Analysis of Pop-Up Book and Biology Virtual Reality Video toward Students’ Habits of Mind

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Abstract. Low reading interest in high school students and the use of information and communication technology (ICT) are still not well integrated into learning. This is due to the lack of interesting biology textbooks and students' habits in using gadgets for entertainment such as social media and games. For this reason, a solution to these problems is the development of pop-up books and virtual reality (VR) videos. This research uses the Research and Development method adapted from Borg and Gall by involving media and content experts for feasibility testing. The pop-up book and VR video evaluation were then carried out, the results showed feasibility without revision of 67% and some product revision suggestions. The results also showed the product responses to habits of mind (HoM) which included in the excellent category (3.7) from 100 students and 30 each from teachers even though preliminary test with a sample of high school graduates was still in the good category (3.2). Also, aspects of creative thinking are best between self-regulation and critical thinking. So, the implications of this research are pop-up book and VR videos are suitable as learning media also very good for improving students' habits of mind.

1. Introduction

Interest in reading students in Indonesia is still low when compared to developed countries that make reading as a routine activity every day so which triggers the low reading ability of students [1]. Students who are diligent in reading have a tendency both in academic and social achievements, but without the motivation to read students will not reach the maximum potential in learning [2], because knowledge, understanding, and skills are obtained from independent learning from reading sources [3]. Factors that cause a low interest in reading students based on observations include the poor quality of books, the environment, the dominance of social media and gadgets to fill spare time. Though the habit of reading books can trigger the brain to think, concentrate, and make the brain work more efficiently by changing the neuropathological structure related to age [4]. Habits of thinking (habits of mind) that have an impact on intelligence do not automatically develop through learning science but must be specifically designed [5].

In general, schools use textbooks as the main learning resource in Biology. The role of books is very large because books can act as sources of information, but currently students also have a tendency to lack interest in reading if the book is thick and unattractive [6]. Based on observations, according to high school students the textbooks provided by the school are dominated by writings that are difficult to understand by students, contain little pictures, and are less attractive. Weaknesses of textbooks can reduce the interest in reading to students and affect the lack of student understanding of the concepts read from textbooks. School textbooks are scientifically weak and not good enough to be
a source of learning due to lack of scientific literacy, question presentation, misconceptions, and visual representation (RV) displayed in textbooks [7, 8]. Even though textbooks are a very important educational component in the learning process and teachers play an important role in preventing misconceptions among students sourced from textbooks [9].

Textbook innovations are needed to meet students' needs for knowledge that is presented interestingly, contains a lot of pictures, has scientific literacy, and contains the latest biological concepts by the progress of biological research. This is in line with the advancement of book publishing technology which used to be only black and white now has a color that is equipped with an animated CD and electronic version [10]. Even though it has entered the digital age, textbooks cannot yet be replaced by gadgets, so innovation is needed in terms of content and packaging [11]. So the need for teaching materials that are interesting, innovative and easy to use to convey the message properly as an appropriate visualization to provide understanding to students [12].

Textbook innovation through this development research in the form of a biology pop-up book that is equipped with virtual reality video (VR). The pop-up book is a book that when opened can bring up 3-dimensional images that make this book more interesting to read. VR is a 3-dimensional video technology that makes users live in real life with the help of VR glasses. The development of pop-up books and VR videos is expected to improve students' habits of mind.

This study has the main goal of developing pop-up books and virtual reality video biology at the high school level to improve students' habits of mind. The purpose of this research is to produce high-level biology pop-up book products and virtual reality video biology, identify the feasibility of pop-up books and virtual reality video biology, determine student responses to pop-up books and virtual reality video biology habits of students through books pop-up with VR video.

The proposed research is related to technological advances in the era of the industrial revolution 4.0, where educators are expected to be able to select appropriate learning resources for students and direct the millennial generation that cannot be separated from gadgets so they can use them for learning. The tendency of students towards the use of gadgets for entertainment has an impact on the lack of interest in reading students in textbooks. One way to overcome the lack of reading interest in high school students and foster habits of mind is necessary to book innovation that is complemented with virtual reality video. In connection with this, the development of pop-up books and virtual reality videos using design software and video editors.

The targets to be achieved in this research are pop-up books and virtual reality video products through software-based development that will be printed and published via streaming video. This product will contribute as a medium of biology learning for high school students that can improve habits of mind so students understand biological concepts that have an impact on improving student achievement. The results of this development research can be used by educators, students, and publishers as consideration for setting the quality standards of textbooks. It also can be used as a reference to study changes in technological progress in the field of instructional media.

2. Research Method
2.1. Research Design
The procedure for developing Biology pop-up books and virtual reality videos consists of three stages, namely preliminary study, development, and evaluation. In this study using the Research and Development (R & D) method adapted from Borg and Gall [13]. Research with this method consists of 10 steps [13] but this research is only limited to steps 6 according to development needs. The first step that refers to R&D (Figure1) is research and information collection, conducting field studies by examining learning media used in schools and student needs. The study of textbooks and learning media used in schools aims to obtain product specifications that include sources, data capacity, production years, formats, software, writers, product contents, advantages and disadvantages of the product. The needs analysis is done to gather the information that there is a need for a learning media that can complement the learning books used in schools. Also, a literature study was conducted to examine the pop-up books and VR videos basic competence according to the material. The study of
pop-up books and virtual reality videos aims to obtain product specifications used in stage 2 which is planning.

![Figure 1. Research and Development Steps [13].](image)

Next, stage 3 is developing preliminary products include the design and validation of pop-up books and VR videos. The validation of the pop-up book design and virtual reality video includes two stages, namely the learning material expert test and the media design expert test. The next step (4) is preliminary field testing. Evaluation testing activities for pop-up book and virtual reality video development focused on formative evaluation which is the final stage to assess the appropriateness of material and design as well as the effectiveness of pop-up books and VR videos that have been produced to increase students' habits of mind. The evaluation involved 6 high school students who had graduated to find out the completeness of the pop-up book and virtual reality video script and the clarity of the pop-up book and VR video material so that the product did not have writing errors or supporting images of the material. The next step (5) is the main product revision through improvement according to the suggestions given by students and teachers in the field-testing stage. The test continued with step 6 that is the main field-testing which involved students and teachers. This test was conducted to evaluate pop-up books on aspects of layout, attractiveness, systematics, language, and creativity while VR videos evaluated the relevance of pop-up books, renewability, content, quality, layout, and duration. Subsequent tests were conducted to collect data on students' responses to habits of mind after the application of pop-up book products and VR videos.

2.2. Participant
The development carried out is making pop-up books and VR Biology videos for high school students. The targets for the development of this product are 100 high school students from 15 different quality level schools and 30 teachers. A trial was conducted to obtain responses and information about the strengths and weaknesses of the products (material and design) that were made.

2.3. Instrument and Data Analysis
Data collection in this study used a questionnaire instrument. Questionnaire to collect data about the suitability of the design and content of the material in the pop-up book and VR video that has been developed. While the habits of mind questionnaires are used to see the effectiveness of pop-up books
and virtual reality videos as a source of independent learning. Data on design suitability and learning material in pop-up books and VR videos were obtained from material experts and design experts. Data analysis based on expert test instruments and design tests were carried out to assess the suitability of pop-up books and virtual reality videos as a source of student learning media.

The assessment instrument design experts, material experts, and the one-on-one test have a scale of 4 scores with answer choices. The questionnaire is also accompanied by an open question to write suggestions and criticisms as well as a statement of media feasibility choice without revision or with revision meaning that media in pop-up books and VR videos are active in the section mentioned in the questionnaire questions must be corrected according to the advice given. Also, measurement of high school students' reading interest and habits of mind after learning to use pop-up books and virtual reality video with a questionnaire that has a scale of 4 scores with questions that are different from the expert assessment instruments. The aspects used in the habits of mind questionnaire are summarized into 7 statements [15] consisting of 16 statements because they are only carried out through self-assessment and selected according to the learning media criteria. The results of the assessment scores on the questionnaire are then converted to an assessment statement. Conversion of assessment scores [13] to assessment statements can be divided into the range and criteria in Table 1. The data obtained were then analyzed descriptively accompanied by suggestions and criticisms obtained from the questionnaire in the open questions section.

| Table 1. Conversion score of questionnaires. |
|---------------------------------------------|
| Score | Criteria        |
|-------|----------------|
| 1.01-1.75 | Not good       |
| 1.76-2.25 | Good Enough    |
| 2.51-3.25 | Good           |
| 3.26-4.00 | Very Good      |

3. Result and Discussion
The main results of this study are biology books that illustrate using pop-up systems and VR video through 6 steps of R&D. At the Research and information collection step, an analysis of student needs for learning media is carried out. The questionnaire was given to 30 high school students from 3 different schools. The result is that 75% of students think that their biology books are dominated by texts, while only 21% think their biology books are dominated by interesting images, and only 4% of students have biology books with balanced text and image composition. All students want to have biology books that are more interesting and other learning media to support them while studying biology, most students choose pop-up books and VR videos. Students also choose some material that is incomplete and difficult to learn with biology books from school including sensory devices, biogeochemistry, ecosystems, enzymes, photosynthesis, immunity, menstruation, development and growth, cells, symbiosis, protein synthesis, digestive system, circulatory system blood, movement system, and viruses. The first stage of the data is then carried out in the planning stage in the form of design, selection of basic competencies, preparation of the book content framework, selection of relevant videos, and preparation of video storyboards.

The pop-up book planning starts with analyzing basic competencies according to the material needed in the needs analysis which is then reviewed in depth of the material. Basic competencies are 3.10 Analyze the relationship between the structure of organ building blocks in the coordination system (nerves, hormones, and sensory organs in relation to coordination and regulatory mechanisms and impairment of functions that can occur in human coordination systems; Analyze ecosystem components and interactions between components 3. 3.2 Explain the process of metabolism as an enzymatic reaction in living things; 3.14 Analyze the role of the immune system and immunization of physiological processes in the body; 3.12 Analyze the relationship of tissue structures that make up the reproductive organs with their functions in the human reproductive system; 3.13 Analyze the relationship of structure and function of genes, deoxyribonucleic acid (DNA), chromosomes in the
application of the principle of inheritance in living things; 3.7 Analyze the relationship between the structures of organ-building tissues in the digestive system in relation to nutrition, bioprocess and impaired liver function that can occur in the human digestive system; 3.6 Analyze animals the relationship between the network structure of organ compilers in the circulatory system in relation to bioprocess and impaired function that can occur in the human circulation system; 3.5 Analyze the relationship between the structure of the tissues that make up organs in the motion system in relation to bioprocesses and functional disorders that can occur in the human motion system; 3.4 Analyze the structure, replication, and role of viruses in life.

The next step is the Develop Preliminary Product biology pop-up book, which begins with a literature review in the form of biological material that will be included in the form of text, images, and pop-ups. The next step is to design a pop-up book using software that is Microsoft Word and Photoshop to arrange the layout of the book. The final step is printing books and pasting the pop-up section of the book. The obstacle faced during production is the difficulty in finding suitable and quality images, besides that the technique of folding the pop-up paper so that it is not too thick becomes an obstacle that must be tried repeatedly before being pasted. The procedure for installing pop-ups is the same as the procedure for folding origami which uses a lot of paper with some varied cuts [16]. The difficulty faced in the installation of pop-ups is the determination of the position of the pop-up so that when the book is closed the pop-up part does not come out of the book's margin [17].

Pop-up book products are equipped with VR videos in accordance with the material in the book. The development steps include selecting the right video, the process of dubbing, texting, and uploading. Production begins with the selection of videos that match with the specifications which are animation and mp4 format. Furthermore, the preparation of dubbing text to fill sound and proceed with the dubbing process in accordance with the animated video content using Video Editor software. Furthermore, the video is given text at the bottom that is displayed as the information for the concept, for example, the names of organs or biological terms. The final step is uploading videos on the website to make it easier for students and teachers to access them. VR videos are uploaded in the form of virtual reality and animated videos, so they can be accessed with or without using VR glasses. We found difficulties in making VR videos which are poor quality video output, rendering and uploading processes that take a lot of time.
The pop-up book (Figure 2) and VR video (Figure 3) from the results of the development were then preliminarily field-tested by material experts from 20 high school biology teachers and 10 ICT (Information and Communication Technology) teachers for media design and content validation. Validation results showed that 67% approve the feasibility of books and videos without revisions and 30% approve the feasibility of books and videos with revisions according to the notes provided including broken images, add pop-up variations, use good spelling, the material is equipped again, there is still space, and needs to improve sound quality. The teacher's assessment of the biology pop-up book with the highest score in the excellent category (3.8) is in the suitability of the letter variations and material layout. Whereas in the VR video assessment, the highest score in the video relevance section with the material is 3.8 with a very good category. The design of the book and video was then revised (Main Product Revision) according to the assessment and notes provided by the media and material experts.

Preliminary Field Testing continued with the subject of 6 high school students who had graduated to find out the suitability of the layout and attractiveness of biology pop-up books and VR videos. The assessment includes the suitability of the letters, layout, attractiveness, creativity, book size, and language that the results fall into the very good category (3.7), except in the layout of the material and pictures that still get a good category (3.1). This result showed that biology pop-up books need a little revision before being tested in small groups. Suggestions from the results of this one-on-one test are the material that must be completed, the location of the material and drawings are arranged more proportionally, and the revision of the pop-up section. Similar to the testing on VR videos that get a
mean score of 3.5 with a very good category except in the video updates section that gets a good
category (3.1). Suggestions from the results of VR video testing are used to revise (Main Product
Revision) video quality, the addition of unique facts, and material content.

![Figure 3. Biology VR Video. Video Sound is in Indonesia Because the Research is Applied in
Indonesia.](image)

The next step was Main Field-testing which involved 100 students from private and public high
schools. The testing pop-up book uses a questionnaire with 10 aspects of statements that include
letters, layout, pop-ups, attractiveness, book size, applicative, systematic, drawing, and language. The
test results (Figure 4) showed an average score of 3.7 with a very good category, but the results of
several aspects are still less than 3.7, namely in the systematic part of the presentation of
attractiveness, material, and language but still in the very good category. These results indicated the
need for revisions in several parts of the book in accordance with the notes of advice from students,
including the quality of the picture, the number of pop-ups, book covers, and letter compatibility.

![Figure 4. Biology Pop-Up Book Test Results for High School Students](image)

Main Field-testing on VR video includes 10 aspects of statement namely relevance, concept truth,
renewal, quality, content, layout, sound, text, duration, and practicality (Figure 5). The test results
showed an average score of 3.75 with a very good category for all aspects. The lowest score on the
aspect of the text presented in the video is still incomplete or equal to the sound presented in the VR
video. Based on the test results, the VR video needs to be revised according to the suggestions given
by students including text improvement, improvement of sound quality, use of VR glasses, improvement of terms and scientific names.
Subsequent tests were carried out to determine habits of mind as a result of evaluating the use of biological pop-up books and VR videos that were measured using the HoM questionnaire given to private and public high school students. The results of evaluating the habits of mind of high school students from the benefits of using pop-up books and VR biology videos can be seen in Figure 6. The results show that all three aspects of HoM (self-regulation, critical thinking, and creative thinking) score very well (> 3.25) both in preliminary, teacher validation, and playing field-testing students, but the score on preliminary is lower than playing field testing. The highest aspect of HoM is creative thinking compared to other aspects and many are chosen by teachers because the use of media that is different from what is commonly used can generate new perspectives to see problems and solutions. Creative attitudes can be improved through problem-based learning and by collaborating technology needed to improve communication between students in completing assignments [18, 19].

Another case with the self-regulation aspect that gets the highest score on playing field-testing on students because with pop-up books and VR video students can realize their thoughts and can use information sources as needed. In line with this in the era of globalization, the ability to organize their learning is very important to be implemented because it will affect student achievement [20]. The aspect of self-regulation is strongly influenced by students’ motivation towards the subject matter and the level of personal interest [20,21].
On the other hand, the critical thinking aspect is lower compared to other aspects because of the need for assignments to find accurate sources, clarity, find different ideas, and understand the abilities of others. Students who can implement critical thinking are more tactful and effective in solving problems and completing assignments [23]. The use of new learning management models can also improve the ability of critical thinking and student learning outcomes [24]. For this reason, learning should be carried out using pop-up books and VR videos to improve habits of mind in all aspects.

4. Conclusion
Based on the research, it can be concluded that pop-up book for high school students consists of sensory devices, biogeochemistry, ecosystems, enzymes, photosynthesis, immunity, menstruation, development and growth, cells, symbiosis, protein synthesis, digestive system, circulatory system, motion system, and viruses. Also, virtual reality video products have been published on YouTube. Biology pop-up book products and VR videos can increase students' reading interest and habits of mind.

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