Validity of Class XI Term I Chemistry Electronic Books (E-Books) Integrated with STEM of High School Students

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Abstract. E-books are an alternative teaching material that can be used by teachers and students anytime and anywhere. Chemistry is one of the sciences that has an abstract concept. By integrating the STEM approach (science, technology, engineering, and mathematics) into the e-book, it is hoped that it will enable students to have critical thinking skills, so that they are able to provide creative solutions, and be able to compete in the world of work. This study aims to develop a chemistry e-book for class XI term 1 integrated with the STEM approach. The type of research conducted is research & development (R&D) with the ADDIE development model. This research is limited only to test the validity only. The instruments used were material and media validity sheets. Based on the results of the validity questionnaire analysis conducted by 4 validators, it was obtained 3.67 for material validity and 3.75 for media validity from the largest scale, namely 4. The data results revealed that the e-book that had been developed was valid in terms of material and media validity so that able to become one of the ebooks that can be tested for development

Keywords: E-book, Chemisty, STEM, Validity.

1 Introduction

Chemistry is the study of the nature and composition of matter which is defined as everything that has mass and occupies space and uses the scientific method in the form of observations made to collect empirical facts [1] and explain what and why a phenomenon occurs around us [2]. Chemistry will be more easily understood by students if learning activities are associated with real-world situations because it can arouse students' curiosity and interest in learning, so that they are able to analyze and evaluate processes that occur around their daily lives [3].

Education is the main pillar in the development of superior generations in this modern era. One of the key areas in education is chemistry, which has an important role in understanding various natural and technological phenomena. In the midst of advances in information and

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communication technology, there is great potential in using modern learning tools to improve student learning outcomes.

One of the skills that a teacher needs to improve is by designing teaching materials that suit the needs. Alternative teaching materials that can be used according to the conditions of the digital era and 21st century skills are electronic books (e-books). E-books are digital versions of printed books that can be accessed and read through electronic devices such as computers, tablets, smartphones, or electronic reading devices (e-readers). E-Books generally have file formats such as PDF, EPUB, or MOBI that allow readers to read, store, and carry book collections practically in one device [4]-[5].

E-Books have become popular due to their practicality in providing quick access to various reading materials without the need to physically carry a physical book. With the support of digital technology, E-Books can also include interactive features such as bookmarks, text search, notes, and font size settings to enhance the reading experience [6]-[7].

Integrating e-books with the learning approach used is also important to improve students' interest and learning outcomes. The learning approach that can integrate chemistry with other sciences is STEM (Science, Technology, Engineering and Mathematic). STEM is believed to improve thinking skills, interest and literacy of learners. Learners can find innovative solutions to problems faced in learning and convey them well [8].

The STEM learning process is a problem-solving activity for students by combining two or more interrelated disciplines. STEM learning consists of four aspects: science, technology, engineering and math. Science is the aspect of nature, the laws associated with chemistry, physics, biology, as well as facts, concepts and principles. Technology aspect is the skill in organizing a technology, skill in operating a tool. Engineering aspect is knowledge in designing and operating a procedure. Mathematical aspects are skills in channeling ideas based on data laws, patterns, space and giving reasons effectively [9].

Some previous studies have shown that teaching materials combined with STEM have good results such as being able to increase student interest in learning, foster critical thinking skills and foster creative thinking skills [10]-[12]. It can be concluded that the use of teaching materials integrated with the STEM approach can provide meaningful learning so as to improve students' ability in problem solving. Based on the description above, a research on the development of chemistry e-book for class XI semester 1 integrated with the STEM approach was conducted. The purpose of this research is to develop teaching materials in the form of valid e-books.

2 Method

The type of research conducted is development research (R&D) using the ADDIE development model. The ADDIE development model consists of five stages, namely analyze, design, development, implementation, and evaluation. However, this research only focuses on the development stage.

2.1 Analyze

In this step, an analysis of the content standards is carried out, especially for chemistry subjects in class XI semester 1. This analysis is used as a reference in developing e-books that are in accordance with existing learning materials. In addition, a needs analysis is also carried out by providing observation sheets for students. This aims to understand and fulfill their needs in the learning process.

2.2 Design

In the design step, several activities were carried out, such as making a checklist for the needs of e-book development. Some of the checklists made include collecting references relevant to class XI semester I chemistry material, preparing the e-book story board, and preparing validation instruments.

2.3 Development

This stage is to validate the e-book that has been designed at the design stage. Module validation is carried out to ensure that the materials and media used in this study are valid. To do so, four validators played a role in assessing the feasibility of the module. The instruments used were material and media validity sheets.

To collect validity data, a validity test questionnaire was used which was arranged with a modified Likert scale, consisting of four alternative answers: 1 = less, 2 = enough, 3 = good, 4

= very good. The scores obtained based on the experts' assessments were then combined and converted into percentage form. The percentage calculation uses the formula:

Percentase of eligibility $=\frac{number\ of\ valiator\ assesment\ scores}{maximum\ number\ of\ values}\ x\ 100\%$

The validity criteria for product feasibility can be seen in Table 1.

Table 1. Product Feasibility Criteria Based on Percentage Score

Score (%)	Category
84 – 100	Very feasible
70 – 84	Feasible
50 – 69	Feasible enough
<50	Less feasiblee

3 Result and Discussion

3.1 Analyze

The results of the analysis of 370 randomly selected participants from various secondary schools in the North Sumatra region are as follows: 164 students from class X, 85 students

from class XI, and 121 students from class XII. In this context, 78.5% of the respondents felt that sometimes chemistry subject matter posed difficulties, while 14.7% found it difficult, and 6.8% felt that they had no difficulties. Factors contributing to this difficulty were identified as follows: 47.7% of respondents referred to the complexity of chemical concepts that must be calculated, 42% felt overwhelmed by the number of interrelated concepts, and 10.3% mentioned other reasons such as concept abstraction, the number of concepts that must be memorized, and the limited media and learning resources available.

As a result of these findings, 55% of the research participants decided to utilize learning apps as the main supporting tool in the learning process. This can be reinforced by data showing that 95% of students utilize mobile devices as learning tools. This opinion is proven by various reasons: 42% consider the app easy to use, 28.4% feel that lessons become easier to understand through the app, 17.8% state that the material presented in the app is more complete, and 11.8% have other reasons such as the ability to interact directly with the teacher, free availability, and recommendations from parents [13].

3.2 Design

At the design stage, the e-book was carried out for chemistry subject semester I class XI integrated with the STEM approach. The results of the e-book design are described as follows:

3.2.1 Menu Login

Once the user has successfully logged in, the login menu can be used to provide a more personalized experience.

Fig. 1. Login Menu for Learners

3.2.2 Menu List

A menu list in an e-book is a feature that provides quick and organized access to various functions and important parts of the e-book. This feature is similar to menus in other software or applications. Here are some of the main uses of menu lists in e-books:

a. Organized Navigation: Menu lists allow readers to easily navigate through different sections of the e-book, such as chapters, pages, or acts. This helps readers to access the content they want without having to wrestle with long scrolls or page abandonment.

b. Content Search: The search feature is often integrated into the menu list. Readers can enter keywords or phrases to search for specific words or topics in the e-book. This is very useful in finding specific information without having to read the e-book from start to finish.

c. Captions or Additional Information: The menu list may provide access to additional captions or information about the e-book, such as author, copyright, or reference information.

The display of the menu list in the e-book can be seen in Figure 2.

Fig. 2. Display of E-Book Menu List

3.2.2. STEM Approach

The STEM (Science, Technology, Engineering, and Mathematics) approach is an educational method that integrates concepts and skills from these disciplines. When applying the STEM approach in the e-book content, the goal is to invite readers, especially students, to be actively involved in understanding and exploring scientific, technological, engineering, and mathematical concepts. Here are some displays of e-book content in accordance with the STEM approach.

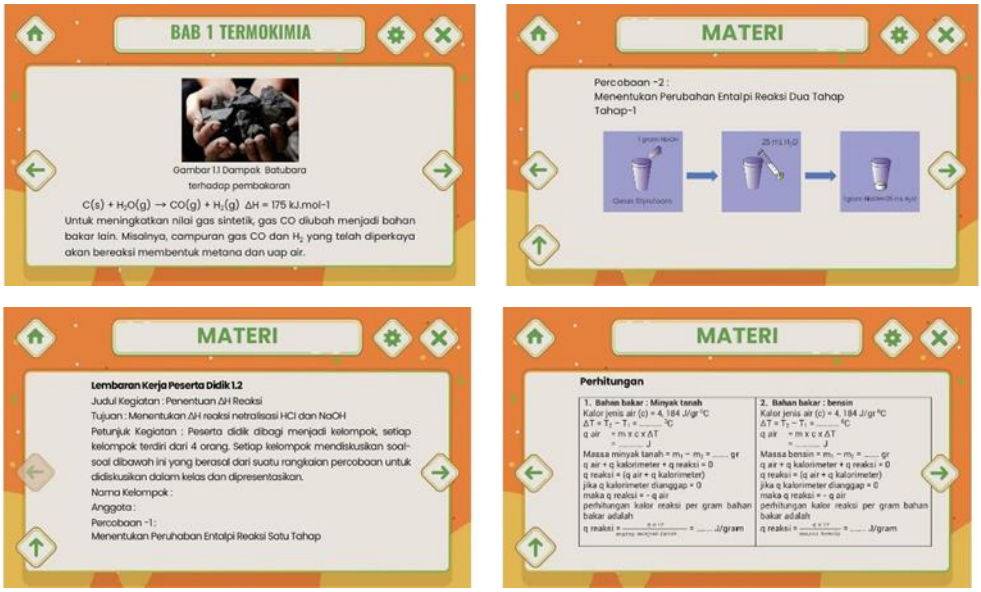

Fig. 3. E-Book Display in accordance with the STEM Approach

3.2 Development

At this stage, the validity of the e-book that has been made from the point of view of material and media is tested by a number of experts. This module was reviewed by four competent expert individuals. The decision to use this number of validators was chosen to measure the validity of the instrument by considering input from experts (expert judgment), which amounts to at least three people [14].

Material validation focuses on the presentation of the content in the e-book. The material validation process is divided into three important aspects, namely content feasibility, language feasibility, and presentation feasibility. The results of this material validation can be seen in Table 2.

Table 2. Material Validation Analysis

Rated Aspect	Value	Category
Content	3.62	Valid
Language	3.77	Valid
Presentation Feasibility	3.62	Valid
The average value	**3.67**	**Valid**

Based on the results of the e-book material validation evaluation, an average value of 3.67 was obtained, indicating the valid category. These results indicate that the content in the e-book has successfully achieved the desired learning objectives, is in line with the characteristics of students, and follows the established concept of chemistry. Evaluation of the suitability of the content of teaching materials reveals that teaching materials have been developed by referring to applicable scientific concepts and theories, as well as paying attention to the latest developments in the field of science and findings from empirical research [15]-[16].

The e-books that have been developed are also designed with easy-to-read fonts and sizes, attractive layouts, and clear images. These advantages in presentation help convey messages and information more effectively, and also provide visual elements that enhance the appeal of the e-book [17]-[18]. The presentation of macroscopic images in the e-book is well adapted from phenomena that occur in everyday life. This step is in line with the fact that observations at the macroscopic level can often be understood through our daily experiences [19]-[20].

Media validation focuses on the media presentation in the e-book. Media validation on e-books aims to ensure that the media elements used in e-books support and enhance the reader's experience and the effectiveness of information delivery. This material validation process is divided into three aspects, namely design, visual appearance, media display. The results of this media validation can be seen in Table 3.

Table 3. Media Validation Analysis

Rated Aspect	Value	Category
Design	3.75	Valid
Visualization	3.65	Valid
Media	3.75	Valid
The average value	**3.75**	**Valid**

The results of the evaluation of media validation show that the average value obtained is 3.75. This figure indicates that the e-book that has been developed has completeness, clarity, and systematic arrangement. In this context, e-book comzponents include introduction, usage instructions, learning materials, evaluation questions, as well as multimedia support such as images, audio, and video. The quality of e-book content has a significant impact on the interaction that will occur during the learning process. E-books are not only influenced by the technology used, but also by the design of its content which plays a crucial role in presenting information effectively [21]-[22].

Interesting and varied media can make the learning process more enjoyable and less monotonous. This can help maintain readers' interest and motivation in reading the e-book. For individuals who have a visual learning style, media validation can ensure that strong visual elements are used effectively to convey information and concepts [23]-[25].

4 Conclusion

The resulting product is an e-book on chemistry class XI term I material. This e-book development uses the ADDIE model which is limited to the Development stage, namely validity. Based on the analysis of the validation questionnaire conducted by four validators, it was found that the validity of the material had a value of 3.67, while the validity of the media had a value of 3.75, on the highest scale of 4. The resulting data shows that the e-book that has been developed has validity both in terms of material and media. Therefore, this e-book has the potential to be tested as a useful source of reading material.

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