



Two-Variables Linear System: A Smartphone-Based-E-Module with a Realistic Mathematic Education Approach

Syariful Fahmi¹, Rafika Yuni Rahmawati² and Soffi Widyanesti Priwantoro³

^{1,2,3}Universitas Ahmad Dahlan

Corresponding Author: syariful.fahmi@pmat.uad.ac.id¹, rafikayunirahmawati@gmail.com², soffiwidyanesti@pmat.uad.ac.id³

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Abstract

An innovative teaching material such as e-module were needed to assist students understanding the concept of mathematics. In this Research is develop an e-module using Realistic Mathematics Education approach in Linear Equation System Two Variables. Research method is using ADDIE model which consist of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The validators of this research were content and media experts, while the research subjects were students of 7th grades in Pleret Bantul Junior High School. The instruments used in data collection were interview and questionnaire. By the calculation results, the e-module was considered feasible by contents and media experts. From the validation of content expert get average of 3.56 with very good criteria, while from the media expert get 3.65 with very good criteria. The e-module was considered practical according to the students' responses. In terms of practicality, average score of small class trial was 3.17 with good criteria, while average score of large class trial was 3.22 with good criteria. So, the average score based on content and media experts also student class trials get 3.40 with very good criteria. Therefore, smartphone-based e-module with realistic mathematics education approach on linear equation system with two variables material was feasible to use.

Abstrak

Penelitian ini bertujuan untuk mengembangkan e-modul dengan berbasis *Realistic Mathematics Education (RME)* pada Sistem Persamaan Linier Dua Variabel. Metode penelitian yang digunakan adalah model *ADDIE* yang terdiri dari lima tahap, yaitu *Analysis, Design, Development, Implementation, dan Evaluation*. Validator penelitian ini yaitu ahli materi dan media serta subjek penelitian adalah peserta didik kelas VIII SMP Negeri 1 Pleret Bantul. Instrumen yang digunakan dalam pengumpulan data penelitian berupa wawancara dan angket. Berdasarkan hasil perhitungan, e-modul termasuk layak oleh ahli materi dan ahli media. Dari validasi ahli materi dan media mendapatkan kategori yang sama yaitu sangat baik dengan nilai rata-rata 3,56 dan 3,65. Berdasarkan uji kepada peserta didik e-modul termasuk praktis dengan kriteria baik pada uji coba kelas kecil dan besar dengan nilai 3,17 dan 3,22. Berdasarkan dari rata-rata gabungan ahli materi dan media serta uji coba peserta didik mencapai rata-rata skor 3,40 dengan kriteria sangat baik. Kesimpulannya e-modul berbasis *smartphone* dengan pendekatan *Realistic Mathematics Education* pada materi sistem persamaan linear dua variabel layak digunakan.

Keywords: e-Module, RME, Linear Equation System with Two Variables

INTRODUCTION

Education is an effort designed deliberately to advance human resources (HR) quality, in line with the development of science and technology in the era of industrial revolution 4.0. Surani (2019) stated that in revolution 4.0 era, technology plays a crucial role, especially the teacher's primary role. Now, teacher's main function is as a facilitator for students by providing learning needs or learning resources for students who are physically near and far.

By the implementation of 2013 curriculum, the teacher has a role as a facilitator, so that it requires students to engage in active learning activities. Therefore, it is essential to have teaching materials or learning resources to motivate and engage students in active learning. Module is a teaching material that helps students in active and independent learning. Modules assist students in learning independently, whether with or without the teacher's assistance, the existence of competency standards can control achievement of student learning outcomes, and students have a greater sense of ownership over the educational process (Setyowati, Parmin & Widiyatmoko, 2013).

An electronic module or e-module is a module that is in line with the development of information and communication technology in an era of industrial revolution 4.0. This is consistent with the minister of Education and Culture's regulation No. 22 of 2016 on the standards for elementary and secondary education procedures, which includes using information and communication technology to enhance the efficiency and efficacy of learning (Solihudin, 2018).

Smartphone is a device that can facilitate students in the learning process. Survey by a research institute in 2018

which is estimated to have more than 100 million active smartphone users in Indonesia (Putra, Sudiana & Pamungkas, 2020). Therefore, smartphones are important among Indonesians, include students. Ease of access in the learning process online and offline should be able to be utilized and make it easier for students.

Mathematics subjects are one of areas of study that plays an essential role in the world of education. This complies with article 37 of Indonesian Law No.20 of 2003 on the National Education system, which says that mathematics is required for primary and secondary school students (Kurino, 2020). The two-variable linear system is one of the terms that students learn in junior high school mathematics classes.

A two-variable linear system is one of the materials used to solve problems based on current circumstances or challenges that arise in everyday life (Achir, et al., 2017). The linear system equation is worth studying because it has practical applications, one of which is estimating the price of an item based on the total quantity already known (Kurniawati & Sutirna, 2019). Students, on the other hand, struggle to grasp the material concept of the two-variables linear system. The two-variables linear system has a low mastery rate and is one of the materials that students find difficult to comprehend (Bey & Asriani, 2013).

According to Aisy (2020) to understand concepts in mathematics using e-modules can be easier and Aprianika (2021) e-modules can be filled with contents using animation, video, and audio. Meanwhile linear system equation needs explanation to change the daily problems to mathematics model. Then, lisarani (2021) said that the animation which can be inserted in e-modul can give concrete experience to abstract and Adi (2020) animation media can explain given information to verbal form.

Based on the interview results on Monday, October 19, 2020, with Mrs. Kis-yanti, S.Pd. as the mathematics teacher of class VIII at SMP Negeri 1 Pleret Bantul, it was found that the teaching materials used by students were government text-books, such as the 2016 revised edition student book, Student Worksheets (LKS), or teaching materials compiled by the teacher presented using PowerPoint. Smartphone-based math e-module was not used. Students continue to struggle with the concept of the two-variables linear system, which includes a lack of knowledge of how to translate story problems into mathematical form as well as the concept of conformity in variables employed for example.

Realistic Mathematics Education (RME) is an approach related to everyday life. Realistic Mathematics Education (RME) approach is used in student-oriented learning and uses the starting point of actual experiences in everyday life (Hamdani, 2011). As a result, the Realistic Mathematics Education (RME) approach immerses students in the actual world and encourages them to consider how to solve a problem they have encountered. This is in keeping with the two-variables linear system curriculum, which is geared at everyday life and requires a practical approach to grasp the concept. Thus, employing a realistic Mathematics Education (RME) approach can aid in instilling or improving students' capacity to comprehend mathematical concepts, particularly those associated with the two-variables linear system.

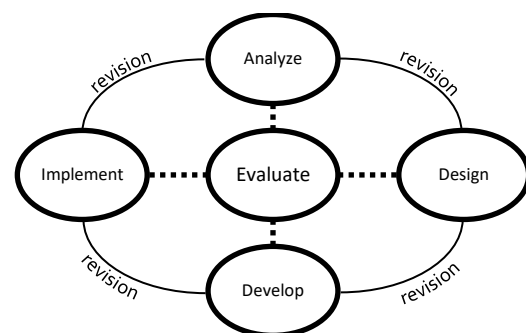
Researchers also conducted interviews with several students, and they found that many still don't understand the notion of a two-variables linear system, particularly when it comes to understanding story problems. Moreover, the students were allowed to bring smart phones to school but were prohibited from using

them during the learning process if there was no agreement with the teachers. In addition, based on the researcher's observation, a smartphone-based e-module for linear equation system with two variables using *Realistic Mathematics Education* (RME) approach was not used.

A lot of software can be used to create e-module, such as Sigil. Sigil produces an output in the EPub (Electronic Publication) format, a digital format introduced by the International Digital Publishing Forum (IDPF) (Maharani, Alqodri & Cahya, 2015). E-module that was created using sigil can be developed in such a way as to make students interested and use smartphones to learn anytime and anywhere.

METHOD

Research and development methodologies were employed in this study. The research and development method are a research approach used to develop a product and test its effectiveness (Sugiyono, 2010).



(Source: Robert Maribe Branch, 2009)

Figure 1. ADDIE Development Model Stages

ADDIE model consists of five stages, namely: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. ADDIE model was used in the development. Analyse, Design, Development or Production, Implementation or Delivery, and Evaluation are the acronyms for the ADDIE model. ADDIE is a model

for learning design that is both methodical and easy (Pribadi, 2014).

Analysis stage was carried out to determine the means of e-module users starting from needs analysis, whether e-module is needed or not, a situation analysis during the learning process and technology analysis. The design stage was carried out through activities to design the e-module to be developed. Development stage was carried out through the realization of e-module design to produce a product, namely e-module. Implementation stage was carried out through trials in the learning process to students, namely small class, and large class trials. However, material and media experts must first evaluate the e-module. The final stage involves a review based on responses to questionnaires sent to materials and media experts, also the students.

The research subjects were two material experts, two media experts, and 30 eighth-grade students from SMP Negeri 1 Pleret Bantul. The trial is repeated twice in the classroom: once with a small class of five students and once with a big class of thirty students. Interviews and questionnaires were used to obtain data. The qualitative data collected from material experts, media experts, and student replies via surveys are transformed to quantitative data using a modified Likert scale with the alternative responses Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS).

The criteria for the e-module are determined by averaging the scores of all respondents who completed the questionnaire; the average score is calculated using this formula:

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

Description: \bar{x} = average score; $\sum x$ = total score;
 n = total respondents.

(Source: Yupinus, Ichsan & Ardiawan, 2020)

After calculation of the average score is obtained, the score is then converted into assessment criteria in four scales in the Table 1.

Table 1. Feasibility Criteria for Validator Assessment

Score Range	Criteria
$\bar{x} \geq M_i + 1,5 SB_i$	Very Good
$M_i + 1,5 SB_i > \bar{x} \geq M_i$	Good
$M_i > \bar{x} \geq M_i - 1,5 SB_i$	Deficient
$\bar{x} < M_i - 1,5 SB_i$	Poor

(Source: Mardapi, 2012)

Description: \bar{x} = average score; $M_i = \frac{1}{2}$ (Ideal maximum score + ideal minimum score); $SB_i = \frac{1}{6}$ (Ideal maximum score – ideal minimum score); M_i = ideal average; SB_i = ideal standard deviation

The validity and practicality of the product can be determined using the data analysis results. If the overall assessment of material experts, media experts, and the student's response to the e-module in the criteria is minimally good, then e-modules are claimed to be valid and practical to use as teaching materials in learning.

Research Limitations

Researchers in developing this e-module has the following limitations: (1) The trial product was only conducted at SMP N 1 Pleret Bantul; (2) E-module can be operated if a supporting application is installed.

RESULT AND DISCUSSION

Result

The product outcomes include smart phone-based e-module that take a realistic mathematics education approach to the material two-variable linear systems. E-module was developed in several stages, as follows:

Analysis

At this stage, needs analysis recognizes that government books, student's worksheet, and PowerPoints are employed as instructional resources in learning. Often, learning takes place through teachers and question-and-answer sessions. Furthermore, there is no e-module capable of being used with a smartphone.

Material analysis, at this stage, it is well understood that the material two-variables linear system is difficult for students to grasp. Students struggle with difficulties relevant to their daily lives, such as modelling mathematics from story problems.

In situation analysis, at this stage, it can be determined that the students were allowed to bring smartphones and use them during learning process if there is an agreement with the teachers. However, the students have not been optimal in using smartphones in the learning process.

In technological analysis, the researcher chose to use sigil application in developing an e-module.

e-module, it used a realistic mathematics education approach at the starting point of each sub-chapter with problems in daily life, interactivity, and use of advanced mathematics for students. The validation process is then carried out by material and media experts.

The following shows the front and back covers and other features such as videos and interactive competency tests.

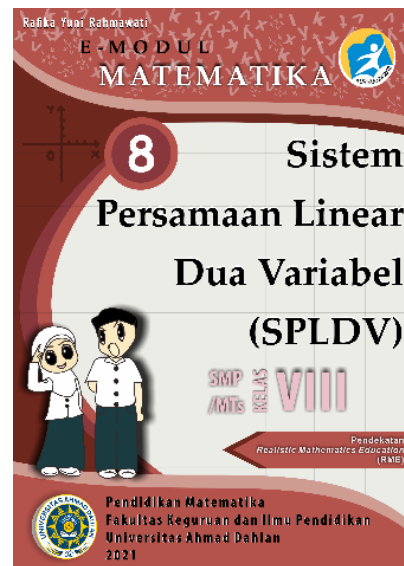


Figure 2. Front Cover

Design

The design stage was carried out by determining the structure of the elements to be included in e-module frameworks, such as cover, title page, introduction, preface, table of contents, instructions for using e-modules, concept map, basic competencies, and indicators of competency achievement, motivation, material, sample questions, exercises, summary, competency test, answer keys, self-assessment, glossary.

Development

At the development stage, product design was realized. The product was produced using Microsoft Word, Sigil, Corel Draw, and Filmora for making videos. Related to



Figure 3. Introduction and Motivation Page



Figure 3. First and Second Author Biography

A Metode Grafik

Mari Amati!



Keliling sebuah kolam ikan berbentuk persegi panjang adalah 28 m, sedangkan panjangnya 6 m lebih panjang dari lebarnya.

Sumber: www.instagram.com

Mari Menalar!

Berdasarkan informasi di atas, tentukan panjang dan lebar kolam ikan tersebut!

Adakah dari kalian dalam menentukan panjang dan lebar kolam ikan menggunakan cara seperti ini?

Figure 4. Materials Page

contoh

1. Tentukan penyelesaian sistem persamaan $\begin{cases} 2x + y = 4 \\ 2x + y = 7 \end{cases}$ secara grafik!

Penyelesaian:

Menentukan titik potong terhadap sumbu x dan sumbu y.

2x + y = 4		
x	y	(x,y)
0	4	(0,4)
2	0	(2,0)

--- Memotong sumbu Y ---

2x + y = 7		
x	y	(x,y)
0	7	(0,7)
3.5	0	(3.5,0)

--- Memotong sumbu X ---

Figure 5. Problems Example

Mari Berlatih!

Latihan 2.1

Soal 1

Keliling sebuah taman berbentuk persegi panjang adalah 460 m. Selisih panjang dan lebar taman adalah 70 m. Tentukan panjang dan lebar taman tersebut menggunakan metode grafik!

Soal 2

Tentukan penyelesaian dari sistem persamaan linear $y = -2x + 1$ dan $y = -x + 2$ menggunakan metode grafik!

Figure 6. Exercises

Simak video berikut!



Figure 7. Video Display

Uji Kompetensi

Setelah kalian mempelajari materi di atas, cobalah soal – soal latihan di bawah ini. Kerjakan soal-soal berikut dengan memilih jawaban yang paling tepat!

A. Pilihan Ganda

Soal 1

Jika r dan s merupakan anggota bilangan asli, maka himpunan penyelesaian dari $r + 2s = 6$ adalah ...

A. $\{(0,3), (2,2), (4,1), (6,0)\}$

B. $\{(0,3), (2,2), (4,1), (6,0), (10,-2)\}$

C. $\{(2,2), (4,1), (10,-2)\}$

D. $\{(2,2), (4,1)\}$

Figure 8. Interactive Competency Test

Implementation

E-module that has been developed and validated by material experts and media experts was then tested twice in class VIII D of SMP Negeri 1 Pleret Bantul, small class trial by five students and large class trial by 30 students. The trials were carried out online via WhatsApp group. Small class trial was carried out on April 5, 2021, and large class trial was carried out from 8 to 10 April 2021. Small class and large class trials were carried out by sending e-module to the WhatsApp group, then the researcher observed and gave a competency test. Lastly, the students filled out the questionnaire.

Evaluation

In the ADDIE development paradigm, the evaluation stage is the final step. This stage is used to assess the quality of e-modules created by researchers. The following are the results of e-module quality.

Validity Analysis

An E-module that meets valid qualifications in terms of material is suitable for use in the learning process if it shows minimally good criteria. The following are the results of e-module validation data analysis by material experts.

Table 2. Calculation Results of Feasibility Questionnaire of Material Experts by Aspect

Aspect	Average Score	Criteria
Content Feasibility	3.56	Very Good
Language Feasibility	3.56	Very Good
Presentation Feasibility	3.79	Very Good
RME	3.00	Good

Table 3. Overall Calculation Results of Feasibility Questionnaire of Material Experts

Material Experts	Average	Criteria
Resource Person 1	3.41	Very Good
Resource Person 2	3.70	Very Good
Overall Average Score	3.56	Very Good

According to tables 2 and 3, the material received an average score of 3,56 in both first and second material experts' assessments. The finding reveal that the designed e-module meet valid material requirements, allowing that to be applied in the learning process because it meets very good criteria. The following are the results of e-module validation data analysis by media experts.

Table 4. Calculation Results of Feasibility Questionnaire of Media Experts By Aspect

Aspect	Average	Criteria
Overall Appearance Feasibility	3.60	Very Good
Consistency	3.83	Very Good
Ease of Use	4.00	Very Good
Benefits	3.33	Very Good

Table 5. Overall Calculation Results of Feasibility Questionnaire of Media Experts

Media Experts	Average Score	Criteria
Resource Person 3	3.71	Very Good
Resource Person 4	3.58	Very Good
Overall Average Score	3.65	Very Good

The first and second media experts' reviews both received an average score of 3,65, as shown in tables 4 and 5. The findings revealed that the designed e-module satisfied valid media criteria, indicating that they could be applied in the learning process right away because they reached very good criteria.

Qualitative data analysis is based on comments and suggestions from material and media experts. Comments and suggestions from material experts include: (1) adding the word approach to the cover; (2) applying consistent margin; (3) correcting inaccurate words and sentences in Competency Achievement Indicators (GPA) and motivation; (4) omitting the column in conclusion; (5) correcting the unnecessary questions; (6) correcting the word price into total price; (7) correcting the answer column in exercise; (8) adding an explanation of the meaning of dependent variable; (9) correcting garden size in exercise 2.1 number 1; (10) correcting the incorrect words in exercise 2.2 number 3, exercise 2.3; (11) correcting the interrogative sentence in the competency test; (12) correcting inaccurate words in the competency test in description number 1.

Comments and suggestions from media experts include: (1) improving the less attractive appearance; (2) correcting inaccurate words and appearance of date in preparing e-module; (3) improving the writing of money value according to PUEBI; (4) correcting screen and font consistency; (5) improving the display on the video; (6) adding a back cover page.

Material and media experts provide feedback, which is then used to improve or revise the final product. The e-module

is then tested with students after it has been revised.

Practicality Analysis

Data from the student response questionnaire answers were used to conduct a practicality analysis. The results of the student questionnaire to e-module in small class trials and large class trials meet **practical** qualifications because they show **good** criteria. The following are the results of student questionnaire data analysis to e-module.

Table 7. Overall Calculation Results of Student Response Questionnaire

Trial Sample	Average Score	Criteria
Small Class Trial	3.17	Good
Large Class Trial	3.22	Good
Overall Average	3.20	Good

Based on the table 7, it can be seen the calculation of student responses in small class trial obtains an average score of 3.17. The result indicates that the developed e-module shows **good** criteria and meets practical qualifications. Meanwhile, the calculation result of student responses in large class trial obtains an average score of 3.22. The result indicates that the developed e-module shows **good** criteria and meets practical qualifications. Thus, the developed e-module falls into good criteria and meets practical qualifications.

Table 8 shows that the combined assessments conducted by material, media experts, small and big class trials yielded an average score of 3,40 and fulfilled the

criteria very good, indicating that the practicality of e-modules is valid and practical to use.

Table 8. Overall Results of Combined Calculation.

Trial Sample	Average Score	Criteria
Material Expert	3.56	Very Good
Media Expert	3.65	Very Good
Small Class Trial	3.17	Good
Large Class Trial	3.22	Good
Overall Average Score	3.40	Very Good

Discussion

This research aims to develop learning resources, namely e-modules with smart phone-based with Realistic Mathematics approach. The problems that occur in school are students' difficulty understanding linear systems with two variables, especially in the story problem section, and the less effective use of smartphones owned by students.

Realistic Mathematics Education (RME) allows students to solve a real problem (Amalia, 2020) and will enable students to instil ideas, concepts, and skills in the learning process (Sari, 2019). In addition, modules with the RME approach make it easier for students to find mathematical concepts presented from problems or story problems related to everyday life (Hilaliyah, 2019). Several studies have developed modules with the Realistic Mathematics Education (RME) approach, including Dianti Z., Izzati, N., & Rimadhona, R., (2020), which develops RME-based modules on Linear Program materials and Hilaliyah, N., Sudiana, R., &

Table 6. Calculation Results of Student Response Questionnaire by Aspect

Aspect	Small Class Trial		Large Class Trial	
	Average Score	Criteria	Average Score	Criteria
Material Presentation	3.14	Good	3.30	Very Good
Appearance	3.36	Very Good	3.27	Very Good
Benefits	3.00	Good	3.03	Good
Attractiveness	3.00	Good	3.12	Good
Time of Use Efficiency	3.40	Very Good	3.33	Very Good

Pamungkas, A. S., (2019) which develops RME modules with cultural value in social arithmetic materials. This research also develops RME-based modules but in electronic modules form known as e-modules.

E-module's advantages are more efficient and can reduce costs because they do not use paper (Kurniawati, 2020) and are an essential source of learning during pandemics that implement distance learning (Pitriani, 2021). In addition, e-modules with additional multimedia can help students understand the material presented (Chong, 2005), and smart phone-based e-modules can overcome low student activity and learning outcomes because students often use smart phones in their daily lives (Saputra, 2020).

It is also based on information that smartphone users in Indonesia are dominated by 61% of students, so their utilization is more accessible for learning media as a support for the learning process (Putra, 2020). Some research on the development of smartphone-based e-modules with the RME approach, such as Hastin (2020), developed a sigil-software-based e-module with a realistic mathematics approach.

Meanwhile, Mila, L. A. (2019) developed Android-based media on realistic math learning, and Lisa, M. L. (2021) developed learning media with a realistic mathematical approach. Research on Hastin (2020) discusses the matter of Relation and Function, while in this research, the material discussed is a system of two-variable linear equations. While the research on Aisy, D. R., Farida, F., & Andriani, S. (2020) the material discussed is a linear system two variables using scientific approaches, but this research is developing the same materials but with the different approach, is that Realistic Mathematics Education. E-modules with smartphone application-based are suitable for use during distance learning (Al-

Muhdhar, 2021) because this e-module contained competency tests that can be directly done through a smartphone and can be operated with the help of e-pub reader applications without an internet network.

E-modules developed using ADDIE development models, namely Analysis, Design, development, implementation, and evaluation. ADDIE development model is an effective development model for developing educational products and other learning resources such as e-modules (Branch, 2009). The development of this e-module begins by analysing the appropriate needs of stakeholders for this research, schools, and students (Danke, 2011). From observation and interviews, researchers concluded that students need a learning resource that can overcome difficulties in modelling mathematics in everyday life and optimize the use of smart phones commonly used by students.

At the design stage, which is the stage to design a product that refers to the analysis of needs (Kurniati, 2016) and development, researchers prepare the material with sources from class VIII math teacher books, student books, and focused math exercises for junior high school class VIII. Then continued by designing e-module templates, designing, and developing learning videos, including materials and videos into the Sigil application, and adjusting to the display on smartphones because adjusting learning content with technology needs to be done to improve the student learning experience (Davis, 2013).

At the implementation stage of e-modules carried out two times, the trial is a small class with five students and a large class with 30 students. And on the calculation of students respond get an average score of 3.17 for small classes with good criteria and an average score of 3.2 for large classes with good criteria. While at

the evaluation stage of the validation results of material experts and media experts obtained an average of 3.56, and 3.65 with very good criteria sequentially. Then if taken the average of student response and validation from media and material experts obtained 3.40 with very good criteria. From this average, it can be concluded that e-modules with smartphone-based with realistic mathematics education are considered valid and practical. They can be used in the learning process with two-variable linear system material, and technology-based e-modules will positively respond to students (Priwanto, 2020).

CONCLUSION

Two variables linear system e-module for smartphone with a Realistic Mathematics Education approach with an average material expert score of 3,56, media experts score of 3,65, students' response on small class trials of 3,17 and a student's reaction on big class trials of 3,22, the content generated is very good included in the criteria.

The average combined score of material experts, media experts, small class trials, and large class trials for the e-module is 3,40, indicating that it is valid and practical. The material two-variable linear system can be used in the learning process due to smartphone-based e-modules with a Realistic Mathematics education approach.

We suggest that: (1) The development e-module is expected to be used in the mathematics learning process, so that it can help students to understand the material; (2) The result of e-module is still far from perfect, due to limited thinking skills and time to perfect it. Therefore, this e-module needs to be developed again; (3) The result of e-module can be a reference material for further development with a better quality.

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