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Development of Physics Digital Comic on Greenhouse Effect

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Abstract

Around 20% of the total population in Indonesia are digital comic readers and this number continues to increase from year to year. This increase has been accompanied by a rise in the number of digital comics on various platforms such as Webtoon, Mangatoon, Bilibili Comics, Manta, Tapas, RE:ON comics, Komikindo v7 and many more. On the other hand, the complexity of the teaching materials being delivered made students less interested in reading textbooks, including physics. Therefore, students are more engaged when the content is presented in the form of illustrated comics, especially in visualizing abstract concepts. This study aims to produce digital physics comics about the greenhouse effect, which can enchance students' literacy and motivation. It's well known that global warming is a global issue that demands a broader understanding and is important to be recognized by the public including students, where one of the causes is the greenhouse effect. This comic seeks to support physics learning media. This study uses Research and Development (R&D) approach with a 4D method. The development stages consist of defining, designing, developing and disseminating. This physics digital comic explains the process of the greenhouse effect. This research shows that digital comics that have been developed have successfully become physics learning media that can increase students' literacy and motivation to learn about global warming and climate change.

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INTRODUCTION

Comics, games, and animation have a big influence and the output value in the incoming media market is in accordance with current life developments (Sheu & Chu, 2017). Comics have been used as a

medium of entertainment for both children and adults (Wicaksono et al., 2020). Faza Meong as general chairman of the Indonesian comic association stated that in Indonesia the number of comic readers exceeds 13 million per day both accessed through comic applications on cell phones and comic books for sale as well as the existence of Komikus (comic community) who hold national comic events and international events every year. More than 100 Indonesian comic titles are released in various applications and social media annually with an intensity of readers reaching 20% of Indonesia's population aged 15-12 years (Wandini et al., 2022). This increase was accompanied by an increase in the number of digital comics on various platforms such as Webtoon, Mangatoon, Bilibili Comics, Manta, Tapas, REON comics, Komikindo v7 and many more.

On the other hand, Physics is a subject that is considered difficult and frightening for most students (Istiyono et al., 2020). Difficulties in understanding and applying physics concepts are problems that are often encountered in learning (Lestari et al., 2021). Physics learning consists of various abstract concepts (Yusuf & Widyaningsih, 2019). That concepts cause difficulties in understanding by students and require high imagination (Hadi & Dwijananti, 2015). To be able to interact directly with objects that are abstract, learning media is needed, which is expected to help facilitate the learning process (Tanjung et al., 2018)

An educator must be able to design learningRepeated Stem media so that students are motivated to learnRepeated Stem (Susanti et al., 2020). The learning media that is often used is in the form of worksheets or modules, which have few pictures so that it makes students less motivated (Anesia et al. 2018). Several studies explain that educators still use a lot of learning resources available on the market that areis not in accordance with the conditions and potential of the school and the characteristics of students (Widyaningrum et al., 2013). The research conducted by Tri Anita Nur Hasanah in 2017 showed that 61% of students relied on textbooks and 71% of students said books were less interesting and difficult to understand (Hasanah et al., 2017).

One way to make learning more fun and to make students more motivated are to use comics as a learning medium (Susanti et al., 2017). Comics have the potential to make scientific subjects more accessible and appealing to a wider audience (Mahendra et al., 2021). Images can convey explanations in a more tangible way than spoken words (Ismaya & Anwar, 2023).

Global warming material is abstract in nature, which requires a deep understanding, and requires students to focus more on following the learning process, so that the concepts explained can be understood by students (Susanti et al., 2021). Global warming is defined as "the unusually fast increase in the average temperature of the earth's surface over the last century, mainly due to greenhouse gases released by human activities." Global warming material includes the greenhouse effect and its consequences for the earth (Mabsutsah & Yushardi, 2022). This material is very important to discuss because about 16 years ago, a synthesis report from the Intergovernmental Panel on Climate Change (IPCC, 2007) showed that a temperature increase of 2°C would cause substantial climate change and very serious related biophysical impacts (Goulder, 2020). In research conducted by Neneng Susanti, Yennita, Azhar in 2020, the results were obtained that in learning school material regarding global warming students was less active, less interested in reading books, and presenting material that students did not understand (Susanti et al., 2020). In research conducted by M. Nor, Zuhi, and Asbiah in 2021 based on interviews that have been conducted with physics teachers at SMA Negeri 12 Pekanbaru, generally global warming material is abstract in nature, which requires deep understanding, and requires students to focus more on following learning process. So that the concepts explained can be understood by students (Nor et al., 2021). Unfortunately, this problem still often occurs due to students' low scientific literacy abilities and students' lack of knowledge about the concept of global warming itself, especially the process of the greenhouse effect where there is the interaction of greenhouse-gas molecules in the atmosphere so that learning requires media.

Based on this description, research and development was carried out regarding digital comics on the material on the greenhouse effect which can present interesting physics concepts on the Webtoon platform. The comic discusses the causes, processes, and effects of the greenhouse itself on global warming. The choice of the Webtoon platform was noted to have a total of 60 million users spread all over the world (Rahantoro et al., 2023).

METHOD

As explained,Repeated Stem comics are researched and developed to explainRepeated Stem the causes, processes, and consequences of the greenhouse effect. This research develops teaching materials in the form of comics with an emphasis on visual design and an interesting plot. This research is a development research adapted from the 4D development model consisting of four main stages, namely Define, Design, Development, and Disseminate (Febriani et al., 2020). Product development is carried outRepeated Word based on a validation process carried outRepeated Word by media experts, learning experts, and material experts. The dissemination stage consists of uploading the comic series to the Webtoon platform and asking for ratings from readers.

1. Define
   At this stage, a literature study from previous research was carried out. The literature study stage was carried out by searching for information on all matters relating to digital comics and research relevant to the digital comics being made. In addition, the global warming in curriculum was also studied, including the physics material for first grade high global students, bearing global mind that increasing global is still a global issue today.
2. Design
   In developing comics as learning media, the product planning stage consists of three stages, namely the comic planning stage, story boarding. in this study using the material process of the greenhouse effect.
   This product is different from other learning comics in that the conversations used are conversations in everyday life so that readers follow the plot presented and use fictional characters to explain the process of the greenhouse effect that occurs. The result is a story board that outlines the required scene for each panel. Story boarding is done using sketches on paper and the IbisPaintX application on the cellphone.
3. Development
   At the development stage, comics are made based on the products that have been determined at the design stage. This process also involves several stages, including line art, coloring, dialogue writing, and packaging. We carry out validation by media experts. After validation, the product is revised and completed.
4. Disseminate
   The last stage is the dissemination stage which is carried out to promote comics to individual and group readers. The distribution is done online on the Webtoon platform considering that the Webtoon platform has a total of 60 million users spread all over the world (Rahantoro et al. 2023).

RESULTS AND DISCUSSION

The results of this research are in the form of digital comics, which will be uploaded on the Webtoon platform on the greenhouse effect material. The purpose of this research is to produce digital comics on the Webtoon platform that are suitable for use as learning media in the process of the greenhouse effect. This digital comic will later be validated by media experts and material experts. The assessment and

suggestions of experts will be taken into consideration to improve the comics that have been made so that the resulting product has a better quality.

Here are some views of the digital comics developed:

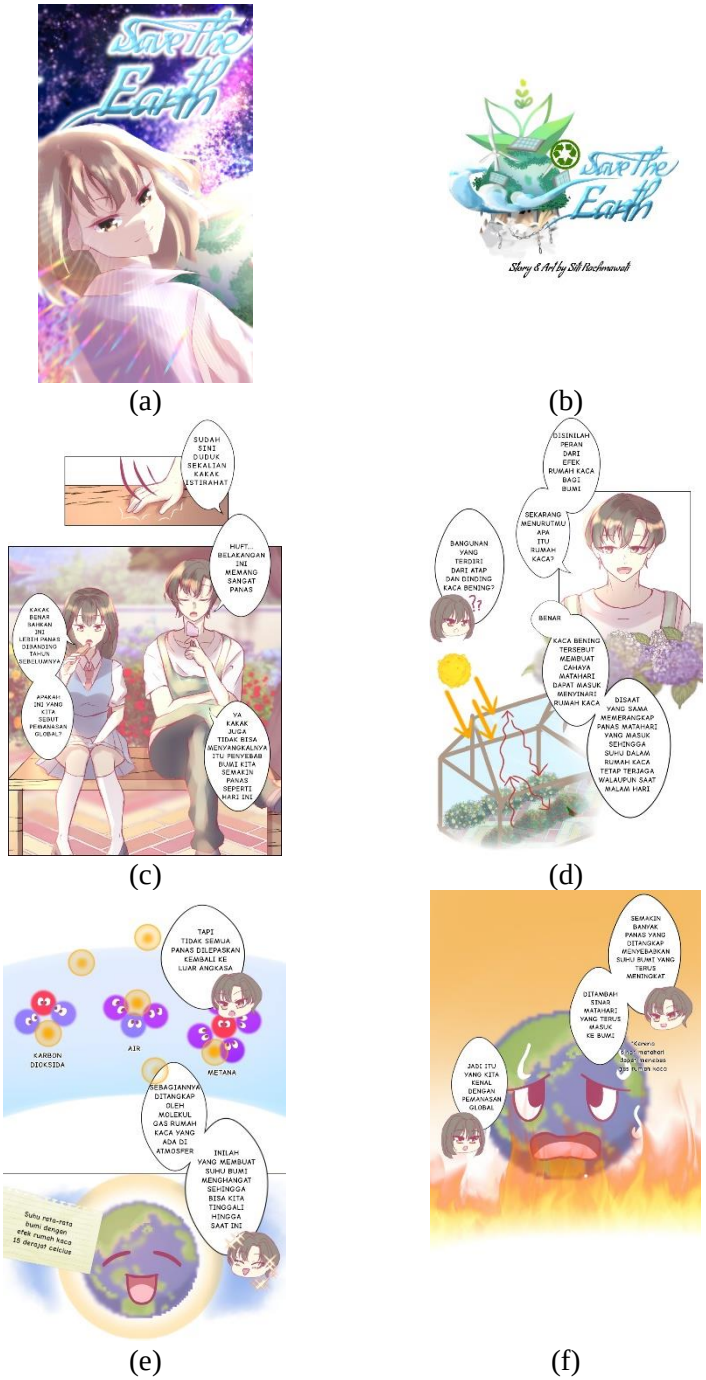

FIGURE 1. Digital comic display of the process of the greenhouse effect, including (a) Comic cover, (b) Comic title cover (a) Character interactions, (b) Explanation of the working greenhouse effect, (c) Explanation of the greenhouse effect on the atmosphere, (d) Depiction of global warming that occurs due to an increase in greenhouse gases.

The product has been validated by media experts with a validation result of 73.33%, and the media is declared valid after being revised. Once the revision is complete, the comic will be uploaded on the Webtoon platform. In July 2023, the number of readers has reached 100 readers. Readers also submit suggestions/comments on the comic “Save The Earth". For example, one reader said: 'This is a super genius idea for me who likes to be bored reading textbooks but really likes reading Webtoon'. However,

there are some criticisms: 'There are conversations that are a bit too to maybe to formal in some words, but still comfortable to read'.

The development of comic teaching media in the process of the greenhouse effect has not existed before on the Webtoon platform. So this is an opportunity for researchers to develop, considering that the material on Global Warming and Climate Change is one of the first-grade physics materials in high school. The Greenhouse Effect comic can make learning more fun and can make students more motivated. Comics can also make language learning easier and increase motivation (Hoffman, 2018), increase vocabulary mastery (Chou et al., 2015), and improve reading comprehension (Maulana & Fitrawati 2017). Skills in making story lines and illustrations are very important so that readers can enjoy the comic.

The comic rating achieved a perfect score of 10 on the Webtoon platform, due to its following content, which makes the reader unknowingly learn along. However, there was criticism of the language being too formal, considering that this is a drama genre that requires conversation as usual. In future research, we plan to make a comic series of other causes of global warming, their effects and ways to reduce them. In addition, dissemination is needed in schools to find out the responses from students and teachers regarding the comic "Save The Earth" as a learning media.

CONCLUSION

This research produced a product in the form of a digital comic on the greenhouse effect process material on the Webtoon platform. This product is declared valid as a validation result of 77.33%. Comics are uploaded on the Webtoon platform and get good comments from readers, and can increase the literacy and motivation of the readers. Researchers hope that the resulting product can become an independent learning media that is not only suitable for students but for all people, considering that global warming itself is a global issue that must be handled together. Dissemination of these comics to students and teachers in schools as learning media is needed to determine the impact of improvements in other aspects.

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