Learning crude oil based on environmental literacy

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Abstract. This research is carried out using design-based research methods to develop chemical teaching materials on crude oil based on environmental literacy. The process of forming and processing crude oil, fossil fuels, the quality of gasoline, the impact of burning fossil fuels and alternative fuels is presented in the form of a chemistry magazine oriented aspects of environmental literacy. The magazine presents text, images, graphics, tables, games, comics, poems and videos that are accessed via QR-code. This research uses Design Based Research that adopts the stages of ADDIE (Analysis, Design, Development, Implement, and Evaluations). The results of the validation test show that the magazine made can be declared valid and is suitable for use. It is hoped that teaching materials can be used to foster student awareness of maintaining and improving the environment.

1. Introduction
The Efforts to overcome environmental problems need to be done through chemistry learning, so students have the awareness to protect and preserve the environment. The use of fossil fuels for various purposes can have a negative impact on environmental sustainability, for example increased air pollution, acid rain, climate change, and increased concentrations of greenhouse gases resulting in the phenomenon of global warming \cite{1,2}. These environmental problems are certainly not something that can be considered trivial anymore. Because of that we need an education that can make people aware to preserve the environment. The right target to provide education is through the world of education, so it is felt necessary to make an environmentally oriented learning \cite{3,4,5}. Some previous researches that related to this research stated that the development of environmental literacy of students has not yet reached satisfactory results \cite{6,7,8}, so it needs to be improved in various ways. Teaching materials need to facilitate the development of environmental literacy that is easily accessible to students and becomes an enriching material that is fun to learn. Environmental literacy needs to be applied to the concept of crude oil, because it is closely related to environmental problems. In addition, environmental literacy is not only knowledge of environmental and ecological concepts, but also can train a deep set of skills, resulting in high motivation to take action on the environment \cite{9}. Environmental literacy has several components that must be achieved by students, namely knowledge, cognitive skills, attitudes and actions as a sense of responsibility towards the environment (behavior / action) \cite{10}. For this reason, environmental literacy indicators become outcomes in teaching materials for crude oil. To be easily accepted by students, environmental literacy indicators as outlined in crude oil material must certainly be packaged and presented in the form of innovative and interesting media. Various forms of learning media on crude oil material have been developed by various researchers \cite{11,12,13,14}.

Teaching materials that is in the form of a magazine have been developed by researchers on several subjects. The results of the study show that teaching materials that are packaged in a magazine are suitable for students to explore teaching material more pleasantly than in the form of ordinary textbooks \cite{15,16,17,18,19,20,21,22}. However, there has been no research for the development of teaching materials in the form of crude oil magazines oriented to the development of environmental literacy. Chemical magazines as an alternative learning resource are more effective than other printed teaching materials such as books and printed modules \cite{17}. That is
because, chemistry magazines pay attention to the presentation of graphic aspects such as pictures and colors in order to increase students' interest in reading [22]. Presentation of information in a chemical magazine can be in the form of text, colored visuals and illustrated images, so students can learn more fun and effectively [23]. In this research, a new feature of the chemistry magazine developed is the use of QR-codes to access videos that complement the information presented, so as to increase students' knowledge and understanding. This research describes the results of research into the development of teaching materials based on environmental literacy, which are packaged in the form of an innovative chemistry magazine.

2. Method
This research uses Design Based Research that adopts the stages of ADDIE (Analysis, Design, Development, Implement, and Evaluations) [24]. In this paper, the research is only carried out until the development stage, which can be described as follows: 1) Analysis: at this stage the researcher conduct the concept analysis and the concept mapping of crude oil teaching materials, discourse analysis to map the relationship of content with environmental literacy; 2) Design at this stage, the researcher collect the material, the pictures, packaging the teaching material in the form of magazine narratives that are equipped with QR-codes to access learning videos. The next step at this stage is create a story board and the magazine design by using software CorelDraw X7. 3) Development: at this stage, the design that has been developed is being adjusted with the aim of making a magazine oriented in environmental literacy. This stage depends to the analysis and design stage.

The product was validated by three expert validators to analyze the suitability of the presentation of material and visuals with environmental literacy indicators. The results of filling out the questionnaire from the validator in the form of eligibility (r) from each item of the evaluation criteria used in the stages of making a chemical magazine. The value (r) is compared with the critical value whose value is r = 0.3. If the value of each criterion is more than 0.3, then the criterion item is declared valid. Conversely, if the r value of the criterion item is less than 0.3 then the item criterion is declared invalid. The formula used for the eligibility value (r) is : $r = \frac{x}{N_n}$ which : $r$ = validity value ; $x$ = total weight of respondent's answer; $n$ = number of respondents; $N$ = total number of questionnaire values [25]. The results of the product revision are used for a limited test to determine product eligibility. The feasibility test was conducted by ten randomly selected students.

3. Result and Discussion
Based on the discourse analysis, learning the crude oil based on the environmental literacy includes five sub materials. The following is a description of the relationship of the crude oil with the environmental literacy indicators: 1) The process of forming crude oil: Identification the process of forming crude oil in nature; Attitudes and energy saving actions in using fossil fuels. 2) Crude Oil Processing: Identification the crude oil processing; Attitudes and actions to care about environmental pollution due to oil spills in refineries. 3) Fossil Fuels & Gasoline Quality: Identification of fossil fuel combustion reactions, Identification of the quality of gasoline quality and its relationship with the combustion reaction, Attitudes and actions in choosing fuel that is safe for the environment. 4) Environmental pollution due to burning of fossil fuels: Identification the environmental pollution due to the burning of fossil fuels, Attitudes and actions to care for the environment by carrying out activities to prevent the impact of burning fossil fuel. 5) Renewable fuels: Identify the characteristics of renewable fuels that are environmentally friendly, Attitudes and actions to conduct experiments in making renewable fuels on a laboratory scale.

Crude oil teaching materials are packaged in the form of a magazine based on the environmental literacy. The teaching material that presented in the magazine, as follow: 1) the process of forming the crude oil is presented in the form of text, images and videos. 2) The fractional distillation process is presented in the form of text and images which are equipped with puzzle games. 3) Some cases of oil spill tragedies that occurred in various countries, the dangers and how to overcome them are presented in the form of text, images and video. 4) The type and quality of gasoline and its effects on
Combustion reactions are presented in the form of text, images and videos. 5) The impact of the incomplete combustion of fossil fuels is presented in the form of cartoon comics, poetry and puzzles. 6) Renewable fuels are presented using text, images and videos. All videos can be accessed by scanning QR-Codes on the related pages that linked to YouTube videos.

Presentation of aspects of magazine content or material begins with presenting phenomena and discourse related to sub material discussed in crude oil teaching material. It is intended that the reader or students can have preliminary knowledge and encourage students to think critically about the material to be discussed. In accordance with the theory of Witte & Beers [26] that phenomena and discourse aim to direct learners who are capable of zero literacy towards multidimensional literacy. The use of pictures, videos, tables or graphics to transfer learning content must be done so that students can understand chemical phenomena easily. The visualization presented will facilitate the delivery of information, so that learning material is more interesting and easier to understand [27].

Based on the magazine that have been made, here are some important and best pictures from the magazine. On pages 15-16 (Figure 3-4), environmental literacy in the aspect of knowledge is presented in the form of comics, so it looks more interesting and more innovative. The knowledge provided is knowledge about examples of the effects of CO gas poisoning from the burning of motor vehicle fuel that goes imperfectly. On page 17 (Figure 5), cognitive aspects are presented in the form of questions that direct students to identify one of the effects of burning fossil fuels. Attitude and action aspects are presented through questions that lead to solutions to these problems.

Figure 1. Front Cover.  
Figure 2. Table of Content.
Figure 6, aspects of knowledge are presented in the form of discourse about biodiesel. Attitude aspects are presented in the form of directing questions to build students' curiosity about one alternative fuel, namely biodiesel. On page 28 (Figure 7), the action is presented in the form of an invitation to experiment with processing used cooking oil into biodiesel. Then the cognitive aspect is presented on page 29 (Figure 8) in the form of questions that require students to characterize the compounds produced after the experiment is completed.
Figure 9 contains a discourse on making bioethanol using raw materials from the skin of Kepok bananas (Latin name: *Musa paradisiaca* L [28]). Kepok banana peel is a waste of bananas that has not been used significantly and only disposed of as organic waste. Generally, Kepok banana peel waste is used as animal feed such as goats, cows, and buffalo. The abundant amount of banana peels will have a beneficial value if used as raw material for making bioethanol [29]. For this reason, through a chemical magazine, students are introduced to how to process Kepok banana peels into bioethanol. It also introduces the manufacture of chemicals based on green chemistry principles [30].

Figure 9, a preliminary question is presented to stimulate students to have thoughts towards the discussion of bioethanol. Furthermore, the knowledge aspect of environmental literacy is described: the potential of Kepok banana peel as a raw material for making bioethanol. Then the attitude aspect of scientific literacy was raised with the invitation to make bioethanol from Kepok banana peel. Making bioethanol from Kepok bananas refers to several published research results [29], [31].

Procedures and techniques for making bioethanol from Kepok banana peel are explained in the form of an image on page 31 (figure 10). In addition to explanations in the form of images, students can use QR-codes that contain links to articles and videos of making bioethanol using alternative different raw materials. It is expected that with the inclusion of experimental procedures in the magazine, students have the desire to practice these procedures. This can develop students’ scientific work skills which are aspects of action in environmental literacy [32]. Cognitive skills can be measured through questions related to experimental activities. The questions asked are: So did you succeed in making bioethanol? If it works, what are the characteristics of the bioethanol that you have produced? Is your bioethanol the same as ethanol that is often found in laboratories? Why the
temperature during the distillation must not exceed 80°C.

**Figure 10.** Procedures and techniques for making bioethanol from Kepok banana peel.

The validation test phase is carried out by three expert validators consisting of two chemical material experts and one media expert. The validation process is carried out by providing a print draft of the magazine to the validator. The validator is asked to fill in the assessment questionnaire and provide suggestions for improvement. Validated aspects include: A) the presentation of the contents of the material (content knowledge), B) language (grammatical aspect) and C) appearance of the magazine. Scoring by the validator done for each indicator and learning material presented in draft magazine. Scores are given using a rating scale of 1 to 5. Score 5 = Very Good, 4 = Good, 3 = Good enough, 2 = Not good, 1 = Very Poor. The results of the validation test can be seen in Table 1.

| No. | Statement Item                                                                 | Average Score | V1  | V2  | V3  | r count | r critical |
|-----|--------------------------------------------------------------------------------|---------------|-----|-----|-----|---------|-----------|
| A   | Content Knowledge                                                              |               |     |     |     |         |           |
| 1.  | The suitability of the contents of the material with aspects of environmental literacy | 4.74          | 4.06| 4   | 0.85 | 0.3      |
| 2.  | Clarity of content knowledge description                                        | 4.58          | 4.11| 4   | 0.85 | 0.3      |
| 3.  | The suitability of illustrations or pictures with content knowledge             | 4.48          | 4.06| 4   | 0.84 | 0.3      |

Table 1. Result of Validation Test.
Table 1 shows that the magazine is valid with the average $r_{\text{count}} = 0.3$ [26]. The highest value is in the material aspect with 0.85, while the lowest $r_{\text{count}}$ value is in the language aspect that is 0.82. From the results of the validation obtained several points of advice from the validators to improve magazine products. The following resumes the suggestions from the validator: 1) Table of contents does not display all contents of the magazine, 2) The sentence structure of the question is not quite right (on page 05), 3) The picture about fractional distillation must be fixed (on page 06), 4) The sentence structure in the quiz filling instructions is not correct (on page 06), 5) Added the equation for the formation of $SO_x$ and $NO_x$ (on page 14), 6) In several pages: improvements to background color contrast with text. Based on suggestions for improvement, then a revision of the magazine draft was carried out. Feasibility test carried out after the draft of the magazine corrected and confirmed to the validator for approval.

The feasibility test was conducted by giving questionnaires to 10 respondents. The feasibility test includes aspects of presenting the contents of the material, language and appearance of the magazine. The aspects and points of the statement in the feasibility test are almost the same as the validation test. But the difference lies in the response of the answer. In the validation test, the validator is asked to provide a value with a rating scale of 1 to 5. In the feasibility test respondents are asked to give a response ‘Yes’ or ‘No’, then the number of responses for each statement is converted into a percentage of responses. The results of the feasibility test can be seen in table 2.
Table 2. The result of feasibility test.

| No | Statement Item                                                                 | % of responses agreed (Yes) ; N = 10 |
|----|---------------------------------------------------------------------------------|--------------------------------------|
| A  | Content Knowledge                                                              |                                      |
| 1  | Clarity the contents of the material in each magazine feature                   | 100                                  |
| 2  | Clarity description of the material presented on each magazine feature          | 100                                  |
| 3  | The suitability of the contents of the material with the aspects of environmental literacy | 100                                  |
| 4  | The appropriateness of providing concrete examples from the environment         | 100                                  |
| 5  | The suitability of illustrations or images with the content                      | 90                                   |
| 6  | Accuracy in placing QR-codes that contain video links or articles related to petroleum material | 100                                  |
| 7  | Clarity of the verses of the Qur'an relating to the environment                | 100                                  |
| 8  | Ease of studying petroleum material                                             | 100                                  |
|    | Average =                                                                      | 98.75                                |
| B  | Language (Grammatical) Aspect                                                  |                                      |
| 1  | The use of spelling, terminology and punctuation                                | 70                                   |
| 2  | The accuracy of the structure of sentences or phrases                           | 90                                   |
| 3  | Consistency in using scientific or foreign terms                                | 100                                  |
| 4  | Ease and clarity of sentences to understand                                     | 100                                  |
|    | Average =                                                                      | 90                                   |
| C  | Display Aspect                                                                  |                                      |
| 1  | Suitability of template selection with magazine content                           | 100                                  |
| 2  | The suitability of the layout of the text, objects and images                   | 100                                  |
| 3  | Font style and size are attractive and easy to read                              | 100                                  |
| 4  | Efficiency and clarity of text display                                          | 100                                  |
| 5  | Presenting illustrations or images with proportional shapes and sizes            | 100                                  |
| 6  | The color combination is appropriate, harmonious and attractive                  | 100                                  |
| 7  | The illustrations present the contents of the magazine appropriately             | 100                                  |
| 8  | Present details that have a good center of view                                 | 60                                   |
| 9  | The appearance of the layout elements on the front and back covers have a unity | 100                                  |
|    | Average =                                                                      | 96                                   |
|    | Total % of Average =                                                           | 94.9                                 |

Table 2 shows that percentage of respondents who agreed was 98.75% in the material aspect, 90% in the language aspect and 96% in the display aspect. The highest value is in the material aspect with 98.75, while the lowest value is in the grammatical aspect that is 90. From these data it can be concluded that the magazine that have been made is very suitable for use as a learning media. Overall, the results of the validation and feasibility tests show that the research product, which is an environmental literacy-oriented petroleum magazine, has high validity and eligibility. Although the results of the validation and feasibility test stated that the magazine oriented towards environmental literacy in crude oil was very suitable to be used as a learning medium, further development was felt to be carried out to correct deficiencies in the magazine that was made. In addition, further research is needed to determine the effectiveness of this magazine in the learning process.
4. Conclusion
The learning material based on the environmental literacy in crude oil material has the following characteristics, as follows: 1) The learning materials are developed into five sub materials aimed at achieving environmental literacy learning outcomes, as follows: The process of forming and processing crude oil, fossil fuels, the quality of gasoline, the impact of burning fossil fuels and renewable fuels. 2) The learning materials is presented in the form of a chemical magazine oriented aspects of environmental literacy. 3) The magazine presents the text, images, graphics, tables, games, comics, poems and videos that are accessed via QR-code. 4) The results of the validation test show that the magazine can be declared valid and is suitable for use. It is hoped that learning materials can be used to foster student awareness of maintaining and improving the environment.

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