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# Validity Analysis of Development of Socrates-Based Linear Algebra E-Modules

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## Abstract

The aim of the study was to investigate the validity level of Socrates-based linear algebra e-module, both material validity and design. This is a research and *development* (R&D) with ADDIE procedure: analysis, design, develop, implement, and evaluate. The participants were 30 students and 2 lecturers who supervised linear algebra courses in the mathematics education study program of Universitas Muhammadiyah Metro. Data collection techniques uses questionnaires provided to material and design validators. Data analysis uses quantitative descriptive. The results showed that the validity rate xof Socrates-based linear algebra e-modules on material aspects was 81.33% with highly valid categories and on design aspects 88% with highly valid categories. Based on the results of the study obtained the conclusion that the e-module algebra linear based on Socrates is declared very valid. Furthermore, further research can be conducted related to the use of Socrates-based linear algebra e-modules in learning to find out effectiveness of using e-modules.

**Keywords:** E-Modules, Socrates, Validity

## 1. Introduction

The rapid development of technology and information and the covid-19 outbreak affect various aspects of life. One of them affects education where there are learning activities. This situation requires educators to have a role in learning to quickly follow the ongoing developments. One of the efforts to improve the quality of learning is the use of teaching materials that meet the students' needs. Some experts (Dimas, 2017; Prastowo, 2014) state that teaching materials are all forms of materials that are systematically arranged to facilitate the learning process and to achieve the graduates' learning outcomes that have been determined. The same thing is also stated by (Gazali, 2016; Nisrokha, 2015) that teaching materials can improve the quality of learning.

Based on the results of observations of linear algebra learning, it was obtained information that students had difficulty in understanding and solving problems independently. The teaching materials that the students had were still very limited to a printed book where students had difficulty in learning the book without the help of lecturers during the current pandemic. Theories have suggested that the use of appropriate teaching materials

determines the quality of learning (Perwitasari & Wahjoedi, 2018). The research analysis of the needs of teaching materials has been done by (Vahlia et al., 2021) to answer that condition, the results of the study showed that it was necessary to develop linear algebra teaching materials that meet the students' characteristics and existing technological developments to facilitate their learning during pandemic times. In the current pandemic, students urgently need teaching materials that are easy to understand and can be used independently. It is believed that the teaching material can lead students to construct their knowledge through questions and steps arranged in sequence from the simplest things, to facilitate online learning today.

Pandemic circumstances and technological developments demand a digital-based learning. This is according opinion (Ceyhan, 2022), that the effective use of technology affects the learning method positively. It is also supported by the situation in the field where almost all students have already been using android. To that end, one of the teaching materials that can be developed and integrated with technology is linear algebra e-modules to facilitate students to study independently. (Ekayanti, 2017; Lestari & As'ari, 2013) state that modules are teaching materials that are systematically arranged with clear learning criteria to facilitate students to learn independently. (Anwar & Rahmawati, 2017) also state that the use of constructivism based mathematics module was very effective in improving students' mathematical understanding on algebra operation material. Thus, e-modules or electronic modules are digitally a form of modules and contain the most directed material in the form of sound impressions, graphics, images, videos, and animations. These e-modules can facilitate students to learn more interactively and independently so that the planned learning achievements can be achieved. Mobile learning is an essential tool to help make sense of mathematics (Johnson & Williams, 2020). The development of this e-module is very necessary because through this e-module students can easily study anywhere and anytime independently. Learning requires interactive and interesting innovations to increase student motivation in learning (Maskur et al., 2017; Sagala et al., 2019).

In addition to modules must accommodate the development of technology in the form of e-modules, and modules must also adapt the characteristics and needs of students. E-modules must be developed according to the learning criteria clearly and coherently (Sipayung & Simanjuntak, 2017). Socrates is a method of learning in which there is an activity of giving questions that lead students in constructing knowledge with steps in order (Yunarti, 2016). Through the Socrates method applied in the e-module of learning, students can think of simple steps first in constructing knowledge and solving their problems. The questions in the e-module are arranged to follow scientific rules. Therefore, the Socrates method can be classified as one of the methods based on scientific approaches. Prior study (Ernawati & A Muhajir Nasir, 2018) concluded that the application of Socrates method could improve mathematics in students in mathematics education study programs.

Based on the results of needs analysis research (Vahlia et al., 2021) and literature review, it is found that there has not been a development of Socrates-based linear algebra e-modules, therefore, sub-sequent research was carried out related to the development of Socrates-based linear algebra e-modules. One of the stages of e-module development is to validate each component in the e-module (Sukiminiandari et al., 2015), with the aim of producing a Socrates-based linear algebra of e-module that is feasible to use in learning.

## 2. Method

This research is an R&D development research. The development model used is ADDE through the stages of *Analysis, Design, Develop, Implement and Evaluation*. (Aldoobie, 2015; Branch, 2009). The analysis stage processes the importance of the development of e-modules in linear algebra learning covering *analysis of problems* in learning, *analysis of students' characteristics* in learning and *analysis of learning materials and learning objectives*. The design stage includes the design of e-modules to accommodate a conceptual framework of e-modules. This design activity consists of studying learning achievements to determine educational materials, designing Socrates-based e-module scenarios, designing e-module materials and designing e-module evaluation questions.

The development stage is an activity as an embodiment of the conceptual framework at the design stage. The made conceptual framework is implemented in the form of Socrates-based e-modules. Besides, this stage also

arranges a validation of e-modules to obtain e-modules that are worth using. The evaluation stage provides feedback on the compiled e-modules which are further revised. The evaluation stage is done in each stage that has been done.

The subjects of this study are 30 students and 2 lecturers who supervise linear algebra courses in the mathematics education study program of Universitas Muhammadiyah Metro. In addition, the study also involved 6 validators: material validators and e-module design validators. Data collection instruments employ the form of questionnaires and interviews. Questionnaire consists of students' and lecturers' response questionnaires, material validation, and design validation questionnaires. Data analysis techniques consist of qualitative and quantitative data. The data that has been obtained is further analysed using the Likert scale to present descriptively.

### 3. Results

The results of this development research are in the form of a product called Socrates-based linear algebra e-module. Socrates-based linear algebra e-modules are electronic modules that lead students to understand the concept of linear algebra. The e-module is designed to guide students in understanding the concept of linear algebra through organized questions to stimulate students' thinking starting from simple steps in constructing knowledge and resolving problems without being told in advance by lecturers.

The designed Socrates-based linear algebra e-modules are further validated by three materials experts and three design experts using the provided instruments. Validation of the material is performed by three lecturers of mathematics education who had more than ten years of teaching and research experience. While design validation was completed by three lecturers who had teaching experience and technology-based learning research. The material validation instrument consists of nine assessment indicators; *content accuracy, self-instruction, self-contained, stand alone, adaptive, user friendly, face, language use, Socrates characteristics*. While the design validation instrument consists of seven assessment indicators: *format, organization, attractiveness, shape and size of letters, space or blank spaces, consistency and supporting quality*. Data validation of both material and design validation are assessment scores, comments and suggestions related to Socrates-based linear algebra e-modules. Material validation aims to assess the content of Socrates-based algebra linear e-module material before being use in student learning. Validation data from three material experts are presented in table 1 as follows:

Table 1: Product Validation Results Data by Material Experts

Validator	Number of Scores	Percentage	Category
V <sub>m1</sub>	60	80,00%	Valid
V <sub>m2</sub>	62	82,67%	highly Valid
V <sub>m3</sub>	61	81,33%	highly Valid
Average		81,33%	highly Valid

Information:

V<sub>m1</sub> : material validator expert 1

V<sub>m2</sub>: : material validator expert 1

V<sub>m3</sub>: : material validator expert 1

The data of material validation results in Table 1 shows that the material validator expert 1 grades the validation assessments with 80.00% as valid category. Validator-2 rates the validation assessments with 82.67% as highly valid category. Validator-3 scores the validation assessments with 81.33% as highly valid category. The average assessment of the three material validators is 81.33% and is in the category of highly valid. The validators also provide comments and related suggestions for e-module. The comments and suggestions from all three expert material validators are presented in Table 2 as follows:

Table 2: Material Expert Comments and Suggestions

Validator	Comments and suggestions
V <sub>m1</sub>	the exercise section is good, but the examples of problems need adding so that readers understand more to do the exercises. The display of the material is good, but it needs additional views to make readers more interested.
V <sub>m2</sub>	All definitions and theorems should use numbering as a name and exercise. You need to give examples of problems and solutions. It should be given a limited example in the form of how to answer some questions. All definitions on the module should be numbered to make them easier for students to refer and to which definitions are used in proofing
V <sub>m3</sub>	the material map section should contain a concept map only, to be more meaningful. In general, this module is good in typing and writing equations, exercises and tasks, and the language with a detail explanation.

Table 2 shows that the exercises on the module are well and complete because a variety of possible problems are provided. What needs improving includes the additional of problem examples and their completion to make students can more easily understand the materials independently to meet the function of the module or is called self-instruction. The provided materials in the module meet the learning achievements of linear algebra courses but the appearance of the material needs improving to make students more interested in learning. In addition, it is also necessary to improve the numbering of all definitions and explanations of the meaning of each definition to make students easy when referring to the definition in solving their problems. Lastly, the material map section should contain a concept map to be more meaningful for users or students. The conclusion of the expert's assessment of material validators indicates that the module is worth using after being revised.

Media validation aims to assess the design of the Algebra Linear e-module application before students use it. A Socrates-based linear algebra e-module can be directly downloaded by a validator for assessment. The result of media validation is presented in full in table 3 below:

Table 3: Media Expert Validation Results

No	Validator	Total Score	Percentage	Category
1	V <sub>d1</sub>	48	96%	Very valid
2	V <sub>d2</sub>	45	90%	Very valid
3	V <sub>d3</sub>	39	78%	Valid
		Average	88%	Very valid

Information:

- V<sub>d1</sub>: design validator expert 1
- V<sub>d2</sub>: design validator expert 2
- V<sub>d3</sub>: design validator expert 3

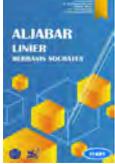
Table 5 shows that the assessment by the design validator-1 is 96% which means highly valid category. Validator design-2 grades 90% which means highly valid category. Validator design-3 scores 78% which means valid category. The average design validation resulted from the three validators is 88% which belongs to highly valid category. It is concluded that the results of the assessment of the three design expert validators on the e-module are very valid and can already be used after revision. Although the assessment of the category is very valid, the application of linear algebra e-modules still requires improvement in some parts to meet the suggestions and comments given by validators. The suggestions and comments provided by the three design validators are presented in Table 4:

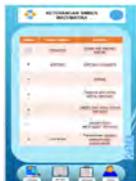
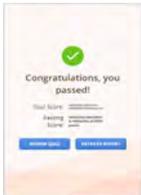
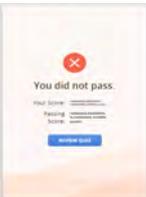
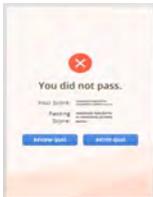
Table 4: Media Expert Advice and Comments

Validator	Saran dan Komentar
V <sub>d1</sub>	The app is very interesting and useful. Paragraphs can be more corrected, but overall, it is appropriate. <i>Font</i> on customized image (scaled down) App functionality is appropriate Very bright and attractive colours
V <sub>d2</sub>	<i>In the cover is written</i> “developer team.” It should be replaced with bright colours (white) so that more button “starts” and should use a type of icon (png) with transparent <i>background</i> . There are six boxes of <i>material buttons</i> in the introduction that may provoke users to choose one, but the six boxes of material do not have a link. For that reason, it is good to use the menu <i>list</i> only instead of the material boxes. The app does not have <i>mute</i> sound option. The design of <i>the single sound icon</i> should work for <i>sound-on</i> and <i>sound-off</i> and there should be button “ <i>next, previous and exit</i> ” and please use transparent <i>background for them</i> . In the <i>evaluation menu</i> should be provided options “ <i>reset</i> ” for users to retry the provided quiz and at the end section there should be a button “ <i>passing score.</i> ” Validators recommend that the <i>layout</i> application is made vertical by ensuring the <i>auto rotate</i> function because the <i>auto rotate horizontal</i> display design will become smaller and is difficult to read.
V <sub>d3</sub>	Please notes the use of this module should meet the appropriate application and tested in various OS which is commonly used by students such as android in various versions. The display of definition should appear <i>step by step</i> , based on the being described materials. Regarding the contents of quiz, it is good to be multiple choice.

Considering comments and suggestions from both material and design validators, the Socrates-based linear of algebra-modules are to revise as final product version and the results are presented in table 5 below:

Table 5: Revised Results of Linear Algebra E-Module Applications

No	Before the revision	After revision
1.	 <p>On <i>the cover</i> there is a black text colour which is not clearly visible. The start button is also the colour combination which is blurred.</p>	 <p>On the colour cover the text is changed to white so that it is clearly visible, and the start button of the colour combination is fixed</p>
2.	 <p>The material box at the beginning of the application allows users to click on the box, although there is not any link.</p> <p>Spaces in paragraphs are still too short and the distance between words are jumbled.</p> <p>There is not any animation yet in the application to make it more attractive for</p>	 <p>The omitted material box is converted into a list of materials so that it is not clicked by the users.</p> <p>Spaces in paragraphs are changed from one space to double so that it looks neater.</p> <p>Animation is inserted in the application so that it looks more attractive. In some parts there is also animation.</p>

No	Before the revision	After revision
3.	 <p>Layout is further arranged between menus and sub menus to avoid confusion among users.</p>	 <p>The arrow of layout has been changed and no longer confuses users.</p>
4.	 <p>Use of one space is too tight</p>	 <p>Use of spaces is changed to 1.5</p>
5.	 <p>There is not any description of the mathematical symbol.</p>	 <p>There is already a description of the mathematical symbol.</p>
6.	 <p>There is not any detailed report menu to make the assessment explanation can be more detailed.</p>	 <p>Improvement of the quiz menu is made. When passing the passing score there is a detailed report menu enabling the assessment explanation to be more detailed</p>
7.	 <p>When you do not pass <i>the passing score</i> there is not any <i>menu "retry quiz"</i> to repeat the work of the quiz.</p>	 <p>Menu improvement quiz is made. When users do not pass the passing score, there is a retry quiz menu to repeat the quiz work.</p>

#### 4. Discussion

E-module is one of the teaching materials that can help students in the learning. (Sari & Anantyarta, 2018) states that one of the factors that affect the ability of students to teach materials is e-module. Socrates-based linear algebra e-modules were developed to facilitate students' learning linear algebra courses both independently and in the assistance of lecturers. The developed e-module based on Socrates is an e-module containing questions that lead students in constructing knowledge. The questions are arranged in order starting from a simple model to a more complex one. Thus, it can train students to hone thinking skills in solving problems.

The results of validation of e-module materials show that Socrates-based linear algebra e-modules are very valid and still need revising. The revision of the e-module is done by adding examples and numbering definitions and explanations so that the students can understand the materials independently. This result is confirmed with the statement of (Nafsiah & Rizal, 2019) stating that e-modules are teaching materials used to help students learn independently based on learning achievements.

Validation of e-module design shows that the e-module is highly valid despite some revisions. The design expert validator provides suggestions to improve e-modules related to the appearance: the use of letter colours, spaces, and menus. This is to make students more interested in using it. E-module design is designed well to make students can easily use it and meet the criteria of user friendly. Similarly stated by (Ariyanto et al., 2018; Oktaviana et al., 2015) who state that well-designed teaching materials motivate students to study well.

#### 4. Conclusion

Considering the results of the development of the Socrates-based linear algebra e-module, the authors concluded that the e-module is declared highly valid seen from both the material and design aspects indicated by an average value of 84.67 ratings. Furthermore, the development of Socrates-based linear algebra e-modules can be continued to the implementation stage or use of e-modules in learning.

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