E-module on elasticity of solids topic through cooperative learning to improve learning outcomes and motivation: Validity aspects

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Abstract. This study aims to describe the validity of the electronic module on the elasticity of solids topic through the cooperative learning model to improve students' learning outcomes and motivation. This research is a research and development with the ADDIE development model. This electronic module was assessed by using the electronic module's validation sheet. The validators of this e-module consisted of two academics and one practitioner. Based on the validation results, it was obtained that the validity of the electronic module was 3.49 with a valid category. It shows that the electronic module on the elasticity of solids topic through cooperative learning models can be used in the classroom learning process to improve student's learning outcomes and motivation.

1. Introduction
The Industrial Revolution 4.0 is the integration of technology in the learning process [1]. It still makes learning easier even though we are currently experiencing a covid-19 pandemic[2]. The current condition, where most students study from home or can be called distance learning, can be done online. So teachers need to innovate in the use of teaching materials [3]. Teachers in the industrial revolution 4.0 era act as facilitators and motivators in the learning process [4].

Digital technology and online media function to find teaching materials that can assist in understanding learning materials[4]. The use of technology-integrated teaching materials such as electronic modules is needed in current conditions [5,6]. E-module are teaching materials that can help students learn subject matter independently using electronic media. As the electronic module can help students learn individually/independently in the classroom, the teacher learns only as a facilitator [7]. E-module is the right choice to make it easier for teachers and students [8].

An electronic module presents self-study materials that are systematically arranged into the smallest learning units to achieve specific learning objectives, which are presented in an electronic format [9]. This e-module can be accessed anytime and anywhere. The advantages of e-module compared to print modules are that they are interactive, easy to navigate, allow displaying/loading of
images, audio, video, and animation and are equipped with formative tests/quizzes that allow immediate automatic feedback [8].

The electronic module using Flip PDF Corporate Edition can be used without the need to download the application. First, it is effectively used in the learning process [10,11] to improve student learning outcomes. The use of this e-module can increase student motivation. Motivation is an internal process that is the main factor in the success and achievement of learning. High motivation to learn will provide a clear goal in a person to absorb information and understand the concept of the material. Learning outcomes are obtained from a person's knowledge, skills, and attitudes after doing learning activities [12]. Motivation is an essential factor in the success of learning outcomes. The higher the motivation in oneself, the higher the process of absorbing information and understanding material concepts [13,14].

The E module in this study uses the Flip PDF Professional application. Several studies have shown that e-module using Flip PDF Professional can improve students' learning outcomes [15,16]. Electronic modules can help students improve their cognitive understanding. With this interactive electronic module, the learning process involves audio-visual displays, sound, movies, and others. The program is easy to understand to be used as a suitable learning medium [17]. Based on the results of interviews with physics teachers during the preliminary study and needs analysis, the teaching materials used in schools were rarely technology-based. In addition, no one has developed materials regarding the elasticity of solids. Learning outcomes were also categorized as moderate, and learning motivation was still in the poor category.

Several studies have been carried out on the development of elasticity of solids e-module [18,19]. However, the study has not explicitly mentioned the model used in learning to use the e-module. Research on learning models at the time of learning shows that cooperative learning models can improve student learning outcomes [20–22] and student motivation in learning [23–25]. It will support the success of the e-module in learning. Therefore, research on the development of electronic modules on the elasticity of solids was carried out through cooperative learning models to improve learning outcomes and student motivation. This study aims to describe the validity of the electronic module on the elasticity of solids to improve learning outcomes and student motivation.

2. Method
This research is a research and development study with the ADDIE model. This electronic module was assessed using the electronic module's validation sheet. The validators of this e-module consisted of 2 academics and one practitioner. Data validation was calculated with the average value of the total score for each aspect of the assessment. The calculation results were adjusted to the assessment criteria [26] in Table 1.

| No | Equation | Average (x) | Category |
|----|----------|-------------|----------|
| 1  | $X > \bar{x}_t + 1.8 \times S_{b_i}$ | $\bar{x} > 3.4$ | Very good |
| 2  | $\bar{x}_t + 0.6 \times S_{b_i} < X \leq \bar{x}_t + 1.8 \times S_{b_i}$ | $2.8 < \bar{x} \leq 3.4$ | Good |
| 3  | $\bar{x}_t - 0.6 \times S_{b_i} \leq X < \bar{x}_t + 0.6 \times S_{b_i}$ | $2.2 < \bar{x} \leq 2.8$ | Quite good |
| 4  | $\bar{x}_t - 1.8 \times S_{b_i} \leq X < \bar{x}_t - 0.6 \times S_{b_i}$ | $1.6 < \bar{x} \leq 2.2$ | Poor |
| 5  | $X \leq \bar{x}_t - 1.8 \times S_{b_i}$ | $\bar{x} \leq 1.6$ | Not Good |

Where:
\[
\bar{x}_t = \text{Ideal average} = \frac{1}{2} (\text{ideal maximum score} + \text{ideal minimum score})
\]
\[
S_{b_i} = \text{Ideal standard deviation} = \frac{1}{6} (\text{ideal max score} - \text{ideal min score}) = \text{Empirical score}
\]

The reliability of the validation results was calculated using the Alpha Cronbach equation. To determine the reliability of the validated teaching materials assessment, it used the reliability criteria r [27].
3. Result and Discussion

The result of the developed e-physics module with a cooperative learning model was used to assist the learning process following the characteristics of the elasticity of solids topic and the characteristics of students in class XI SMAN 3 Ternate City. The developed e-module was equipped with experimental Student Worksheet (LKPD) guidance, aiming to improve student learning outcomes. E-module is one of the teaching materials that can improve students' mastery of concepts and think independently [28,29]. The e-module can be accessed at the following link http://elastisitaszatpadat.online/mobile/index.html. The following is an example of the appearance of the solid elasticity e-module developed, which can be seen in Figure 1.

![Figure 1](image)

**Figure 1** The cover view of the solid elasticity e-module

The developed e-module contained the elasticity of solids topic. It consisted of the cover, introduction, table of contents, instructions for using the module, concept map, keywords, chapter titles, motivations related to life, student worksheet with PhET Simulation media, material descriptions, scientists’ physics, physics applications, physics info, examples of thinking question, notes on important formulas, summaries, independent questions, glossary, answer keys, and bibliography. The elasticity of solids topic was divided into three meetings. Each meeting contained a problem equipped with student worksheets to conduct experiments through PhET Simulation media and questions of strengthening thinking in the e-module. It was to assist students in analyzing experiments [30,31]. Then, in the e-module, there were examples related to life. The material and application in life contained physics info, notes on important formulas, physics applications, a summary of each sub-chapter, and a competency test used to determine students' understanding in each meeting. The update of the developed module compared to existing books is presented in Table 2.

| No | Module Update |
|----|---------------|
| 1  | E-module with Flip Builder |
| 2  | The module was equipped with a PhET media on Student Worksheet (LKPD) for virtual experiments to be carried out and given questions of strengthening thinking |
| 3  | The initial motivation was linked to daily life's examples in each lesson, such as a child pulling a slingshot, playing with plasticine, spring swings, motorized vehicles that have shock breakers |
| 4  | Equipped with examples of thinking related to everyday life problems |
| 5  | Given a column for physics info, physics scientists, physics applications and notes on important formulas for each sub-section of the material, video links/video barcodes |

The e-module of the elasticity of solids in this study used the Flip PDF Professional application. The hallmark of the e-module was that it could be used anywhere in the form of a professional Flip PDF. There was a video link to add insight and practicum media using PhET simulation, which helped children interactively conduct virtual experiments. The development of the module was divided into
three meetings on the elasticity of solids, namely the modulus of elasticity, Hooke's law, and the arrangement of springs (series and parallels).

The e-module developed was reviewed based on the results of the assessment of 3 validators from media experts and material experts, both from academics and practitioners. E-module validation was based on aspects of e-module component assessment such as validation of student teaching material formats, language validation, content validation of student teaching materials, presentation validation, validation of the benefits/usability of teaching materials on electronic modules. The results of the assessment of the validity of the e-module elasticity of solids are presented in Table 3.

Table 3. The results of the validity and reliability of the module

| Aspect          | Validator | Average | Criteria |
|-----------------|-----------|---------|----------|
| Module Format   | 3.00      | 3.67    | 3.44     | Valid    |
| Module Contents | 2.80      | 3.90    | 4.00     | Very Valid |
| Presentation    | 2.87      | 3.73    | 4.00     | Very Valid |
| Benefits/usage  | 3.00      | 4.00    | 3.67     | Very Valid |
| Language        | 2.20      | 3.68    | 3.78     | Valid    |
| Average         | 3.49      |         |          | Valid    |
| Module validity category |          |         | Very Valid |
| Average overall reliability |          |         | 0.99     |
| Category overall reliability |          |         | Very High |

Suggestions from reviewers on the developed e-module can be seen in Table 4.

Table 4. Suggestions from reviewers on the module

- Many misspell, such as missing letters
- Inconsistent spacing
- Example questions are reproduced with answers
- More practice questions
- Add a game section to overcome student boredom in learning
- If possible, tuck in the corner of character education and national culture

The following changes to the contents of the e-module based on suggestions from the validator are presented in Table 5.

Table 5. e-module content changes

| Before                                      | After being validated                      |
|---------------------------------------------|-------------------------------------------|
| No games yet                                | Add a game section to overcome student boredom in learning |
| No tucked character education corner and the nation's culture yet | Tucked in the corner of character education and national culture |

Table 2 shows the results of e-module validation with a value of 3.49 in the valid category. The reliability is 0.99, with a very high degree of reliability. It shows that the e-module format already contains learning objectives, guidelines in student worksheets, examples of questions related to everyday life, information, and a summary of the material. The e-module can stand alone, the numbering system is clear, the design is clear. The e-module is attractive, easy to use, and communicative. The validated e-module was then revised according to the suggestions from the three validators.
The characteristics of the e-module were self-contained; if all learning materials are contained in the e-module, it can stand alone. The developed e-module did not depend on other media or teaching materials, and the format of the E-module corresponded to the characteristics of the e-module. The developed e-module helped students by providing convenience for students in learning [32]. Furthermore, in table 2, the results of the calculation of the validation of the contents of the e-module, which consists of three aspects of the assessment, namely aspects of material coverage, aspects of the material description, and aspects of up to date. Validation of the contents of this e-module is included in a very valid category. Obtaining a score with a very valid category indicates that the content of the e-module is extensive and deep, the content of the e-module is accurate to facts, principles, theories, terms and concepts of physics, and the content of the e-module follows the development of science.

It corresponds to the characteristics of the e-module [32] that a good e-module is one of them with adaptive characteristics, namely the developed e-module adapted to knowledge and technology. The validation of the presentation of the e-module contained in Table 2 consists of four aspects of assessment, namely aspects of presentation techniques, aspects of supporting material presentation, aspects of presenting learning in e-module, and aspects of presenting student worksheets in e-module. Obtaining a score with a very valid category indicates that the presentation of the e-module is systematic, the balance of substance between the chapters in the chapter, the concept is coherent, has been centred on students, fosters curiosity. The presentation of student worksheets on the e-module is appropriate. Flip PDF Professional is different from the pdf that is usually used. In terms of appearance, Flip PDF Professional is like an e-book display that can be flipped while reading it [33,34].

Validation of the e-module's benefits/usability in table 2, which consists of aspects of the benefits containing three items, is considered a very valid category. Obtaining a score with a very valid category indicates that the e-module can be used as a teacher's guide in learning. The e-module can be used as a guide for students in independent learning, and the e-module can be used in learning to solve problems. By using the e-module, students can learn independently and focus on their abilities [32,35]. Language validation in table 2, which consists of two aspects, obtained a very valid category. Obtaining a score with a very valid category indicates that the language in the e-module already contains proper grammar and spelling.

Therefore, the results of the e-module validation were reviewed from aspects of format, content, presentation, and benefits/usability and language aspects. In Table 2, it is found that the developed e-module was good but still needed a minor revision to be better. Besides, the developed physics e-module was feasible and could be used in the trial phase at school, and the e-module is reliable. Finally, this e-module was revised so that it was feasible to be implemented in classroom learning.

4. Conclusion
The conclusion from the results of this study is that the electronic module on the elasticity of solids topic through cooperative learning models can be used in the learning process in the classroom to improve learning outcomes and student motivation. This research implies that the module on solid elasticity topic is valid for use in schools. Thus, this e-module can be implemented in classroom learning to review further the effectiveness and the student's responses to the module.

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