An interactive e-book development based on green chemistry study on Hydrocarbon

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Abstract. The aim of this study is to make an interactive e-book based on the green chemistry approach. This interactive e-book was prepared by using the development research method by Richey, Klein, and Nelson with the DDE model (Design, Development, and Evaluation). Interactive aspects of this teaching material are the “watch for know” column that presents related learning videos, links that contain related general knowledge, practice questions and competency test at the end of learning activities that consist of questions, scores, and the answer key. This interactive e-book includes green chemistry aspect as an approach by providing contextual cases in hydrocarbon subject. This interactive e-book is valid after going through two types of validation, that were content and media validation. There are two validator in each type of validation. The validation questionnaire is an instrument used in this study. The content validation questionnaire consist of subject accuracy, recency, and communication aspect. The media validation questionnaire consist of media design and navigation/operation aspect. The media validation questionnaire consist of media design and navigation/operation aspect.

1. Introduction

Teaching materials are one of the important aspects of the learning process which is needed by teachers and students. In terms of technology used, the kinds of teaching materials consist of four categories, printed teaching materials such as handouts, books, modules, student worksheets, brochures, leaflets, wall charts, photos/pictures, models/mockups. Hearing teaching materials (audio) such as cassettes, radios, and audio compact disks. Audio-visual teaching materials such as video compact disks, films. Interactive multimedia teaching materials (interactive teaching materials) such as CAI (Computer Assisted Instruction), interactive multimedia compact disks (CD), and web-based learning materials [1].

Teaching material is a guide for a subject that was written and compiled by relevant field experts and meets the rules of textbooks and is officially published and disseminated [2]. One type of teaching material that is most often used is books. Books are written teaching materials that present knowledge which is composed of bound and cover-bound sheets [1]. With the existence of good teaching materials or learning resources, participants are expected to be able to acquire and increase their knowledge. Therefore, we need teaching materials that are easy to apply and efficient in use. Through the current development of science and technology, the use of printed books can be transferred to using the electronic version or commonly known as e-books.

The very rapid development of science and technology as it is today provides opportunities for every student to be able to learn independently, whatever, and whenever according to their learning interests. The teacher no longer acts as the only learning resource but acts as a learning designer. Teachers are required to be able to design learning by utilizing various kinds of appropriate media so
that the learning process takes place effectively and efficiently [3]. Various media can be developed by the teacher, including developing teaching materials in interactive e-books form that can help students learn independently, practically, and efficiently.

E-books play an important role in the learning process because they can increase learning productivity, make learning more effective and efficient, and they are not obsolete like printed books in general. The most important part of using e-books is that it allows students to learn independently [4]. Even though e-books have several advantages compared to printed books, until now most e-books are only presented in the form of text and images, so it is necessary to develop e-books that can present videos, simulations, and animations for the material to be delivered.

Interactive e-books are very suitable to be developed for chemical materials because the chemical material presented must include three levels of representation [5]. The pictures, videos, and animations are shown can clarify the concept to be presented [6]. Information obtained verbally and visually from interactive e-books will be stored in long-term memory. In addition, exercises that provide feedback to students can teach students, entertain, or encourage students to continue learning [7]. Therefore, through interactive e-books students' understanding and interest in learning chemistry can be improved [8].

The preparation of e-books can differ from one and another even though in the same subject and approach used. One of them is by integrating green chemistry into this teaching material. This was made because the thematic presentation of concepts in e-books can make students better understand science in an integrated manner [9]. Incorporating green chemistry into teaching materials invites students to prevent pollution and make the environment as a priority in understanding the material [10].

Several universities have incorporated green chemistry into their specific curriculum. However, this has obstacles in terms of implementing it because the structure in a department or university is very complex [11]. So that the integration of green chemistry is only carried out in certain parts of learning. Therefore, in this research, green chemistry will only be used as an approach to the teaching materials to be developed. So that through this research the teacher can develop teaching materials that provide experience to students in utilizing technology in learning as well as instilling awareness in preserving the environment.

Chemistry subjects are one of the essential subjects for students who choose to major in Science. Students are required to follow this subject. High school chemistry materials are the basis for understanding the next chemical material. Chemistry subjects must be presented by covering three levels of representation, namely the symbolic, macroscopic, and submicroscopic levels [5]. Chemical materials also need to be introduced through a direct approach to nature, for example, the green chemistry approach. This is done so that chemical materials can be introduced to students through natural conditions because almost every change in matter involves a chemical process are examples of chemical processes.

Based on the background, the aim of this study is to make an interactive e-book based on the green chemistry approach.

2. Methodology

2.1. Research Method

The research design to be carried out is developmental research that aims to produce a valid, practical, and effective an interactive e-book based on green chemistry teaching material. The research method is Developmental Research by Richey, Klein, and Nelson. The development model is the DDE (Design, Development, and Evaluation) [12].

2.1.1. Designing. The activity of conducting analysis and making product plans. Activities will be carried out through literature studies from the curriculum and previous research journals. At this stage, the researchers determined the theme of developing teaching materials in the form of an interactive e-book to be developed.
2.1.2. Development. The activity of making products based on designs that have been made and conducting formative evaluations. In this step, researchers developed interactive e-book teaching materials based on green chemistry using the 4 STMD methods by Sjaeful Anwar [13].

2.1.3. Evaluation. The activity of using, testing, and assessing the feasibility of teaching material products that have been developed. In this step, the researcher check the teaching materials’ validity.

2.2. Instrument

2.2.1. Open questionnaire. An Instrument for content validity of the content or material presented in the teaching material. Validated by two material experts

2.2.2. Open questionnaire. An Instrument for Media validity of media in terms of appearance, features, writing, readability, etc. Validated by two media expert.

3. Result and Discussion

3.1. Designing

In this step, researchers collect various information about the types of teaching materials that are considered the most effective to be developed. The results obtained are the researchers made interactive e-book teaching materials. An interactive e-book is one of the teaching materials that can be used by students to learn independently. In addition, interactive e-books also not only present text and images but can also present various features that invite students to be able to interact with these teaching materials.

E-books provide learning experiences for students in two ways: First, the useful features displayed in the e-book can directly improve their learning outcomes. Second, increasing knowledge regarding information and communication technology [14]. In addition, learning with technology can provide a positive learning experience in enhancing active learning through peer interaction and understanding multiple representations of molecular structures using technology [15].

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3.2. Development

Some activity in this step are:

3.2.1. Analyzing the applicable curriculum as a reference in compiling material in teaching materials. The most important aspect of designing the development of teaching materials is paying attention to the demands of the curriculum [1]. This means that the teaching materials prepared must be in accordance with the applicable curriculum. In the 2013 curriculum, the government has determined CC (core competency) and BC (Basic Competency) and applies to all schools with the same level in Indonesia. KI is a categorial description of the competencies that students must learn for a school level, class, and subject. The BC is a competency that students learn for a subject in a certain class [16]. Even though CC and BC have been established by the central government, the ways to achieve them, and what teaching materials are used are fully returned to educators as professionals.

3.2.2. The next step is to collect literature for the concepts presented in the teaching materials. Books that are used as literature are:

- Bradi, James. Et al. 2015. Chemistry, seventh edition.
- Chang, Raymond. 2005. Kimia dasar JILID 1. Jakarta: Erlangga.
3.2.3. Made the draft of teaching material. This draft contains the concepts, theories, and materials of hydrocarbons. In addition to presenting material, this draft includes pictures, video links, and practice questions and competency questions which are the main material in the preparation of interactive e-book teaching materials.

3.2.4. Made a storyboard. This contains the materials in the draft teaching materials and is equipped with information which is a reference in the preparation of an interactive e-book.

3.2.5. Compilation of interactive e-books. Researchers carry out this step by working with programmers. During the preparation of the interactive e-book, researchers always coordinated through storyboards that had been prepared in the previous stage. The interactive aspects of this teaching material can be seen in the following figure.
Figure 3. Interactive link. Directly connected to the browser in their device to open more information.

Figure 4. Practice room. It shows some questions related to the subject that they have learned.

Figure 5. Green Chemistry aspect in the concept text.

Figure 6. Green Chemistry aspect in the chemical reaction.

Using green chemistry approach to a teaching material is something that suitable for chemistry subjects. This concept emphasizes a method based on reducing the use and manufacture of hazardous chemicals, both from a design and a process perspective. The chemical hazards referred to in the green chemistry concept cover various threats to human health and the environment, including toxicity, physical hazards, global climate change, and depletion of natural resources (Anwar, 2015). In addition to being more environmentally friendly, green chemistry can also be used in various fields, such as economics and education around the world [17] Many advances that have been made in embedding green chemistry concepts, principles, strategies, and tools into the modern chemistry curriculum [18] one of them is using green chemistry as an approach in this teaching material.

3.3. Validation

In this step, interactive e-book was validated. Validation process consist of content validation and media validation. Content validation was carried out by two content expert validators. Media validation was carried out by two media expert validators. The purpose of this validation is to find out and ensure that the teaching material meets the established criteria. Some parts of teaching material that have revised after being checked by the validator show in the following figure:
After the interactive e-book teaching materials were validated by the content validator and the media validator, several changes were made. Among them change in appearance and content of teaching materials. Several revisions were made after content validation are inserting green chemistry approach into indicators, especially in basic competency 4th, replacing a few words in the text to improve the meaning of sentences, incorporating aspects of green chemistry in chemical reactions, and replacing videos that were unclear into videos that more clearly in relation to the concept being conveyed.

The validation results from media validation are improving some views of teaching materials to make them look more attractive, adding images to certain questions, and changing the type of font in certain features, and enter interesting invitations according to the age of the students.
4. Conclusion
The characteristics of this teaching material are presenting material and various features such as direct access links, videos, practice questions, and competency tests that invite students to interact with the teaching material.

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