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Development of Android-Based Mathematics E-Module

Hamzah Upu[1*], Rahmat Syam[2], Marwan[3]
[1] Universitas Negeri Makassar, Indonesia
[*]Email: hamzah.upu@unm.ac.id
[2]Universitas Negeri Makassar, Indonesia
[*]Email: rahmat.syam@unm.ac.id
[3] Mathematics Education Postgraduate Program, Universitas Negeri Makassar, Indonesia
Email: marwan_uin88@yahoo.co.id

Abstract
This study is research and development that aims to describe the process of developing an Android-based mathematics E-Module, to discover the results of developing an Android-based mathematics E-Module that is valid, practical, and effective, and show the specifications of an Android-based mathematics E-Module. The study subjects were students of grade XI TIPH at SMKKN Makassar, with 34 students. This study employed a 4D development model: define, design, develop, and disseminate. Expert validation data was obtained from filling out the questionnaire by the expert, the practicality data was obtained from observation of learning implementation and teacher's response questionnaires, and the effectiveness data were obtained from the student's response questionnaire and learning outcomes test. The data obtained were analyzed and interpreted in terms of validity, practicality, and effectiveness. The expert validators were used to examine whether or not the Android-based mathematics E-Module is feasible. The practicality questionnaire was used to discover the teacher's opinions about the ease of students in using the E-Module. The effectiveness questionnaire is used to determine students' opinions after using the E-Module, and the test learning outcomes to determine the student's ability after learning to use the E-Module. The study results indicate that the mathematics E-Module development process starts from the initial to final analysis stage until the E-Module prototype is produced in the form of an apk file format. The results of the development show that the average Expert Validation Value (NVA) of the E-Module and lesson plans are valid, the results of the implementation of learning and the teacher's response are in the very good category, so the E-Module is stated as practical, the results of students' responses are in positive category, and the average value of the learning outcomes are above the KKM, so the E-Module is stated as effective. The specifications of the E-Module contain Three-Dimensional Mathematics material.

Keywords: *E-Module; Mathematics; Android.*

PENDAHULUAN

The Covid-19 pandemic that hit Indonesia in early March 2020 greatly impacted various aspects of life, especially in education. At first, there were still many teachers who were not familiar with technology in learning. The educational technology industry is growing rapidly and dominates education, so it has become a choice in schools (Williamson, Macgilchrist, & Potter, 2021). Almost all schools use technology in learning during this pandemic.

Learning that takes place requires learning resources that are easily accessible and carried by students. However, books that are characterized by the 2013 Curriculum are still limited. Moreover, mathematics subjects in vocational schools with core competencies and basic competencies have changed (Dirjen Dikdasmen Kemendikbud, 2018). So other learning resources are needed to overcome this problem.

ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

Ramadhani & Fitri (2020) stated that E-Module teaching materials are also called electronic teaching materials because they have integrated ICT into them. Maryam, Masykur, & Andriani (2019) stated that the E-Module contains material, limitations, methods, and ways of evaluation that are arranged in an orderly and attractive manner to achieve the desired competence according to the level of complexity electronically. Utami, Jatmiko, and Suherman (2018) state that E-Modules is one of the determinants of the success of the process of delivering messages from educators to students.

Mathematics with forestry content is a mathematics subject using problems related to forests according to the field of expertise in Forestry Vocational Schools. The material used is three-dimensional, which includes point-to-point distance, point-to-line distance, and point-to-plane distance. Anggriani, Nurhayati, & Subchan (2018), Zahedi (2018), and Suci, Arnellis, & Rosha (2014) revealed the use of mathematics in forestry. In addition, solid geometry is also a problem that often arises in the final national examination, final school examination, and university admission test. Based on data from the Education Assessment Center of the Ministry of Education and Culture (2019), it is known that in the academic year 2018/2019, the percentage of students who answered correctly on geometry material was 43.89%.

Ahmar & Rahman (2017) stated that teaching materials based on Android could be used in the learning process and motivate students to learn. Meanwhile, Jihad, Susilawati, & Sobarningsih (2018) also concluded that android, a mobile learning device, can improve students' and teachers' mathematical understanding.

The results of filling out the Makassar State Forestry Vocational School (SMKKN) questionnaire showed that 97% of Class XI students had android cellphones. This indicates that almost all students have an android cell phone or smartphone that can be used for learning. Meanwhile, the availability of internet access in their area shows that all students have internet network access. So it can be used to send applications or access learning resources on the internet.

It is also known that when students do Fieldwork Practices (PKL) and are given printed teaching materials or learning companion books, their books often get wet or lost in the forest. Sesanti, Marsitin, & Agustina (2018) state that a vocational school curriculum gives students less face-to-face mathematics lessons. Thus effective mathematics learning interactions for students are required to tackle this problem. This interaction can be realized by providing students with mathematics E-Modules that can be installed on their Android phones.

According to the Ministry of Education and Culture (2016), modules are subject matter that is prepared and presented in writing so that readers are expected to absorb the material themselves. E-Modul is a development of the module. E-Modul (Electronic Module) or electronic/digital module follows the usual module structure but is in digital form. Fitri, Netriwati, & Andriani (2021) stated that using e-modules in the learning process creates interactive learning. Some software that can be used to build e-module is Flipbook Maker, Caliber, and Smart Apps Creator (SAC). The developed e-module is in the form of an application package file (apk) format.

Regarding SAC, it is a desktop application to create android and Ios mobile applications without programming code and can generate formal HTML and exe. This application can be saved in the type of Ahl file or apk file that can be run on a laptop or an Android phone. (Latif, Utaminingsih, & Su'ad, 2021).
This study aims to describe the process of developing an Android-based math E-Modul, find out the results of valid, practical, and effective math E-Modul, and show the specifications of an Android-based math E-Modul. The hypothetical model of this research is that the E-Module of mathematics can improve the quality of learning at SMKKN Makassar.

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

METHOD

This type of research is Research and Development or Research and Development (R & D). This research was conducted from September 2021 to February 2022 at the Makassar State Forestry Vocational School. This study applies the research design revealed by Thiagarajan, Semmel, & Semmel (1974), namely the Four-D model design (Define, Design, Develop and Disseminate). The subjects of this study were students of Class XI TIPH SMKKN Makassar in the 2021/2022 academic year, with a total of 34 people.

The procedures of this research were: Define by determining the product developed and its specifications, analyzing needs in the form of literature and potential studies, problems and applicable curriculum related to the E-Module mathematics three-dimensional material; Design by making a design for the product that has been selected at the definition stage in the form of formulating competency achievement indicators and making an E-Module framework that is prepared; Development by manifesting it in the form of a product and repeating product validation to conform to the previously set specifications, making three-dimensional E-Modules, validating E-Modules, conducting limited trials of E-Modules and analyzing practicality and the effectiveness of the E-Modul and corrected existing deficiencies so that it becomes an E-Modul that has met the criteria; and Disseminate by means of products that have been tested are disseminated for the benefit of others or can be written in journals or given directly through the mathematics teacher mainly in SMK who opened the forestry expertise program.
Data collection techniques at the design validation stage were data collected from the results of filling out questionnaires given to experts and input or comments given about the products that have been designed. Then, in the limited trial phase, data on the practicality and effectiveness of the e-module were collected. Data on the practicality of the e-module were from the results of observations of the implementation of learning and the results of the teacher's response questionnaire, while data on the e-module effectiveness were from the student response questionnaire and student learning outcomes. Analysis of the results of the validation of the E-Module mathematics and lesson plans were carried out by interpretation using a predetermined assessment range.

RESULT AND DISCUSSION

Result

1. Description of the Android-Based Mathematics E-Module Development Process

The process of developing this Android-based math E-Module is described using 4D stages as follows:

a. Defining Stage

1) Early-Late Analysis

The existing condition is the occurrence of learning in the network at SMKKN Makassar. When learning from home was carried out during the Covid-19 pandemic, students used Android phones to study. Data on the ownership of a Class XI android cellphone as shown in Graph 1.

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

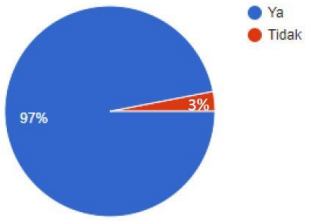

Figure. 1 Android Phones Ownership of Grade XI

Graph 1 shows that 97% have an android phone while only 3% do not. It indicates that almost all students have Android phones that can be used for learning. Next, data on the availability of Class XI internet networks can be seen in Graph 2.

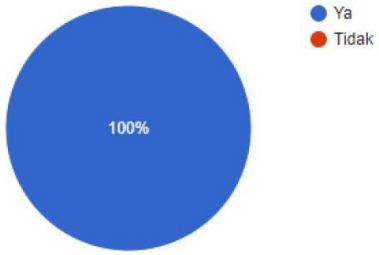

Figure. 2. Internet availability in grade XI

Graph 2 shows that 100% of students have internet network access. This means that all students could access the internet network for sending applications and accessing learning resources on the internet. Thus, the android cellphone could make math E-Modules that students would use.

2) Student Analysis

Based on filling out the questionnaire and discussing it with the mathematics teacher, it is known that: In general, students have an android cellphone and an internet network is available in their area. This is also supported by the internet subsidized by the Ministry of Education and Culture and credit assistance from SMKKN Makassar. In addition, no digital learning resource was available for students on their Android phones, so the materials were still in the form of a pdf shared with WhatsApp groups or Google Classroom.

3) Material Analysis

SMKKN Makassar uses the Revised 2013 Curriculum, where three-dimensional geometry material is taught in class XI Semester 1. Based on Basic Competence, it is known that in the three-dimensional geometry topic, there are three subtopics: the distance between points, the distance from a point to a line, and the distance from a point to a plane.

4) Task Analysis

Task analysis was carried out to determine the suitability of the tasks given in the E-Modul with the learning objectives. The mathematics e-module is organized into three learning activities. Each activity was equipped with a Student Worksheet and an evaluation form to determine the achievement of student competencies.

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

5) Specification of Learning Objectives

The specification of learning objectives was used to determine the learning objectives achieved after studying the E-Module by the learning material.

b. Design Stage

1) Media Selection

Media selection was done by identifying the suitability of the E-Module selection with the selected three-dimensional material. The E-Module was chosen because, based on the preliminary analysis results, it provides information that an android cellphone is available at each student's home and there was an internet network in the area.

2) Format Selection

The format of this E-Module follows the module format in general but is adapted to digital form. Format E-Module mathematics consists of 7 main menus.

3) Initial E-Module

The initial design of the E-Modul was carried out to produce a product prototype in the form of an E-Module apk file format. The steps for the initial design of the E-Module that have been carried out were: creating assets and E-Modules using SAC 3 (Education version). Some examples of assets created are shown in fig. 3.

(a)

(b)

(c)

(d)

(e)

(f)

Figure 3. Examples of E-Module Assets Created (a) Initial Background Assets, (b) Background, (c) Application Logo, (d) Sub Menu Button, (e) Distance of Child to Drone, (f) Initial Display of Learning Videos.

The assets are inputted into the SAC 3 application and name the section with Main Menu, then create new sections for the other 7 main menus. Next, replace the background with the background that has been created. Input the required images and buttons from the created assets folder. The display of the E-Module that has been equipped is shown in Figure 4.

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

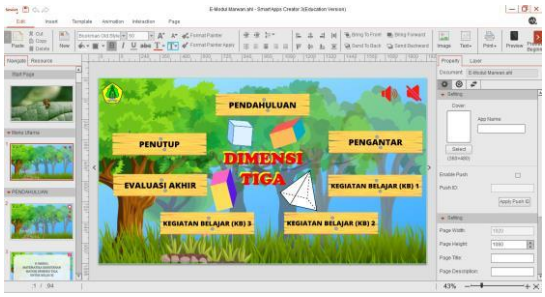

Figure 4. E-Module Display After Complete

After everything is working properly, the last step is to convert it into an apk file so that it can be installed on an Android phone by clicking on the Smart-Output-Android menu.

2. Description of Valid, Practical, and Effective Android-Based Mathematics E-Module

Development Results

a. Development Stage

The development stage was carried out by first validating the instruments used by experts to determine whether or not the instrument was appropriate to use. Validation of E-Module instruments, lesson plans, and implementation of learning, teacher response questionnaires, student response questionnaires, and learning outcomes tests used indicated valid categories and was ready to be used.

The results of the development of valid, practical, and effective Android-based mathematical E-Modules are as follows:

1) Expert Validation

Expert validation was carried out on the development of this mathematical E-Module product. There are two validated products: the three-dimensional geometry E-Modul and the lesson plan. The E-Module and lesson plans have been validated by two lecturers: media experts and material experts. The data on the validity of the E-Module are shown in Table 1.

Table 1. Data Analysis of E-Module Validation Results

No.	Aspek Penilaian	V1	V2
1	Format	18	21
2	Language	15	16
3	Illustration	10	9
4	Content	28	30
Jumlah		71	76
Expert validation result		85	90
Average		88	

Thus, it can be concluded that this three-dimensional mathematical E-Module is included in the "valid" category and is ready to be implemented. The data on the results of the validity of the lesson plan are shown in Table 2.

Table 2. Data Analysis of Lesson Plan Validation Results

No.	Aspek Penilaian	V1	V2
1	Content	11	15

ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

2	Construct	24	23
Jumlah		35	39
Expert validation result		80	88
Average		88	

Thus, it can be concluded that this three-dimensional geometry material lesson plan is included in the "valid" category and is ready to be implemented.

2) Practicality

The practicality data of the E-Module mathematics material in three dimensions consists of an observation sheet on the implementation of learning and teacher response questionnaires. The data from the observation sheet on the implementation of learning are shown in Table 3.

Table 3. Data Analysis of Learning Implementation Observation Sheet Results

No.	Indicators	Average		Average/Indicator	Category
		Yes (1)	No (0)		
1	A. Introduction Part	3.00		100	Very Good
2	B. Main Part	4.83		97	Very Good
3	C. Closing Part	3.33		83	Good
	Average Score			93	Very Good

Based on the practicality criteria that have been set, it can be concluded that the three-dimensional mathematical E-Module material from the aspect of learning implementation is called "Practical." The data from the teacher's responses are shown in Table 4.

Table 4. Data Analysis of Teacher Response Results

No.	Indicators	Average for each choice				Average score/ aspect	Average Percentage	Categories
		VNA	NA	A	VA			
1	Responses to mathematics e-module	0	0	9	32	3.7	93	Very Good
2	Responses to lesson plan	0	0	9	24	3.7	92	Very Good
	Average						92	Very Good

Based on the practicality criteria that have been set, it can be concluded that the E-Module of three-dimensional mathematics material from the teacher's response aspect is called a "Practical" teacher response.

3) Effectiveness

Effectiveness was measured using student response questionnaires and student learning outcomes. Description of student response data to learning using the E-Module three-dimensional mathematics material as shown in Table 5.

Table 5. Analysis of Student Response Questionnaires

No.	Indicators	Average for each choice				Total of Score	NRP Percentage	Categories
		VNA	NA	A	VA			
1	E-module Appearance	3	13	80	108	701	86	Very Positive
2	Materials	2	21	104	77	664	81	Positive
3	Language	12	54	95	43	623	76	Positive

ISBN: 978-623-7496-62-5
Vol, 11 Issue 5

4	Feeling	22	43	104	69	772	81	Positive
5	Questions	1	10	104	89	689	84	Positive
		Average					82	Positive

The test of students' learning outcomes using the E-Module mathematics shows the percentage of competency mastery levels obtained, as shown in Table 6.

Table 6. Description of Competence Mastering

Score Range	Level of Competence Mastering	Frequency	Percentage (%)
85 – 100	Very Competent	3	8.82
70 – 84	Competent	28	82.35
60 – 69	Competent Enough	3	8.82
0 – 59	Not Competent	0	0.00

The percentage of students with a minimum level of competency mastery in the competent category is 91.18%. So that according to the success criteria, if a minimum of 90% of students in the category are at least competent, then the mastery of student competencies has met the classical standard. So it can be concluded that the E-Module three-dimensional mathematics geometry material meets the aspect of effectiveness because it is effective from the aspect of student responses and learning outcomes.

b. Dissemination Stage

The dissemination stage was carried out by distributing the E-Module at the Makassar City Mathematics teacher forum and to fellow mathematics teachers at the Forestry Vocational School. While the implementation is done by sending applications in class XI TKSDH and XI TRRH SMKKN Makassar.

3. Description of the specifications of the Android-based math E-Module

Specifications of Android-based math E-Module as shown in table 7.

Table 7. Specifications of Android-based math E-Module

Application Name	:	E-Module Dimensi Tiga
Description of Application	:	Application of E-Module Dimensi Tiga is a digital forestry mathematics module that contains three-dimensional material. This e-module consists of seven main menus: introduction, introduction, learning activity 1, learning activity 2, learning activity 3, final evaluation, and closing.
Advantage of Application	:	1. Assisting students to understand the materials by using animations 2. Motivate students to study
Year	:	2022
Size	:	71,80 MB
Type of Application	:	Education
Field of Application	:	Mathematics
Level	:	Vocational School
Link of Application	:	bit.ly/emodim3
Developer	:	Marwan

Discussion

Based on the 4D development model, the Android-based math E-Modul development process is at the definition and design stages. The definition stage is carried out by conducting a preliminary-late analysis according to Thrum & Barzel (2021) and Siswanto, Hilda, & Azhar (2019). The analysis of students follows Ahmar & Rahman (2017). Material analysis is in accordance with Rochsun &

Agustin (2020), conveying that students will not be interested in learning if the material being taught is not related to their daily lives. The specification of learning objectives is in accordance with Sofyan, Anggereini, & Saadiah (2019), who states that goals need to be set in making E-Modules. Media selection is in accordance with Siswanto, Hilda, & Azhar (2019). The initial design of the E-Module was chosen by Latif, Utaminingsih, & Su'ad (2021).

The results of the validity analysis are in accordance with Roskaputri, Mardiyana & Fitriana (2021) and Sofyan, Anggereini, & Saadiah (2019). The results of the practicality analysis are in accordance with Aditya (2018) and Siswanto, Hilda, & Azhar (2019). The results of the effectiveness analysis are in accordance with Rohman (2018), who states that the E-Module of the counting rules he developed received a very positive response in a limited trial of 87.5. Of course, this can happen because students get new experiences in learning mathematics. So the students' response given is very positive or positive.

The dissemination phase consists of dissemination and implementation. Both are done so that related parties can take advantage of the products produced. In accordance with the statement by Fitrianna, Priatna, & Dahlan (2021), the link sent to the user must work, know how to use it, and can be absorbed by students and teachers.
The Android-based math E-Modul specification shows a description of the E-Modul being developed. This specification consists of the application name, description, year, size, type, application field, tier, apk address, and developer. The e-Module produced by Rochsun & Agustin (2020) is in the form of a pdf file. But the explanation does not provide product specifications in line with Siswanto, Hilda, & Azhar (2019), who produce products in the form of apk. Although it has included a link to download, it does not include the specifications. Product specifications help users understand whether the application to be installed is in accordance with user needs or not.

CONCLUSIONS AND SUGGESTIONS

After being developed and researched, the following conclusions can be drawn: The process of developing an Android-based mathematical E-Module through two stages, namely the definition stage and the design stage; the validity, practicality, and effectiveness of the Android-based mathematics E-Module through two stages, namely the development stage and the dissemination stage; and the specification of this Android-based math E-Modul called the three-dimensional geometry E-Modul which Marwan developed in vocational mathematics lessons and can be downloaded at bit.ly/emodim3 which contains three-dimensional material with seven main menus, namely introduction, introduction, learning activities 1, learning activity 2, learning activity 3, final and closing evaluation, made in 2022 with a size of 71.80 MB.
It is hoped that further research can develop other mathematics materials or other subjects by linking them to forestry or according to majors in other vocational schools.

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Vol, 11 Issue 5

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Vol, 11 Issue 5

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