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DEVELOPMENT OF ANDROID-BASED MULTIMEDIA E-MODULES FOR JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT
The research carried out is in the form of development to produce an Android-based math multimedia e-module development product. Model Pengembangan yang digunakan dalam penelitian ini yaitu 4D (define, design, develop, dan dessiminate). From the development process, a product resulting from the development of an Android-based math multimedia e-module for junior high schools is valid and very feasible. The results of material validation from 2 material validators were 86% (very feasible) and 92% (very feasible). Meanwhile, from the media validator, the results obtained were 57.33% (fairly feasible) and 86.33% (very feasible). The developed e-module contains correct material and can be easily accessed by students. As for the practicality test results, the average result was 82.57% (very feasible). This shows that the developed e-module meets the very feasible criteria. The presence of this developed e-module has an impact, namely it can be an alternative teaching material to support learning activities by educators in schools.
Keywords: cartesian coordinates; development; e-module.

ABSTRAK
Penelitian yang dilakukan berupa pengembangan dengan tujuan menghasilkan produk pengembangan multimedia e-modul matematika berbasis Android*. Model Pengembangan yang digunakan dalam penelitian ini yaitu 4D (define, design, develop, dan dessiminate). Dari proses pengembangan diperoleh produk hasil pengembangan multimedia e-modul matematika berbasis* Android *untuk SMP yang valid dan sangat layak. Hasil dari validasi materi dari 2 validator materi adalah sebesar 86% (sangat layak) dan 92% (sangat layak). Sedangkan dari validator media diperoleh hasil 57,33% (cukup layak) dan 86,33% (sangat layak). E-modul yang dikembangkan sudah memuat materi yang benar serta dapat dengan mudah diakses oleh peserta didik. Sedangkan untuk hasil uji kepraktisan didapatkan hasil rata-rata 82,57% (sangat layak). Hal ini menunjukkan bahwa e-modul yang dikembangkan sudah memenuhi kriteria sangat layak. Hadirnya e-modul yang dikembangkan ini memiliki dampak yaitu dapat menjadi bahan ajar alternative untuk menunjang kegiatan pembelajaran oleh pendidik di sekolah.*
Kata kunci: *e-modul; koordinat kartesius; pengembangan.*

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Introduction

Information and communication technologies significantly improve and simplify the learning process at different levels of education. Information and communication technologies facilitate flexible scheduling, easier assessments, and increased parental involvement, thereby improving student engagement and learning outcomes (Azis et al., 2024). In addition, ICTs play an important role in regulating the educational process, particularly in higher education, by providing access to diverse digital resources and encouraging effective management of the learning environment (Zhakieva et al., 2024). Overall, the integration of information and communication technologies in education leads to personalized learning experiences, increased motivation, and wider access to educational resources, although challenges such as technology access and teacher training still need to be addressed (Daudova & Katsueva, 2024).

Currently, the use of technology in learning has encouraged innovation in the education system. The integration of mathematics education in the broader context of science and technology is essential for fostering innovative problem-solving skills. Research shows that relevant interventions in the math classroom can improve student motivation and achievement, especially when applied effectively by educators (Gaspard et al., 2021). In addition, the coherence between mathematics and science education significantly contributes to students' analytical problem-solving abilities, highlighting the importance of a well-structured curriculum (Scherer & Beckmann, 2014).

The sustainable framework for STEM education, which emphasizes flexibility and innovation, has shown promising efficiencies in secondary and higher education, demonstrating that resource allocation and curriculum design are critical to improving educator outcomes (Ulmeanu et al., 2021). In addition, a sociocultural perspective on learning opportunities in mathematics underscores the need for equitable access and community involvement in educational practices (Goos, 2014). Overall, this insight suggests a balanced approach to education reform that is in line with rapid advances in science and technology (Li et al., 2020). Therefore, technology must also be utilized to improve the quality of education by implementing learning media.

According to Diantari, et al. (2018), learning media is everything that can channel messages, can stimulate students' thoughts, feelings, and will. The media is an intermediary between educators and students in communication. Without communication media, it will not happen and the learning process as a communication process will also not be able to take place optimally. Effective learning media is essential to optimize educational outcomes in both traditional and digital contexts (Asghar et al., 2023; Doz et al., 2022; Okoye et al., 2021). Therefore, educators are required to use media in the learning process.

According to Tafonao (2018), one of the ways to overcome existing problems is the need for quality education programs, that provide a variety of knowledge, skills, and values, to produce resilient, independent, and responsible human resources in overcoming global challenges. Rahayu (2020) stated that mathematics has a lot of scope. For a long time, students have been faced with difficulties in learning mathematics material, what else is a challenge for educators to present learning for students in the form of virtual classes in mathematics material is quite

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a difficult part. Therefore, there is a need for a solution to present learning in mathematics material to be easier and understood by students.

Based on the results of a survey conducted at SMP Negeri 2 Way Seputih, it was found that problem-solving skills are still lacking learning support facilities are already available and supportive. Supporting facilities in learning such as projectors and occasionally in one month students are told to bring smartphones. However, these facilities have not been used optimally in mathematics learning because there are still limitations to make for educators to use multimedia in mathematics learning. In mathematics learning, educators prefer manual learning without using multimedia compared to using multimedia, while according to (Indriyani, et al., 2021; Sari, et al., 2021) The use of Androids in learning both inside and outside the classroom can motivate students to learn. The use of multimedia can also improve students' critical thinking and collaboration (Saputra, et al., 2023; Osińska, et al. 2022).

Based on the above problems, teaching and learning activities should be supported by a learning process that provides opportunities for students to be more active in learning using Android-based e-modules so that in this research new media will be developed.

Teaching and learning activities should be supported by a mathematics learning process that provides opportunities for students to be able to use their e-module learning media. Through mathematics learning related to Android-based e-modules, participants will be more aware of how important learning and learning mathematics is not only by using books but also by using Android as a learning medium.

Agustina and Vahlia (2016) stated that to support the process, teaching materials that contain daily life problems can be adjusted to the use of mathematical materials. This can make it easier for students to understand as well as be able to learn the teaching materials provided by educators themselves. According to Nopriyanti and Sudira (2015), multimedia refers to the use of multiple forms of media to present information, including text, graphics, animations, images, and videos. With advancements in technology, education and learners can now integrate, combine, and interact with various media in ways that were previously unimaginable.

Learning using modules aims for students to be able to learn independently or with the help of educators as little as possible, the role of educators does not dominate and not individually in the learning process, train the honesty of students, combine the level and speed of students in the implementation of the student learning process, and students can measure the level of mastery of the material in learning by themselves.

In the learning process, students are actively involved and have direct experience, so the modules are packaged with constructive-based learning that provides opportunities for students to contribute their knowledge and grow and develop scientific attitudes. One of the difficulties in carrying out the learning process is that it is not optimal for educators and students because there are no permanent modules. Existing teaching materials have not been developed or printed in a systematic, cooperative, and sustainable manner.

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Research Methods

This research uses Research and Development research, Research and Development aims to create a product or develop a product in a better and more attractive direction. According to Sugiyono (2015). The Development Model used in this study is 4D. This development model is adapted from Kurniawan & Dewi's (2017) development of Instructional Design with a 4D development model, which is an extension of the define, design, develop, and disseminate found by Thiagarajan.

Data Collection Instrument

Data collection instruments used in the research and development of the Mathematics e-module media base Android This is in the form of an expert validation questionnaire and a media validation questionnaire. Validation sheet instrument e-module Mathematics in this development research is used to obtain data from material expert lecturers, media expert lecturers, and educators as evaluation materials e-module mathematics developed. The material and media validation questionnaire grid and student response questionnaire are seen in Table 1-3.

This material test questionnaire is adapted from Pribowo (2018) with a grid that can be seen in Table 1.

Table 1. Material validation questionnaire

No.	Aspects	Indicator
1.	Curriculum	1. Suitability KI/KD
		2. Accuracy of the material
2.	User	3. Suitability of media with student development
		4. Suitability of the way of delivering material with the development of students
3.	Fill	5. Accuracy of the order of presentation of the material
		6. Accuracy of placement of material titles, sub-headings of materials,
		7. Clarity of material content

This media test questionnaire is adapted from Pribowo (2018:1-12) with a grid as can be shown in Table 2.

Table 2. Media validation grid

No.	Aspects	Indicator
1.	Display	1. Accuracy of learning media layout elements
		2. Accuracy in color selection in developed multimedia
		3. Clarity of media formats
2.	Text	4. Correctness of typeface selection
		5. Accuracy of font size selection
		6. Accuracy in color selection in text
3.	Picture	7. Accuracy of image selection
		8. Image quality
4.	Packaging	9. Compatibility of the display with the content
		10. Media quality
5.	Programming	11. User compatibility
		12. Accuracy of instructions for use with media content

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User response aims to find out the user's response to Android-based multimedia e-modules, the assessment is seen from the understanding. Indicators of user response and the use of media development in the form of e-modules are shown in Table 3.

Table 3. Student response questionnaire

No.	Aspects	Indicator
1.	Content and objectives	Completeness
		Purpose
2.	Learning	Providing learning opportunities
		Interest and attention
3.	Aesthetic	Display quality
		Facilities
		Concept Suitability

The data collection process, namely using data from questionnaires, is qualitative data that is quantitatively used on a Likert scale with six levels of response criteria, including "very feasible, feasible, moderately feasible, not feasible, very unfeasible" (Riduwan and Akdon: 2013).

Data Analysis Techniques

The analysis carried out in this study is by grouping the types of data obtained so that researchers can easily understand the data and draw conclusions. The categories of validation results and practicality can be seen in Table 4 and Table 5.

Table 4. Product validity

No.	Average Interval of Expert Assessments	Criteria for Members
1.	80 < score ≤ 100	Very worthy
2.	60 < score ≤ 80	Proper
3.	40 < score ≤ 60	Quite decent
4.	20 < score ≤ 40	Not eligible
5.	0 ≤ score ≤ 20	Very unworthy

Source: (Riduwan and Akdon: 2013)

Table 5. Product practicality criteria

No.	Average Interval of Assessments	Category
1.	80 < score ≤ 100	Very worthy
2.	60 < score ≤ 80	Proper
3.	40 < score ≤ 60	Quite decent
4.	20 < score ≤ 40	Not eligible
5.	0 ≤ score ≤ 20	Very unworthy

Source: (Riduwan and Akdon: 2013)

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Results and Discussion

The research product developed is in the form of mathematics learning media in the form *of* e-modules. The subject matter used is Cartesian coordinates. The final product of the media developed is in the form of *an* e-module with .pptx (PowerPoint) and app (Android application) files. This aims to make it easier for users to access the final product developed. Product testing was carried out at SMP Negeri 2 Way Seputih which is located on the east cross road, Way Seputih, Seputih Banyak. The test subjects were 10 students of class VIII B who were randomly taken. Presentation of Development Results

The define stage is the initial stage in development which is the basis for determining the direction of the research. Based on the results of field observations, several obstacles or problems were obtained, which are as follows: 1) The ability to solve a problem of students is still lacking. 2) Mathematics learning support facilities have not been used objectively in the mathematics learning process. 3) Educators have never used media in learning mathematics on cartesian coordinate material. The design stage is an advanced stage of the definition stage. At this stage, the design is carried out in the form of *an* e-module.

Based on several evaluations that have been mentioned earlier in the initial design of the e-module, a follow-up design was carried out that aimed to improve the design of *the* e-module. The following are some designs before and after evaluation. The initial design can be seen from Figure 1-4.

Before

Figure 1. Initial view

After

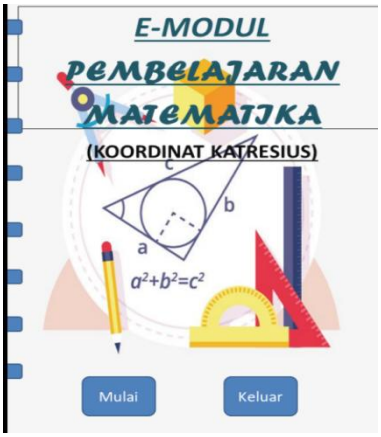

Figure 2. Initial view

Figure 3. Display of material content

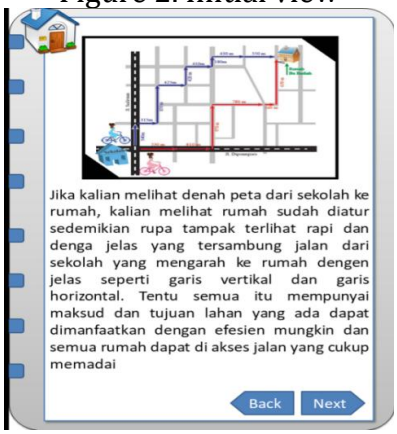

Figure 4. Display of material content

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The development stage is a continuation of the previous stage. At this stage, *the* e-module *media* is designed so that feasibility tests and practicality tests can be carried out. Validation tests and practicality tests, when the product meets the minimum criteria, are quite good in terms of validation and practicality. The resulting initial product can be seen from Figure 7-11.

Display 7. Product initial display

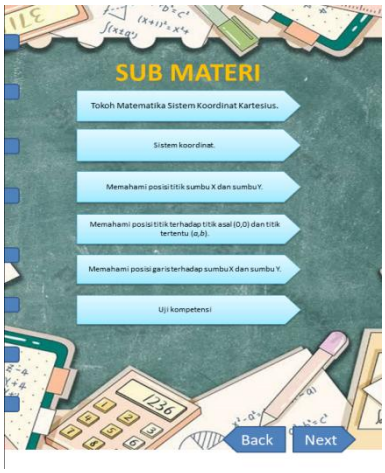

Figure 8. Sub menu display

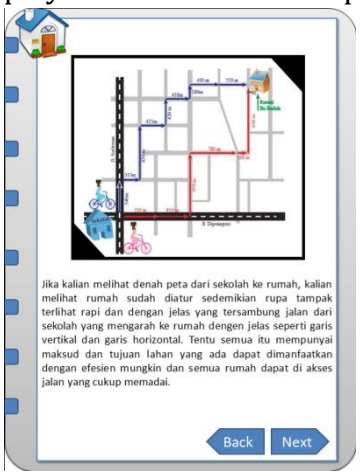

Figure 9. Material display

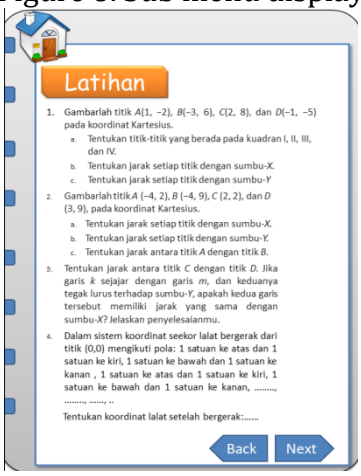

Figure 10. Quiz display

The resulting product is a product based on the results of the evaluation and validation tests that have been carried out. The development validation test is in the form of a media validation test and a material validation test. The validation test that is carried out first is the material validation test. The results of the product material validation test can be seen in Table 6.

Table 6. Data from material validation results

No.	Material Expert	Validator (V)	Yield (%)	Presentation
1	Yeni Rahmawati, M.Pd.	V1	86	Very worthy
2	Suprianto, S.Pd.	V2	92	Very worthy

Based on the results of the material validation test, it can be known that the description of the content of the development product in terms of material can be

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known. The assessment of the material validator shows that the material presented follows the material validation indicators. The material in this product is made based on the basic competencies of compulsory mathematics for grade VII. The completeness and clarity of the content of the material conveyed is very important to support students' understanding of learning a material.

The products developed have been prepared to make it easier for students to learn. Based on the results of material validation, it can be shown that the product developed can be another learning medium or another alternative for students learning. This is shown in the giving of the initial problem to obtain a conclusion from the concept discussed. The results of the analysis of the material validation from the material validator can be seen in the attachment. The results of the validation test indicate that the product developed has met the valid criteria. After meeting the valid criteria, a material validation test was carried out.

The next test is the media validation test. The media validation test can be tested by 2 validators who meet the qualifications of media validators. The results of the validation test of media experts can be seen in Table 7.

Table 7. Media validation data

No.	Media Members	Validator (V)	Yield (%)	Presentation
1	Dr. Dwi Rahmawati.,M.Pd	V1	57,33	Quite decent
2	Arif Hidayat, S.T. M.Kom	V2	86,67	Highly Worthy

Based on the results of the material validation test, it can be known that the description of the content of the development product in terms of media can be known. The assessment from the media validator shows that the media presented follows the media validation indicators, namely the layout display and layout display, teka, images, and animations. The media in this product is made based on the material in this product is made based on the basic competencies of compulsory mathematics for grade VII. The completeness and clarity of the content of the material conveyed is very important to support students' understanding of learning media.

The next test is a product trial. Product trials are carried out to determine the practicality of the product. The product practicality test on May 13, 2023, was carried out on 15 students of SMP Negeri 2 Way Seputih randomly selected. The product practicality test is carried out to find out whether the product developed is ready to be used in learning activities. The data from the practicality test can be found in the following Table 8:

Table 8. Practicality analysis

No	Assessed Aspects	Total Score Valuation
1	Can be *installed* easily	65
2	Attractive media display	59
3	The writing can be read clearly	70
4	Media usage instructions are communicated	64
5	The buttons in the media work well	66
6	The material is presented in sequence	62
7	The material presented in the media is easy to understand	58

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No	Assessed Aspects	Total Score Valuation
8	The language used is easy to understand	65
9	The exercises provided are clear	59
10	The exercises provided follow the material presented	62
11	The layout of each piece is not confusing	62
12	The use of media makes the material easier to understand	60
13	The media used contains more interesting lessons	58
14	The suitability of the image display in the media	60
15	Self-reliance in learning with the help of media	59
Sum		929
Percentage (%)		82.57%
Description of Practicality Criteria		Highly Worthy

Based on the questionnaire, the student's responses include aspects of the feasibility of content, language, design, and interaction of the product that has been outlined with indicators. Based on the table above, a score of 929 was obtained with a percentage of 82.57% which met the "very feasible" interaction with practicality. The "very feasible" interaction means that the response of students using media in the form of multimedia e-modules is very practical. Based on the feasibility aspect, the content shows that products in the form of multimedia e-modules can make it easier for students to understand learning materials associated with Androids. This reality is supported by the results of interviews submitted by students who use multimedia e-modules with materials that are associated with existing materials.

In the linguistic aspect, it shows that the use of words or sentences in the multimedia e-module is easy to understand, the use of words or sentences in the multimedia e-module is simple and easy to understand by students. In practical activities, the use of multimedia products shows that multimedia e-modules can be used to encourage student's enthusiasm for learning. Multimedia e-modules can be used independently in mathematics learning.

The final stage is the spread stage. At this stage, it is distributed on a small scale so that media in the form of multimedia e-modules can be used in the learning and learning process.

The product in research and development is in the form of a multimedia Android-based mathematics e-module on Cartesian coordinate material. Multimedia e-modules emphasize the discussion of learning materials related to Android. Students can understand problems related to mathematics learning by using multimedia e-modules. Multimedia e-modules are designed according to the needs of students in learning mathematics. The use of multimedia e-modules can encourage students' enthusiasm in the mathematics learning process. The results of product development in the form of multimedia e-modules are in line with relevant research that can be concluded that the use of multimedia e-modules can make it easier for students to understand mathematics learning materials and can support the achievement of goals in the learning process. The multimedia e-module development products produced are following technological developments. The existence of adequate facilities and infrastructure supports the use of multimedia e-modules. The use of Android-based mathematics e-module multimedia development in Cartesian coordinate material has several advantages, namely in the

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form of making it easier to understand problems related to Cartesian coordinate material, encouraging enthusiasm in learning mathematics, being able to repeat the discussion of learning materials, the use of *multimedia* e-modules It can be done independently or in groups can encourage students to be more active, the use of words or sentences that are easy for students to understand. This is following the results of research by Winarto, et al. (2023) that Android media can help in solving problems in learning.

Conclusion and Suggestion

Based on the development process, the results of the development of Android-based mathematics e-module multimedia for junior high school were obtained that are valid and very feasible. The results of the validation of the material from the 2 material validators were 86% (very feasible) and 92% (very feasible). Meanwhile, from the media validators, the results were obtained 57.33% (quite feasible) and 86.33% (very feasible). *The* e-modules developed already contain the correct material and can be easily accessed by students. As for the results of the practicality test, an average result of 82.57% (very feasible) was obtained. This shows that the e-module developed has met the criteria for being very feasible. The presence of this *developed* e-module has an impact, namely, it can be an alternative teaching material to support learning activities by educators in schools.

The product development process is carried out with the limitations of the situation and conditions. Therefore, there are several suggestions in terms of utilization and development. In terms of utilization, namely: 1) the use in terms of students is that the e-module can make it easier for students to understand the material of cartesian coordinates; 2) the use in terms of educators is that this e-module can help educators in conveying material of cartesian coordinates so that it becomes easier for students to accept; and 3) the use for schools, e-modules can be the beginning to develop learning at the school. Meanwhile, from the development of the product, the development results still meet the feasible criteria, which means that this product can be used in learning activities, so it is still necessary to conduct an effectiveness test to obtain an effective e-module to be used in learning activities.

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