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By Arifin & Lestari

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Development of Bacterial Genetics Teaching Materials Based on Flipbook Maker in Microbiology Subject to Improve Learning Motivation

As'ad Syamsul Arifin, **Endang Sri Lestari**

[1]IKIP Budi Utomo Malang, Jl. Citandui No. 46, Malang 65123, Indonesia

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ABSTRACT

Microbiology is the study of microbes where one of the materials is bacterial genetics. The results of observations about microbiology learning students experienced difficulties in understanding bacterial genetics, and there was no teaching material on bacterial genetics. Flipbook-based teaching materials are an alternative solution for teaching bacterial genetics well to students. The purpose of this study was to develop flipbook-based bacterial genetics teaching materials in microbiology courses at IKIP Budi Utomo. The development research model used is 4D including define, design, develop, and disseminate. This research is limited to the development stage. The results showed that the assessment of bacterial genetics teaching materials from material experts was 90.38%, media experts were 90%, field practitioner tests were 91.67% so that it met the very worthy criteria. The readability test with most of the students answered strongly agree with the statements about bacterial genetics teaching materials. The flipbook-based bacterial genetics teaching materials in the Microbiology course can improve learning motivation.

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INTRODUCTION

Microbiology is the study of microbes, microorganisms. Microbiology is a branch of biology and requires supporting science in chemistry, physics, and biochemistry. Microbiology is often called the practical science of biochemistry (Mayasari, 2020). The scope of studying microbiology includes an understanding of the history of the discovery of microorganisms, the kinds of microorganisms in nature, the cell structure of microorganisms and their functions, the metabolism of microorganisms in general, the growth of microorganisms and environmental factors, and applied microbiology both in the environmental and agricultural fields (Widodo, 2016). One of the materials taught in the Microbiology course at IKIP Budi Utomo is bacterial genetics.

Genetics is the study of genes including the structure of genetic materials, what information is stored in the genes, how the genes are expressed, and how the genetic information is transferred. Genetics is also the study of heredity and variation. The order of DNA bases constitutes the

bacterium's genotype. A particular organism may possess alternate forms of some genes. Such alternate forms of genes are referred to as alleles. The cell's genome is stored in chromosomes, which are chains of double-stranded DNA. Genes are sequences of nucleotides within DNA that code for functional proteins. The genetic material of bacteria and plasmids is DNA. The two essential functions of genetic material are replication and expression (PN, 2006). Bacterial genetics is the study of genes contained in bacteria.

Based on the results of observations, microbiology learning at IKIP Budi Utomo went quite well. Lecturers have not used learning models while teaching. However, students still have difficulty understanding material related to bacterial genetics. Students have difficulty understanding genetic material and the process of transferring genetic information contained in bacteria. The process of transferring genetic information to bacteria is quite complicated because it involves several stages. These stages should be accompanied by pictures or videos to make it easier for students to understand the material. Students are less motivated because it is difficult to digest the meaning of the process of transferring genetic information. Besides, students are less motivated in learning because of the monotonous presentation discussion learning method. Lecturers have never developed teaching materials that explain in detail bacterial genetics. Teaching materials are materials or subject matter that are arranged systematically, which are used by teachers and students in the learning process (Pannen, 1995 in Sadjati, 2012). There are various kinds of teaching materials, one of which is teaching materials using the flipbook.

Flipbooks are sheets of paper that resemble albums or calendars. This media can be used individually or in groups of 4-5 people. This media can be carried anywhere and can be put in a shirt pocket because of its small shape. Students can study anywhere and anytime using this flipbook (Wahyuliani, Supriadi, & Anwar, 2016). Flipbook Marker which is software used to make a book display or other teaching material into a digital electronic book in the form of a flipbook. The software can be downloaded for free or for free via internet access (Sugianto, Abdullah, Elvyanti, & Muladi, 2017). Flipbook is a development of an e-book which is used as a learning medium. The term flipbook is taken from a children's toy that contains a series of different pictures, if opened from one page to another it will show that the pictures seem to move. Moving pages can be done by dragging the page like our fingers are turning a book page, and simultaneously with the dragging process of real folded pages such as paper being bent. With the form of a flipbook that utilizes the page switching effect, it is hoped that it can attract student learning motivation so that student learning outcomes will increase (Ramayana, 2014 in Searmadi & Harmurti, 2016).

Motivation is a series of attempts to provide certain conditions so that someone wants and wants to do something and if he doesn't like it he will trying to eliminate or avoid the feeling of dislike. So motivation can be stimulated by external factors, but the motivation grows within a person. The environment is one of the external factors that can generate internal motivation oneself to learn (Emda, 2017). Teaching materials in the form of a bacterial genetics flipbook can be an external factor that can motivate students to learn.

The flipbook teaching materials are prepared using the flipbook maker application. The flipbook maker application is an application that supports learning media that will help in the learning process because this application is not only fixated on writing, but can include motion animation, video, and audio that can make learning interesting (Wibowo et al., 2018). The advantages of the flipbook maker application include: being able to provide a flip effect, namely opening or turning the pages of a book so that it is like reading a real book, making electronic books with this application is very easy, the e-books produced are not only books, but can be equipped with images, sounds, and videos, and the products we produce can be published in SWF or Flash, HTML for publication on the website (Asmi, Surbakti, &Hudaidah, 2018). The purpose of this study was to develop a flipbook maker-based bacterial genetics teaching material in the Microbiology subject at IKIP Budi Utomo Malang.

RESEARCH METHODS

Research Design

Educational development research is a process used to develop and validate educational products. The results of development research not only develop existing products but also find knowledge or answers to practical problems (Asmi et al., 2018). The development research model used in this research is the 4D development research model which broadly consists of 4 stages including define, design, develop, and disseminate. Define procedure consists of certain stages consisting of front-end analysis, student analysis, assignments analysis, concept analysis, and analysis Learning objectives. The next stage is designed which is done to produce prototype development results. This research and development prototype produced a flipbook of bacterial genetics. The next step is to develop. Learning material is developed stage through several fixes before it's ready for use by users. The process of improving learning material is based on formative evaluation, one of which is through experts consideration. Formative evaluation activities for flipbook of genetics bacterial is conducted by material experts, media experts, and lecturer in microbiology. The final step in the developed stage was the product readability test. Readability test was carried out on classes that have taken Microbiology courses (Thiagarajan, Semmel, & Semmel, 1974).

Population and Samples

The population in this study were all biology education study program lecturers and Biology Education study program students at IKIP Budi Utomo Malang. The samples of this study were one lecturer of microbiology subjects as field practitioners and 10 students of the Biology Education study program at IKIP Budi Utomo Malang class of 2018 who had taken the Microbiology course (legibility test).

Instruments

The instruments used in this study included a material expert validation questionnaire, a media expert validation questionnaire, a field practitioner validation questionnaire, and a student legibility test questionnaire. The instruments used in this study included a material expert validation questionnaire, a media expert validation questionnaire, a field practitioner validation questionnaire, and a student readability test questionnaire. Assessment indicators on the material validation questionnaire included aspects of content, presentation, and language feasibility. Assessment indicators on the media validation questionnaire include cover design, size of presentation of learning materials, content design, and learning activities. The assessment indicators on the field practitioner questionnaire included the feasibility of content presentation, grammar, and display. The indicators on the student readability test questionnaire include materials, displays, and benefits. In the readability test questionnaire, precisely on the benefit aspect, there are points about whether or not teaching materials can motivate students.

Procedures

In the defined stage (introduction) includes curriculum analysis, analysis of student characteristics, material analysis, and analysis of learning objectives. At the design stage, the researcher has made an initial product (prototype) or product design. The product designed in this study a flipbook maker-based bacterial genetics teaching material. In the development stage, there are two activities, namely: expert appraisal and developmental testing. The expert appraisal is a technique for validating or assessing the feasibility of a product design. Developmental testing is the activity of testing product designs on the real target subject. At the time of this trial, response data, reactions, or comments from the target user model were sought. The trial results are used to improve the product. After the product has been repaired, it is then tested again to obtain effective results. At this stage, students' motivation was also measured using a readability test questionnaire, precisely at the points of the benefits of the teaching material. At the disseminate stage, it is carried out by socializing teaching materials through distribution in limited quantities to educators and students. This distribution is intended to obtain responses and feedback on the teaching materials that have been developed. If the

response of the target users of teaching materials is good, then printing in large quantities and marketing is done so that the teaching material is used by a wider target audience (Thiagarajan et al., 1974). This research was conducted only up to the development stage.

Data Analysis

The type of research data on the development of Flipbookmaker-based bacterial genetics teaching materials is qualitative and quantitative data. Qualitative data were obtained from a questionnaire containing suggestions submitted by material expert validators, media experts, field practitioners, and respondents on the legibility test. Quantitative data were obtained through a questionnaire containing the assessment scores of the validators and the respondents who tested the readability of the worksheets. The results of the validation test of teaching materials by the validator and the readability test in the form of the score of the question items were analyzed using descriptive statistics, namely the mean percentage with the following formula

$$P = \frac{\Sigma X}{\Sigma Xi} x\ 100$$

Information:
P = Percentage;
ƩX= The total number of scores obtained from the validator;
Ʃxi = Total ideal score
Source: Wicaksono, Kusmayadi, &Usodo (2014)

Based on the results of calculating the percentage of the validation sheet analysis, it is interpreted into the criteria which can be seen in the following table:

Table I. Validator Assessment Criteria

Percentage	Criteria
83,5%-100%	Very good or Very worthy
63,5%-83%	Good or Worthy
44,5%-63%	Worthy enough
25%-44%	Not good or not worthy

Source: Akbar (2013)

RESULTS

The results of the study were in the form of a flipbook maker-based assessment of bacterial genetics teaching materials by material validators, media validators, lecturers as field practitioners, and legibility tests. The results of the assessment of the validators and field practitioners are presented in table 2.

Table 2. Result of Material Expert Assessment

Aspect	Indicator	Score	Category
Content	Suitability of the material with CPMK	4	Very worthy
	Material Updates	4	Very worthy
	Material accuracy	4	Very worthy
	Encourage curiosity and motivation	3	Appropriate
Presentation	Presentation support	4	Very worthy
	Presentation technique	3	Worthy

	Presentation of learning	4	Very worthy
	Coherence and wrinkling of thought lines	4	Very worthy
Language eligibility	Communicative	4	Very worthy
	Straightforward	3	Worthy
	Dialogical and Interactive	3	Worthy
	Conformity with the development of students	3	Worthy
	Compliance with language rules	4	Very worthy
Percentage average		90,38	Very worthy

Based on table 2 it is known that the assessment of material experts shows a percentage of 90.38 with very worthy criteria. Suggestions from material experts are that each picture presented in the flipbook should be accompanied by a source, do not forget to include a bibliography.

Table 3. Results of the Media Expert's Assessment

Indicator	Point of assessment	Score	Category
Cover design	Layout	4	Very worthy
	Colour	4	Very worthy
	Letter	4	Very worthy
	Cover Illustration	3	Worthy
Size of learning material presentation	Compliance with ISO	3	Worthy
	Conformity with material	4	Very worthy
Content design	Layout consistency	3	Worthy
	Layout harmonization	3	Worthy
	Complete layout	4	Very worthy
	The layout accelerates the page	4	Very worthy
	Simple content typography	3	Worthy
	Typography content makes it easy to understand	4	Very worthy
	Content illustration	4	Very worthy
Learning Activities	Can motivate students in learning	4	Very worthy
	Easy to use by students in learning	3	Worthy
Percentage average		90,00	Very worthy

Based on Table 3, it is known that the media expert's assessment of the flipbook maker-based bacterial genetics teaching material shows a percentage of 90 with very worthy criteria. Advice from media experts on the cover should be that the writing color contrasts with the background color of the cover. The color background of each subsection should be distinguished so that it is easier for readers to recognize the different subsections.

Table 4. Results of Assessment of Field Practitioners

Aspect	Indicator	Score	Category

Feasibility of content	Components of practicum instructions	3	Worthy
	Meaningfulness	4	Very worthy
	Curriculum	4	Very worthy
	Title Determination	3	Worthy
	Writing	4	Very worthy
Grammar	Use The Indonesian Language well and correctly	3	Worthy
	Communicative and straightforward language	4	Very worthy
Display	Interesting	4	Very worthy
	The flow of thinking is clear and systematic	4	Very worthy
Percentage average		91,67	Very worthy

Based on Table 4, it is known that the field practitioner's assessment of the flipbook maker-based bacterial genetics teaching material shows a percentage of 91.67 with very worthy criteria. Suggestions from field practitioners are that the teaching materials that are made should be given practice questions so that they can be used as learning materials for students.

Table 5. Percentage of Test Result Product Readability

Aspect	Assessment			
	Strongly agree	Agree	Disagree	Totally of disagree
Material	76,67	23,37	0	0
Display	66,67	33,37	0	0
Benefits	63,37	36,67	0	0
Average (%)	68,90	31,14	0	0

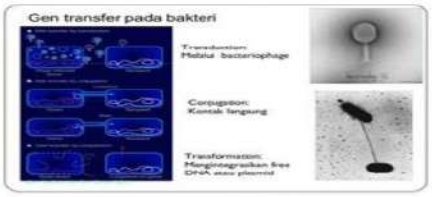
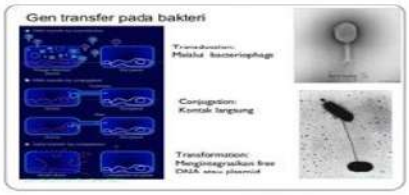
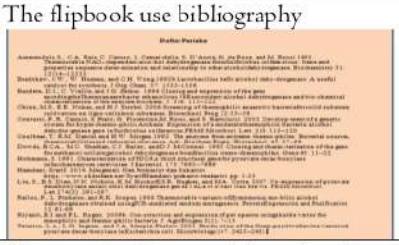
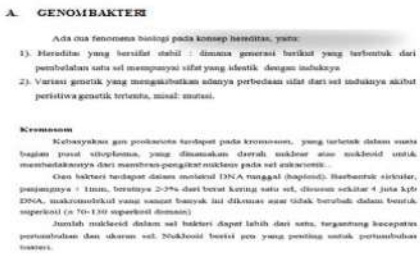
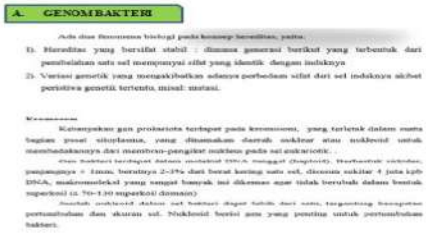
Based on Table 5, it is known that 68.90% of all statements were answered by students with very agreeable answers and 31.14% answered with agreed answers. There were no students who answered disagree or strongly disagreed with the statements on each indicator.

Data regarding student learning motivation is presented in Table 6. There are 4 aspects of the benefit points of the student readability test questionnaire that are related to student learning motivation, namely student skills, student interest, student independence, and student ability to defend opinions. The score on the questionnaire showed that 8 out of 10 students per aspect or 63.37% of students answered strongly agree. 2 out of 10 or 36.67% of students answered agree.

Table 6. Student's Learning Motivation

Aspect	Percentage of Answered Strongly Agree (%)	Percentage of Answering Agree (%)
Teaching materials can make students diligent in facing assignments	63.37	36.67
Teaching materials can increase students' interest in facing problems	63.37	36.67
Teaching materials can make students learn independently	63.37	36.67
Teaching materials can enable students to defend their opinions	63.37	36.67
Mean	**63.37**	**36.67**

Table 6. Validator comments on teaching materials before and after revision

No.	Before Revision	After Revision
1.	Each picture presented in the flipbook is not accompanied by a source  Gambar 6.2 Gen transfer pada bakteri	Each picture presented in the flipbook is accompanied by a source  Gambar 6.2 Gen transfer pada bakteri (Sumber: Hamdani, 2014)
2.	The flipbook has not used a bibliography	The flipbook use bibliography 
3.	The cover is given a writing color that does not contrast with the background color of the cover 	The cover is given a writing color that contrasts with the background color of the cover 
4.	The background color of each subsection is not distinguished 	The background color of each subsection is distinguished 
5.	The teaching materials are not given practice questions	The teaching materials are given practice questions 

DISCUSSION

The product of teaching materials developed meets very feasible requirements if it shows a score between 83,5% -100%. Based on the data and data analysis, the results showed that the flipbook maker-based bacterial genetics teaching materials met the very feasible criteria with the percentage of assessment from material experts of 90.38%, media experts by 90%, field practitioner tests of 91.67%, and legibility testing with most students answered strongly agree. During the readability test, students have distributed a soft file flipbook of bacterial genetics and a questionnaire. Students feel enthusiastic and motivated because they have never previously learned to use a flipbook. There are 4 aspects of the benefit points of the student readability test questionnaire that are related to student learning motivation, namely student skills, student interest, student independence, and student ability to defend opinions. The score on the questionnaire showed that 8 out of 10 students per aspect or 63.37% of students answered strongly agree. 2 out of 10 or 36.67% of students answered agree. This means that almost all students strongly agree if this teaching material can motivate. This is in line with research conducted by Noviyanita (2018) that with a flipbook maker, the contents of electronic teaching materials which include material and practice questions are presented vary, not only text but some pictures and videos support the material. Besides, it makes it easier for students to learn in certain sections as desired. The flipbook teaching materials that are prepared allow students to read, see pictures, listen to, and watch videos, and can practice the procedures contained in the teaching materials (Hastuti & Rohman, 2017).

The flipbook-based teaching material for bacterial genetics provides material in the form of concept maps and explanations as well as practice questions in the form of text and videos on the process of exchanging genetic material and mutations in bacteria. The material in the bacterial genetics flipbook, in general, includes the bacterial genome, exchange of genetic material in bacteria, mutations, bacterial genotypes and phenotypes, regulation of protein synthesis in prokaryotes, and repair of DNA damage. The following is a display of the covers of the bacterial genetics flipbook.

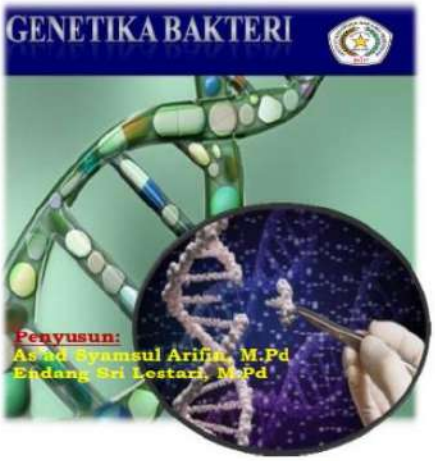


Figure 1. The covers of bacterial genetics flipbook
Source: Personal documentation

The cover shows a title and an image that supports the title. The cover background color is dominated by green. Color has a very important meaning and function in the life of an organism. Not only humans but also animals and plants have an interest in color. Humans can take advantage of color both for various purposes of everyday life and to explore knowledge and knowledge (Adisendjaja, 2003). Green is associated with plants, nature, the environment. The effects on the product include colors that are friendly to the eyes, soothing, and calming. The image on the cover shows a close

relationship with the material. When students saw the cover of the bacterial genetics flipbook, they felt attracted and pleased. The following is a display of the contents of the bacterial genetics flipbook. The following is a display of the contents of the bacterial genetics flipbook.

Figure 2. Display of contents of the bacterial genetics flipbook
Source: Personal documentation

The content display shows that there is text accompanied by an image. According to Haryanti (2018) images or photos are included in visual media. This media serves to transmit messages from the source recipient to the message recipient. The message that will be conveyed into symbols of visual communication needs to be understood correctly, meaning that the message delivery process can be successful and not cause errors. Image media relies heavily on the sense of sight. There are several advantages in using image media, namely: it is concrete, images can overcome space and time constraints, image media can overcome the limitations of our observations, can clarify a problem, and are cheap, easy to obtain, easy to use, without the need for special equipment (Afriyanti, Fadillah, & Sukmawati, 2012). The bacterial genetics flipbook uses good and correct Indonesian language and is adapted to Enhanced Spelling (EYD). The scope of Enhanced Spelling (EYD) includes five aspects, namely the use of letters, writing letters, writing words, writing absorption elements, and using punctuation marks (Finoza, 2001 in Sukmawati, Nurhayati, & Iswary, 2013).

Similar research was carried out, among others, Wibowo et al., (2018) who argued that the e-module using the kvisoft flipbook maker application produced in this study was considered suitable for use in mathematics learning set material. Yulaika, Haryani, & Sakti (2020) suggest that the use of flip book-based electronic teaching materials in economic learning has a positive impact on improving student learning outcomes and increasing student activities including visual, oral, listening, writing, and emotional. Setiyo, Zulhermanan, & Harlin (2018) suggest that learning media using a flash flipbook in the Machine Elements I course developed by researchers produces valid and practical learning media to be applied to the learning process. Validity is seen from the validation results of material experts, linguists, and media experts. Mulyadi, Wahyuni, & Handayani (2016) shows that flash flipbook media development can improve students' creative thinking skills in science learning in SMP.

CONCLUSION

Based on the description above, it can be concluded that the flipbook maker-based bacterial genetics teaching materials in the Microbiology course meet the very appropriate criteria from the assessment of material experts by 90.38%, media experts by 90%, and field practitioners (lecturer in microbiology) by 91.67%. Also, the readability test showed that most students answered strongly that they agreed with the content in the flipbook. The readability test of students shows a positive response

to the existence of this teaching material and showed that bacterial genetics flipbook teaching materials could increase student motivation. Further research is needed to measure the magnitude of the increase in motivation through class action research or quasi-experiments on bacterial genetics flipbook teaching materials.

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