Validity of physics student e-book based on the STEM approach to improve knowledge competence

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Abstract. Achieving the competency of students' knowledge in learning Physics is still not optimal. This is due to the lack of available teaching materials that fit the needs of students, teaching materials available are only in the form of printed teaching materials and there is no approach in them, and learning has not been entirely centered on students who demonstrate lack of independence in learning. Utilization of technology is one of the efforts to facilitate learning in accordance with the needs of students by developing non-printed teaching materials in the form of a student ebook based on the STEM approach. The purpose of this study was to produce a student ebook based on a valid STEM approach. This type of research is research and development using the ADDIE model. The method used in this research is descriptive statistics. Student ebook validity was assessed by four experts using a validity questionnaire. The validity of the student ebook was analyzed using the formula Aiken's V. The results of the validation showed that the aspect of the validity of the material substance was 0.89; visual display 0.92; and learning design 0.88. Based on the data analysis that has been done, student ebooks get an average value of 0.90 in the valid category. Thus, the student ebook based on the STEM approach can be implemented in physics learning to improve students' knowledge competence.

1. Introduction
The industrial revolution 4.0 affects many areas of human life, including the field of education. Education 4.0 is said to be the future of education that complements the phenomenon of digital penetration in life. Superior human resources and skills in their fields are needed in the 4.0 industrial revolution. Various efforts have been made by the government to answer this challenge, including developing a content-based to competency-based curriculum. The aim of the 2013 Curriculum is to prepare the next generation who are faithful, character, creative, and innovative. The government has also compiled PP RI No. 32 of 2013 concerning national education standards. One part of the national education standard is the standard of facilities and infrastructure.

Permendikbud No. 26 of 2016 concerning the standard of facilities and infrastructure regulates the teaching materials available in schools. Teaching materials used in learning are modules and textbooks [1]. Textbooks consist of teacher books and student books which are part of the means of implementing the 2013 curriculum in learning. A student book is a book that contains material in the form of concepts and formulations constructed by students with problems that are arranged based on the scientific approach [2]. In addition, student books are a source of learning that can motivate students to learn and improve learning outcomes [3]. Student books can be said to be teaching materials to help students understand learning material. Development of student books tailored to the
needs and characteristics of students which is integrated with a scientific approach. So, it can provide a learning process according to the demands of the process standards.

Learning should take advantage of technology to make it easier to explain learning materials and make it easier for the education sector to develop innovative teaching materials. Technology used in learning such as computers, laptops and smartphones. Computer assisted learning can contribute to the attention of students relatively higher than ordinary learning [4]. Each educator learning process is required to implement an approach that is in accordance with the characteristics of competencies and students. The 2013 curriculum learning approach is a scientific approach that includes scientific, contextual, and STEM approaches to be implemented in physics learning. Learning Physics is expected to hone the abilities of students and emphasize mastery of concepts, processes, attitudes, and technology [5]. So, the implementation of the approach can improve students' understanding in learning Physics.

The reality that occurs in the field of learning physics is not as expected. Based on the observation activities at senior high school (SMAN 15 Padang), it can be seen from the implementation aspect of learning that students have not been able to solve problems and find concepts, there is still a lack of interest and motivation in learning, still lacking in problem solving, and students still find it difficult to determine the equations will be used in answering the questions. This results in the ability of students in the aspect of knowledge is still low. Furthermore, in the aspect of using physics teaching materials, it was found that in learning students more often used Student Worksheets and rarely used student books. The student book used only contains material and questions. The student books used have not been able to realize learning that can activate students in solving problems. The factors that cause these problems are the condition of students and the availability of learning resources that are still not in accordance with the needs of students.

Starting from the expected conditions with conditions in the field, gaps are found. One effort that can be done is the development of student books that are tailored to the needs of students. Student books are developed with a structure and learning design following technological developments called student ebooks. Student ebook is a non-printed teaching material that can combine all media elements that are relevant to learning material. This Student ebook can be run on computers, laptops, and smartphones. Learning by utilizing technology can combine all media elements including text, images, sound, animation, and video [6]. The use of technology in learning can also increase the competence of students [7]. So, the use of technology can be used to develop student ebooks to make learning more interesting.

The student ebook developed has a learning approach that is suitable for use, namely the STEM (Science, Technology, Engineering and Mathematics) approach. STEM is an approach that integrates several disciplines [8]. Learning with the STEM approach can shape students to have the ability to think critically, creatively, collaboratively, and communicatively. STEM uses an inter-science approach and is implemented with problem-based active learning [9]. So, the STEM approach can develop if it is associated with the real world or the environment experienced by students.

Likewise with the integration of the STEM approach in this student ebook, students can understand the concept of science and be able to relate problems to phenomena in their life. The technological aspects of STEM are closely related to the development of the current digital era. Technology users have the ability to access, find, and use a wide variety of information contained in digital technology [10]. In learning, students can explore various technologies related to physics material. In technical aspects, students can carry out experiments or design simple tools related to physics. Mathematical aspects, formulate mathematical equations in physics material. Thus, it is necessary to develop student ebooks based on the STEM approach to improve knowledge competencies.

The student ebook being developed must be of high quality and meet the standard of teaching materials. One of the criteria for an eligible student ebook is a student ebook that has valid criteria. Product validity is done by presenting several experts who are experienced in assessing the products that have been designed [11]. The validity component of student ebook development includes the feasibility of material substance, visual appearance, and learning design [12]. Thus it is necessary to validate student e-books based on the STEM approach to determine the feasibility of using student ebooks in learning.
2. Research Method
This type of research is development research (research and development), the development model used is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Validity is in the development stage which is the process of making the design real. This means, in the design stage in the form of a planning framework. The main activity at the development stage is to test the validity of the product that has been developed before implementation. The validity test is carried out by several experts who act as validators. Validation of the student ebook aims to see the appropriateness of the material substance, visual appearance, and learning design of the student ebook being developed. In addition, the purpose of student ebook validation is to determine whether a product is functioning or not.

The stage of testing the validity of the student ebook to the validator is 1) Asking experts as validators to assess the appropriateness of the student ebook, 2) the validator is asked to provide an assessment of the student ebook that has been made based on the items contained in the questionnaire, validity test, 3) After the assessment is complete, then revisions are made in accordance with the criticism and suggestions that have been given by the validator.

The data collection instruments for the validity test included an instrument validation questionnaire and a student ebook validation [13]. The analysis for the validity test uses a Likert scale, with the following steps: 1) Giving a score on each item includes alternative answers (4 = very good, 3 = good, 2 = sufficient, and 1 = less), 2) Adding the total score of each validator to all indicators, and 3) Processing the validity test values based on the Aiken's V formula in Equation 1.

\[ V = \frac{\sum x}{n(c-1)} \]  

Information: \( s = r - l_0 \), \( l_0 = \) lowest score on validity (in this case = 1), \( c = \) highest score on validity (in this case = 4), and \( r = \) number given by the validator. Knowing the valid or invalid categories of the student e-book are shown in Table 1.

| Table 1. Validity category [14] |
|-------------------------------|
| Value | Category |
| \( \geq 0.6 \) | Valid |
| \( < 0.6 \) | Invalid |

3. Results and Discussion
The validation includes validation of material substance, visual appearance, and learning design. A product will be valid if the product can measure what it should be measured. The validity and validity instruments of the student ebook that had been designed were tested for validity. The validity instrument was validated by three experts, namely FM, UM, and PR. The validity of the student ebook was validated by four experts, namely FM, UM, RD, and PR. The results of product validation are described as follows.

3.1 Instrument Validation Results
Before validating the product being developed, three experts first validate the instrument. The purpose of instrument validation is to measure what you want to measure. So, a valid instrument can produce valid data on the product being developed. The results of the instrument validation consisting of eleven indicators are shown in Table 2.

| Table 2. Result of instrument validation analysis |
|-----------------------------------------------|
| Indicator | V Value | Category |
| --- | --- | --- |
| Measuring the level of validity of student ebook | 1 | Valid |
| Instructions for use clear | 1 | Valid |
Based on Table 2. It shows that the results of the validity instrument assessment are in the valid category with an average value of 0.94. The mean V value obtained is equal to 0.6. So that this instrument can be used to measure the level of validity of the student ebook being developed.

### 3.2 Student eBook Validation Results

The validity of the student ebook was carried out after the validity of the instrument. The student ebook validity test was conducted by four experts with validity aspects including the feasibility of the material substance, visual appearance, and learning design. The results of the student ebook validation on the feasibility aspect of the material substance consisting of ten indicators are shown in Table 3.

| Indicator | V Value | Category |
|-----------|---------|----------|
| In accordance with scientific principles | 1 | Valid |
| Complete material coverage | 0.83 | Valid |
| Contains actual information | 0.83 | Valid |
| The language used is standard and understandable | 1 | Valid |
| Clarify the basic concepts of learning materials | 0.75 | Valid |
| The illustrations / pictures / animation / videos provided are relevant | 0.75 | Valid |
| Information from reliable sources | 0.92 | Valid |
| The student ebook contains the STEM components | 1 | Valid |
| Material according to competence in the curriculum | 1 | Valid |
| Exercise questions can increase students’ understanding | 0.83 | Valid |

Based on Table 3. It shows that the student ebook developed is in the valid category of the material substance with an average value of 0.89. The product is said to be valid if each indicator gets a V value equal to 0.6. The results of validation are used as a guide to see the feasibility of student ebooks, so that student ebooks can be used in learning. Then, the results of the student ebook validity on the feasibility aspect of a visual display consisting of four indicators are shown in Table 4.

| Indicator | V Value | Category |
|-----------|---------|----------|
| The layout is proportional and attractive | 0.83 | Valid |
| Have a good letter composition | 1 | Valid |
| Color has an interesting composition and appearance | 1 | Valid |
| The illustrations / pictures / animation / videos are present relevant | 0.83 | Valid |

Based on Table 4. It shows that the student ebook developed is in the valid category of visual appearance feasibility with an average value of 0.92. Each indicator in the aspect of the feasibility of visual display obtained a large V value equal to 0.6. The results of the validation are used as a guide to see the feasibility of a student ebook, so that the student ebook can be used in the learning process.
The results of the student ebook validity on the learning design aspect consisting of seven indicators are shown in Table 5.

Table 5. Result of student ebook validation on learning design aspects

| Indicator                                           | V Value | Category |
|-----------------------------------------------------|---------|----------|
| Title                                               | 1       | Valid    |
| Core competencies - basic competencies (KI-KD)       | 1       | Valid    |
| Learning objectives according to KI-KD              | 0.92    | Valid    |
| The material is in accordance with the learning objectives | 1       | Valid    |
| There are questions according to the learning objectives | 0.75    | Valid    |
| Exercise questions can stimulate students to develop knowledge | 0.75    | Valid    |
| Exercise questions can stimulate students to develop thinking skills | 0.75    | Valid    |

Based on Table 5, it shows that the student ebook developed is in the valid category of the learning design feasibility with an average value of 0.88. Each indicator in the feasibility aspect of the learning design obtained a large V value equal to 0.6. The results of the validation are used as a guide to see the feasibility of a student ebook, so that this student ebook can be used in learning at school.

Based on the description above, it can be stated that the student ebook based on the STEM approach developed is in the valid category of material substance, visual appearance, and learning design with an average score of 0.90. Overall, the student ebook was declared valid because in every aspect the V value was equal to 0.6. This means, student ebooks based on the STEM approach can be used in the learning process in schools. After analyzing the validity of the product, it is known that the student ebook being developed is in the valid category. However, there are several suggestions given by the validator at the formative evaluation stage. Based on the criticisms and suggestions, the student ebook was revised. The suggestions given by the validator are in Table 6.

Table 6. Revised of student ebook according to validator suggestions

| Before the Revision                                      | After the Revision                                      |
|----------------------------------------------------------|--------------------------------------------------------|
| There is no video and animation list yet                 | There is already a list of video and animation          |
| There are no instructions for use in the student ebook   | There are already instructions for use in the student ebook |
| There is no reference to every image cited               | There are already references to every image cited       |
| There is no reference to every video cited               | There are already references to every video cited       |
| Eliminate “demo 3D Pageflip”                            | Without “demo 3D Pageflip”                              |

Based on Table 6, shows the validity of the student ebook being developed, there are still some revisions made to improve the student ebook. An example of revision is completing references to each image and video contained in the student ebook. Examples of student ebooks before and after the revision are shown in Figure 1-4.
4. Conclusion

The validity of the student ebook based on the STEM approach is in the valid criteria with an average value of 0.90. The validity component of the student ebook development includes the feasibility of the material substance with a value of 0.89; the feasibility of visual appearance with a value of 0.92; and the feasibility of the learning design obtained a value of 0.88. After the student ebook developed is in valid criteria, the student ebook is suitable for use in learning physics at school.

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