The making of electronic modules on alternative fuels material based on green chemistry

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Abstract. This research was conducted to produce teaching materials in the form of e-modules on alternative fuels based on green chemistry fuel material. The presentation of material and visualization that used in this e-module based on green chemistry includes the losses caused by the use of fuel oil and the solutions offered to overcome them by the presence of alternative fuels based on green chemistry. This research uses the Design Based Research method with the ADDIE model. The e-module is tested for its feasibility. The results of the feasibility test show 94-100% of the respondents agreed to all the criteria in the e-module. These results indicate that the green chemistry-based alternative fuel e-module that has been made is feasible to use. This research is useful to increase student awareness about the importance of protecting environment through chemistry learning process.

1. Introduction
Chemistry is directly related to our daily lives [1]. Its use is very common for everyone in the world because we can survive on this earth regardless of the chemicals in it. However, the negative benefits that can be taken, there are also many negative effects that can be caused [2].

The use of fuel oil (BBM) is one application of chemicals in everyday life that has many benefits for human life. Intermediate benefits from the use of fuel, there are also many losses incurred. An example is air pollution which will further enhance human health and the sustainability of our earth. This creates a difference in the wider community considering its continued use. Another case of the impact of pollution due to fuel use is global warming [3], acid rain, and climate change [4]. There are many ways that can be done to minimize the negative impact of pollution of fuel use, one of them is by using the principles of green chemistry into the manufacturing process [5]. The application of the principle of green chemistry in minimizing the negative impact of fuel use pollution, is a very appropriate choice because green chemistry covers all aspects and types of chemical processes related to the negative impact of chemicals on human health and the environment [2]. This is one example of the practice of the contents of QS. Al-Araf verse 56 which states the prohibition for humans to make damage to the earth and advice to guarantee the environment.

Popularizing green chemistry in educational institutions to students is one way that can be done to increase public awareness about the importance of applying the principles of green chemistry in everyday life, especially in finding pollution solutions due to the use of BBM [5]. Education oriented to green chemistry offers a solution to our current environmental problems, because this provides an
opportunity for us to help move the younger generation towards people whose quality of life is increasing, especially in providing solutions to petroleum pollution [6].

Green chemistry can be integrated into the education curriculum, it is proven to be able to improve students' understanding of chemical concepts that are more environmentally friendly [7,8]. Research conducted at St. Olaf College also shows that integrating the principles of green chemistry into educational curricula can be an alternative to saving the environment [6].

The easiest way that can be taken to integrate the principles of green chemistry into the education curriculum is to make textbooks that relate the principles of green chemistry to chemical aspects in everyday life. This opinion is supported by research from [9,10-12]. However, the use of textbooks has many disadvantages in its implementation, especially in the concept of BBM. This is because there is no visualization in textbooks such as images, audio and video. Even though visualization, such as the process of formation, processing and pollution due to the use of fuel oil, is needed.

The solution that can be done to the shortcomings of the textbook is to make an e-module. The e-module selection to integrate green chemistry on the BBM concept is the right choice because this media has characteristics and building components that are so complete to convey information about green chemistry to students [1,13]. In addition, e-module is an interesting learning media that can be used for students. Interesting learning can increase students' interest and passion in learning, so students are active in the learning process [14].

Based on research conducted at Scranton University in 2000, it was found that students became more aware of the importance of protecting the environment by applying the principles of green chemistry from learning organic chemistry [15]. The use of e-module as a source of reading material for students is expected to help us all in finding solutions to pollution of the environment around us, especially those caused by the use of fuel [16].

Based on the background that has been stated, the formulation of the problem in this study is how the results of the feasibility test of green chemistry-based alternative fuel e-module? This study aims to analyze the feasibility test of green chemistry-based alternative fuel e-module.

2. Experimental Method
The research method used is the Design Based Research method with the ADDIE model. Design Based Research integrates the development of solutions to problems in the learning environment by identifying the principles of design itself. This method aims to develop educational materials designed to support learning. The procedure of this study uses the ADDIE model (analysis, design, development, implementation, and evaluation) [17]. However, for this research, the design of making e-module based on green chemistry-based alternative fuel is only carried out up to the stage of analysis, design and development.

The analysis phase includes making needs analysis, concept analysis, concept maps, and content analysis. While the design stage is the stage of making an e-module design which includes the collection of material, images, videos and others that are related to green chemistry-based alternative fuel materials and products in the form of storyboards and flowcharts. In the development phase e-module is made according to the design made at the design stage. The e-module was validated and tested for its feasibility to 15 respondents. The products produced in this study are in the form of E-modules on Alternative Fuel Materials Based on Green Chemistry.
3. Result and discussion

3.1. The display of electronic modules on alternative fuels material based on green chemistry

Figure 1. The main display of e-module.

Figure 1 is the view that first appeared when opening the e-module. On this slide a large title is displayed, namely E-module of Alternative Chemistry based on Green Chemistry and there is a start button to enter the main menu. In this initial display there is a picture of a gas station nozzle hose decorated with green leaves that makes the symbol of the theme that will be discussed in this e-module namely alternative chemistry based green chemistry.

Figure 2. The main menu display of e-module.

Figure 2 is the main menu where there are five buttons that are links to the menu choices that have been presented. The five menus are introductory which contain an overview of the contents of the module, instructions for use which contain instructions and introduction of key functions to make it easier for users of e-modules, material which is the core of the e-module, evaluation containing questions to
measure understanding the user after studying the material from the e-module, and the author's profile containing the profile of the e-module compilation team.

Figure 3. One of quiz display of e-module.

Figure 3 is one type of quiz on the e-module. This scene is made so that users have initial knowledge about the types of fuel and their designation.

Figure 4. One of experiment display of e-module.
Figure 4 is a practical guide to making bioethanol from banana peel containing stages of making bioethanol from kepok banana peel that has been visualized through images so that users are easier to apply and the e-module display is even more interesting.

3.2. The result of validation test of electronic modules on alternative fuels material based on green chemistry

| No | Rated Aspect                        | $r_{\text{count}}$ | $r_{\text{critical}}$ | Result |
|----|-------------------------------------|---------------------|------------------------|--------|
| 1  | Learning aspect                     | 0.73                | 0.3                    | Valid  |
| 2  | Material substance aspect           | 0.87                | 0.3                    | Valid  |
| 3  | Display and navigation aspect       | 0.81                | 0.3                    | Valid  |
| 4  | Evaluation aspect                   | 0.78                | 0.3                    | Valid  |

3.3. The result of feasibility test of electronic modules on alternative fuels material based on green chemistry

| No | Rated Aspect                        | Average      | Result       |
|----|-------------------------------------|--------------|--------------|
| 1  | Learning aspect                     | 100%         | Very decent  |
| 2  | Material substance aspect           | 98.83%       | Very decent  |
| 3  | Display and navigation aspect       | 94%          | Very decent  |
| 4  | Evaluation aspect                   | 98%          | Very decent  |

4. Conclusion
The validation test showed that the results of the $r_{\text{count}}$ were between 0.73-0.87 and could be declared valid. The results of the feasibility test showed that 100% of respondents agreed on learning aspects, 98.8% of respondents agreed on the substance aspects, 94% of respondents agreed on the display and navigation aspects, and 98% of respondents agreed on evaluation aspects. In general, it can be concluded that green chemistry-based alternative fuel e-module is feasible to be used as a learning media.

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