unattractive learning media can result in the emergence of laziness and boredom in students when the learning activity process takes place, for this reason, media development is needed as stated by Pangestu et al., (2021) in their research where development in learning media greatly supports students in understanding mathematical concepts.

Student motivation in learning is more or less influenced by media utilization. In line with Hartatin et al., (2021) who state that one way to motivate and increase students' interest in learning is by utilizing the use of media. With interactive media, a pleasant learning atmosphere will be created. The use of monotonous learning media such as print media tends to make students unmotivated to learn and find mathematics boring (Septiyani & Apriyanto, 2019). Mathematics learning media must be innovative and packaged attractively according to the times so that students are easy and motivated to learn (R et al., 2019). Innovation is needed and adapted to the current times.

The learning media used today are textbooks which are often considered boring. As a learning medium, books must attract students' motivation to learn, making it easier to understand and master the material (Anita et al., 2021). The media used must also be able to increase students' memory of what is learned. Therefore, teachers must adapt the learning media to the material to be conveyed and the effectiveness of the media (Hartatin et al., 2021).

Learning activities are also inseparable from the influence of the development of science and technology. This was also conveyed by Maryana et al., (2019) in their research that the impact of technological progress is also felt in the field of learning. The 21st-century learning challenge is closely related to the utilization of digital media technology (Sintiya et al., 2021). Teachers must be able to optimize their potential and must also keep up with technological developments to keep up with the times (Sholeh et al., 2021). A teacher must be able to utilize technological advances to achieve educational goals

The development of technology in the digital era must be maximally utilized in learning activities, one of utilize technology in learning is by utilizing digital media as learning media. One of the innovative media that can be used for student learning activities is the electronic module (e-module) (Widiazizah et al., 2022). E-module are electronic books

whose contents are related to material in the form of animation, video, images, and text and can appear on smartphones (Laili et al., 2019; Supriadi, 2015; Syahroni et al., 2016). In line with R et al., (2019) who explained that e-module are a summary of material that is packaged practically and flexibly and can then be accessed on a smartphone, thus supporting the learning process. The existence of e-module students can access anywhere and anytime through their smartphones or computers.

E-module must be more than just a collection of content as found in conventional printed books. E-module should be structured to be more interesting for students. This idea is supported by expert assessments from Hidayat et al. (2017) which encourage the development of creative E-module formats, equipped with animations, videos, and real-world applications to increase attractiveness and understanding.

Other studies have also revealed that e-module provide convenience for students by allowing access to material anytime and anywhere (Alwan, 2018), thus helping to clarify their understanding of abstract concepts (Lestari et al., 2018). E-module are expected to make students easy and motivate students to learn. In learning mathematics, students find it difficult to integrate material with real life (Ratriana et al., 2021). To make learning more meaningful, teachers can introduce various contextual problems that exist around them.

Referring to the results of previous research, this research seeks to create an interactive E-module, presenting interactive animations accompanied by various visual aids such as images and videos(Asyifa & Suwarno, 2024). This effort is expected to generate student enthusiasm and engagement, which in turn is expected to have a positive impact on the achievement of their learning outcomes.

RESEARCH METHOD

This research is a Research and Development (R&D) study or development research. The model used is the modification of 4D (Define, Design, Develop, and Deseminate) into 3D. The product of this research is an interactive e-module on trigonometry material for high school / vocational high school students. This product was developed with the aim of facilitating the learning process of mathematics.

The research was conducted at one of the State Vocational Schools in Malang Regency, namely SMKN 1 Gedangan. This was done because the school had not yet varied mathematics learning media. The research subjects were X Accounting class students at SMK Negeri 1 Gedangan in 2023/2024. The main reason for choosing this class is that students in

the accounting program are often faced with practical applications of mathematics in accounting, such as statistical calculations, trend analysis, and financial projections, all of which require an understanding of trigonometry The selection of this class is based on the material developed in the module, namely trigonometry material contained in class X.

The development stage used is to adopt a modified 4D model (Define. Design, Develop, Disseminate) from Sivasailam Thiagarajan, Dorothy S. Semmel, and Melyn I Semmel but without going through the deseminate stage due to time constraints, so it became a 3D model. The stages used in the 4D model are described as follows (Pangestu et al., 2021).

1) Define

The defining stage is a process of defining problems and collecting data by paying attention to the objectives and materials being developed (Sholeh et al., 2021). There are several activities carried out, namely problem analysis, concept and task analysis, and goal determination.

2) Design

This design is carried out to design the concept of the product to be developed (Pangestu et al., 2021). This stage consists of determining the learning media, determining the format, determining the title and content of the e-module, determining the initial design, and determining the test. At the end of the design stage, a product design will be produced in the form of an interactive e-module on trigonometry material.

3) Development

The development stage is the preparation of e-module based on the design concept that has been done previously. At the development stage, there are validation activities, revisions, product trials, and product effectiveness tests. Validation activities are carried out on material and media expert validators on the feasibility and practicality of the products that have been made (Pangestu et al., 2021). If the product developed is not feasible and practical, it must be revised according to the validator's suggestion. Then it is tested again until it is declared feasible and practical to use. Product trial activities are carried out to test the practicality of a product to students by distributing questionnaires (Sholeh et al., 2021). Two stages were conducted in conducting this trial, namely small group and large group trials. The small group trial involved 5 students and the large group trial involved 13 randomly selected students.

4). *Disseminate*

The dissemination stage is the promotion and distribution of interactive e-module products with the aim that the product can be accepted by users.

The following achievement criteria in the study are shown in Table 1.

Table 1. Research Achievement Indicators

No.	criteria	collection technique	Data analysis technique
1	E-module media validity	The e-module validation process involves a team of experts using a validation tool.	If the average score of each component of the tool by the validators reaches a minimum of 3 (ranked as a good category), then the e-module status can be authorized.
2	Practicality of E-module media	The practicality of the e-module was assessed through student feedback collected through a questionnaire.	If at least 75% of students show positive responses to the developed media, then the e-module is considered practical and easy to use.
3	effectiveness of E-module media	The effectiveness of e-modules is measured by testing pre-test and post-test questions.	If the results of the post-test learning completeness based on school provisions reach the value then the student learning outcomes are said to be complete and the N-Gain results using SPSS IBN, based on the normality gain (N-gain) formula if the score obtained is ga, then the test has high normality

E-module validity measurement is measured based on material and media expert validation. The validation sheet instrument is used to determine the feasibility of e-module using 1-4 Likert scale criteria. Quantitative description analysis was used for data analysis. Then analyzed and arranged according to the various intervals of the truth category, the list below shows the range used to determine the validity category according to the approach proposed by Darwis (Maryana et al., 2019).

Table 2. Validity Category Interval

score acquisition	Description
$3.5 < Va \leq 4.00$	Very Valid
$2.5 < Va \leq 3.5$	Valid
$1.5 < Va \leq 2.5$	Valid Enough
$1.5 \leq Va$	Invalid

Description : Va = Validity

To continue the validity test, a practicality test is needed. The practicality test of a product is obtained from the results of students' positive responses to the media, namely the interactive E-module. The data obtained will be measured based on the level of practicability by utilizing a specially modified formula (Yolanda & Wahyuni, 2020).

$$S = \frac{f}{N} \times 100\%$$

Description :

S = Practicality score

F = Total Score

N = Maximum Score

After the data is measured based on the practicability level formula, the data is then categorized based on the following modified practicability criteria (Mahuda et al., 2021).

Table 3. Practicality criteria

Score Acquisition	Description
$S \leq 20$	Tidak Praktis
$20 < S \leq 40$	Kurang Praktis
$40 < S \leq 60$	Cukup Praktis
$60 < S \leq 80$	Praktis
$S \geq 80$	Sangat Praktis

Description: S = Practicality score

Furthermore, the effectiveness test of a product is obtained by increasing the value of the pre-test class and increasing the fulfillment of the Minimum Completeness Criteria (KKM). If the results of the post-test learning completeness based on school provisions reach a score of ≥70 then the student learning outcomes are said to be complete. In addition, the product effectiveness test was also carried out based on the difference between the results of the pretest and posttest conducted on students. Furthermore, the score results will be carried out a calculation based on the normality gain (N-gain) formula. The following are the criteria for determining the N-gain results (S. Wahyuni et al., 2020).

$$N - gain = \frac{Score\ Postest - Score\ Pretest}{Score\ Maximum - Score\ Pretest}$$

Tabel 4. *N-gain Criteria*

Score Acquisition	Description
$ga \geq 0.7$	Highly effective
$0.3 \leq ga < 0.7$	Effective
$ga < 0.3$	ineffective

Description: ga = *N-gain score*

RESULTS AND DISCUSSION

Define

There are several activities carried out, namely problem analysis, concept and task analysis, and determination of objectives. Information collection was carried out through observation and interviews, to obtain the following results: a) The level of student

participation and enthusiasm in undergoing mathematics learning has not reached its maximum potential, this is because when learning takes place 25% of students do not pay attention to the teacher's explanation. and this has an impact on student learning outcomes which look less than optimal when daily tests are carried out. The learning media applied in classroom learning has also not been varied, the teacher only uses PPT media, and the source material of the package book to explain the material, which the material presented in the package book is too formal and rigid so that students are often bored and less interested in participating in learning.; b) The learning media product developed is an interactive e-module on even semester trigonometry material. The product developed has never been used at SMK Negeri 1 Gedangan; c) The purpose of product development is to increase student interest in learning mathematics so that it can improve student learning outcomes but the media applied must also pay attention to the feasibility of applying the applicable curriculum.

Design

This stage consists of determining the learning media, determining the format, determining the title and content of the e-module, determining the initial design, and determining the test. The learning media developed in the development of interactive e-modules on even semester trigonometry material for class X is the Anyflip platform. The format, title, content, and initial design of the interactive e-module have been adjusted to the material and class. The format, title, content, and initial design of the interactive e-module have been adjusted to the material and class. The test used in the interactive e-module uses contextual description questions. The following is an example of the design part of learning media using E-module shown in Figure 1.

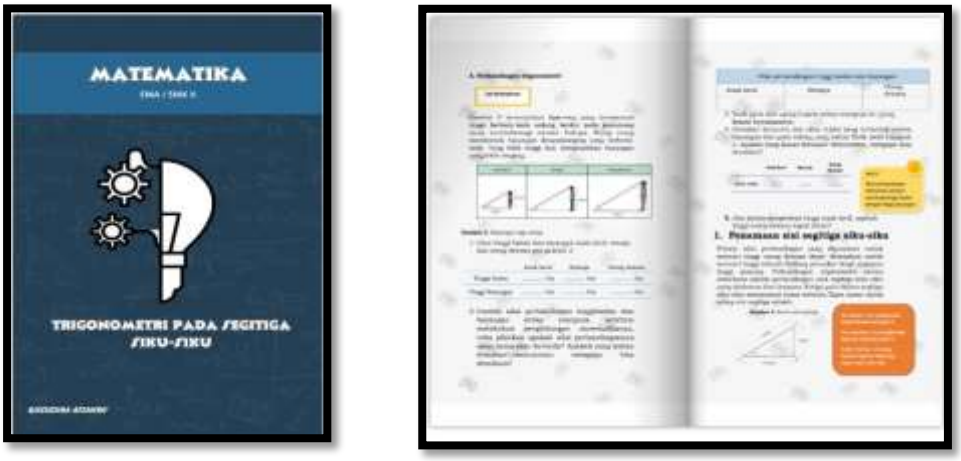

Figure 1. *Design* E-modul

Develop

The development stage is the preparation of e-module based on the design concept that has been done previously. At the development stage, there are validation activities, revisions, product trials, and product effectiveness tests. Field trials were conducted to obtain student response data through questionnaires. The results of careful assessment and examination are used to improve and refine the developed materials until they reach the optimal level of efficiency. The validation results, carefully detailed by the material and media experts, are presented in the table below.

Table 5. media validation results by experts

No	Validation type	Average score	Max score
1	e-module completeness	3	4
2	Content eligibility	3	4
3	linguistic components	4	4
4	graphical component	4	4
Sum		14	16
Presentation %)		87.5	100
Va		3.5	

Based on the information in Table 5, it can be concluded that the average percentage result of validation by experts is 87.5% and the Va value obtained is 3.5 which means feasible but there are minor revisions. This means that the E-module developed by this researcher is feasible or valid.

Data on the results of practicality were taken by giving a practicality sheet for interactive e-module on trigonometry material in right triangles to math teacher. The following interactive e-module practicality results are shown in Table 7.

Table 7. Results of Practicality by Mathematics Teacher

No	Questions	Alternative Answer			
		1	2	3	4
1	The instructions in using the interactive E-module are clear			√	
2	Interactive e-module have an attractive appearance				√
3	The time needed by the teacher in delivering the material is shorter			√	
4	Interactive e-module can make it easier for teacher to help students understand trigonometry material in right triangles.				√
5	Learners can learn independently from interactive E-module			√	
6	The language used in the interactive E-module is simple				√
7	The language used in the interactive E-module is easy to understand.				√
8	Learning using interactive E-module can facilitate teacher in helping				√

	students connect trigonometric material on right triangles related to everyday life.				
9	The presentation of material in the interactive E-module can help students in understanding trigonometric material in right triangles.				√
10	The questions in the interactive E-module can facilitate the teacher in helping students understand trigonometric material in right triangles				√
SUM		37			
PRESENTATION		92.5%			

Based on the results of practicality, it shows a percentage of 92.5%, meaning that this E-module is very practical to use.

During the initial testing stage of the small class, the evaluation of the developed product aims to effectively measure student responses while providing an assessment of the overall product quality. There are 8 indicators of student response questionnaires involved, such as guidance on the use of the E-module, the appearance of the E-module, time efficiency, language in the E-module, clarity of the e-module, and ease of material to understand. The small-scale trial was conducted on 5 SMK class X students from different majors at SMK Negeri 1 Gedangan who were randomly selected, namely 1 student from the catering department, 3 students from the TKR (automotive) department, and 1 student from the Accounting department. The following results are shown in Table 8.

Table 8. small-scale practicality results

number of scores obtained	maximum number of scores	Percentage of student response
164	184	89%

From the pilot study involving 5 SMK students, it was found that the student response rate reached 89%. This indicates that the developed electronic module, which is scheduled to be used by researchers, proved to be effective and very practical to be implemented at the next large-scale trial stage.

Based on the results of the large-scale trial, the average percentage of practicality is shown in Table 9.

Table 9. Big-scale practicality results

number of scores obtained	maximum number of scores	Percentage of student response
341	416	81.97 %

Table 9 shows that the percentage of student practicality results is 81.97%, so it is concluded that the media developed and used in learning is good and very practical and can be carried out at the next stage.

The effectiveness test of the interactive e-module was carried out by giving pre-test and post-test questions. The purpose of doing this test is to find out how effective the interactive E-module is for the student learning process. The effectiveness test was carried out through a learning outcome test on some Xth-grade accounting students totaling 13 out of 25 students in one class. The results of the test are summarized in table 10 below

.

Table 10. Pre-test and Post-test Results of the E-module Effectiveness Test

respondent	*Pre-Test*	*Post-test*	rate of increase
1	0	80	80
2	20	100	80
3	20	100	80
4	20	90	70
5	20	60	40
6	0	80	80
7	0	80	80
8	0	60	60
9	0	80	80
10	20	100	80
11	0	80	80
12	0	80	80
13	20	90	70
Sum	120	1080	
average	9.23	83.07	
Percentage of completeness		84.61%	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NGain	13	-.80	19.25	8.2962	10.19494
Valid N (listwise)	13				

Gambar 2. recapitulation result of *Pre-test-Post-test*

Based on the results of Table 10, it shows that the average student learning outcomes using E-module media are 83 with the number of completeness of 11 students, and 2 students who are not complete. The percentage of completeness obtained from the average score obtained is 83%, so 83% of students have been declared complete and meet the KKM score.

Figure 2 shows that the results of the N-Gain using SPSS IBN obtained a result of 10.194. Based on the normality gain (N-gain) formula, if the score obtained is ≥0.7, then the test has high normality.

Based on this statement, a result is drawn that the E-module media developed is very effective in the learning process. In some learning activities, students seemed more excited and fully engaged with the media. Putting together the results of discussions and findings, it can be concluded that the interactive E-module media for trigonometry material being developed has standards as effective learning materials and is considered very suitable for use.

Disseminate

The dissemination stage is the promotion and distribution of E-module products with the aim that the product can be accepted by users. This stage has not been carried out by researchers due to time constraints.

CONCLUSIONS AND SUGGESTIONS

The development of digital book learning media (E-module) can improve student learning outcomes and learning motivation of class X vocational students in the mathematics subject of trigonometry material on right triangles. The results of the study state that the interactive E-module media is very valid as measured by the validity test of material and media experts of 87.5% or the value of Va-3.5 which means that the media is valid for use. The results of the practicality test obtained very practical criteria which amounted to 92.5%. The results of practicality by students obtained a result of 81.97% which means that the media is very practical to use. The results of the effectiveness test were obtained from the pretest and posttest results with a percentage increase of 84.615% and an N-gain value ≥0.7, which means that the media effectiveness level of the interactive e-module is very high. From the post-test results, it can be concluded that the interactive E-module is very effective in improving student learning outcomes.

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