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The Development of Engineering Drawing E-Module for Vocational School

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INTISARI

Pembelajaran Menggambar Teknik di era pandemi mengharuskan guru mengganti pembelajaran menggunakan E-learning atau melalui media online lainnya. Oleh karena itu, diperlukan modul pembelajaran digital yang dapat membantu siswa belajar secara mandiri. Penelitian ini bertujuan untuk menghasilkan e-modul yang valid, praktis dan efektif. Metode yang digunakan adalah Research and Development (R&D) dengan model pengembangan ADDIE (*Analysis, Design, Development atau Produksi, Implementasi atau Delivery and Evaluation)*. Sampel penelitian ini adalah siswa SMKN 1 Jakarta jurusan Teknik Konstruksi Properti yang mengambil Mata Pelajaran Gambar Teknik Tahun Pelajaran 2020/2021. Hasil penelitian menunjukkan: (1) E-Module Pembelajaran Gambar Teknik, (2) Validitas modul pembelajaran valid pada aspek isi dengan nilai 0,93 > 0,67 dan aspek format yang diperoleh 0,85>0,67, (3) Kepraktisan modul pembelajaran berdasarkan tanggapan guru 94,29% dalam kategori sangat praktis dan berdasarkan 30 tanggapan siswa adalah 76,50% dalam kategori praktis, (4) E-Modul pembelajaran menggambar teknik, secara efektif dapat meningkatkan aspek kognitif siswa dilihat dari hasil belajar siswa dan efektif meningkatkan aspek psikomotorik siswa dilihat dari hasil tugas gambar yang dihasilkan.

Kata Kunci : Modul E-Learning, R&D, Gambar Teknik

ABSTRACT

Engineering Drawing learning in the pandemic era requires teachers to replace learning using E-learning or through other online media. As a result, digital learning modules are needed that can help students learn independently. This research aimed to produce a valid, practical and effective e-module. The method used was a Research and Development (R&D) with the ADDIE development model (Analysis, Design, Development or Production, Implementation or Delivery and Evaluation). The sample of this research was the students majoring in Property Construction Engineering SMKN 1 Jakarta who take Engineering Drawing Subject for the 2020/2021 academic year. The results revealed: (1) Technical Drawing Learning E-Module, (2) The validity of the learning module was valid on the content aspect with a value 0.93 > 0.67 and the format aspect obtained was 0, 85>0.67, (3) The practicality of the learning module, based on the teacher's response, was 94.29% in very practical category and based on 30 student responses was 76.50% in practical category, (4) the E-Module of technical drawing learning, can effectively improve the aspects of the students' cognitive seen from student learning outcomes and effectively improve the aspects of student' psychomotor seen from the results of the resulting picture task.

Keywords: *E-Learning Module, R&D, Engineering Drawing*

INTRODUCTION

Nowadays Indonesia is in the Covid-19 pandemic, so the government has issued a new policy to stop its spread, namely inviting the public to implement Physical Distancing [1]. Learning in SMK (Vocational Schools) aims to be able to produce graduates who are ready to go directly into the business and industrial world who meet the

requirements for the intermediate level. SMK also has a slogan, namely SMK BISA. SMKN 1 Jakarta is one of the secondary schools that produces skilled graduates to go directly to work in accordance with the majors they have. Engineering Drawing is one of the courses for grade X in the odd semester. This lesson consists of theory and practice. Definitely, Engineering Drawing is the oldest subjects of engineering study courses [2]. In the Vocational school, students are expected to master the skills of this lesson because it is the basis of all subsequent lessons.

The first observation done by the researcher at SMKN 1 Jakarta on Engineering Drawing Course was low. This can be seen from the students' scores below the minimum standard of completeness / KKM. It can be concluded that the mastery of Engineering Drawing material is still less than half of the number of students who are under the KKM. Thus, it can be concluded mastery of the material needs to be improved so that the learning outcomes are more optimal.

The pandemic situation requires teachers to use E-learning or other online media in teaching and learning process. Students are lack of motivation, independence, and low creativity in learning during the pandemic [15][16]. Online learning through applications is the wisest thing to stop its spread. Obviously, using technology makes learning more effective since nowadays various information are covered mostly in multimedia platform [3]. Innovation in improving learning outcomes and understanding of the material is developing the Engineering Drawing learning module to be more interesting and interactive to improve the students' learning outcomes during the pandemic. It makes the Engineering Drawing course more conducive and develops students' comprehension quality [4]. Clearly, modules are learning resources created by teachers and can be adapted to the students' needs and can be adapted to school conditions. By using the learning module, students can carry out learning activities independently and increase their creativity. [3] found that using e-module in Engineering Drawing improved students' achievement because the module used varied media and available resources that have been planned, prepared, and developed.

The present study has been supported by some previous studies related to the development of e-module on Engineering Drawing Course. A study conducted by [5] showed that the development of e-module using Sprint Layout application can improve the students' learning quality on Workshop Work and Engineering Drawing course. Then, [6] conducted a study about the development of web-based e-module on Industrial Fashion Manufacturing course. The study showed that using e-module in learning effectively improves students' knowledge viewed from their tasks about home fashion. The two findings above were supported by [7]. He found that using interactive multimedia in Engineering Drawing course can improve students' learning motivation. Therefore, the present study entitiled *The Development of Engineering Drawing E-Module For Grade X At SMK (Vocational School)* is considerably important to be conducted since it can help students build their creativity, improve their skills, knowledge, and learning motivation, and ease them in doing the learning activities independently.

METHOD

This research aimed to develop an Engineering Drawing e-module for Grade X SMK. The research method used in this research was a Research and Development method. The development model used was known as ADDIE (*Analysis, Design, Development, Implementation* and *Evaluation*) proposed by [8][14]. The sample of this research was 30 students of SMKN 1 Jakarta. The Engineering Drawing e-module for SMK was the object of this research.

The developed research consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

a. Analysis

At this stage, there were three analyses conducted: needs analysis, curriculum analysis, and student characteristic analysis.

b. Design

This stage began by designing the module based on the result of the analysis conducted before. Then, any element needed is decided to arrange the module based on the needs. Furthermore, instruments needed for assessing the developed e-module were arranged by considering any aspects of the module: content, language, layout, presentation, and learning activities based on the syllabus.

c. Development

At this stage, the development of the product was done as the realization of the product that has been developed. Then, the data analysis towards the result of e-module assessment was done by validator to get the validity of the module. The aspects can be seen in Table 1 below.

Table 1. The Validity Aspects of Engineering Drawing e-module

No.	Format Aspects	Data Collection Method	Instrument
1	Content	Discussion with interactive learning media experts and lecturers	Validation sheet
2	Language		
3	Media		
No	**Material (Content) Aspects**	**Data Collection Method**	**Instrument**
1	Content quality	Discussion with interactive learning media experts and lecturers	Validation sheet
2	Learning quality		
3	Layout quality		

Source: modified by Ratumas Ayu (2018)

d. Implementation

At this stage, the developed module was used by the teacher in the classroom and the students did the posttest. At this stage, the practicality test was also conducted to know the practicality of the module. The data were collected by distributing the practicality questionnaire to the teachers and the students. It can be seen in Table 2 and Table 3 below.

Table 2. Practicality Questionnaire of E-module by Teachers

No.	Aspects
1	The ease of using e-module
2	Time efficiency
3	Easy to interpret
4	Appropriate with the materials

Source: modified by Daryanto (2016)

Table 3. Practicality Questionnaire of E-module by Students

No.	Aspects
1	The ease of using e-module
2	Time efficiency
3	Media attractiveness
4	Comprehending the materials

Source: modified by Daryanto (2016)

Lastly, the effectiveness test was conducted to know the effectiveness of using the module whether it can improve the student learning outcome. The analysis was done by comparing the results of the student learning outcomes from experiment class and control class. It can be seen in the Table 4 below.

Table 4. Research Design of *Pretest* and *Posttest* Group Design

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O3
Control	O2	-	O4

Information:
X : Learning using e-module
O1 O2 : Pretest
O3 O4 : Posttest

e. Evaluation

At this stage, the researcher evaluated the e-module based on the advice and the result of validation sheet given by the validators.

RESULTS AND DISCUSSION

This research produced an e-module on Engineering Drawing course. The details of the resulting e-module consisted of components. These components consisted of brief material/ theory, equipment, work steps in drawing, job descriptions, completed with pictures and videos. The steps taken to develop the technical drawing e-module are:

1. Analysis Stage

The analysis stage was carried out to get an overview of the conditions in the school and then analyzed related to Engineering Drawing course for grade X at SMKN 1 Jakarta. At this stage, three stages were carried out, namely *observation, curriculum analysis*, and *student characteristics analysis*.

a. Observation

The results of observations conducted at SMKN 1 Jakarta on Engineering Drawing course at grade X. Based on the initial observations of the learning process in the online class by looking at the obstacles that occur during the online learning process, the conclusions obtained from observations and interviews with several students were found that in learning the teacher only explained the existing material. Students did not

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understand the material because it was explained online and the students lack of motivation in studying Engineering Drawing course because online learning was boring for them. As a result, learning becomes less interesting, boring, so students were not able to carry out learning independently at home. This caused student low interest and motivation to learn Engineering Drawing course. It can be proven by the students who submitted the assignments lately. The teacher also said that the students were often late in submitting assignments because they did not understand the material.

b. Curriculum Analysis

Based on the results of the curriculum analysis, it can be seen that the main objectives of the Engineering Drawing learning process are that students are able to understand the types and functions of drawing equipment, apply procedures for using technical drawing equipment, draw types of lines on technical drawings, and draw letters, numbers and etiquette on Engineering Drawing course. This means that after following this learning process, it is expected that the students have competence in Engineering Drawing lessons, namely the competence to understand, apply procedures for using drawing equipment, and draw using equipment in manual drawing.

c. Student Characteristics Analysis

Based on the analysis of students, it was found that generally at this stage, students were able to think abstractly and logically. And students already have the ability to be able to plan something, not only limited to the implementation of an activity. Students will be more motivated to do something if they are maximally involved and able to stimulate their ability to study independently at home.

d. Material Analysis

Engineering Drawing e-module consists of nine materials with different areas and coefficients. It can be seen in Table 5 below.

Table 5. Subjects

No.	Subjects
1	Drawing tools and equipment
2	Types of lines and procedures for drawing letters, numbers, and etiquette on Engineering Drawing
3	Procedure for drawing plane shapes, orthogonal (2D) projections, and pictorial projections (3D)

2. Design Stage

In this study, e-modules were selected which were designed and developed in accordance with the basic competencies in the syllabus.

a. Design of Engineering Drawing Digital Module Position Map Page

Based on the basic competencies contained in the syllabus for the Engineering Drawing course, the next step was to design a digital module position map page that contained learning materials in accordance with the basic competencies contained in the syllabus.

b. Module Content Design

The module content design was carried out. The learning activities consisted of 4 materials that were made according to the basic competence needs in the syllabus. The main materials in each learning activity are:

1) Learning Activities 1

The design of the first learning activity module was the materials regarding the types and functions of equipment in Engineering Drawing, the materials in the first learning activity are:

a) Explain the functions and types of drawing tables
b) Explain the functions and types of drawing pencils
c) Explain the function and type of eraser
d) Explain the function and types of term
e) Explain the function and types of right-angled ruler
f) Explain the functions and types of curved/mall rulers and screen printing
g) Explain the functions and types of rapid

2) Learning Activities 2

The design of the second learning activity module was the materials regarding drawing lines, letters, and numbers using Engineering Drawing equipment. The materials in the second learning activity are:

a) Explain about lines, letters, and numbers
b)Explain how to draw symbols in technical drawings
c) Explain about the picture ticket

3) Learning Activities 3

The design of the three learning activity modules was the materials regarding drawing procedures for drawing plane forms, orthogonal projection images (2D), and pictorial projections (3D). The materials in the three learning activities are:

a) Explain how to divide a line and an angle
b) Explain how to make an angle
c) Explain how to draw a plane (regular polygon)

3. Development Stage

At the product development stage, the realization of digital e-module products for Engineering Drawing lessons was carried out learning procedure with take advantage of the web and the *Google Classroom* application. After that, the Engineering Drawing e-module was validated by experts in their fields, namely lecturers and teachers.

1) Instrument Validation

At this stage, the instrument in the form of a questionnaire was validated first by the expert before being given to the validator. The questionnaire has been improved based on the suggestions from expert validators of Engineering instruments. The following is the validator assessment data based on the contents of the questionnaire in Table 6 below.

Table 6. Validator assessment of the content questionnaire in the Engineering Drawing learning e-module

No.	Indicators	Aiken's V	Description
1.	Content aspect	0.92	Valid
2.	Format aspect	0.83	Valid
3.	Language aspect	0.75	Valid
Total		0.83	Valid

Based on Table 6, it can be seen that in the content aspect the Aiken's V value is 0.92 with the Valid category. Then, in the format aspect the Aiken's V value is 0.83 with the Valid category, and in the language aspect the Aiken's V value is 0.83. 0.75 in the valid category. Thus, the total of the average content validation is 0.83> 0.667. Hence, it can be concluded that the Content Questionnaire in the Engineering Drawing learning E-module is in the "valid" category.

2) Content Validation

At this stage, the e-module had several improvements based on suggestions from the validator. The following is validator assessment data based on Content in Table 7

Table 7. Validator assessment of content in the Technical Drawing learning e-module.

No.	Indicators	Aiken's V	Description
1.	Content aspect	0.88	Valid
2.	Learning aspect	0.88	Valid
3.	Layout aspect	0.85	Valid
Total		0.87	Valid

Based on Table 7, it shows that in the Content aspect, Aiken's V value is 0.88 with the Valid category, in the Aiken's V value learning is 0.88 with Valid and categories on the aspect of the layout the value of Aiken's V is 0.85 in the valid category. Thus, the total of the average content validation is 0.87>0.667. Hence, it can be concluded that the content of the E-module is in the "valid" category.

3) E-Module Format Validation

The stage of validating the E-module format for Engineering Drawing had improvements based on suggestions from the validator. The following is the data validator assessment based on the module format in Table 8.

Table 8 Validator assessment of the format in the Engineering Drawing learning e-module

No.	Indicators	Aiken's V	Description
1	Content aspect	0,90	Valid
2	Language aspect	0,77	Valid
3	Media aspect	0,83	Valid
Total		0,83	Valid

Based on Table 8, it can be seen that in the content aspect the Aiken's V value is 0.90 with the valid category. Then, in the language aspect the Aiken's V value is 0.77 with the valid category and in the media aspect the Aiken's V value is 0.83 with the valid category. Thus, the total of the average of format validation is 0.83 > 0.667. Hence, it can be concluded that the value of the Technical Drawing learning e-module format is in the "valid" category.

Based on the suggestions given by the validator, a revision of the e-module was carried out

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so that the e-module of Engineering Drawing learning was valid and feasible to be tested as teaching material in Engineering Drawing course at SMKN 1 Jakarta.

4. Implementation Stage

Implementation is a real step to implement the developed technical drawing learning e-module. The implementation was limited to a predetermined research location, namely grade X majoring in TKP SMKN 1 Jakarta.

a. Practical Test

This stage aims to get an e-module of Engineering Drawing subjects that is practical for teachers and students.

a) Practical Test Data Based on Teacher Response

Practicality relates to the ease of use of the developed module. Practical data were obtained through a questionnaire filled out by the teacher. The results of the assessment of the practicality of e-learning modules are summarized in Table 9 below.

Table 9. Practical Results Data for Engineering Drawing e-module according to Teacher Responses

No.	Teacher	Achievement Percentage	Category
1.	1	94.29	Very practical
Mean		94.29	Very practical

Based on Table 9, it can be seen that the percentage of expert/teacher assessments is obtained on average 94.29% with very practical category. These results indicated that the developed e-module for Engineering Drawing course made it easier for teachers to help students learn independently and assist teachers in conveying the concept of learning materials.

b) Practical Test Data Based on Student Responses

The practicality of e-module also requires input in the form of responses from students. This data was obtained after learning, through a questionnaire given to students. Based on the results of the questionnaire, it can be seen that the practicality of developing e-modules for Engineering Drawing course was based on student responses through questionnaires with an average percentage 76.50% so that it can be concluded that e-modules learning engineering drawing subjects fall into the "practical category".

b. Effectiveness Test

The results of the effectiveness test were carried out to see the effectiveness of students using the developed e-module.

1) Trial of Question Instruments

a) Question Validity Test

Based on the results, it was known that the analysis of test questions had 30 questions in total tested on 30 students in other classes. Then, the test results obtained from the test questions, 25 questions were declared valid, while 5 questions were declared invalid and declared invalid.

b) Question Reliability Test

Based on the results of the analysis of the questions, the reliability of the test items was 0.9. These results were converted and the reliability of the questions in the very high category was obtained.

c) Level of Problem Difficulty

Based on the results of the calculation of the test questions, it obtained 1 question in the easy category, 24 questions in the medium category and 5 questions in the difficult category.

d) Differential Power Index

Based on the calculation of the discriminatory power of each test item, 1 question was obtained in the very good category, 17 questions in the good category, 9 questions in the sufficient category and 3 questions in the poor category.

2) Student Cognitive Learning Outcomes

Student learning outcomes were known by looking at students' abilities in answering the *pretest* and *posttest* questions. Student learning outcomes in Engineering Drawing course carried out in the experimental class and control class can be seen in Table 10 below.

Table 10. *Gain Score* Test Results

Class	Experiment Class	Control Class
*S*pre	63.600	67.2
*S*post	82.133	75.533
Gain	0.5175	0.254
Description	Moderate	Low

Based on these data, the results of the experimental class *gain* calculation obtained an average *pretest* 63.600 and an average *posttest* 82.133. Thus, the *gain* was 0.5175. This means that the experimental class had an increase in learning outcomes in the medium category because 0.30 <g < 0.69. In the control class, the average of *pretest* was 67.2 and the average of *posttest* was 75,533. Thus, the *gain* was 0.254. This means that the control class also had an increase in learning outcomes, but the increase was in the low category G<0.29. The effectiveness of the learning outcomes of students' cognitive aspects using the Engineering Drawing e-module was higher or better than the learning outcomes of students who did not use the Engineering Drawing module.

3) Student Psychomotor Learning Outcomes

The effectiveness of the Engineering Drawing e-module was assessed from the skills obtained from the student drawings in the experimental class (using the Engineering drawings e-module). Based on the level of achievement of the practical value of students, it obtained an achievement rate 59.93% and converted based on according to [9] in the effective category. It can be concluded that the use of e-module of technical drawing is effective in improving students' soft skills in drawing.

5. Evaluation Stage

At the evaluation stage, the researcher made improvements based on the input results from the validation sheet that had been filled out by the validator. The purpose of the evaluation phase was to refine the module. The data were in the form of input, criticism and suggestions from experts and field tests to be followed up by gradual revisions for the development of better media.

CONCLUSION

Based on the results, it can be concluded that the Development Research resulted a valid, practical, and effective E-Module for Engineering Drawing Course at SMKN 1 Jakarta with the ADDIE development model.

The research on the development of learning module resulted in a validity test that met the content aspect with an average 0.87 categorized as valid, and the format aspect obtained with an average 0.83 categorized as valid. Thus, it can be concluded that the E-Module developed is valid to be used as a learning module in the learning process.

In the practicality test, the media can be used as a whole well. This can be seen from the results of the teacher responses with an average obtained 94.29% in the very practical category and the results of the student responses with an average obtained of 76.50% in the practical category. These results indicated the E-Module developed was included in the practical category used by teachers and students.

The effectiveness test of the developed module was seen from the learning outcomes of the students who use the module better than the learning outcomes of the students who use the old module. The results showed that there were differences in learning outcomes in terms of cognitive and psychomotor aspects and the effective use of the module. Thus, the learning module was valid, practical and effective to improve aspects of students' cognitive and psychomotor

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