APPLICATION: Applied science in Learning Research
Vol. 1 No. 2 October 2021, Page. 106 - 112
E-ISSN: 2797-0655

Reconstruction of STEM-Based Learning Videos on Topics of *Escherichia coli* Bacteria

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ABSTRACT
The purpose of this development research is to determine the design and feasibility of STEM-based learning videos on Escherichia coli bacteria material. The type of research used is research and development (R & D) with a 4D development model. However, in this study, it was limited to 3D without the Dessiminase stage. The research subjects were students of the 6th semester biology education study program with a total of 7-10 students. The data used are quantitative data (validation questionnaire scores and student responses) and qualitative data (suggestions and comments from validators and students). Data retrieval using a material and media validation questionnaire instrument and student response questionnaires. The results obtained are the formation of a product in the form of STEM-Based Learning Videos on Escherichia coli Bacteria with the "Eligible" category where 69.4% for material validation and 70.2% for media validation. Meanwhile, for student responses, the percentage is 78% in the interesting category. This product is expected to help students in learning independently so as to support the improvement of learning outcomes and student interest in learning. In addition, this product can be a source of supporting learning in the learning process as well as a source of reference for the wider community.

***Keywords**: Reconstruction; Tutorial Video; STEM; Escherichia coli Bacteria**.*

INTRODUCTION
In the current era of the industrial revolution 4.0, the development of science and technology (IPTEK) is progressing rapidly. The development of science and technology has an impact on the field of education, because education is a process of self-development in humans so that they can face all obstacles and challenges in life so that education becomes a basic need for humans (Yusuf, 2019).

The education curriculum used in Indonesia today is the 2013 curriculum. In the 2013 curriculum, the teacher's role as educator, teacher, learning resource and facilitator requires teachers to be creative and innovative in the learning process. Teachers must be able to make learning interesting, effective and fun so as to increase the interest and motivation of students in learning. Learning by teachers is expected to develop the thinking skills and skills of students to make it easier for students to solve problems in the era of the industrial revolution 4.0 (Izzan, 2012).

The learning process usually uses the help of teaching materials in explaining phenomena that are difficult for students to understand, one of which is the use of learning media. Learning media are everything that can be used to channel messages (learning materials), so that they can stimulate the attention, interests, thoughts and feelings of students in learning activities to achieve learning goals (Meishanti, 2021). The use of learning media must be adapted to the subjects and materials to be taught (Sumiharsono & Hasanah, 2018).

The use of learning media will greatly help the effectiveness of the learning process as well as the delivery of messages and lesson content so that it can help students improve understanding and thinking skills because they present information in an interesting and reliable manner. One of the learning media is computer media. The use of computers to present and combine text, sound, figures, animation and video

with tools and connections so that users can interact, create and communicate is known as multimedia (Pramuji et al., 2020)

The use of multimedia applications in learning will increase efficiency, motivation, and facilitate active learning, experimental learning, consistent with student-centered learning, and guide students to learn better. Result of research by (Munir, 2010) states that the memory of people who read alone is ± 1%. This memory can be increased again to 25-30% through television, while the use of hypermedia can increase memory as much as 60%.

Currently teachers have used information and communication technology by utilizing software in science learning but the use of computer software in science learning is only used as a media for teaching presentations by teachers, very few teachers use interactive multimedia in science learning to students individually (Cheppy, 2007). In addition to the use of interactive multimedia, science learning today needs to involve the use of technology and precision in designing science products known as STEM-based learning.

Science, Technology, Engineering, and Mathematics (STEM) is an approach in the development of the world of special education in the field of science. STEM education is an integrated learning between science, technology, engineering, and mathematics to develop students' creativity through problem solving processes in everyday life (Winarni et al., 2016). STEM education is formed based on the combination of several disciplines into a unified form of a whole new approach. The disciplines that are components of the STEM approach are science, technology, engineering, and mathematics. The integration of these several disciplines into one unit is expected to be able to produce competent and quality graduates not only in terms of mastery of concepts but also in applying them to life (Pramuji et al., 2020). Stem applications in learning can encourage learners to design, develop and utilize technology, hone cognitive, manipulative, and affective skills, and apply knowledge (Kapila & Iskander, 2014). This is supported by (Afriana et al., 2016) where learning using STEM approach is expected to produce meaningful learning for students through the integration of knowledge, concepts and also logical skills.

STEM learning has an impact on the learning process. Stem-based learning is able to increase motivation and provide experience in the process of manufacturing techniques. In addition, this learning is able to improve students' achievement in the final exams of the school (Suwarma et al., 2015). STEM education program is in the form of integrating entrepreneurial thinking into the teaching and learning of science through the skills of the science process in the form of Entrepreneurial Science Thinking (EsciT).EsciT can improve students' achievements and learning interests (Syukri et al., 2013). Development of STEM learning media with augmented reality to improve students' mathematical spatial capabilities (Arifin et al., 2020).

Based on the background description that has been stated, the development of STEM-based learning video media is to improve the ability of students to identify Escherichia coli bacteria. In order for the learning media to be applied properly, the STEM approach was chosen. Thus, this research is a development research that aims to produce a product in the form of STEM-based learning videos to improve students' learning abilities and motivation.

METHOD

The type of research used is research and development (R&D). The development design used is a 4D development model including a) define, b) design, c) development, and d) dissemination. However, in this study, only 3 stages were used. In this study, the subject of the research trial was a 6th semester student of the Biology Education Study Program at KH University. A. Wahab Hasbullah Jombang. The number of trial subjects used was limited to the number of 7-10 students.

The data in this study are quantitative data and qualitative data. Quantitative data obtained from the results of the questionnaire. Qualitative data were obtained from responses, suggestions, and corrective comments from validators and student respondents. In this study, data collection used a validation questionnaire (materials and media) and student response questionnaires. The questionnaire used in this quantitative data analysis uses a Likert scale. The assessment of the Likert scale category described by (Riduwan, 2019) can be seen in Table 1.

Table 1. Likert Scale Category Assessment Guidelines

Media and Material Validation Assessment	Student Response Assessment	Score
Very worthy	Very Interesting	5
Worth	Interesting	4
Decent enough	Interesting enough	3
Less worthy	Less attractive	2
Not Good	Very Unattractive	1

The data on the validation assessment of media experts, material experts, and student responses collected were analyzed by adding up, compared with the expected number to obtain a percentage (Riduwan, 2019), or it can be written with the following formula:

Eligibility Percentage (%) = X (validator expert score) / Xi (max score) x 100% ….. (1)

Eligibility Percentage (%) =∑X(total score of students) / ∑Xi(total max score) x 100%....(2)

The collected data were analyzed using quantitative descriptive analysis techniques used in the distribution of scores and percentages against the rating scale categories that have been determined according to Table 2. After presenting in percentage form, the next step is to describe and draw conclusions about each indicator.

Tabel 2. Percentage Scale Criteria

Achievement percentage (%)	Media and material validation assessment criteria	Student response assessment criteria
81-100	Very worthy	Very Interesting
61-80	Worth	Interesting
41-60	Decent enough	Interesting enough
21-40	Less worthy	Less attractive
0-21	Not Good	Very Unattractive

(Riduwan, 2019)

RESULT AND DISCUSSION

Result

Based on the development stages including define, design, and development, the research data obtained are as follows:

- *Define*

At this stage, a needs analysis is carried out covering the problems faced and the potential that arises where the researcher conducts a survey to the location for testing the quality of well water as an ingredient of the product to be developed. In addition, researchers observed characteristics of students as subjects who used product development. In addition to conducting surveys, researchers also conduct preliminary studies by conducting studies that are relevant to the research carried out by researchers. The results at this stage are used as material for the next stage.

- *Design*

At this stage, the product design will be designed into a STEM-based learning video. The design is done by compiling storyboards and video production. The preparation of the storyboard includes a sequence of scenes (scenes), views and descriptions containing skilled text on the screen, the location of objects, and the position of taking figures. While the video production process uses the Adobe Premier Pro application where the following is a presentation of video editing footage of STEM-based learning.

Figure 1. STEM-Based Learning Video Initial View

Figure 2. Display Material on STEM-Based Learning Videos

Figure 3. Display of Well Water Quality Test Activities on STEM-Based Learning Videos

- *Development*

At this stage, the learning videos that have been developed will be validated by experts to determine the feasibility of the video including media and material assessment. Experts will provide useful comments and sugges tions to make the video better. The data from the recapitulation of the validation assessment are presented in Table 3 for material validation and Table 4 for media validation.

Tabel 3. Material Validation Result Data

No	Rating Details	Score		Information
		Average	%	
1.	The truth of the practical concept of well water quality testing	4,3	86,6	Feasible
2.	The words and terms used are consistent	3,3	66,6	Feasible
3.	Figure and animation suitability with the material	3,6	73,3	Feasible
4.	The scope of the material is related to the sub-material discussed	3,3	66,6	Feasible
5.	The truth of the content submitted	3,3	66,6	Feasible
6.	Submission of material logically and systematically	3,0	60	Decent Enough
7.	STEM analysis is in accordance with the scope of the material	3,3	66,6	Feasible
	Average	**3,44**	**69.4**	**Feasible**

Tabel 4. Media Validation Result Data

No	Rating Details	Score		Information
		Average	%	
1.	Use of EYD-compliant languages	3,3	66,6	Feasible
2.	Use of language that does not give rise to double interpretation	3,3	66,6	Feasible
3.	Easy-to-understand use of language	3,3	66,6	Feasible
4.	Figure Focus	4,3	86,6	Very Worthy
5.	Font size	3,6	73,3	Feasible
6.	Font size Voice actor quality /dubbing	3	60	Decent Enough
7.	Volume	2,6	60	Decent Enough
8.	Musical instruments	3,6	73,3	Feasible
9.	Interactive video display	2	40	Not Worthy
10.	Interesting practicum presentation	4	80	Feasible

No	Rating Details	Score		Information
		Average	%	
11.	Practical presentation is easy to follow	4	80	Feasible
12.	Help learn independently	3,6	73,3	Feasible
13.	Ease of optimizing videos	4,3	86,6	Very Worth
	Average	**3,45**	**70,2**	**Feasible**

Based on the results of the data in Table 3 and Table 4, it shows that STEM-based learning videos on Escherichia coli bacteria are in the "Eligible" category with a percentage of 69.4% for material validation and 70.2% for media validation. However, it needs to be corrected or revised according to the validator's suggestions and comments, including: a) writing scientific names must be consistent and correct, b) STEM analysis needs to be added again with adjustments to the material, c) there is a need for subtitles or explanatory writing on the video, d) it is necessary there is an introduction to the tools and their functions before practicum activities, and e) the sound of the video needs to be clarified again (voice quality).

In addition, the product test results data were also conducted on student respondents which are presented in Table 5. Looking at the results of the student response trials, it can be concluded that STEM-based learning video media is interesting to use in learning activities. This is in accordance with the results of previous studies stating that STEM-based learning videos are interesting to use as learning media.

Tabel 5. Student Response Trial Results Data

No	Rating Details	Score			Information
		∑X	∑Xi	%	
1.	The look of this learning media is interesting so as to make it more vibrant	85,7	100	85,7	Very Interesting
2.	The material presented in this medium is easy to understand	82,8	100	82,8	Very Interesting
3.	Figures and animations presented according to the material	74,2	100	74,2	Interesting
4.	Types of text used in easy-to-read learning videos	77,1	100	77,1	Interesting
5.	The language used in this medium is simple and easy to understand	82,8	100	82,8	Very Interesting
6.	The sound in this learning video is clearly heard	65,7	100	65,7	Interesting
7.	This learning medium is easy to operate	85,7	100	85,7	Interesting
8.	This learning medium makes it easy to learn independently	65,7	100	65,7	Quite Interesting
9.	The figures in the learning video can be clearly seen	80	100	80	Interesting
10.	This learning video media pioneers understanding STEM in Escherichia coli material	80	100	80	Interesting
	Average	**78**		**78%**	**Interesting**

Discussion

This STEM-based learning video on Escherichia coli material was developed with the aim that it will later become a source of information. This video was developed to support students in understanding Escherichia coli material. In addition, this video can also be a reference for the general public. This is shown in the content of the learning video which includes a) Escherichia coli bacteria material, b) related to well water quality testing activities and c) STEM analysis on both points (points a and b).

Product specifications STEM-based learning videos on Escherichia coli bacteria material include: a) Learning videos are presented on Escherichia coli bacteria identification materials, b) Learning videos are packaged in video form using the Adobe premiere pro application, c) Learning videos are prepared using the STEM approach, d) Learning videos are made using a Canon 1300D DSLR camera, and e) Learning videos are packaged in CD form and published through the Youtube channel.

Based on the product specifications above, it can be concluded that the advantages possessed by STEM-based learning videos on Escherichia coli bacteria material are: a) student learning resources without being limited by space and time, b) variations in learning resources in the implementation of learning, and c) integration into in online learning. In addition to the advantages, this video also has

disadvantages, namely a) educators need a long time and a lot of energy to make videos like this and b) there is no form of evaluation for students to find out understanding of the concept. The skills of educators are highly demanded to be able to develop or design this learning video product. This is to spur educators to be more skilled and have competence in utilizing the existing science and technology around.

CONCLUSION

The results of development through 3 (three) stages namely define, design, and development produce products in the form of STEM-Based Learning Videos on Escherichia coli Bacterial Material. Through validation activities it was obtained that this product is in the "Eligible" category with a percentage of 69.4% for material validation and 70.2% for media validation. In addition, the results of the student response trial obtained 78% showed students interested or enthusiastic in using this development product. However, it needs to be improved on some aspects according to the suggestions and comments of the validators in order for the developed products to be better and become a variety of learning resources for the world of education.

The suggestion for follow-up of this development process is to do the last stage of disseminase where it is necessary to conduct extensive product trials involving several classes and schools. In addition, other researchers may make reference to similar or relevant research with diverse material.

The researcher's gratitude was conveyed to the Institute of Research and Community Service (LPPM) KH. A.Wahab Hasbullah University Jombang who has provided support and facilities in the implementation of this research.It is also conveyed to validators and student respondents who have helped spend time and effort for the development of STEM-based learning video products on Escherichia coli bacteria material.

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