Augmented reality water rocket: develop an enrichment book of physics

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Abstract. The aim of this study is to develop an enrichment book “physics concept of water rocket” through augmented reality of water rocket. The study was based on Research and Development method with ADDIE approach which consist of five steps; analyse, design, develop, implementation and evaluation. Data were gained from observation and questionnaire distribution at 12 senior high schools in Jakarta. The enrichment book has been examined by some experts; material, media and learning experts. The enrichment book was tried to 35 students. Based on feasibility and test results, we conclude that the enrichment book is proper to help student visualize the physics concept of water rocket through augmented reality of water rocket.

1. Introduction
Reading is very important to gain knowledge, information or ideas through a book, newspapers, magazine or the other reading materials. In 2012 UNESCO studied the reading habit of Indonesian people. Based on their study, there was only 1 from 1000 of Indonesian read a book. This number is too low compared to the European number of reader. We must concern to this result whereas reading not only helps people to gain knowledge and information but also help in student habit formation [1].

There are many type of books, one of them is an enrichment book. Enrichment book helps reader to enrich their concept, knowledge and experience. At school, this book helps teacher to achieve the learning objective [2,3]. Based on observation to 12 school libraries in Jakarta, there are only a few numbers of enrichment books; 75% of school libraries have five to ten enrichment books, whereas the rest does not have any of it. We also gained preliminary data from Pusat Kurikulum dan Perbukuan (Puskurbuk) which shown by figure 1. The data showed that the growth of enrichment book from 2014 to 2017 was slow. To produce an attractive enrichment book, an augmented reality application may also include in the book. This application utilized a smart phone to display an animation. Through augmented reality application, reader get virtual experience and increase their reading interest [4].
A lot of students don’t like to read physics material, because most of books in Indonesia discuss physics only in theoretical manner, equation and complex calculation. It set of difficulties for student to enjoy physics. Therefore, students don’t have ability to connect physics theory with the daily life phenomenon [5]. To solve this problem, we develop an enrichment book “physics concept of water rocket” through augmented reality application to help student visualize physics theory [6], enjoy the theory, have strong motivation and feel positive [7].

Water rocket is a rocket made from PET bottles. This rocket is used as a learning media in physics course [8]. It is very fun because student made of water rocket, launch it and get information of physics aspect on water rocket activity such as inertia, gravitation, acceleration, air drag, Newton Law, impulse, momentum, projectile motion and free-falling body [9,10].

2. Research Method
This study was based on Research and Development (R&D) method with ADDIE approach. ADDIE approach consists of five steps; analyze, design, develop, implement and evaluate. Those steps have been done on November 2017 to July 2018. The output was an enrichment book “physics concept of water rocket” through augmented reality application.

The first step of this study was do a preparation, refined the physics aspect of water rocket, did a data collection from water rocket launch. The second step was designed the book layout, created the book illustration, produced 3D image of water rocket and launcher by blender software. After that produced experiment videos and designed illustration markers. The marker was a unique image pattern, it must be captured by camera and recognized by AR application. The third step was development. At this step, the enrichment book and augmented reality application were developed. The book was able to stimulate student to construct their knowledge through a simple experiment; build and launch a water rocket in augmented reality application. The application helped student to enrich their scientific capability such as gain data in differ variables.

The enrichment book “physics concept of water rocket” consists of four chapters. Chapter one explained the basic information of water rocket. Chapter two discussed the physics aspect of water rocket, for examples Newton Law, weight, momentum, air drag and parabolic motion. Chapter three showed water rocket launch. Chapter four discussed the real rocket.

The enrichment book also contains several topics; important information, who is he, science laboratory and quiz. “Important information” displays several crucial information. “Who is he” present physicist. “science laboratory” provide several number of simple experiment. “quiz” come out with several numbers of question for the reader.
After build the enrichment book, the next step was augmented reality development. Unity 3D software was conducted to generate an account in Vuforia. Vuforia engine offers advanced computer vision and a wide range functionally to support AR application by capturing the unique pattern and activating the AR application. The following step was installed software development kit as well as java development kit, collected image, 3D animation, video, marker and uploaded it to unity 3D. Then build the project in an APK platform as shown in the figure 6 and figure 7.
This was the last step in the research. Validated the enrichment by material, learning and media experts. The validation was conducted from questionnaire with four Likert scales as shown by table 1. The questionnaire was then proceeded qualitatively through percentage technique [11] as shown by following equation

\[ P = \frac{F}{N} \times 100\% \]  

where, \( P \) is the percentage level of student comprehension, \( F \) is the frequency of respondents, and \( N \) is the total number of respondents.

| Percentage       | Interpretation          |
|------------------|-------------------------|
| 0% - 25%         | Inappropriate           |
| 26% - 50%        | Less feasible           |
| 51% - 75%        | Feasible                |
| 76% - 100%       | Very feasible           |

3. Results and Discussion

The enrichment book “physics concept of water rocket” through augmented reality application has been examined by three experts; material, media and learning experts. The examination result was then utilized to revise and improve the book. The results were shown by figure 7.
According to the data in figure 7, the average value of material feasibility was 85%. This number showed that the material agreed with curricula. The average value of language feasibility was 85.3%. It means the sentences were easy to understand. The average value of presentation feasibility was 86.3%. It indicated the book appearance is interesting. While the average value of augmented reality design feasibility was 86.3%. It revealed that 3D animation was interesting and visualized the water rocket well.

Table 2. Feasibility study of experts

| No | Expert             | Average percentage (%) | Interpretation |
|----|--------------------|-------------------------|----------------|
| 1  | Material expert    | 85                      | Very feasible  |
| 2  | Media Expert       | 88                      | Very feasible  |
| 3  | Learning Expert    | 80                      | Very feasible  |
|    | Average            | 84.3                    | Very feasible  |

Table 2 showed a feasibility study from three experts; material, media and learning expert. Whereas average percentage of material expert was 85%, media expert was 88% and learning expert was 80%. Therefore, the average percentage of three experts were 84.3%. So that the enrichment book “physics concept of water rocket” through augmented reality application was feasible as a learning media, and able to visualize the kinematics aspect of water rocket.

Furthermore, the enrichment book tried to 35 students of XI grade of SMA 77 Jakarta. In this study gained the feasibility and acceptability information of the enrichment book to the students. The results were shown by table 3.

Table 3. The results of the enrichment book trial

| No | Assessment aspect      | Average percentage (%) |
|----|------------------------|------------------------|
| 1  | Content of physics     | 80                     |
| 2  | Gravica persentation   | 82                     |
| 3  | Language               | 84                     |
| 4  | Book advantages        | 82                     |
| 5  | Augmented Reality      | 85                     |
Table 3 showed that 85% of the students were interested in the augmented reality application. We can conclude that augmented reality application was able to motivate students to learn and get the book contents. The feature in augmented reality application explained the physics concept well [12].

4. Conclusions
Based on the data, it can be concluded that the enrichment book "physics concept of water rocket" through augmented reality application is proper as a student learning media. Therefore, augmented reality application increased student reading interest. It helped student visualized concept and application of kinematics aspect of water rocket without doing any direct experiment.

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