
***STEM-Based E-Module (Science Technology Engineering and Mathematics)
on Class XI Respiratory System Materials***

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ABSTRACT

This e-module was developed during the covid-19 pandemic to make it easier for students to learn material that can be accessed from the link provided, this development research aims to develop a STEM-based learning e-Module on respiratory system material for class XI high school students by applying components STEM on each sub-material of the respiratory system to determine the feasibility of the media, materials and student responses to the developed e-module. The research method used in this research is the 4-D method, namely define, design, develop and detect. Data collection techniques were carried out using media expert validation tests, material expert validation tests and student response questionnaires distributed randomly via google form. The results of this development show the feasibility of the media 76% with appropriate criteria, 90% of the feasibility of the material with very feasible criteria, and the results of the student response questionnaire 86% with very interesting criteria. So that the development of STEM-based e-modules is feasible to be developed and can be used as a reference in learning.

Keywords: *e-Module, STEM, respiratory system material*

INTRODUCTION

Learning is a process of interaction between students and between students and educators and learning resources in a learning environment (Permendikbud No. 103 of 2014). So that in the learning process it is very important for interaction to occur, Meishanti (2019) states that the success or failure of a teaching and learning process in the classroom depends on its components including students, curriculum, teachers, methods, facilities and infrastructure as well as the student environment.

Biology subjects are considered difficult subjects to understand, because the material in them is more complex and many terms are difficult to understand, thus making students less motivated to learn them. Students' reading interest in the subject matter is also quite low. This is because students today are more happy and motivated to learn by using their gadgets.

Meishanti (2019) suggests that this indication is possible, one of which is due to ineffective student learning factors, even students feel unmotivated when taking lessons in class, which then causes students to lack or not understand the difficult material given by the teacher.

Therefore, to study it, teaching materials are needed that contain pictures and information that are presented in a complete and interesting manner and are not monotonous and do not make students feel bored, especially during the Covid-19 pandemic, students study online and need teaching materials that are easy to use. in accordance. Setiyadi et al. (2017) states that teaching materials are learning media that have a very basic function during the flow of teaching and learning as a reference for educators and students, thereby increasing effectiveness in teaching and learning activities. Considering the main role of the biology module to improve the quality of the learner's learning path, the educator as the person most responsible for the success of the learning path is required to be able to understand the meaning, characteristics, principles, provisions, and procedures. of module development.

Learning by applying the module is not only focused on educators but students can do it independently without an educator. The use of the module also does not depend on other learning media or does not have to be used in conjunction with other media so that it is more efficient. One way to improve student understanding and learning outcomes is to develop good teaching materials. One of the teaching materials that can be developed is the module. However, during the COVID-19 pandemic, students are required to do online learning at home, and currently educators are required to be more creative and innovative in developing a learning media so that students do not feel bored in participating in learning. activity. The most effective learning media used is e-Modul.

An electronic module is an electronic version of a print module that can be read on a computer and designed with the required software. E-module is a learning tool or facility that contains materials, methods, limitations and evaluation methods that are designed systematically and attractively to achieve the expected competencies according to the level of complexity electronically (Priyanthy, 2017). Modules are teaching materials that are systematically arranged in a language that is easily understood by students according to their level of knowledge and age, so that they can be studied (independently) or with minimal guidance from educators (Prastowo, 2013).

Ardiansyah (2016) states that the development of increasingly sophisticated science and technology makes the learning process fun and interesting and not difficult. Creating an interesting and fun learning process, namely being able to utilize technology as used as teaching material to support the ongoing learning process. Teaching materials are grouped by form and how it works. Teaching materials according to their form are printed teaching materials, listening teaching materials, and listening teaching materials. Teaching materials according to how they work consist of: non-projected teaching materials, projected teaching materials, audio teaching materials, video teaching materials, and computer media teaching materials. In accordance with the times, teaching materials are not only in the form of books but can also be taken from the internet or from other sources in the form of journals, articles,

electronic books (e-books), and electronic modules (e-modules), making it easier for students to access various materials, which will be studied. In addition, according to Firdaus and Hamdu (2020) the use of STEM-based mobile learning is expected to provide real and concrete examples of STEM learning in the classroom which is supported by enrichment modules, learning implementation plans, media, worksheets, test questions and performance assessments.

Permanasari (2016) states that the application of STEM in learning can encourage students to design, develop and utilize technology and apply knowledge. (Wiyono et al., 2012) stated that the development of science and technology requires an effort that can facilitate access to the development of these sciences. The accuracy of choosing the method or presentation approach is the key to success in actualizing the learning outcomes that have been formulated.

The STEM learning process can help students to collect, analyze, solve problems and be able to understand the relationship between one problem and another (Nessa et al., 2017). The presentation method was developed with reference to the learning outcomes to be actualized. In summary, the presentation method needed in science learning is one that can encourage students to be able to solve problems in life both individually and in groups by applying knowledge and utilizing technology as a form of concern and contribution to responsible environmental quality improvement. Considering the main subject of biology, it is hoped that the function of educators can determine learning in accordance with the 2013 curriculum in an effort to improve the quality of education. learning that is in accordance with the 2013 curriculum, one of which is STEM (Permanasari, 2016). The application of STEM can be supported by various learning methods, STEM can train students to apply the knowledge learned in school with phenomena that occur in the real world (Meishanti, 2020)

STEM stands for an interdisciplinary learning approach between Science, Technology, Engineering and Mathematics. Kelley & Knowles (2016) define STEM as an approach to teaching two or more STEM subjects related to practice authentically so as to increase student interest in learning. The approach of these four aspects is a harmonious match between problems that occur in the real world and problem-based learning. This approach is able to create a cohesive learning system and active learning because these four aspects are needed simultaneously to solve problems. The solution given shows that students are able to unite abstract concepts from every aspect (Rahmi et al., 2014)

Based on the description above, the researcher has a research objective, namely to describe the feasibility of STEM-based E-Module media on class XI respiratory system material, describe the feasibility of STEM-based E-Module material on class XI class respiratory system materials, and describe the attractiveness of STEM-based E-Modules. . on the material of the respiratory system class XI.

METHOD

The development of STEM-based learning e-Modules in this study uses a 4-D model consisting of four stages, namely define, design, develop and dissemination (Sugiyono, 2010):

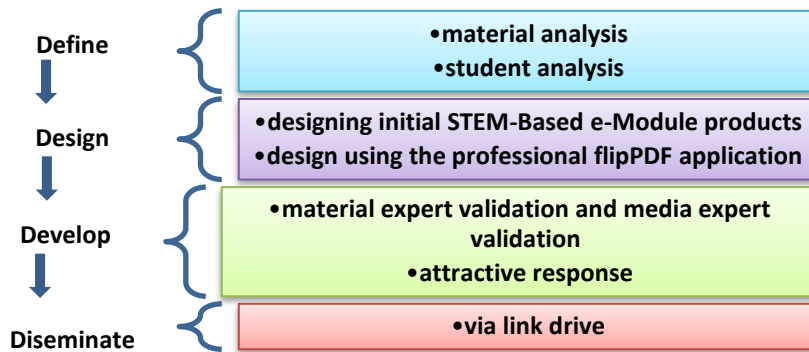


Figure 1. 4D Development Model

Define, this stage is the initial stage in the 4D development model. This stage aims to analyze the product development requirements according to user needs. At this stage, the researcher made a needs analysis questionnaire that was distributed randomly to the students of class XI high school through an online system using google form.

Design, at this stage the design of STEM-based e-Modules for respiratory system materials is carried out according to basic competencies.

In this development stage, the development of STEM-Based E-Module media is carried out whose media is validated by the validator team to determine the quality of learning media and material expert validators.

Disseminate. At this stage, it contains activities to disseminate products that have been tested to be used by others through the distributed links. This stage will be carried out if the product that has been developed is considered valid, practical and effective for use via a web browser or google chrome and the like.

Data analysis for the validation of material experts and media experts uses the following formula and questionnaire validation criteria according to table 1. below:

$$\text{Percentage of eligibility/attractiveness} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

Table 1. Criteria for interpretation of validation questionnaires

No	Average score	Response Criteria
1	0%-20%	Very not worthy
2	21%-40%	Not feasible
3	41%-60%	Decent enough
4	61%-80%	Worthy
5	81%-100 %	Very Worthy

Source: Adapted from (Sudaryono, 2013)

For the attractiveness of STEM-based e-module media, after obtaining a score, the attractiveness percentage is then searched with the following interpretation criteria:

Table 2. Criteria for interpretation of response questionnaires

No	Average score	Response Criteria
1	0%-20%	Very Unattractive
2	21%-40%	Not attractive
3	41%-60%	Quite interesting
4	61%-80%	Interesting
5	81%-100 %	Very interesting

Source: Adapted from (Riduwan, 2013)

RESULT AND DISCUSSION

Based on the research objectives regarding the development of STEM-based e-modules on respiratory system material, then referring to the research methodology, research on the development of STEM-based e-modules has been carried out through valid, practical, and interesting stages, which were compiled based on the Four D development model (4-D), namely Define, Design, Develop, Disseminate. The following development research activities are carried out, namely:

Define stage, that is with material analysis and student analysis, for material analysis obtained KD. 3.8 "Analyzing the relationship between the structure of the tissues making up the organs of the respiratory system in relation to bioprocesses and functional disturbances that can occur in the human respiratory system", the material for the Human Respiratory System, while the analysis of students through the dissemination of analysis of development research needs through google form. The information obtained from the needs analysis is that students have never used STEM-based e-Modules, during the covid-19 pandemic, students really need interesting supporting media for the continuity of teaching and learning activities, then analyze the material by determining KD and materials.

This E-Module Design (design) stage is also equipped with instructions for use and practice questions to determine the extent to which students can understand the material or discussion

in each chapter in the STEM-based e-Module Respiratory System Material, and is equipped with an answer key. along with the discussion. This STEM-Based E-Module Respiratory System Material is designed using the professional flipPDF application and students do not need to install this application when using this STEM-based e-Module, it can be opened in a web browser or google chrome and the like.

Develop stage, the quality of the media is obtained from the validation results of material experts and media experts, from the validation results it will be known errors or deficiencies in the media so that they can be corrected. Researchers will find out if the media that will be developed is said to be feasible or not by looking at the results of the assessment as well as suggestions and input from the validator, then measuring the attractiveness of the learning e-Module, then a research instrument is compiled containing student response questionnaires distributed online via google form. The following are the results of developing STEM-based e-module media for respiratory system materials:

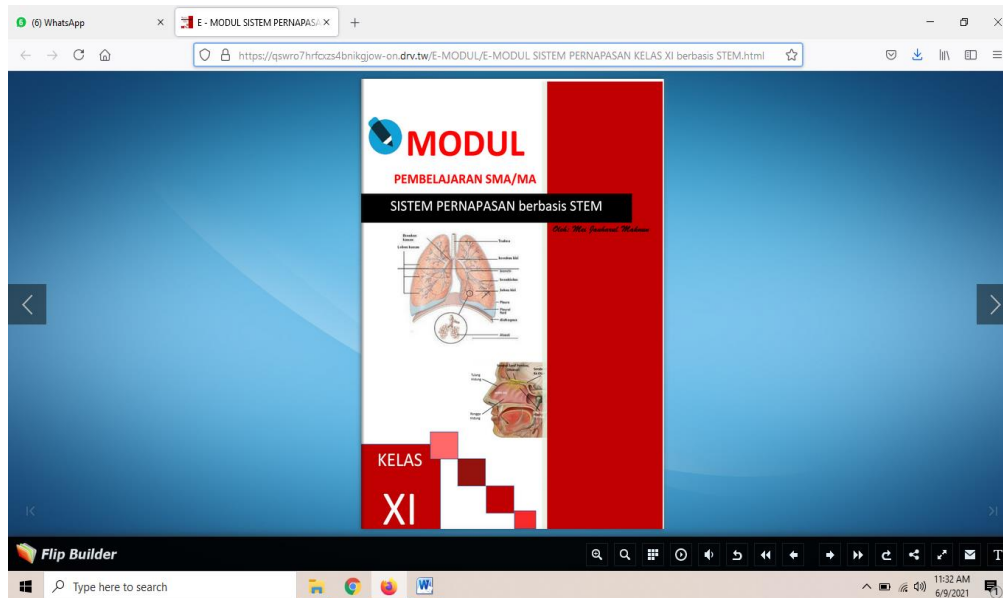


Figure 2. Cover of STEM-based e-Module material for class XI . respiratory system

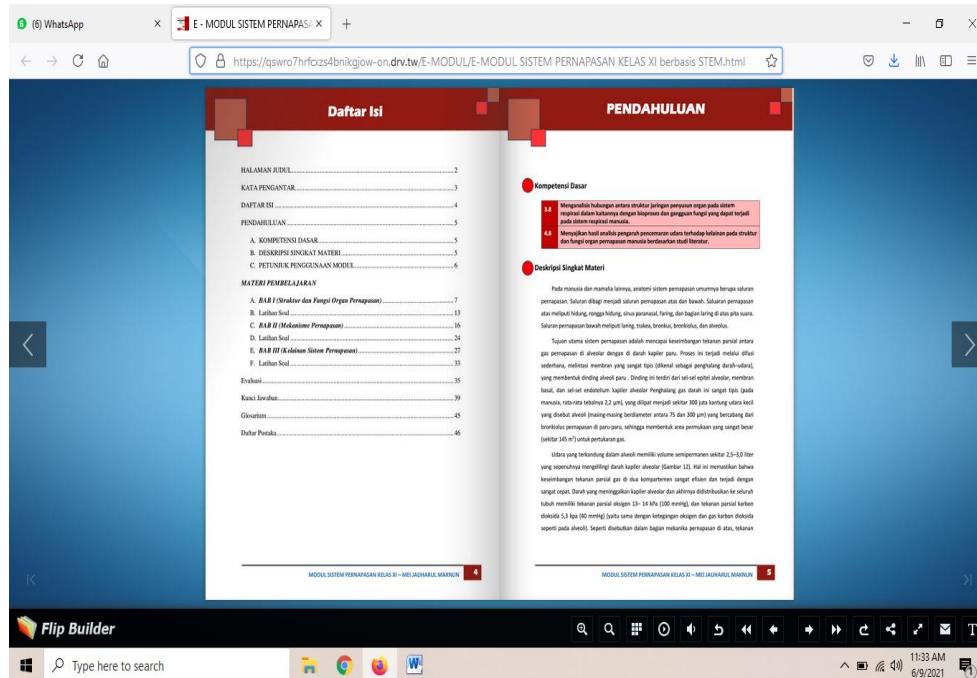


Figure 3. Table of contents, KD, and procedures for using STEM-based e-Modules for class XI, respiratory system materials

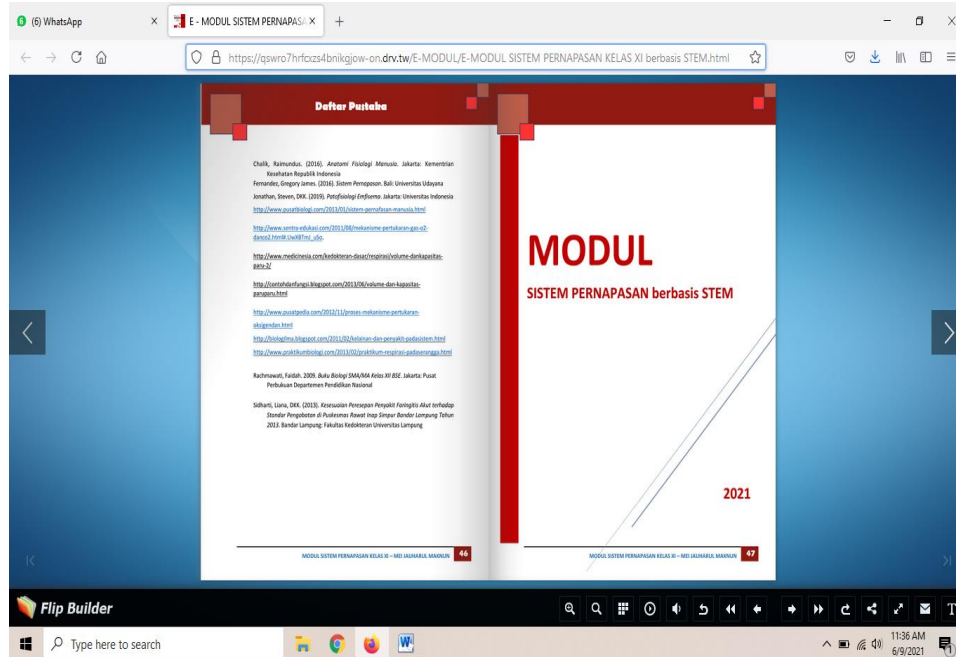


Figure 4. Bibliography of STEM-based e-Module material for class XI pernapasan respiratory system

Disseminate stage, the dissemination stage is carried out via a link on google drive which can be accessed <https://s.id/E-MODUL-Sistem-Pernapasan-KelasXI>

After the STEM-based e-module product for the respiratory system material was finished, the researchers then validated the material expert and validated the media expert. Following are the results of material expert validation:

Table 3. Results of expert validation of learning materials

No	Criteria	Score			Presentation And Media Feasibility Criteria	
		V	X	Xi		
1	Media served in accordance with KD. 3.8 "Analyzing the relationship between the structure of the tissues making up organs in the respiratory system in relation to bioprocesses and functional disturbances that can occur in the human respiratory system"	5	5	5	100%	Very Worthy
2	Able to show biological phenomena	5	5	5	100%	Very Worthy
3	Required in learning the material of the respiratory system	4	4	5	80%	Worthy
4	Able to explain the concept of respiratory system material	5	5	5	100%	Very Worthy
5	The material presented does not contain misconceptions	4	4	5	80%	Worthy
6	The material is in accordance with the needs of students in learning	5	5	5	100%	Very Worthy
7	Able to facilitate students to improve cognitive, psychomotor, affective skills.	4	4	5	80%	Worthy
8	Fostering motivation for students to study harder	4	4	5	80%	Worthy
9	Explanation sentences are clear and easy to understand	4	4	5	80%	Worthy
10	Vocabulary depth according to the material	5	5	5	100%	Very Worthy
AMOUNT			45	50	90%	Very Worthy

From the data in table 3 above, it can be seen that the results of the material expert validation obtained a score of 5 for aspects of the assessment at number 1, number 2, number 4, number 6 and number 10 obtained a 100% presentation with very feasible eligibility criteria. And the acquisition of a score of 4 on the aspect of assessment number 3, number 5, number 7, number 8 and number 9 with a percentage of 80% eligible criteria.

The results of the validation of the material experts have suggestions and input, namely in general the material presented is in accordance with the age of the students, only needs to be improved so that there is no repetition of explanations for example on the material of the throat branch, there is no need for an explanation of the windpipe branch, and also improve the writing of terms to be more precise. This material is appropriate for the age of the students because it is in accordance with K.D 3.8. Analyzing the relationship between the structure of the tissues that make up the organs in the respiratory system in relation to bioprocesses and functional disorders that can occur in the human respiratory system. In accordance with the criteria for interpretation of the validation questionnaire according to (Sudaryono, 2013), the average acquisition is said to be very feasible. This also shows that the theoretical concepts, case examples, and practice questions contained in the STEM-Based e-Module teaching materials for respiratory system materials are in accordance with the learning in the 2013 curriculum. The following are the results of the validation of learning media experts, the following results are obtained:

Table 4. The results of the validation of learning media experts

No	Criteria	Score			Presentation And Media Feasibility Criteria	
		V	X	Xi		
1	Media effectiveness for repeating learning materials	4	4	5	80%	Worthy
2	The media presented does not contain misconceptions	3	3	5	60%	Decent enough
3	The media presented does not contain misconceptions	4	4	5	80%	Worthy
4	Proportional text size	4	4	5	80%	Worthy
5	Easy to understand language	4	4	5	80%	Worthy
6	Interesting media used	4	4	5	80%	Worthy
7	Harmonious color combination	3	3	5	60%	Decent enough
8	Easy to use	4	4	5	80%	Worthy
9	Can be used repeatedly	4	4	5	80%	Worthy
10	Easy to share	4	4	5	80%	Worthy
AMOUNT			38	50	76%	Worthy

From the data in table 4 above, it can be seen that the results of media expert validation obtained a score of 4 for aspects of the assessment at number 1, number 3, number 4, number 5, number 6, number 8, number 9 and number 10 obtained a presentation of 80% with proper eligibility criteria . And the acquisition of a score of 3 in the assessment aspect number 2 and number 7 with a percentage of 60% of the criteria is quite feasible and received good comments from media experts. While the student response questionnaire for the attractiveness of the media obtained the following results:

Table 5. Results of student response questionnaires

No	Assessment Aspect	Score		X	Percentage	Criteria
		R	Xi			
1.	You better understand the concept of the respiratory system by using this e-module learning media than using a regular book.	63	5	4,2	84%	Very interesting
2.	Pictures, descriptions and equipped with youtube links can support you in teaching and learning activities.	68	5	4,6	92%	Very interesting
3.	The e-module media that you use can prevent you from misunderstanding the concept of learning the respiratory system material.	60	5	4	80%	Very interesting
4.	The e-module learning media can make it easier for you to understand the respiratory system material.	63	5	4,2	84%	Very interesting
5.	With this e-module, you will feel excited to learn about the respiratory system.	63	5	4,2	84%	Very interesting
6.	The language used is easy to understand	67	5	4,5	90%	Very interesting
7.	Interesting STEM-based respiratory system e-module media display	67	5	4,5	90%	Very interesting
8.	STEM-based respiratory system	68	5	4,5	90%	Very

	e-module media color is appropriate					interesting
9.	The STEM-based respiratory system e-module media writing can be read clearly	69	5	4,6	92%	Very interesting
	Amount		45	39,3	86%	Very interesting

The results of student responses to the development of teaching materials were obtained through student response questionnaires. There were 15 respondents who had filled out student response questionnaires to the developed media. Of the 15 respondents in the assessment aspect, you understand the concept of the respiratory system better by using this e-module learning media instead of using a regular book, you get a percentage of 86% with very interesting criteria. The characteristics of STEM that appear to facilitate learning allow students to build on their own experiences and provide opportunities to build science skills and mathematical knowledge through design analysis and scientific inquiry (Kelley & Knowles 2016). you from a misunderstanding of concepts in studying the material of the respiratory system which only gets a percentage of 80% but with very interesting criteria.

Sukmana (2017) states that STEM provides benefits, including: a) Having real-world issues and problems in the hearts of students. With this, it is expected to foster empathy and reduce brawls, b) Bind students with guided inquiry and open closed exploration, c) Actively integrate the engineering design process, d) Help students see the relationship between science and mathematics through content integration, e) Expect and facilitate collaboration between discourse and sensitivity learners, f) Taking risks by initiating a learning environment that seeks more than one solution to each problem, and g) Understanding that failure is part of the process and respecting it. (Putra, 2021) This requires educators to be more skilled and have competence in utilizing the science and technology that is around educators and also need to have supporting facilities and infrastructure.

CONCLUSION

The STEM-based e-Module learning media on the respiratory system material for class XI was developed using a 4-D model consisting of four stages, namely define, design, develop and disseminate. This STEM-Based E-Module on respiratory system material has a 90% material expert validation percentage with very feasible criteria, and a media expert validation percentage of 76% percent with appropriate criteria, so the media can be used as another reference in learning respiratory system materials, while the response students to the attractiveness of 86%, it can be concluded that the STEM-based e-Module learning media on the respiratory system material for class XI has been declared feasible and ready to be disseminated as a learning reference for students.

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