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Developing Biogas Digital Comic for Improving Renewable Energy Literacy

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Abstract.
The use of renewable energy as a substitute for fossil energy must continue to be promoted to achieve sustainability. This study aimed to reveal the development of digital comics on the topic of biogas energy as a learning medium. The method used is research and development with the DDDE model (Decide, Design, Develop, and Evaluate). The results showed that biogas digital comics were very good to be used as learning media. This study recommends the use of comics as a medium of learning on other topics.

Keywords: Biogas Digital Comic, Improving, Renewable Energy Literacy

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1. INTRODUCTION

Energy plays an important role for the existence of a country. Its existence greatly affects economic conditions and all aspects of its derivatives. Energy can affect every aspect of life including social, political and even the security of a country [1]. Every country must have a roadmap to meet its energy needs [2]. In addition to dependence on fossil energy sources, the development of renewable energy sources will be a very promising alternative. Government and community cooperation in ensuring the availability of energy sources is absolutely necessary.

Education plays a vital role in the success of the government in the energy sector [3]. Through education, people are educated to be able to save energy [4, 5]. Through education, people can make energy transitions. Increasing people's energy literacy is the task of educational institutions at all levels. Teachers are important actors to disseminate knowledge, insight and awareness about energy to students at the elementary and secondary school levels. Teachers need to be equipped with various strategy that are considered effective in increasing the energy literacy of students.

Several efforts to increase students' energy literacy include fieldwork at home [6], project-based learning [7], dorm energy competition [8], and comic media [9], [10]. Previous research has shown that comics are proven to motivate students to learn. In addition, comics have the advantage of being a permanent visual medium, in contrast to films and animations, which are determined by the speed of the viewing process. In addition, comics are also simple, presenting stories that contain messages that are easy to digest [11, 12]. This study aims to reveal the process of developing comics learning media in introducing alternative sources of biogas energy.

2. RESEARCH METHOD

2.1. This study uses research and development (R&D) methods. This research is used to produce certain products and test the effectiveness of these products. The design chosen is the DDD-E model (Decide, Design, Develop, Evaluate) as shown in Figure 1.

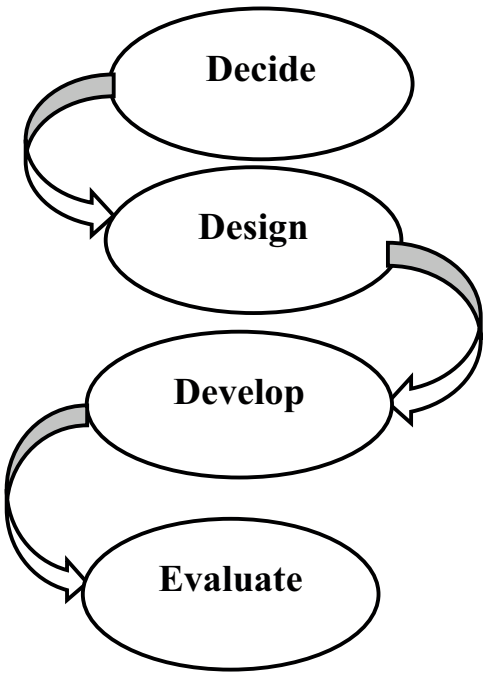

Figure 1: DDD-E model R&D design.

The research and development procedure for biogas alternative energy digital comic media includes the following steps:

Decide. At this stage the researcher conducted a preliminary study in the form of a needs analysis. The preliminary study was conducted through in-depth interviews with

science teachers at each level of education. The results of the interviews are taken into consideration in formulating the objectives of media development and the type of media to be selected. Some science teachers suggested that the media developed be made as attractive as possible. This stage decides the choice of media to fall on digital comics with considerations: there are interesting images, flowing stories, and easy to carry and access.

Design. At this stage the researchers began to make the stages of designing comic media in flow charts and story boards which were supported by the program structure. The program structure states the objectives of media preparation, the competencies that are expected to emerge after reading comics, what content should be displayed, and the required resources.

Develop. At this stage, the design contained in the storyboard has begun to be applied in comic media. The process of making this product goes through several stages, namely: (1) Creating comic scenarios using the Microsoft Word application, (2) Visualizing the scenario using Cartoon Story Maker and Canva software, (3) Designing comic layouts using the Comic Life application, and (4) Digitizing using the comic life and PDF applications. This digital comic media has a format consisting of a cover page, a basic competency page and learning objectives, character introduction, and content pages for biogas-themed comics.

Evaluate. At this stage, the comics media that have been made are validated by experts before being used in learning and tested for their effectiveness. Validation is carried out by content experts and media experts. Validation was carried out to see the feasibility of comics as learning media. The validation sheet given is in the form of a closed questionnaire using a Likert scale with a rating scale of 4 = very good, 3 = good, 2 = pretty good and 1 = not good. Calculation of the validation sheet using the formula:

$$N = \frac{\sum fm}{\sum fa} \times 100\% \quad (1)$$

Where N = eligibility level, fm = total score obtained and fa = maximum score. Aspects assessed by media experts include the appearance of writing, display of images, the functioning of comics as learning media and the benefits of media in supporting the achievement of student competencies. The final score of the expert assessment was confirmed on the criteria shown in Table 1.

3. RESULT AND DISCUSSION

TABLE 1: Criteria for validation of teaching material feasibility.

No	Score	Validation Criteria
1	$75\% < V \leq 100\%$	Very good
2	$50\% < V \leq 75\%$	good
3	$25\% < V \leq 50\%$	Pretty good
4	$0\% \leq V \leq 25\%$	Not good

3.1. Content, Context and Competence

The results of the needs analysis in the DECIDE phase resulted in several decisions, one of which was determining the level of education chosen, the competencies to be developed and the content and context of the chosen learning. The education level chosen is high school. The results of the analysis on the science curriculum (physics, chemistry and biology) at the high school level decided that the development of digital comic media is directed at strengthening basic competencies: (1) Analyzing the limitations of energy sources and their impact on life in cognitive aspects and (2) Presenting ideas/ the idea of the impact of limited energy sources for life and efforts to solve problems with alternative energy on the psychomotor aspect. This competency is obtained from the field of physics studies level 12.

At the beginning of the media, content is presented regarding the limitations of fossil-based energy sources as a context/problem. This problem is the basis for the search for alternative energy. Researchers chose biogas as an alternative energy based on the results of research studies in the area around the school where the research was conducted. The research was conducted in a city in West Java. The development of biogas as energy is closely related to livestock such as cattle. Research data on the potential of biogas from cattle farming is also described as an important part (context) that will be raised in the dialogue in the comic.

3.2. Comic Design

Comics as learning media have different functions and packaging from comics in general. In addition to having an entertaining function, comics as a learning medium must support certain learning outcomes. Therefore, at the beginning of the comic, the basic competencies to be built and the learning objectives are stated. The next page contains character introductions consisting of Jeki, Bu Jeki, Ua Cen, Joni, Pak Guru, and Kinanti. The digital comic takes the theme of renewable energy, especially

biogas energy. Therefore, in the comic there is an explanation of biogas energy and an illustration of how it is made as shown in Figure 2.

3.3. The Eligibility of Comics as Learning Media

The opinion of content experts and media experts in the early stages shows the feasibility of this comic media to be implemented in the classroom. The average score of content experts shows a score of 75.75 on a scale of 100, while media experts indicate a score of 85 on a scale of 100. Referring to the criteria given in table 1, this comic media can be categorized as very good to be used as teaching materials. The total scores of content and media experts can be seen in Table 2 and Table 3.

Table 2: Eligibility of comic according to content experts.

	Assessment Aspect	Score (%)
1	Relevance	78
2	Accuracy	75
3	Completeness	70
4	Basic concept	80
	Average	75.75

Table 3: Eligibility of comic according to media experts.

	Assessment Aspect	Score (%)
1	Post Display	90
2	Image Display	85
3	Media Functions	80
4	Presentation	85
	Average	85

Digital comic media is expected to increase public literacy, especially middle school students, to the utilization of cow dung waste into biogas renewable energy. The rapid development of science and technology makes comics not only made manually but can also be packaged digitally based on mobile devices. Comic elements can attract students' attention because it consists of pictures. Thus, comics media are very effective in transferring character values through characterizations in comic stories. Comic media will facilitate the teaching and learning process, especially in realizing abstract learning concepts through more concrete examples in everyday life that are full of character values [13].

Figure 2: Comic design: (a). Cover design (b) Character recognition (c) Biogas production (d) Sample conversation (e) Closing section.

Digital comics (e-comic) are made with attractive designs, colorful and in accordance with the environmental conditions of rural communities. In addition, this renewable energy digital comic also presents material discussions that are in accordance with basic competencies, interesting storylines and strong characters. The use of digital comic media can also make it easier for students to understand the picture as a whole, build imagination, then pour out their ideas in an orderly manner. The advantage of digital comics compared to print is that they have borderless capabilities. If comics in print have a limited lifespan due to the durability of paper, digital comics in the form of electronic data can be stored in digits or bytes, and can be transferred to various storage media. Adopting a comic media style with digital packaging based on mobile devices to convey learning messages is an alternative for developing learning media in the future. Digital comic media can be accessed independently by students anywhere and anytime.

4. CONCLUSION

This research has demonstrated the feasibility of digital comics in the context of using biogas as a learning medium. The preparation of learning media that is designed by paying attention to input from users and paying attention to the development of the world of information and technology will have the opportunity to be more accepted by students who are dominated by the millennial generation. The digital comics (e-comic)

developed in this research are made with attractive designs, colorful and in accordance with the environmental conditions of rural communities. In addition, this biogas energy digital comic also presents a discussion of material that is in accordance with basic competencies, interesting storylines and funny but still educative characters. This research still has limitations, especially the feasibility aspect which was only assessed by two experts. Further research needs to measure the effectiveness of using comics as a learning medium that can improve student learning outcomes and 21st century skills.

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