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# Supporting STEM and critical thinking on energy transformation topic: pre-study of digital reality book

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Abstract. Technology is growing rapidly. Many devices could be used to support the learning process in the classroom, particularly in integrative science learning. Nowadays, learning materials can be acquired through various digital forms. In this study, the tendency of the needs and interests of students toward learning materials, specifically in energy transformation topic, would be briefly explained. Based on the data obtained, students were more curious when they were provided the supporting learning materials such as pictures and videos while learning the energy transformation topic. The data illustrated that 64.3% of respondents stated that the combination of text, images, and videos enhanced their curiosity on the matter. Some questions must also be provided to improve their STEM knowledge and critical thinking. Therefore, Digital Reality Book with many features can be selected as an alternative to deliver learning material about Energy Transformation in supporting STEM and critical thinking.

## 1. Introduction

The 21st-century skills require students to enhance their capability to use technology in many fields. There is a paradigm shift toward the development of technology from conventional to high-tech basis. In education, the transformation can be seen by the enhancement of technology in many aspects. The development of long-distance education is the example where a student can learn online everywhere, and visiting the classroom for the full meeting is not required. It is also supported by the development of several media, such as e-learning and various type of digital media. The use of technology makes learning more effective and efficient because the data transfer will be so fast. Beside it, the form of learning media would be simple, easy to be accessed and can be saved in the small devices like a smartphone.

The application of technology cannot fully replace the old one. The prior learning, such as a printed book, is still used to support the learning process. However, nowadays, the more effective and efficient media, like digital book or e-book, are preferred to be used by many students. Digital book is not the new technology at all, and it has invented by Michael Hart with his project called Project Gutenberg, which is appeared online in 1994 [1]. In 1999, the American publisher Simon & Schuster began marketing the digital book which was accompanied by the printed version. The development of digital

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book changes the way to read in processing words on a screen compared to words in a printed book [2]. So, the trend of using printed books should be reduced, and it is time to switch to a digital book.

The idea was rising since the misused of the modern technology device such as a smartphone. Students have ignored the technology for learning media, and they tend to play online games or social media on their gadget. Whereas, so many features that they can use on a smartphone in supporting the learning process. The unavailability of learning materials is considered as the reason for the misuse of the gadget. Therefore, developing teaching materials tailored to technology, kind of like a digital book, allows students to involve technology in the learning process. There are several advantages of the digital-book compared to the printed book, for instance, available everywhere, quick updates, sharable content, affordable, embedded with an augmented reality experience and only need one device for many books [3].

One of the goals of 21<sup>st</sup>-century skills is improving students' critical thinking, which requires students to think critically and quickly about issues around them. Students' critical thinking skills can be trained in the computer environment and appropriate teaching process [4]. Therefore, the appropriate learning media is required to support the goals of 21<sup>st</sup>-century skills particularly in enhancing students' critical thinking. To seek the ideal learning media which match with the students' necessary, this article will explore student's perception of the using technology embed learning media called the digital book, which contains STEM and Critical Thinking as complements. Energy transformation is the best learning material to be developed because many disciplines can review it, and this article has a relation with the prior research about energy transformation [5].

## 2. Experimental Method

#### 2.1. Sample

The total sample of the research was 28 students of the science education program. The sample came from two different academic years.

#### 2.2. Method

The data were collected from a questionnaire which was spread out using Google Form. The indicator of the questionnaire consists of preferred learning materials (general information and learning materials), types of learning material are often read and trusted learning materials. All data were calculated descriptively using percentage and graphic. The article is part of development research using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model [6]. The aim of capturing the data is to analyse the needs of students toward a digital book as an analysis phase, specifically developing instructional analysis.



**Figure 1.** The ADDIE Model, with a focus on Analysis (developing instructional analysis).

## 3. Result and Discussion

### 3.1. Result

The result of these articles is the initiation phase of the research process, which analyzes the necessary information about the needs of students in using digital book. Based on the data, students preferred to choose the most effective and the easiest way to access the learning materials. Students tended to read the general information from the internet using their browser (62.1%) instead of reading general or daily information from books, both printed and digital (3.6% and 14.3%). The online media was still also be preferred by students and gain the highest percentage in reading learning materials (39.3%). Also, more than eighty percent of students using online media or browser more than the other media (see Table 1).

	Printed Book	Digital Book	<b>Online Media</b>
	(%)	(%)	(%)
Preferred reading materials (general information)	3.6	14.3	62.1
Preferred reading materials (learning materials)	35.7	25	39.3
Reading materials that are often read	7.1	7.1	85.8
The most trusted reading materials	64.3	25	10.7

Table 1. The	Percentage	of the Ty	pe of Learn	ning Media
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Figure 2 illustrated that most of the students (more than 20 students) spent their time to read information from the browser or online media with the time approximately 1-2 hours a day. Also, students still use the browser or online media as their reading material, which students spent less than 1 hour a day — only a few students are reading the e-book, which is lower than the printed book. More than five students read printed book with a various time proportion. Overall, students prefer to read information from the online media/ browser than the other type of media. The time portion of students to read e-book/ digital book is still low.



**Figure 2.** The spending time of students in reading the various type of learning resources

The response of students' stimulus that makes them more curious and critical is presented in Figure 3. Students believed that the stimulus and features of learning media significantly influence their curiosity and critical thinking. Most of the students (72%) stated that the combination of questions, pictures, and videos on the learning material made them more critical. Around 16% of respondents stated that questions on the text, such as in an e-book, can make them intrigued to know more about the information and argue what they read. The pictures on the text also have a significant role in improving students' curiosity and critical thinking (12% of total respondents). If the text is not accompanied by

various type of supported learning materials presentation, students did not choose the option. The graphic shows that there are no respondents interested in choosing the text, which is not accompanied by the question, pictures, and videos (0%). Also, the text with the sound feature is not popular with students (0%).



**Figure 3.** The type of stimulus that makes students curious to know deeply and critically.

The additional data shows that around 85.7% of respondents were interested in STEM (Science, Technology, Engineering, and Mathematics) learning, and they want to learn more in-depth about STEM. It was supported by the data that students were familiar with STEM learning, such as learning energy topic (about 89.3%), that have many connections to the other disciplines. In the specific concept of energy, students tended to choose the type of energy as their favourite concept instead of metabolism. More than 80% of respondents wanted to use a digital book which is equipped with many pictures and videos as their learning media. The overall data is presented in Table 2.

Aspect	Yes	No
Interest to study STEM	85.70%	14.30%
Familiar to energy concept	89.30%	10.7
	Type of energy	Metabolism
The most preferred concept	75%	25%
	<b>Printed-book</b>	E-book
The most preferred media	10.70%	89.30%

Table 2. The brief responds for the interest of STEM, concept, and types of media

## 3.2. Discussion

The need for learning media increases due to the development of technology, making students are required to gain more insights. There are several media they can use to enrich their knowledge to improve their understanding in the school. The digital technology is a primary tool to assist the student in adding the new broadly information or making their media as learning resources [7]. In this technology era, most of the students prefer to read information from digital media, such as news portal, social media, or television. That kind of media updates the new information quickly and effectively, so students do not need to find them in the library or to buy the newspaper every day. Most of the students are also read online media often than other kinds of media. It shows that digital media has a vast power

to influence people when delivering so many messages to users. Nevertheless, the printed textbook also is still utilized as a primary resource because it is trusted than the other resources.

Respondents preferred to read information online through their device. Reading any information from internet dominate student's portion in reading. It can be caused by a variety of online media that presents many creative contents with different appearances. It makes reader and user comfort to linger interacting with their gadget. The availability of the mobile platform makes the user more natural to read information everywhere and everywhen. That is why users often stick with their devices, which is at the same time, users are also able to use the entertainment features. Users are consuming nearly 2 hours on social media sites every day [8]. If they visit the other sites, they are predicted to spend more than 2 hours with their gadget. So, the time to interact with their device will dominate their overall time. Spending time too long for using gadget will have two different impacts, positives, and negatives. Connecting user with extended friends and helping them to develop their perspective on the issues [9] are the positives which are needed to be owned by students in this digital era. Still, Santhosh (2019) also stated that someone who is interacting online media too long often leads to addiction, and it is categorized as the negative side. If it is used wisely in an appropriate way, it can boost students' learning process and their productivity. However, it also can lead to poor academic performance if it is misused [10]. Hence, the using of digital media must be accompanied by good supervision.

The positive impacts of digital media lead the teacher to transform the learning material style from conventional to the digital platform. For the science learning material, digital media will have a significant impact. The digital platform can make the student more self-motivated because it can be adjusted based on our needs. Further, digital media provide a better context [11] such as various pictures and video embedded on learning materials. Science will have a great benefit when using digital media since the characteristic of science material is mostly abstract and consist of concept. The using of digital media will help students to get a better understanding of learning science. To enhance students' curiosity and critical thinking, the respondents believe that the questions, pictures, and videos on learning material are responsible to boost their skills. Thus, the development of e-book as digital media, which is combined with the critical thinking questions, many pictures, and videos is urgently required.

To accommodate the students' need, the e-book would be made based on the newest curriculum guidance. The e-book will contain learning material on energy transformation and STEM-Critical Thinking concept to enhance students' critical thinking. Some of the critical thinking questions on digital books can support students to understand the concept deeper to overcome the problem. That is mean that the involvement of technology can stimulate students to think spontaneously and meaningfully. To make the content of a digital book more interesting, it may focus on STEM content contextually [12] with presenting practicum activity, which combines several disciplines into one frame. The energy transformation is selected to be the topic of the e-book because only 25% of students preferred metabolism concept. It means that students have the difficulties to study metabolism as a part of the energy transformation topic. The e-book also will be combined with the videos of the real experiments that are made in the laboratory to present the experiments on energy transformation topic. Therefore, the product of the media called Digital Reality Book.

#### 4. Conclusion

The students tend to use their gadget as media to learn and gain the information. The development of media is required to accommodate students needs in enhancing their critical thinking. STEM also need to be immersed as a part of media to lead them learning integrated science which has a relation with other disciplines. The combination of STEM and Critical Thinking questions on a digital book is one of the solutions as an attempt to provide the experiences to the students in learning science. The new experiments video will be embedded in the digital book to enrich students understanding on energy transformation topic. Based on the initial analysis, the development of digital reality book is required to support STEM learning and enhancing students' critical thinking.

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