Development of Digital Biology Book on Antioxidant Activity of Red Dragon Fruit Extract (*Hylocereus Polyrhizus*) for Class XI High School Students

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ABSTRACT

With technological advances, digital-based learning resources are needed that can be studied by students independently. The results of the research can be used as a learning resource, one of which is in the form of a digital book. This study aims to determine the quality and feasibility of digital books compiled as learning resources. The type of research is research and development (R&D) which refers to the 4D development model (Define, Design, Development and Disseminate). Data collection techniques with instruments in the form of expert assessment questionnaires and response questionnaires. The research subjects consisted of material experts, media experts, biology teachers and 37 students of SMA N 1 Koba class XI. Product data were analyzed descriptively qualitatively to determine the quality and feasibility of the compiled digital book. The results of research and development (R&D) obtained a Digital Book product for high school students class XI bioprocess material. Product assessment by material experts 88.64% (very good), media experts 86.11% (very good), biology teacher experts 100% (very good). The results of the small-scale test of students were 94.29% (very good) and the large-scale test was 98% (very good). Results Based on this research, digital books are appropriate to be used as a learning resource for class XI cell bioprocess materials.

1.   Introduction

Learning is an activity with the guidance of teachers or with the students' own efforts. In learning activities, students do not only interact with teachers as a source of learning, but with other learning sources. With the advancement of technology, digital-based learning resources are needed that can be studied by students independently. Learning resources are devices, materials or materials, equipment, settings and people with whom students can interact with the aim of facilitating learning and improving their performance (Januszewski & Molenda, 2008).

Based on interviews with biology teachers at SMA Negeri 1 Koba on November 25, 2021, it was found that biology learning for grade XI bioprocess material in learning uses textbooks, modules and learning videos. The material presented in the textbook can be said to be sufficient and students are also very interested in the learning resources used because there are audio and visuals, but in the cell bioprocess material, students also have difficulties and obstacles because the learning resources used in the form of videos seem very monotonous.

Cell bioprocess material is one of the biology materials for grade XI high school which studies the processes that occur in cells. The content of cell bioprocess material includes cell membrane transport (diffusion and osmosis), protein synthesis and cell division as a basis for understanding bioprocesses in living systems. Students' knowledge of cell bioprocess material needs to be enriched with other biological processes that occur in cells, one of which is the capture of free radicals by antioxidant compounds.

Antioxidants are chemical compounds that can donate one or more electrons to free radicals, so that the reaction to free radicals can be inhibited and prevent the presence of new free radicals (Halliwell & Whiteman, 2004). This process is carried out by the human body to ward off free radicals in cells in the human body which are formed in large quantities, so the body needs antioxidants from outside the body. There are concerns about the possibility of unknown side effects from synthetic antioxidants which cause natural antioxidants to become a much-needed alternative. Natural antioxidants can be found in red dragon fruit.

Red dragon fruit is a fruit that has a very attractive color with a high antioxidant content. Red dragon fruit contains vitamins B1, B2, B3, C and various antioxidants, such as phenols, flavonoids, and betasianins. The content of dragon fruit can ward off free radicals originating from within the body (Lubis, 2021). Based on research conducted by Febrianti et al. (2019) it is known that red dragon fruit flesh extract is relatively safer for normal vibroblast cells than its skin extract.

Testing the antioxidant activity of extracts or test samples can be done using various methods including DPPH, ORAC (Oxygen Radical Absorbance Capacity), TRAP (Total Radical-Trapping Antioxidant Parameter), TOSC (Total Oxyradical Scavenging Capacity), TEAC (Trolox Equivalent Antioxidant) and FRAP (Ferric Reducing/Antioxidant Power) (Mermelstein, 2008).

To determine the antioxidants in red dragon fruit juice, a test can be carried out using the DPPH (1,1-diphenyl-2-picryhydrazyl) method. The DPPH method is a very fast, simple and also very accurate method and this method is also widely used. In addition, the DPPH method has been proven to be accurate, reliable and practical (Christalina et al., 2018). The antioxidant activity of red dragon fruit can be used as a source of biology learning for high school students in grade XI on cell bioprocess material in the form of digital books. A digital book is a book that is compiled, converted and published into a digital format consisting of text, images or videos and can be read or displayed using a computer or other electronic devices. The compilation of digital books from research results is expected to enrich biology material, especially about cell bioprocesses.

2. Methodology

This study uses the Research and Development (R&D) research method. The development model used is the 4D development model proposed by Thiagrajan et al. (1974). The 4D model consists of several stages including definition, design, development and dissemination. The research was conducted from June to July 2022. These steps can be described in the following Figure 1.

Figure 1. Research and development steps

The stages of compiling learning resources are described as follows:

Definition Stage

The definition stage aims to establish and determine learning requirements, the objectives of which include learning objectives and limitations on learning materials. In this stage, there are the following steps:

a) Initial Final Analysis
The analysis is directed at deciding important issues in the progress of digital book media. At this stage, reality and order emerge to facilitate determining the basic steps in building enrichment book media that are suitable to be made. This analysis considers fundamental issues that are then used to determine the next steps for progress.

b) Student Analysis

The student analysis stage is carried out to determine the characteristics of students which include the percentage of minimum completion criteria (KKM) of students and the learning resources used. The results of this student analysis will later be used as a reference framework in designing learning resources that will be created.

c) Concept Analysis

The concept analysis stage is an examination of ideas that are expected to determine the identification of material components that will be taught to students in the advanced book media that is being created. The concept analysis stage is the identification of the main concepts that will be taught and arranging them systematically by describing the concept of the material.

d) Learning Objective Analysis

The formulation of learning objectives is carried out to convert the objectives of the concept analysis into basic competencies. The preparation of learning objectives or indicators of learning achievement is based on basic competencies and indicators listed in the 2013 Curriculum.

Design Stage

At the design stage, the media design will be used as a learning resource. According to this design stage, it aims to design the media that will be developed. In this stage there are the following steps:

a) Media Selection

At the media selection stage, it is adjusted to the results of the concept analysis that has been carried out and adjusted to the characteristics of the students. The selection of media is very important related to the efficient learning process and can make students more active, and in the learning process students are no longer centered on the teacher. The media that will be used is in the form of a digital book that has been adjusted to the learning objectives and the rules for compiling correct learning resources.

b) Format Selection

At the media format selection stage, it is intended to be able to design or design the contents of learning media that are adjusted to the learning materials and the 2013 curriculum used at SMAN 1 Koba. The selected format must be able to characterize a digital book that is designed systematically starting from (1) selecting a design platform, (2) selecting book size and font type, (3) compiling a draft and identifying the contents. At the initial design stage, what is meant is a design made before the trial.

c) Development Stage (Develop)

At this development stage, the final form of the learning resources that have been made can be produced after going through revisions based on input from experts and trial data. In this stage there are two steps as follows:

Expert Validation

At the expert validation stage, there needs to be theoretical and practical consideration of the expert regarding the validity of the initial design. The validators themselves consist of experts in the field of biology and experts in the field of education. The validators are asked to validate the learning resources that have been produced based on the initial design. Suggestions from the validators are used as a basis for revising the learning media that are used as learning resources.

The assessment aspects assessed by the validators are made in the form of an assessment scale. The type of scale used is a Likert scale. in this study using the product quality category according to Sugiyono (2019) which is found in Table 1.

Table 1. Likert Scale Category Assessment Guidelines

Assessment	Score
Very Good	4
Good	3
Less	2
Very Less	1

The assessment of the digital book enrichment data collected by experts is analyzed by adding up, compared to the expected amount that will be obtained, the percentage or can be written with the following formula: $NP = R\ /\ SM\ \times\ 100\%$. Description:
NP: Percentage Value,
R: Score obtained,
SM: Max Score

Table 2. Percentage Scale Criteria

Percentage of Achievement (100%)	Assessment Criteria
76-100	Very Good
51-75	Good
26-50	Less
0-25	Very Less

Furthermore, the values obtained from each validator are then interpreted into assessment categories to determine the quality of the product produced by referring to the percentage scale criteria according to

Sujarwinanti et al., (2020) based on the following Table 2.

Design Revision

The revision of the digital book design was carried out after going through the design assessment stage to obtain assessments, responses and suggestions from the validators.

Trial

a) Small-scale trial

The media that has been revised is then tested on students. The small-scale trial was only carried out on 7 students to get input from students on the learning resources that have been used. The class selected for the trial was class XI MIPA 3 SMA Negeri 1 Koba.

b) Large-scale trial

The media that has been tested on a small scale is then tested on a large scale. Large-scale trials were only conducted in one class to obtain input from students on the learning resources that had been used. The class chosen for the trial was class XI MIPA 3 of SMA Negeri 1 Koba. The trial was carried out by 30 students. The assessment criteria for student responses to the quality and suitability of enrichment digital book products using the Guttman scale according to Sugiyono (2019) are as follows Table 3.

Table 3. Guttman Scale Criteria

Score	Crteria
Yes	1
No	0

The assessment of the collected student questionnaires is analyzed by adding them up, comparing them with the expected amount to obtain the percentage of it and then interpreted into the assessment categories Table 2.

Dissemination Stage

The dissemination stage is the stage of using learning resources that have been developed and have been tested on a small scale and a large scale trial. This stage is carried out to test the effectiveness of digital book learning resources in the learning process.

3.   Results and Discussion

a.   Define Stage

Based on the results of interviews with biology teachers at SMAN 1 Koba, it was found that the curriculum used was the 2013 curriculum and it was found that biology learning for grade XI bioprocess material in learning used textbooks, modules, and learning videos. lack of enrichment material on bioprocess material at SMAN 1 Koba. Enrichment material in biology learning only consists of HOTS questions.

At the student analysis stage, the activities carried out were to find out students in accordance with the design and development of learning resources. The students in question are high school students majoring in MIPA class XI. The Minimum Completion Criteria (KKM) for biology at SMAN 1 Koba class XI MIPA 3 are with a value of 70 and 75.67% of students who achieve KKM. Students in class XI MIPA 3 total 37 people, namely 18 females and 19 males. Students have an average age of 15-18 years, children of that age are in the formal stage.

According to Piaget's learning theory in (Ibda, 2015) children of this age are at the formal operational stage. The main characteristic of child development at this stage is having abstract and purely symbolic thinking. Therefore, the students who were used as the test subjects for this research were at the stage where they could think logically. The interview results were used as a reference to prepare aspects related to the biology learning resources that were created. So that a digital book learning resource was produced that was created using the Canva application and then made into a corporate flip pdf that was suitable for students.

At this analysis stage, the activities carried out were to identify, detail and systematically compile the main materials studied by students with relevant concepts. The learning materials in this study were bioprocess materials which included cell bioprocesses, types of bioprocesses, free radicals and antioxidants. Based on the facts in the field, students enjoy learning if the learning materials delivered by the teacher are more concise but easy to understand.
Analysis of learning objectives is carried out to determine indicators of learning achievement. By writing down the learning objectives, researchers can find out what studies will be displayed in the digital book and finally determine the learning objectives that are achieved according to KI and KD 3.2 Biology Class XI.

According to Sulthon (2017) teachers must be creative in developing effective activities in developing various activities, making learning aids and media, effective learning if teachers can achieve learning objectives, so that learning is fun teachers must be able to package the material so that it is easier for students to understand, use learning media

that is in accordance with the material to attract students' attention in participating in teaching and learning activities.

b. Design Stage

According to Meiristanti & Puspasari (2020) this design stage aims to design the media to be developed. In this stage there are the following steps: The design stage begins with the selection of digital book media. Then continued with the selection of the digital book format using the Canva graphic design platform, Flip PDF Corporate, book size, font type and material draft. The initial design for the development of the Cell Bioprocess Digital Book consists of the beginning, middle and end. The first part includes the cover page, digital book identification, foreword, table of contents, instructions for use, core competencies, basic competencies and learning objectives.

The middle part includes material covering the definition of cell bioprocess, types of cell bioprocess, free radicals, antioxidant activity and red dragon fruit, how it works, research results. The last part includes a glossary, bibliography and about the author. This is in accordance with the requirements for compiling a good digital book. The design of the Cell Bioprocess digital book is made as attractive as possible in order to attract the attention of students. the appearance of the digital book can be seen in Figure 2.

Figure 2. Cover, Material and Back Page of the Digital Book of Cell Bioprocess

c. Development Stage (Develop)

The development stage is the stage to develop the design results that have been made previously. Development is carried out on biological objects that have been selected in the Cell Bioprocess material. The results of the development are in the form of a digital book that will be assessed as an initial prototype by material experts, media experts and biology teachers.

a. Results of Assessment by Material Experts

Assessment of the digital book by material experts to see the aspects of the feasibility of the content and language in the Digital Book of Cell Bioprocess. The validation results can be seen in Table 4.

Table 4. Percentage of Material Expert Assessment

No	Aspect	Percentage	Category
1.	Content Suitability	90%	Very Good
2.	Language	87,5%	Very Good

Table 4 shows that the assessment of material experts for the aspect of content feasibility obtained a percentage of 90% and the linguistic aspect obtained a percentage of 87.5%. The aspect of content feasibility received a percentage of 90% in the very good category. The assessment items assessed include digital books that invite students to live out the teachings of their religion, the suitability of the material with the 2013 Curriculum, the breadth and depth of the material and the suitability of the material presented with the latest developments in biology.

The linguistic aspect received a percentage of 87.5% in the very good category. The assessment items for the linguistic aspect, namely the readability of the language in the message (teaching material) used in the digital book are easy for students to understand, the accuracy of the sentence structure, the standardization of terms, the accuracy of spelling, and the consistency of the use of scientific/foreign names received a percentage. This is supported by Nurlaili (2011) who said that the use of a clear sentence structure can make it easier for students to understand the message of the teaching material. The cumulative value of the aspects of content and linguistic feasibility received a percentage of 88.64%, so it is included in the very good category. Based on the assessment, the material expert recommends that the digital book is suitable for use for trials without revision.

b. *Media Expert Assessment Results*

The assessment of the digital book by the media expert to see the presentation and graphic aspects in the Cell Bioprocess Digital Book. The validation results can be seen in Table 5.

Table 5. Percentage of Media Expert Assessment

No	Aspect	Percentage	Category
1.	Presentation	82,14%	Very Good
2.	Graphics	100%	Very Good

Table 5 shows that the media expert's assessment for the presentation aspect obtained a percentage of 82.14% and the graphic aspect obtained a percentage of 100%. According to Lestari et al. (2018) stated that visual-based media (pictures/images) play a very important role in learning and can facilitate understanding. According to Wahanani (2013) hyperlink means jumping to another document or a series of texts or which can take to another position in a document to another section. Hyperlinks are used in indexing on the web and information retrieval. The type of link that can help provide users with the flexibility to get accurate information without having to enter new keywords but with the help of hyperlinks on the title, author, subject and other information that is considered related. In the graphic aspect, the assessment percentage was 100% in the very good category.

The assessment items that were assessed included the selection of the type and size of letters that support digital books to be attractive so that they are easy to read by students. In the overall appearance item, the digital book is attractive, it gets a percentage of 100%. The selection of the type and size of letters and the overall appearance of the digital book are important in order to increase students' curiosity. According to Arsyad (2011), it is recommended to choose a normal font, not decorated, and use capital letters and lowercase letters proportionally. The accumulative value of the presentation and graphic aspects with a value obtained of 86.11%, so that it gets an assessment with a very good category.

c. *Biology Teacher Assessment Results*

Assessment of digital books by biology teachers to see aspects of the feasibility of content, language, presentation and graphics in the Cell Bioprocess Digital Book. Table 6 shows that the assessment of material experts for the aspect of content feasibility obtained a percentage of 100%, the linguistic aspect obtained a percentage of 100%, the presentation aspect obtained a percentage of 100% and the graphic aspect obtained a percentage of 100%. The validation results can be seen in Table 6.

Table 6. Percentage Assessment of Biology Teachers

No	Aspect	Percentage	Category
1.	Content Eligibility	100%	Very Good
2.	Language	100%	Very Good
3.	Presentation	100%	Very Good
4.	Graphics	100%	Very Good

The material in the enrichment digital book is the most important thing in the development of enrichment digital books so that students can understand the concept of the material, so that it is structured systematically and must be relevant (Prastowo, 2015).

Therefore, the enrichment digital book contains an overview of concepts that are arranged systematically and discuss the definition of cell bioprocesses, types of cell bioprocesses, free radicals, and red dragon fruit extract antioxidants. In addition, there is a video which is an audio-visual media to facilitate understanding in studying the material. This is because audio-visual is a very interesting form of content. According to (Agustiningsih, 2015) states that the use of video as additional media can help clarify and understand concepts. The accumulative value of the assessment from the biology teacher with that obtained is 100%, so that it gets an assessment with the category "Very Good". Based on the results of the biology teacher's assessment, it can be concluded that the digital book is suitable for use after revision.

d. *Design Revision*

The digital enrichment book revision was carried out after going through the design assessment stage to obtain assessments, responses and suggestions from the validator. Design revisions were carried out to produce the final prototype.
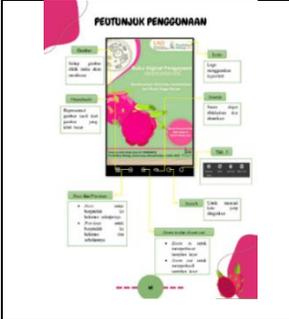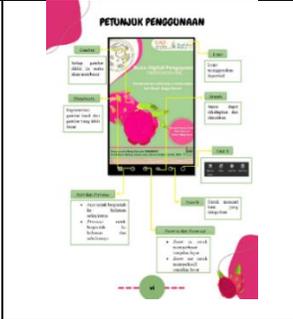
Preliminary Design Instructions for Use	Final Design Instructions for Use

In the final prototype, typos were corrected and instructions in the image section were clarified.

In the final prototype, the image parts and color contrast that were not quite right were corrected so that the writing was easy to read.

In the final prototype added in the video caption

e. Trial

The trial in this study was divided into two, namely a small-scale trial and a large-scale trial. The small-scale trial was conducted in class XI MIPA 3 on 7 students and the large-scale trial on 30 students of class XI MIPA 3 SMAN 1 Koba.

a) Small-Scale Trial

The results of the four aspects in the small-scale trial that obtained a maximum percentage of 100% were 3 aspects, namely language, material and benefits. While the display component received a percentage of 80.95% categorized as very good in Table 7.

Table 7. Results of the Small-Scale Trial

No	Aspect	Percentage	Category
1.	View	80,95%	Very Good
2.	Language	100%	Very Good
3.	Material	100%	Very Good
4.	Benefits	100%	Very Good
Final Response of Small Scale Trial		**94,29%**	**Very Good**

The results of the overall small-scale trial student responses received a percentage of 94.29% categorized as very good, it was concluded that the

digital book developed was worthy of use. According to (Rosida et al., 2017) students are more interested in using e-books because they have a display and format that displays images/videos so that they have a higher meaning than just reading and listening to videos, and phenomena that are in accordance with the material can help foster student learning motivation.

b) *Large-Scale Trial*

The aspects that get a maximum percentage of 100% in large-scale trials are the appearance and language aspects. The material aspect gets a percentage of 90% and the benefit aspect gets a percentage of 95% categorized as very good in Table 8.

The results of the large-scale student trial overall got a percentage of 98% categorized as very good, so the digital book developed is suitable for use as a learning resource for class XI cell bioprocess material.

Table 8. Results of Large-Scale Trial

No	Aspect	Percentage	Category
1.	View	100%	Very Good
2.	Language	100%	Very Good
3.	Material	90%	Very Good
4.	Benefits	95%	Very Good
Final Response of Small Scale Trial		**98%**	**Very Good**

c. *Dissemination Stage*

The digital book produced at the end of the development stage as in attachment 41 (final prototype). At this dissemination stage, the activity carried out is to distribute digital books that have been tested and declared suitable for use. Digital books are distributed via the WhatsApp application to biology teachers at SMA Negeri 1 Koba. The website address to access the digital book is as follows: https://online.flipbuilder.com/nlmfe/zafg/

4. Conclusion

Based on the assessment carried out by material experts, the developed media has a very good in content category. The experts also decided that the developed media has a very good category for the visual of media and also given by teachers. The results of the small-scale and large-scale digital book trials were both very good, respectively. This media can be said to be suitable for use as a learning resource for high school biology for grade XI on cell bioprocess material.

Acknowledgment

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