

Development of Web-Based E-Learning on Virus Material in Biology Education Study Program

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ABSTRACT

This development research (Research and Development) aimed to evaluate the characteristics, validity, practicality, and effectiveness of website-based e-learning for virus material in the Biology Education Study Program at Muhammadiyah Bulukumba University, using the ADDIE model comprising Analyze, Design, Development, Implementation, and Evaluation stages. Designed for easy access on digital devices, the e-learning incorporates multimedia features such as images, text, animations, sound, and videos, enhancing engagement and learning effectiveness. The e-learning demonstrated high validity, though improvements in language and coherence are needed for optimal results. It also received positive feedback on practicality from lecturers and students for its ease of use. Effectiveness was evident in improved student outcomes, with pretest scores rising from an average of 59.95 to 85.67 in the posttest. Overall, the e-learning was deemed valid, practical, and effective, with recommendations for large-scale trials and development of additional materials to further enhance its utility.

Keywords: *Development, E-Learning, Website, ADDIE, Virus, Validity, Practicality, Effectiveness.*

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INTRODUCTION

The learning process is a process of transforming knowledge and learning materials delivered by educators or other learning sources to other recipients of information through certain tools or media. In the learning process, things that have a very important role to attract the attention of students to be more enthusiastic in understanding the material presented are learning media (Zahwa & Syafi'i, 2022). The advantages of using media in education are as follows: (1) the delivery of subject matter can be uniformed. (2) The learning process becomes more straightforward and interesting. (3) The learning process becomes more interactive. (4) Time and energy efficiency. (5) Improve the standard of student learning outcomes. (6) Media allows learning to take place anywhere and anytime. (7) Media can help students develop a good attitude towards the topic and the learning process. (8) Shift the function of the teacher to a more positive and constructive approach (Saparuddin et.al., 2022).

Ahmadi and Ibda (2019) stated that the presence of a digital era that has undergone a transformation in the field of information and communication technology (ICT) is known as the era of the industrial revolution 4.0. Human daily activities are preoccupied with the use of technology. One of them is in the realm of education which requires innovation in teaching materials. The use of technology in the field of education can have an impact on learning and teaching activities that can run more effectively (Aldi et al., 2022). Website is a method for displaying information on the internet, in the form of text, images, sound and video that is interactive and has the advantage of connecting (linking) one document with another (hypertext) which can be accessed through a browser. A browser is software for

accessing web pages, such as internet explorer, Mozilla firefox, opera, safari and others (Hadi et al., 2020). E-learning is one form of communication media. This communication media not only facilitates and streamlines the learning process, but can also make the learning process interesting (Palennari and Daud, 2019).

E-learning is an innovation in education that contributes greatly to changes in the learning process. Students will be more active in the learning process, teaching materials can be packaged in various formats and dynamic forms. The characteristics of the application of e-learning in the world of education itself is the ability to achieve a high level of accuracy and learning achievement. one product of the integration of information technology into the world of education is E-learning or electronic learning. E-learning is a learning system that utilizes electronic media as a tool to assist learning activities.

The development of e-learning aims to support the implementation of education, so that the campus can provide better information services to its community, both inside and outside via the internet (Nurlinah et al., 2018). Meanwhile, according to Yodha et al, (2019) the advantages of implementing e-learning are, a simple learning process, ease of obtaining material because it is in the form of soft files, and working and collecting assignments becomes easier because it is done online and is able to minimize the cost budget or save costs, and can learn anytime and anywhere (Septyanto et al., 2020). Learning can be said to be successful when students are active in the teaching and learning process (Fuad et al., 2020). Active learning is needed for students as a result of the teaching and learning process not only how teachers provide knowledge only to students, but from themselves, students must also be active in bringing about changes in behavior. The behavior in question is how students what is active learning about cognitive, affective, and psychomotor. The use of media in learning will improve student achievement. Students will be more interested and understand the subject matter well if they have adequate learning resources and use effective learning media (Batara et al., 2023).

Learning media is a tool that serves to convey learning messages (Nurhaya et al., 2023). The use of tools as a complement to the use of verbal language is an effort to make learning more dynamic and the process of delivering subject matter more systematic, making it easier for teachers in the process of delivering information. Multimedia-based learning media in the classroom is developed based on the assumption that the communication process in learning will be more meaningful, increase interest in learning and make it easier to understand the material. Learning does not only take place formally in the classroom, but can be done anywhere when students gain knowledge and new things that are positive and add to their insight (Moto, 2019).

One of the subjects that is the topic of this research is biology learning. Biology learning involves direct experience, and students need to be supported in understanding it, specific material requires teacher creativity and innovation in the learning process (Herman and Saleh, 2023). Biology as a science is not just a collection of Latin terms and scientific names that must be memorized but knowledge obtained through sensing, adaptation and abstraction (Sulastri et al., 2023). From the background of this problem, it encourages the creation and introduction of one of the learning applications, namely e-learning. Through e-learning applications, it is hoped that it can help teachers in improving the activity and efficiency of the learning process and help in achieving learning objectives. In addition, students are expected to be able to more easily obtain information about the learning that is followed so that they can be more active in participating in learning activities.

METHOD

This research is included in the type of research and development. The results of website-based e-learning development were tested at the Biology Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Muhammadiyah Bulukumba with the subjects in this study were students and lecturers of Microbiology

courses (virus material) at Universitas Muhammadiyah Bulukumba. This e-learning development applies a type of development research that refers to the ADDIE development model.

The ADDIE model consists of 5 stages, namely analyze, design, development, implementation and evaluation. The selection of this development model is based on the consideration that the model provides a clear, complete, and systematic procedure but is simpler and in its development involves expert judgment, so that before the field trial the learning device has been revised based on the assessment, suggestions and criticisms from the experts.

FINDING AND DISCUSSION

The result of the research is described through the five stages of the ADDIE development model used in this study as follows:

Analysis

At this stage, researchers collected initial data through interviews conducted at the Biology Education Study Program at Muhammadiyah Bulukumba University to find out what material would be taught to students in the General Biology course. From the results of the interviews that have been conducted, researchers then analyze the problems faced by students both in the form of material and learning media used, as for the things analyzed by researchers, namely: needs analysis, student analysis and content analysis.

Needs analysis is carried out through observations on campus to collect information in the field related to the needs of students and lecturers and to find out the availability of facilities and infrastructure in the learning process. Student analysis is carried out to collect information related to students by conducting interviews about the things they enjoy in supporting the learning process and analyzing the problems faced, for example Biology learning material which is abstract in nature so that it makes it quite difficult for students to understand the material taught and the media used in the teaching and learning process. Content analysis, structure analysis and goal analysis are carried out by conducting a literature review related to the material to be taught. From the results of this analysis, researchers can find out the obstacles experienced by lecturers and students.

Design

At this stage, designs are made that will become the final product and the designs needed to assess e-learning media. Broadly speaking, the design that will be made by researchers, consists of:

E-Learning Design for Virus Material

Things that need to be done in designing an E-learning include: Determining the title of the e-learning that will be developed, namely the E-biolearning website. Prepare references by collecting sources in the form of textbooks, scientific journals and articles. Existing references are analyzed based on needs (in accordance with core competencies and basic competencies),

Designing e-learning content

Creating a storyboard. Storyboard is a document that describes all components of the final product. The following is a storyboard design of the website to be developed.

Developing content in the form of virus subject matter, learning videos and 3D animation, layout and design.

The devices used in making media are laptops, android smartphones, and several software that will be used in the manufacturing process.

Smart and interactive tools. This feature aims to make learning easy. It provides a smart and intuitive way to build learning. It makes it easy to add sections, lessons, topics, and quizzes to content. It also makes it possible to add audio and video files, presentations, and other interactive resources.

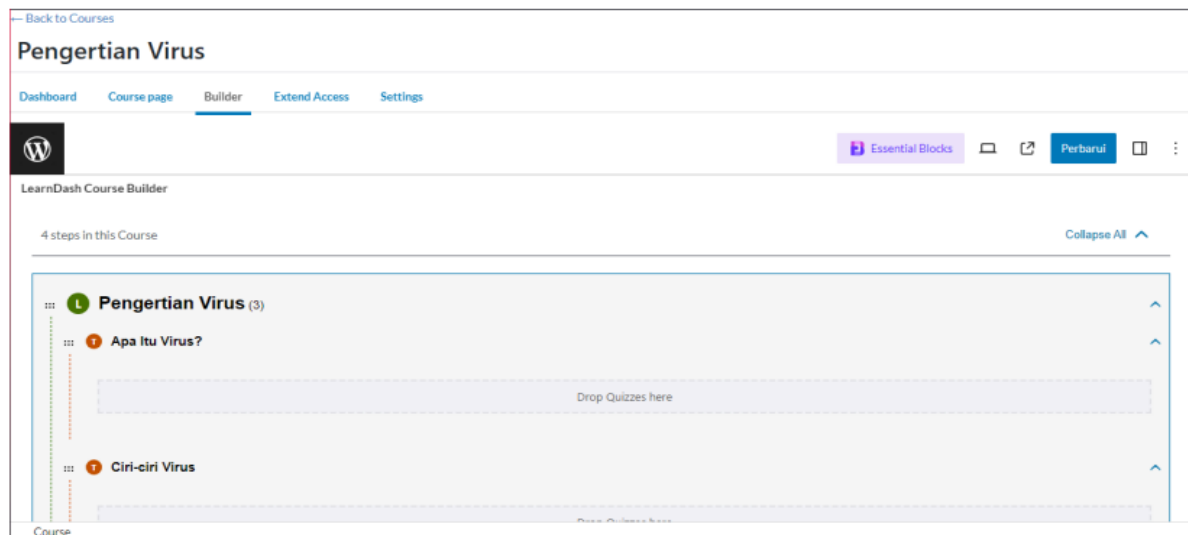


Figure 1. Smart learning features

Creation of practice questions

This feature provides a quick and easy way to add, edit and move questions within the quiz feature. This feature allows to choose from different question types, insert media.

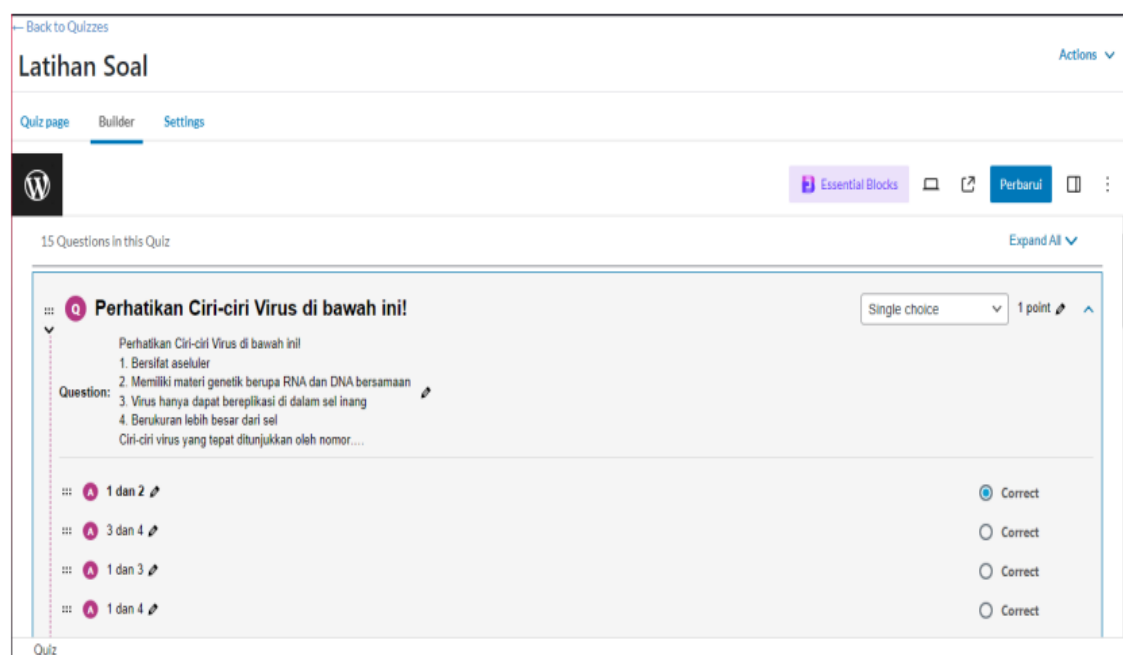


Figure 2. Quiz and question bank features

Development of Web-Based E-Learning on Virus Material in Biology Education Study Program
Assignment creator

This feature allows you to create assignments. Assignments can be enabled for each lesson and/or topic in the lesson. This feature allows to check student understanding of the material.

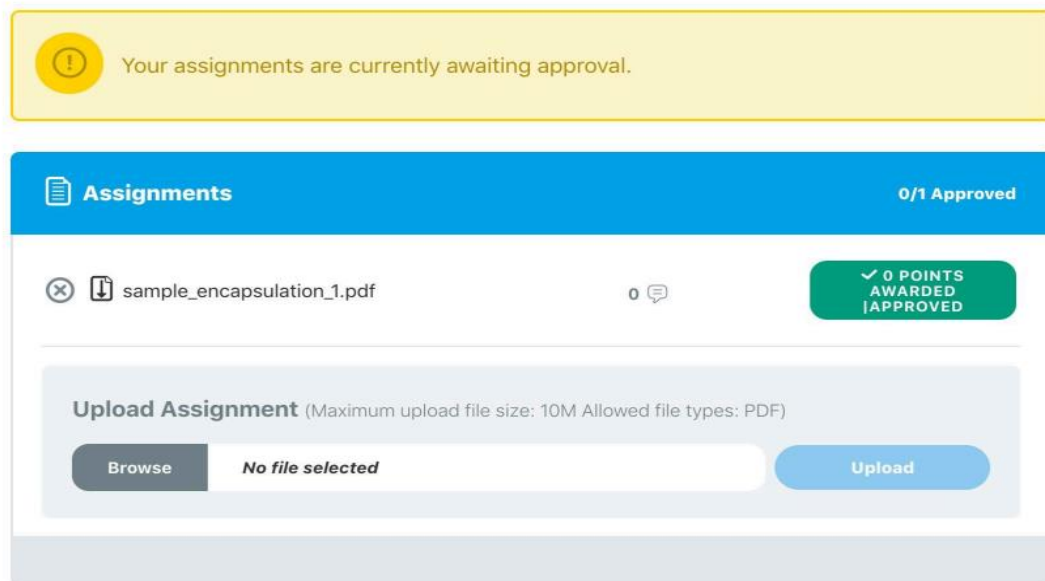


Figure 3. Assignment creator feature

Special Requirements Feature, Focus mode, Grading

This feature is useful as a report card to provide a visualization of the value of the learning that has been completed by students.

Report Card for: Nilai			Expand All Collapse All
Overall Grade			A
	Materi		
▼	Quizz		A
Type	Name	Score	
Quiz	Latihan Soal	93,4%	

Figure 4. Assessment features

Certificates

A certificate feature that offers official certificates upon successful completion of friendships and quizzes.



Figure 5. Certificate

Reporting Features

Contains overviews, reporting data, activity streams, and progress charts. The material on this e-learning is virus material that has been adapted to the material

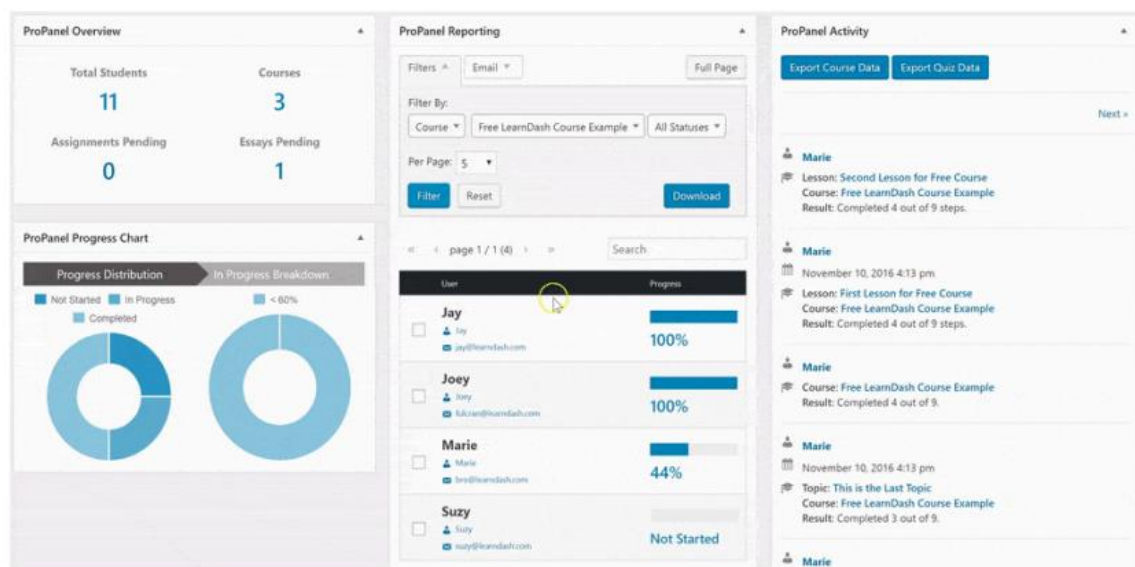


Figure 6. reporting features

Research Instrument Design

The research instrument used is a questionnaire given to validators, lecturers and students. The questionnaire that will be made consists of: 1) questionnaire for validity test, namely e-learning validation questionnaire and instrument validation questionnaire, 2) questionnaire for practicality test, in this case is student response questionnaire and lecturer response questionnaire 3) questionnaire for effectiveness test is learning outcomes test.

The e-learning validation questionnaire consists of the instrument title, assessment instructions, assessment aspects, assessment indicators, assessment scale, instrument item description, validator suggestions/comments, date and name and signature of the validator. Meanwhile, the practicality test questionnaire consists of the instrument title, assessment instructions, statement number, indicators, statement items accompanied by

assessment options. Meanwhile, the effectiveness test questionnaire consists of a student questionnaire to see learning outcomes. The suggestions and corrections from two expert validators on elearning development can be seen in Table 3.1.

Table 1. Web-based E-learning based on Corrections and Suggestions from Validators

Aspect	Correction and Suggestion
Supporting performance of the material	Make more picture

Development

At this stage, biology e-learning on problem-based virus learning and research instruments were developed.

E-Learning Development

Web-based e-learning must include several main components. These components include: 1) introduction part is the opening chart of learning. An e-learning, this section contains: (a) opening, containing the general appearance of the website (b) introductory explanation of e-learning which is the scope of e-learning content. (c) learning indicators to be achieved through the presentation of material (2) learning activities are the core part in the presentation of subject matter and exercises as an evaluation of the material. This section contains a description of the subject matter that must be mastered by students. The differences in the results of prototypes 1 and 2 can be seen in the following figure:

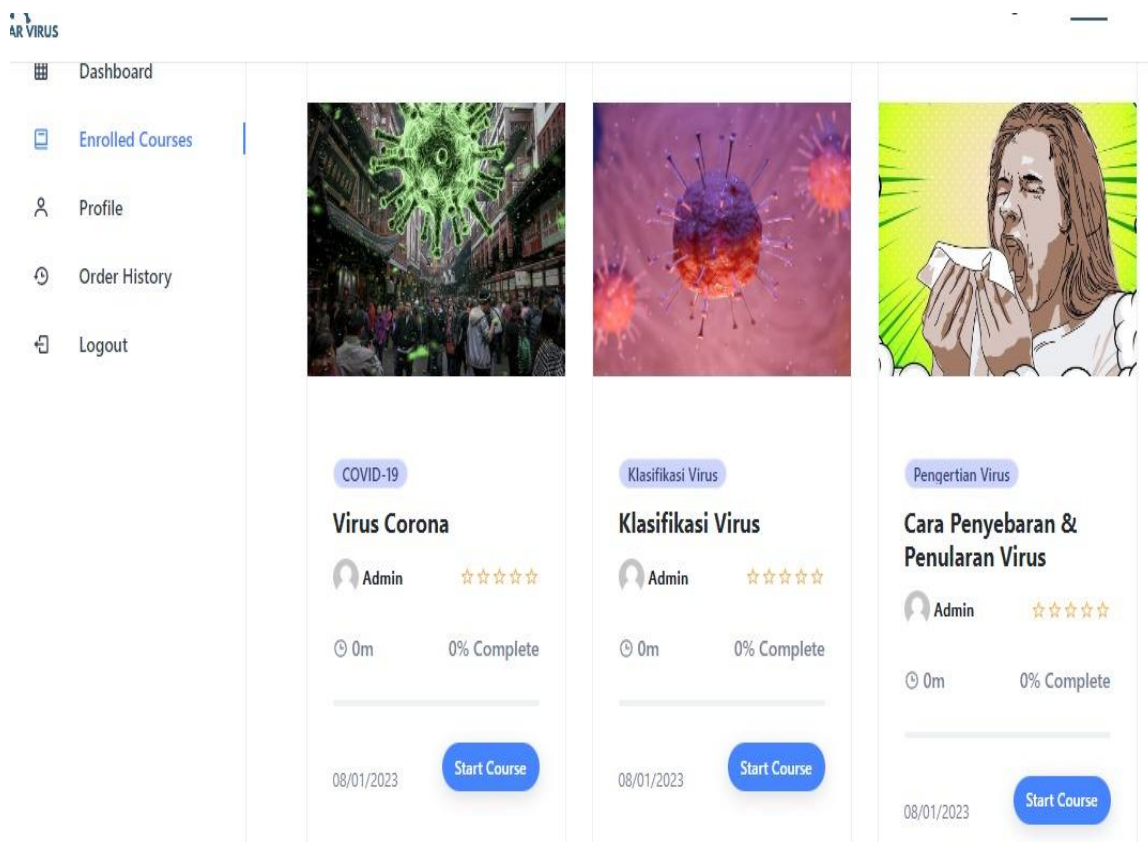


Figure 7. Initial View of Prototype 1



Figure 8. Initial View of Prototype 2

Instrument Development

Instrument development is made in accordance with the planned components. The research instruments developed, namely: 1) validation sheet for e-learning, 2) validation sheet for e-learning implementation questionnaire, 3) validation sheet for lecturer response questionnaire, 4) validation sheet for student response questionnaire, 5) validation sheet for learning outcome test instrument, 6) e-learning validation sheet used to test the validity of e-learning, 7) module implementation observation sheet, 8) lecturer response questionnaire and 9) student response questionnaire used to test the practicality of e-learning developed, and 10) learning outcome test instrument to test the effectiveness of elearning developed.

The research instrument was developed based on several assessment aspects. The aspects assessed for the validation of web-based e-learning, namely aspects of presentation techniques, supporting material presentation, content feasibility components (material coverage, material accuracy, currency, and stimulating curiosity), language components, communicative, straightforward, and coherence and conciseness of thought flow. Student and Lecturer response questionnaires were developed by researchers by looking at several aspects, namely aspects of content feasibility, language, appearance, and benefits. Indicator statements in each aspect are equipped with 4 answer options, namely very suitable (4), suitable (3), less suitable (2), and not suitable (1). While the development of learning outcomes test instruments was developed in the form of multiple choice questions with 20 items with 5 alternative answers and 4 numbers of essay questions. The instruments developed and used in the study can be seen in the appendix.

The research instrument that has been developed, then validated by two expert validators by providing suggestions and corrections which are used as a basis for making improvements to e-learning so that it is feasible to be implemented in the learning process at the University, as well as providing an assessment of the instrument sheet. Related suggestions and corrections to the instrument validation sheet given by two expert validators can be seen in the appendix.

In the questionnaire, there are several criteria to test the validity of E-learning, namely: (a) content concept, consisting of the suitability of the material with the media used, the language used is easy to understand, (b) design concept, consisting of the accuracy of theme selection, the location of the features used, the ease of use of the media, the suitability of the media with the characteristics of students, the attractiveness of the media display. The validators who validated the e-learning made consisted of two expert validators. When conducting validation activities, the validators also provide suggestions and comments on learning media by writing directly on the validation sheet.

Student and Lecturer Response Instrument

Student response instrument and lecturer response, used to test the level of practicality of e-learning that has been developed. The student response questionnaire consists of three assessment indicators, namely the ease of understanding the contents of e-learning, the attractiveness of the e-learning display and the presentation of learning. Each indicator consists of five statement items related to learning media. In addition, the assessment sheet is also equipped with 4 answer options namely strongly agree (SS), agree (S), disagree (TS) and strongly disagree (STS). For the lecturer response questionnaire filled in by 3 lecturers as respondents, the Lecturer response questionnaire consists of five assessment indicators including the attractiveness of the website display, suitability of learning objectives, ease of use, ease of understanding the contents of e-learning on virus material.

Evaluation sheet for student learning outcomes test

The evaluation sheet for the learning outcomes test aims to measure the effectiveness of the e-learning application developed. It is said to be effective if > 80% of all trial subjects meet learning completeness and the value of learning outcomes after using the media shows an increase from before the use of the media.

Implementation

At this stage, the products that have been produced are tested or implemented in the learning process. In the field trial, instrument results will be obtained about student responses, lecturer responses, e-learning implementation, and evaluation of learning outcomes tests. The implementation stage is carried out after the development process is complete. Products and instruments that have been validated are then implemented in the trial class, namely class 21 semester 6 2023/2024 Biology Education at Muhammadiyah Bulukumba University consisting of 24 students. Limited trial activities were carried out 3 times a meeting with virus material. The implementation stage includes:

Introduction of Website-Based E-Learning

In the implementation stage, the first thing to do before implementing the developed e-learning is product introduction to students and lecturers. The initial introduction is done by giving understanding to students in using and doing assignments in e-learning, this is done so that students are easy in doing activities during the learning process. The introduction is needed so that students and lecturers can use the e-learning that has been developed properly so that the practicality and effectiveness of the device can be measured.

The stage where products that have been validated at the development stage have been tested again by conducting practicality and effectiveness tests. Practicality test was conducted by lecturers as practitioner validators through lecturer response questionnaires and student response questionnaires filled by 24 students. Then the effectiveness test was carried out by using website-based e-learning for biology lessons in even semester virus material for three meetings. Then, at the end of learning, a learning outcome test is conducted to obtain data that becomes a reference in determining effectiveness.

Evaluation

At this stage, an assessment of biology e-learning on learning virus material that has been developed is carried out, whether the e-learning is valid, practical, and effective. The results of this stage are used to analyze whether the e-learning media developed by researchers are capable and well used as additional learning resources for lecturers and students in the learning process.

Characteristics of E-learning developed

Web-based e-learning must include several main components. Content in the form of virus subject matter, learning videos and 3D animations, layout and design.

Devices used in making media are laptop, android smartphone, and some software that will be used in the making process. The supporting features in the developed e-Learning are as follows:

Smart and interactive tools

This feature aims to make learning easy. It provides a smart and intuitive way to build learning. It makes it easy to add sections, lessons, topics, and quizzes to content. It also allows you to add audio and video files, presentations, and other interactive resources.

Creation of practice questions

This feature provides a quick and easy way to add, edit, and move questions within the quiz feature. This feature allows to choose from a variety of question types, insert media.

Assignment creator

This feature allows you to create assignments. Assignments can be enabled for each lesson and/or topic in the lesson. This feature allows to check student understanding of the material.

Assessment

This feature is useful as a report card to provide visualization of the value of learning that has been completed by students.

Certificate

The certificate feature offers an official certificate upon successful completion of meetings and quizzes.

Reporting Feature

Contains overviews, reporting data, activity streams, and progress charts. The material in this elearning is virus material that has been adapted to the material. In the first stage of the development process, namely the analyze phase, it is carried out by observing learning activities and conducting interviews with course lecturers and students. After that, collecting relevant references by searching for development-related journals and University Biology books and reviewing the curriculum and syllabus used in courses applied in the Biology Education Study

Program at Muhammadiyah Bulukumba University. This is done to determine the suitability of the product to be developed.

In the second stage, the design phase, where at this stage the preparation of e-learning is carried out, starting with grouping the material that will be included in e-learning. After completion, the next stage is to design the website, in the form of selecting the features that you want to have on the website. On the website there are several features provided such as intelligent and interactive tools for easy course creation drag and drop course maker to create learning or material easily. Furthermore, the quiz maker feature with question banks. The quiz maker provides a quick and easy way to add, edit and move questions in a quiz. You can choose from a variety of question types, incorporating any media. The next feature is the assignment creator. This feature allows you to create assignments. Assignments can be enabled for each lesson and/or topic in the lesson. This feature allows to check the student's understanding of the material. Features for setting material requirements, focus mode that allows users to create a distraction-free environment.

The next feature is assessment. This feature is useful as a report card to provide a visualization of the grades of the learning completed by the students. Next is the certificate feature that allows you to offer official certificates upon successful completion of meetings and quizzes. Furthermore, there is a report feature that contains overviews, reporting data, activity streams, and progress charts. The material in this e-learning is virus material that has been adapted to lecture material. After designing the practicum guide, the results of the design stage are in the form of prototype 1.

The next phase is development where the initial product of the guide (prototype I) produced is then carried out a series of tests to get input and suggestions that build e-learning to make it better and feasible to use as learning media. The test uses an instrument in the form of an expert validation sheet. During the e-learning development process there were some notes from the validator that must be considered. The analysis used in determining the level of validity of e-learning is Gregory's analysis where it is obtained that both validators give an assessment of having strong relevance and very high content validity (scale results: 1) so that it can be used after making minor revisions. After validating the e-learning, the results of the development stage were obtained, namely prototype II.

The next stage is implementation. Where prototype II was tested on the test subject, namely Biology Education Study Program Students at Muhammadiyah Bulukumba University. The trial conducted is a limited scale trial which is only in one class of Biology Education Study Program students. At this stage, the trial was carried out to obtain student responses to the e-learning that had been developed and to observe the implementation of learning in using the e-learning that had been developed. After analyzing the student response questionnaire, the average of students showed that students gave a very positive response to the e-learning that had been developed. While the learning outcomes test showed that all students reached the KKM. So that at the evaluation stage it was found that the e-learning developed was valid, practical and effective to use.

The e-learning characteristics referred to refer to the distinctive features that distinguish the e-learning from other forms of learning. Based on the result of this research, the website-based e-learning on virus material in Biology Education Study Program of Universitas Muhammadiyah Bulukumba has some important characteristics that are in accordance with ADDIE development model.

First, this e-learning is designed with a clear structure and easily accessible by users, namely lecturers and students. The material is presented in a structured manner with various supporting elements, such as text, images, and videos that can enrich the understanding of virus material. In addition, the design of this e-learning display is responsive and user-friendly, making it easy for users to navigate and access learning materials without technical difficulties.

Secondly, this e-learning enables independent learning, where students can access the material anytime and anywhere. Interactive features such as quizzes, discussions, and feedback from lecturers support active and collaborative learning. It also provides opportunities for students to develop digital literacy skills, which are increasingly important in modern education.

Third, this e-learning is based on active learning principles, where students not only passively receive information but also engage in various activities that stimulate critical thinking and in-depth understanding of the material. Through multiple choice and essay tests integrated in the e-learning, students can evaluate their understanding of the material directly, with feedback provided immediately after the test is completed. Thus, the characteristics of this website-based e-learning are not only limited to the delivery of materials digitally, but also include various features that support active, independent, and collaborative learning processes, which are in accordance with the learning needs in today's digital era.

E-learning validity

In the questionnaire, there are several criteria to test the validity of e-learning, namely: (a) content concept, consisting of the suitability of the material with the media used, the language used is easy to understand, (b) design concept, consisting of the accuracy of theme selection, the location of the features used, the ease of use of the media, the suitability of the media with the characteristics of students, the attractiveness of the media display. The validators who validated the e-learning made consisted of two expert validators. When conducting validation activities, the validators also provide suggestions and comments on learning media by writing directly on the validation sheet. The activities carried out in the validity data analysis process are guided by Gregory.

Table 2 Expert Validation

No	Item	Validator		Keterangan Gregory
		1	2	
1	Presentation Technique	4	3	D
		4	3	D
		4	3	D
		4	3	D
2	Presentation Support	4	3	D
		4	3	D
3	Coverage of material	4	3	D
		4	3	D
		4	3	D
4	Material accuracy	4	3	D
		4	3	D
		4	3	D
		4	3	D
5	Up-to-date	4	3	D
		4	3	D
		4	3	D
6	Summarizing Curiosity	4	4	D

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		4	4	D
		4	3	D
7	Language Component	3	3	D
		3	3	D
8	Communicative	4	3	D
		4	3	D
9	Dialogical and Interactive	4	3	D
		4	3	D
10	Straightforward	4	3	D
		3	3	D
11	Coherence	3	3	D
		4	3	D
	Average	3.86	3,06	D
	Presentation Technique			

The results obtained show that the average value of the validity of the developed material is 1, which refers to the value of content validity. However, it needs to be clarified regarding the results that show an average value of 3.86 and 3.06 on the evaluation items by the validators. In this context, the validity value in question refers to the value given by the validator to each aspect of the material tested, such as presentation techniques, presentation support, material accuracy, and so on. The value of 3.86 on average indicates that most of the items tested have a fairly good level of validity, as they are above the median value (which is usually 3.0 on a 4-point scale).

However, the lower score of 3.06 in some aspects also indicates that there are certain parts that still require further improvement or refinement. For example, in the language and coherence component, the lower score (such as 3) indicates that the developed materials need to be slightly adjusted to be more in line with better language standards and more coherent in delivering messages. From these results, it can be concluded that the developed e-learning materials are valid for use, but some aspects, especially related to language and coherence, need to be improved to achieve a higher level of validity. Overall, the results of this validation still indicate that the developed web-based e-learning has sufficiently met the material validity standards, although further improvements are highly recommended to ensure conformity with all predetermined development criteria.

E-learning that has been developed through a validity process carried out by expert validators. Validation was conducted by two validators. The two validators then validated the elearning by using a validation sheet that had been prepared by the researcher. The test used an instrument in the form of an expert validation sheet. During the elearning development process there were several notes from validators that had to be improved.

The analysis used in determining the level of validity of elearning is with Gregory's analysis where it is obtained that both validators give an assessment of having strong relevance and very high content validity to e-learning using a Likert scale and analyzed using Gregory's analysis so that it is concluded that e-learning has been valid in terms of presentation components.

This shows that the e-learning developed is feasible to use as teaching media in the biology learning process. However, still pay attention to the criticisms and suggestions given for further revision so as to obtain the appropriate learning module. Quality teaching media and worthy of being applied in the learning

process if it has met the validity standards on predetermined aspects which are then assessed by experts or experts (Banjarani et al., 2020).

Practicality of E-Learning

Student response questionnaire instrument and lecturer response, used to test the level of practicality of e-learning that has been developed. The instrument in the form of a questionnaire for lecturer and student responses was distributed after the virus material meeting was completed to see the responses of lecturers and students related to the use of e-learning. The following results of the Lecturer's response questionnaire can be seen in the following table:

Table 3. Results of Lecturer Response Questionnaire

No	Respondents	Average	Percentage
1	R1	4	100
2	R2	3,4	86
3	R3	4	100
Average		3,8	95

Based on the results of the Lecturer's response above, 95% was obtained, which in the interpretation of Yamasari (2010), shows that the Lecturer's response is in a very positive category.

It is obtained an average value of 85.5 which shows that student responses are in the very positive category. Based on the analysis used to obtain student response data and lecturer responses, it was obtained that the average student and lecturer responded very positively to the e-learning developed. The very positive response given by students and lecturers shows that the e-learning developed by researchers is able to help students and lecturers in general biology course virus material.

The concept of learning by using e-learning learning media is not only focused on lecturers who provide subject matter, but with the presence of electronic devices connected to the internet network students can be actively involved in the teaching and learning process. And also the use of e-learning media can be used anytime and anywhere by accessing the system used online. The use of this media will not only increase student knowledge but can ease the burden of a lecturer because some lecturer functions can be taken over in a computer program, laptop or mobile phone. In the use of e-learning learning media there are advantages such as easy to absorb because it uses multimedia facilities in the form of an image, text, animation, sound or video, much more effective in financing and available 24 hours a day.

E-Learning Effectiveness

This learning outcome test evaluation sheet aims to measure the effectiveness of the e-learning application developed. It is said to be effective if > 80% of all trial subjects meet learning completeness. Furthermore, after being given e-learning, a post test was conducted to see the comparison of learning outcomes. The average student score before using e-learning was 59.95 and after the trial, the average learning outcome test was 85, meaning that e-learning is effective to use because it improves learning outcomes. The description can be seen in the following figure:

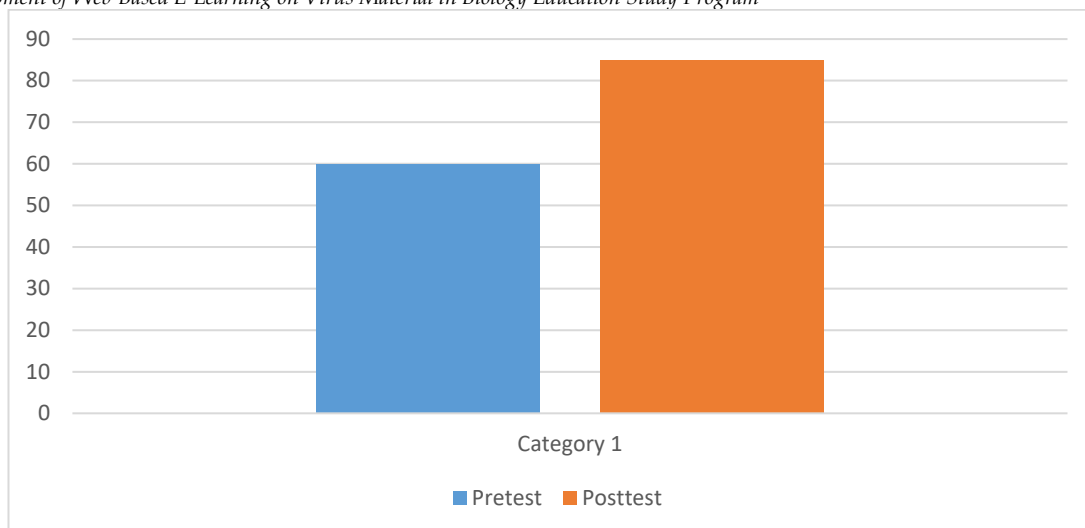


Figure 8. Pretest-posttest comparison

The benefits of using e-learning media in learning are that it can be cost-efficient, flexible in choosing the time and place to access it, and provide opportunities for students independently so that they are in full control of the success of the learning process. Learning outcome itself is a result that is achieved after passing the learning process, interaction with the environment in order to gain knowledge that will produce behavior in accordance with the expected learning objectives. Using e-learning-based learning media has an influence on improving student learning outcomes.

According to Affandi et al., (2022) This media can minimize the level of student cheating in doing work. Then the research reviewed by (Darliah, 2016) obtained the results that the increasing number of e-learning usage by students also increases student enthusiasm and student learning achievement is also getting higher because students often use e-learning as a facility in learning. In research written by (Utami, 2021) explained through his journal, namely related to the effectiveness and optimization of the use of LMS can be seen in the implementation of the use of LMS which in general has developed well as an educational method in the learning process. The results of teacher responses also show that the LMS has been in the “Very Good” category as an advanced learning method.

CONCLUSIONS

The developed website-based e-learning serves as an accessible, cost-effective learning medium with multimedia features such as images, text, animations, sound, and videos, enhancing student knowledge and facilitating lecturers' teaching processes. Accessible anytime and anywhere, it offers the advantages of clear content delivery and 24/7 availability, making learning more efficient. Validation results indicate that the e-learning meets validity standards, although improvements in language and coherence are needed for higher validity. It is deemed practical, supported by positive feedback from lecturers and students, and effective, as evidenced by an increase in student pretest scores from an average of 59.95 to 85 after implementation. This underscores its utility as a valid, practical, and effective tool for education.

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