



# Development of Web-Based Interactive Learning Media Using the Learning Management System in the Artificial Intelligence Course, Faculty of Engineering

Khofifah Al Mukarramah<sup>1\*</sup>, Udin Sidik Sidin<sup>2</sup>, Sanatang<sup>3</sup>  
<sup>1,2,3</sup>Universitas Negeri Makassar, Makassar, Indonesia

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## ABSTRACT

This study aims to analyze the level of validity, practicality, and effectiveness of the development of web-based learning media in the Artificial Intelligence course at the Department of Electrical Engineering, Faculty of Engineering, State University of Makassar. The research uses the Research and Development (R&D) method with a mixed methods approach. Media development integrates ADDIE, 4D, and Borg and Gall models which include the analysis, design, development, implementation, evaluation, and dissemination stages. The research design used the Nonequivalent Pretest and Posttest Control Group Design. The research subjects consist of 42 validators of material experts, validators of media experts, and 42 students of Electrical Engineering Education class of 2024 and 298 students of Informatics and Computer Engineering Education class of 2024. Data collection techniques were carried out through observation, interviews, questionnaires, and experiments, while data analysis used validity and reliability tests, descriptive statistical analysis, and N-Gain Hake tests. The results show that web-based learning media is in the very valid category with a percentage of media expert assessment of 93.5% and material expert of 95%. The level of practicality of media is also in the category of very practical based on the aspects of ease of use, appearance, technical quality, and usefulness. In addition, the results of the effectiveness test showed a significant increase in learning outcomes in the experimental group compared to the control group with a significance value of  $0.000 < 0.05$  and supported by an N-Gain value which showed the effectiveness of media in improving student understanding. Thus, the web-based learning media developed is declared valid, practical, and effective so that it is suitable for use as a learning innovation in higher education.



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## INTRODUCTION

Education is a process of activity that is common in human life. Because the educational process can be found in various regions of the world. To achieve a good educational process, it is necessary to have a deep knowledge of how the educational process can take place. Education is a human effort to be able to develop their personality in accordance with the values that apply in the community and culture and can create a more characterful human being. The educational process also aims to increase the potential of students who are useful, especially for themselves, religion, society, and the nation and state. The education system that applies in Indonesia, both in terms of curriculum and technology, often undergoes changes. This is due to the rapid technological progress in this modern era, as well as the development of technology in the world of education. Technological advances in general have a very important role to support the success of the educational process. As a result of the advancement of information and communication technology, it has changed people's behavior to complete work and overcome various problems. This is inevitable, because technological advances will continue to run in accordance with scientific advances. The use of technology is essentially aimed at making human work easier in daily life. Digital technology is one example that humans today cannot possibly be separated from rapidly developing technology. The development of the digital world in the world of education also has a very significant influence on the interaction patterns of teachers and students. Students who have good technology literacy on average tend to get bored faster when learning takes place conventionally (Fauziyah

et al., 2026). The world of education is currently entering the era of the media world, where learning activities demand the reduction of lecture methods and replaced with the use of many media (Surbakti et al., 2023).

If referring to the current curriculum development, students not only play the role of recipients of messages but also as messengers so that two-way or even more communication is formed. In this communication, learning media is needed to increase the effectiveness of the achievement of a learning. Paradigm *teacher centered* tends to be less effective when asked to review knowledge that requires student interaction, there is a need for teacher innovation in choosing the media used to attract students' attention (Ningrum et al., 2020).

Good learning media and in accordance with the needs of learning activities will create an effective and efficient learning process so that the material delivered by teachers to students can be absorbed optimally. Based on how it is used, Silahuddin (2022) Stating that learning media is divided into two, namely traditional or conventional media and modern or complex media. Traditional or conventional media are simple media, such as maps, graphic symbols, and serial images. Meanwhile, modern media is media that is integrated using electronic tools such as computers. Modern learning media, there is what is called interactive learning media. Interactive learning media is a multimedia device that is equipped with a controller that can be operated by the user so that the user can choose what they want for the next process, then ask, and get answers that then affect the computer to perform the next function. One of the benefits of learning media is that it can clarify the presentation of messages and information, so that it can facilitate and improve the learning outcome process (Sola et al., 2022).

Looking at current developments, it is no longer the time for educators to provide teaching conventionally (*teacher center*) which only uses lecture and memorization methods. The use of learning media is one of the components of the teaching and learning process that plays a very important role in supporting the success of the teaching and learning process. According to Sriwahyuni and Mardono (2016), media are different types of components in a learner's environment that can provide stimulation for learning.

Because the existence of learning media can make it easier for educators to deliver subject matter in relation to the learning objectives that have been formulated in the learning plan. Based on the results of observations made at the beginning of the interview with the lecturer related to the Artificial Intelligence course at the Department of Electrical Engineering and Informatics and Computer Engineering Education, Faculty of Engineering, State University of Makassar on August 15, 2025, information was obtained if the learning resources used or used in the learning process of the course were still using other media, and teaching materials from the internet. He also complained that until now the learning media used in the educational process is still limited because the data obtained by students is still not efficient, he hopes that in the future there will be learning resources or educational media that can be used. Where this education includes learning resources in the form of media, images, audio, and videos.

Based on interviews with several students who program the Artificial Intelligence course, it is known that the learning media used in the learning process so far is still dominated by the presentation method using PowerPoint. The use of these media is highly dependent on the material presenter so that the learning process tends to be centered on the lecturer. This condition results in students easily feeling bored, less active, and not able to learn independently because the learning process takes place in a monotonous and less interactive manner. In fact, learning in the Artificial Intelligence course requires media that is able to display dynamic conceptual visualizations so that students can more easily understand abstract and complex material.

Previous research has shown that web-based learning media and *Learning Management System* (LMS) has a positive contribution to improving the quality of learning. Research by (Y. I. Putra & Ridoh, 2021) entitled "Development of Web-Based Learning Media to Improve Student Skills in Basic Web Programming Courses at STKIP Muhammadiyah Muara Bungo" shows that web-based learning media is effective in improving student skills. However, the research still focuses on basic web programming courses and has not discussed the development of interactive media in the Artificial Intelligence course that requires visualization of more complex concepts. Research by (A. A. Putra & Nuryadi, 2020) titled "Development of Moodle LMS-Based Interactive Learning Media Reviewed from *Cognitive Loads Theory*" produced Moodle learning media that is suitable for use in learning, but the research was applied to mathematics learning at the secondary school level so that it was not in accordance with the characteristics of Artificial Intelligence learning in universities. In addition, research by (Simbolon, 2022) entitled "Development of Interactive Learning Media Using Moodle as a Supporting Means *Blended Learning* Students" shows that Moodle's LMS is able to increase the learning flexibility of students, but has not developed learning media that specifically contains Artificial Intelligence materials such as *machine learning*, *neural network*, as well as interactive visualization of AI algorithms.

Based on some of these previous studies, it can be seen that the development of web-based learning media and Moodle LMS has been widely carried out and proven to be effective in improving learning outcomes and student motivation. However, previous research still focused on general courses, secondary school learning, and the

implementation of *blended learning* in general. Until now, there is still limited research that specifically develops web-based interactive learning media using LMS in the Artificial Intelligence course within the Faculty of Engineering, State University of Makassar. Thus, there is a research *gap* in the form of the unavailability of web-based interactive learning media designed according to the characteristics of Artificial Intelligence materials and the needs of students in higher education.

The urgency of this research is based on the importance of developing learning media that is able to support independent learning (*self-directed learning*) and technology-based learning (*technology-enhanced learning*) in the digital era. According to (Lumbantobing, 2023), digital learning media is able to expand access to learning, increase learning flexibility, and facilitate the diversity of student learning styles. In addition, the rapid development of Artificial Intelligence technology requires universities to provide innovative, interactive, and relevant learning media to the needs of the world of work. This is in line with the opinion (Lontaan et al., 2023) which states that Artificial Intelligence is a field of science that requires a strong conceptual understanding and visualization because it includes various techniques such as *machine learning*, artificial neural networks, natural language processing, and computer vision. Therefore, the development of web-based interactive learning media is important so that students do not only depend on lecturers' explanations, but are also able to learn independently through interesting, adaptive, and easily accessible media at any time.

Based on this description, the formulation of the problem in this study is: (1) how is the validity of the development of Artificial Intelligence learning media, Faculty of Engineering, State University of Makassar, (2) how practical is the Artificial Intelligence learning media of the Faculty of Engineering, State University of Makassar, and (3) how effective is the learning media of Artificial Intelligence, Faculty of Engineering, State University of Makassar. Therefore, this research was conducted with the aim of developing web-based interactive learning media using *the Learning Management System* in the Artificial Intelligence course that is valid, practical, and effective to improve the quality of student learning at the Faculty of Engineering, State University of Makassar.

## METHOD

In this study, the development model used is an integration between 4D, ADDIE, and Borg and Gall models which aims to produce a more systematic and comprehensive development procedure. 4D models are used to define to analyze learning needs, student characteristics, and problems that occur in Artificial Intelligence learning. Next, the stage design and development refers to the ADDIE model which includes media design, web-based product development with multimedia integration, as well as implementation in the learning process. The ADDIE model is a development model consisting of five systematic stages, namely analysis, design, development, implementation, and evaluation which is used to produce structured learning products (Scott, 2019). Meanwhile, the Borg and Gall model is used in development research to provide systematic steps ranging from information collection, planning, initial product development, trial, revision, to final product that is suitable for use in learning (Gall et al., 2007).

The data collection techniques in this study include interviews, questionnaires, and documentation. Interviews are used to obtain in-depth information from lecturers and students related to the learning process, learning resources, obstacles faced, and the need for Artificial Intelligence learning media. The questionnaire was used to measure respondents' perception of the feasibility of the media from the aspects of material, media, and utility. The research instruments used include interview guidelines, questionnaire sheets, media validation sheets, and questionnaire validation sheets. The interview guidelines are structured in a semi-structured manner so that researchers can explore information flexibly but still in accordance with the focus of the research. The questionnaire sheet was prepared using the Likert scale to measure the response of students and lecturers to learning media, especially in the aspects of ease of use, appearance, technical quality, and the benefits of media in learning. Media validation sheets are used by subject matter experts and media experts to assess the feasibility of content, language, design, and suitability of media with learning outcomes. The questionnaire validation sheet is used to ensure that the research instrument has met the validity aspect of the content so that it is suitable for use in data collection (Sidin et al., 2021). Instrument validity is the level of accuracy of an instrument in measuring research variables in accordance with the measurement objectives that have been set (Azwar, 2012).

The sample in this study is determined based on a non-probability sampling technique with a type of purposive sampling, which is the selection of research subjects based on certain considerations in accordance with the research objectives. The research sample consists of 42 students of the 2024 Electrical Engineering Education Study Program and 38 students of the 2024 Informatics and Computer Engineering Education Study Program. This study uses a quasi-experimental design *Nonequivalent Pretest-Posttest Control Group Design*, i.e. the experimental and control groups were not randomly selected, but both were given a pretest and a posttest, while the treatment was only given to the experimental group (Creswell, 2014). This design is used to see the effect of the use of Artificial Intelligence learning

media on improving student learning outcomes. The analysis of improving learning outcomes was carried out using the N-Gain Hake test to measure learning effectiveness based on the difference in pretest and posttest scores. N-Gain is used to see the level of improvement in learners' learning outcomes based on a comparison of scores before and after treatment (Hake, 1999).

The data analysis techniques in this study include validity test, reliability test, descriptive statistical analysis, and N-Gain test. The validity test is used to determine the level of feasibility of instruments and media based on expert assessments of content and construct aspects. The reliability test is used to determine the consistency of the instrument in measuring research data when used repeatedly under the same conditions (Scott, 2019). Descriptive statistical analysis is used to describe research data such as the level of validity, practicality, and user response to learning media. The N-Gain test is used to measure the improvement of student learning outcomes before and after the use of Artificial Intelligence learning media (Suharsimi Arikunto, 2013).

## RESULTS

### A. Media Development Process

#### 1. Analysis Stage

The needs analysis stage is carried out to identify problems, field conditions, and learning needs that must be met in the development of Artificial Intelligence learning media. This analysis was carried out through observations, interviews, and literature review on October 7, 2025 at the Electrical Engineering Education Study Program, State University of Makassar. Based on the results of the interview with Dr. Udin Sidik Sidin, S.Pd., M.T., information was obtained that the delivery of Artificial Intelligence material is still dominated by the use of print media. Students tend to be passive because they do not have media that can be used to explore concepts independently.

#### 2. Design Stage

The design stage aims to compile the structure, appearance, and workflow of web-based learning media.

- a) The design of the material structure is prepared based on the learning outcomes of the artificial intelligence course. The design of the navigation flow is designed using a *flowchart* that illustrates the relationship between the main pages of the lecturer as shown in the image below:

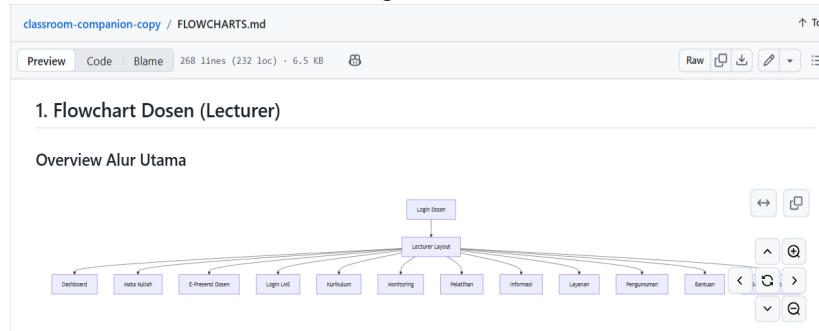


Figure 1. Interactive Learning Media *Webflow* for Lecturers

- b) The design of the navigation flow for students is designed using a *flowchart* that describes the relationship between the main pages of the lecturer as shown in the image below:

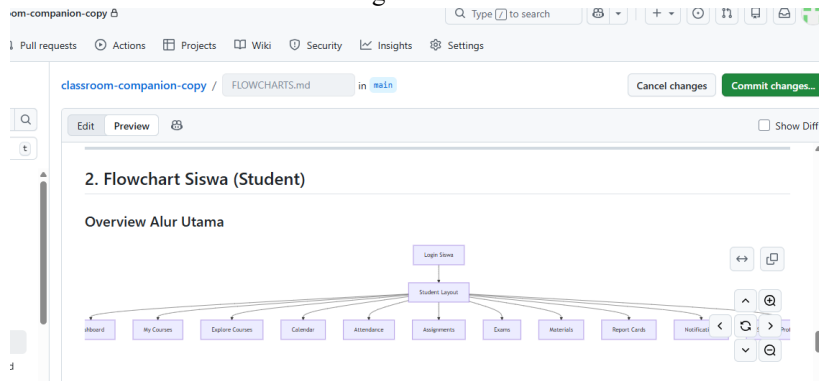
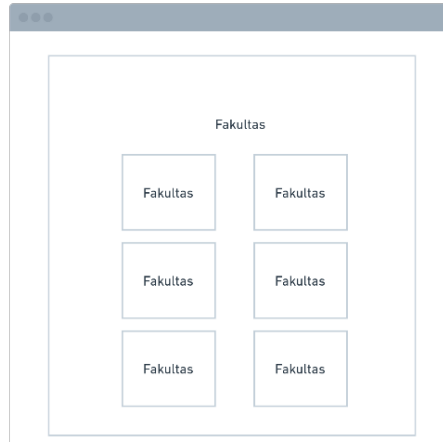
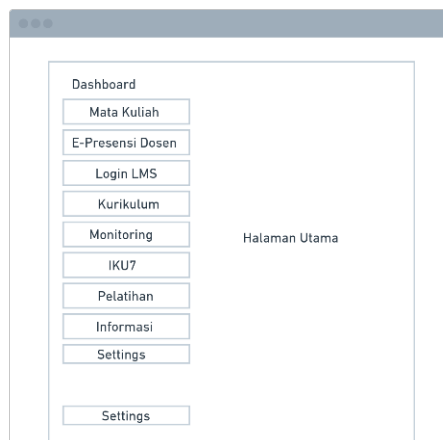


Figure 2. Interactive Learning Media *Web Flow* for Students

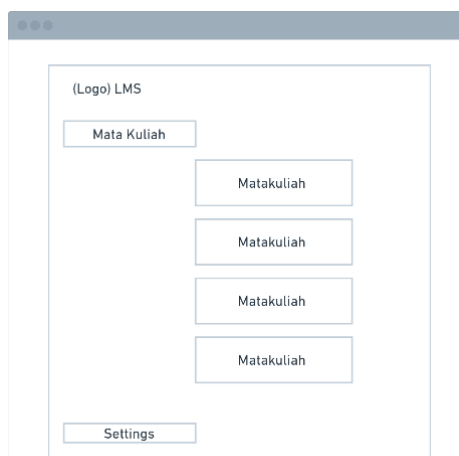




**Figure 6.** Home (Students/Lecturers)



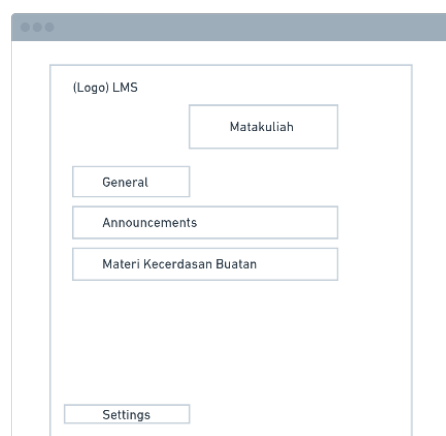
**Figure 7.** Detail Page (Student/Lecturer)



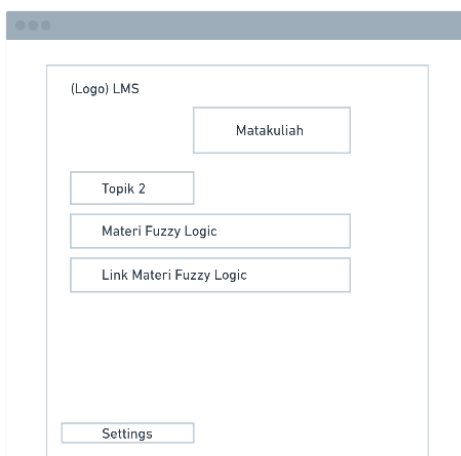
**Figure 8.** Course Details Page (Student/Lecturer)



**Figure 9.** Course Material Details Page (Students/Lecturers)



**Figure 10.** Upload Page (Student/Lecturer)



**Figure 11.** Access to Student Materials

The data from the validation of artificial intelligence media in assessing the aspects of media validity of material experts, media experts and practicality were filled in by validator 1 and validator 2. Before filling out the media validation sheet, the validator looks at and provides suggestions for media improvement both in terms of material and media. The data from the validation of artificial intelligence media by validators has been calculated on average for each validator. The following is presented:

1) Media Expert Data Validation

**Table 1.** Validation Results by Media Experts

Nu.	Aspects	Validator		Percentage
		V 1	V 2	
<b>A.</b>	<b>Ease of Use and Navigation</b>	<b>24</b>	<b>23</b>	<b>94%</b>
1.	The media is easy to understand and use.	5	5	100%
2.	The media structure is logical and easy to understand.	5	5	100%
3.	Instructions in the medium are clear, concise, and easy to follow	5	4	90%
4.	The media is equipped with enough examples and exercises to help students understand the material.	4	4	80%
5.	The media provides adequate guidance for completing learning tasks and activities	5	5	100%
<b>B.</b>	<b>Display and Graphics</b>	<b>23</b>	<b>23</b>	<b>92%</b>
6.	The design and layout of the book media is interesting and informative	5	4	90%
7.	Drawings, illustrations, and diagrams are clear and easy to understand.	5	5	100%
8.	Use of consistent colors and fonts and is comfortable to read	5	4	90%
9.	The page layout and overall design facilitate comfortable reading	4	5	90%
10.	The overall appearance and graphics of the book media support the learning process	4	5	90%
<b>C.</b>	<b>Technical Quality</b>	<b>22</b>	<b>25</b>	<b>94%</b>
11.	The content of the media is accurate, up-to-date, and in accordance with the learning material.	4	5	90%
12.	The language used in the media is easy to understand and communicative.	4	5	90%
13.	Well structured and logical media	5	5	100%
14.	References or sources of information presented	5	5	100%
15.	There are examples and exercises that are relevant and useful	4	5	90%
<b>D.</b>	<b>Benefits</b>	<b>23</b>	<b>24</b>	<b>94%</b>
16.	Media helps improve understanding and ability in Refrigeration Maintenance courses.	5	5	100%
17.	Book media helps in completing assignments and practice questions.	4	5	90%
18.	The media helps in preparing for exams and practicums.	4	5	90%
19.	Book media is useful in applications in the world of work	5	5	100%
20.	The use of media makes it easier for lecturers in the learning process	5	4	90%
<b>Total Score</b>		<b>92</b>	<b>95</b>	<b>1870%</b>
<b>Average</b>		<b>4,6</b>	<b>4,75</b>	<b>93.5%</b>

**Table 2.** Results of Assessment of the Practicality of Learning Media Based on Aspects of Use, Appearance, Technical Quality, and Usefulness

Nu.	Aspects	Validator		Percentage
		V1	V2	
A	Ease of Use and Navigation	24	23	94%
B	Display and Graphics	23	23	92%
C	Technical Quality	22	25	94%
D	Benefits	23	24	94%
<b>Total Score</b>		<b>92</b>	<b>95</b>	<b>1870%</b>
<b>Friendly</b>		<b>4,6</b>	<b>4,75</b>	<b>93.5%</b>

Based on [Table 1](#), the tabulation of data from the results of Media validation by 2 validators in terms of Media media was found in the assessment criteria of the ease of use and navigation aspect with a percentage value of 94%, the assessment criteria for the display and graphics aspect assessment received a percentage value of 92%, the technical quality aspect assessment criteria received a percentage value of 94%, the assessment criteria for the usefulness aspect

received a percentage value of 94%. Based on the description above, an average validation score of 93.5% was obtained with a very valid category. This means that the learning media from segimedia is feasible and can be used, but this media will still be improved according to the suggestions given by the validators.

2) Preparation of Materials, Learning Videos, and Training Assignments

The materials, videos, quizzes, and exercise assignments contained in the learning media are taken based on the content of the Artificial Intelligence course module. All text/font content in the learning media is the default. The creation of this learning media uses the web Learning Management System.

3. Development Stage



Figure 12. Media Cover

**SAB I**  
**PENGANTAR KECERDASAN BUATAN**

**A. CAPAIAN PEMBELAJARAN MATA KULIAH**

Setelah melaksanakan kegiatan pembelajaran ini mahasiswa diharapkan mampu memahami dasar-dasar kecerdasan buatan

**B. INDIKATOR**

1. Menjelaskan definisi dan Sejarah pengembangan kecerdasan buatan
2. Menjelaskan ruang lingkup dan aplikasi AI dalam dunia modern
3. Pemahaman terkait aplikasi MATLAB

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**Gambar 1. 1 Perkembangan kecerdasan buatan aplikasi AI**

**C. MATERI**

1. **Definisi dan Sejarah Pengembangan Kecerdasan Buatan**

Terdapat mata bidang keilmuan yang paling penting saat ini dan akan datang adalah ilmu tentang Kecerdasan buatan. Kecerdasan buatan ini adalah mata bidang ilmu komputer yang sangat diperlukan dalam mengaplikasikan

Figure 13. Material

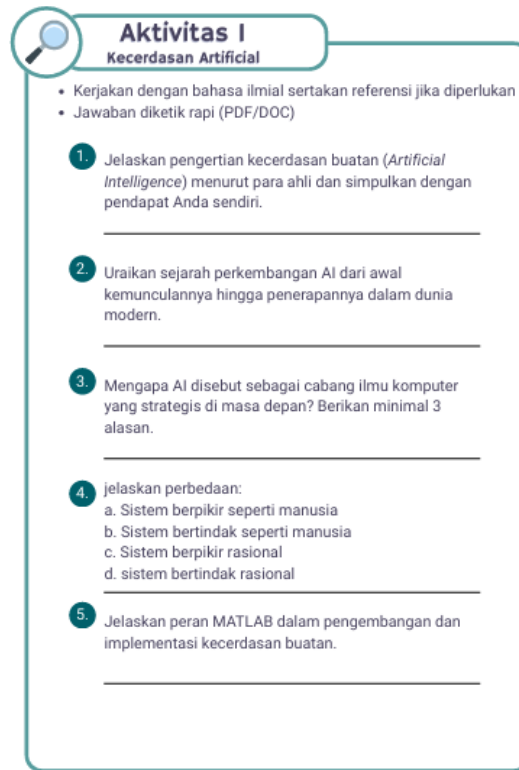


Figure 14. Media Question Exercise

a. Expert Validation

The media that has been created must be validated by experts to find out that the media developed is valid and feasible, both in terms of material, language, and appearance. At this stage, the media developed is validated by 2 experts consisting of 1 material and media expert and 1 material and media expert.

b. Student Trials

The trial was carried out on students of the Informatics and Computer Engineering Education Study Program and Electrical Engineering, including ease of use, suitability of materials.

1) Subject Matter Expert Data Validation

Table 3. Validation Results by Subject Matter Experts

Nu.	Aspects	Validator		Percentage
		V1	V2	
<b>A.</b>	<b>Compatibility</b>	<b>20</b>	<b>20</b>	<b>100%</b>
1.	Purpose Learning Suitable with Required competencies	5	5	100%
2.	The material presented can be easily understood by students	5	5	100%
3.	Relevance of the material to learning outcomes	5	5	100%
4.	Relevance of the image to the material	5	5	100%
<b>B.</b>	<b>Content Quality and Purpose</b>	<b>37</b>	<b>38</b>	<b>93.75%</b>
5.	Collapse of material content delivery	4	5	90%
6.	Clarity of material delivery	5	5	100%
7.	Scope of the material presented	5	4	90%
8.	Presentation of illustrations on each sub-Media	4	4	80%
9.	Presentation of images that support the material	5	5	100%
10.	Accuracy in the use of Language	5	5	100%
11.	Presentation material Interesting and not boring	5	5	100%
12.	Presentation of practice questions according to learning outcomes	4	5	90%

Nu.	Aspects	Validator		Percentage
		V1	V2	
<b>C.</b>	<b>Instructional Quality</b>	<b>14</b>	<b>14</b>	<b>93.3%</b>
13.	The material presented can foster students' motivation to learn	4	5	90%
14.	The material presented can attract students' interest in learning	5	5	100%
15.	Conformity of the formative test with the content of the material	5	4	90%
<b>Total Score</b>		<b>71</b>	<b>72</b>	<b>1.430%</b>
<b>Average</b>		<b>4.7</b>	<b>4.8</b>	<b>95.3%</b>

**Table 4.** Results of Assessment of the Validity of Learning Media Based on Aspects of Suitability, Quality of Content and Objectives, and Instructional Quality

Nu.	Aspects	Validator		Percentage
		V 1	V 2	
A	Compatibility	20	20	100%
B	Content Quality and Purpose	37	38	93.75%
C	Instructional Quality	14	14	93.3
<b>Total Skkor</b>		<b>71</b>	<b>72</b>	<b>1.430%</b>
<b>Friendly</b>		<b>4.7</b>	<b>4.8</b>	<b>95%</b>

Based on Table 3, the tabulation of data from Media validation results by 2 validators in terms of material was obtained, Media was found to have a percentage score of 100%, the criteria for assessing the quality of the content and objectives aspects of obtaining a percentage value of 93.75%, the criteria for assessing the instructional quality aspect received a percentage value of 93.3%. Based on the description above, an average validation score of 95% was obtained with a very valid category. This means that the learning media in terms of material is feasible and can be used, but this media will still be improved according to the suggestions given by the validators. Based on the results of the assessment that has been obtained, it is known that the media developed has been feasible, both in terms of content or material, language and appearance so that the media can enter the implementation stage to see the feasibility value and response given by students.

## B. Results of Media Practicality and Effectiveness Tests

### 1. Implementation Stage

The implementation stage began with a small group trial involving 12 students, consisting of 6 students from the Department of Electrical Engineering Education and 6 students from the Department of Informatics and Computer Engineering Education, Faculty of Engineering, State University of Makassar Semester IV class of 2024. Furthermore, the field trial will be carried out on February 4, 2026 involving 80 students, 42 students each from the Department of Electrical Engineering Education and 38 students from the Department of Informatics and Computer Engineering Education at the same faculty and batch. Before the use of media, the lecture began with greetings and introductions. The media is then distributed to students before the delivery of the material, then students learn the content of the media and do exercises in the artificial intelligence courses available in it.

#### a. Small Group Trials

**Table 5.** Results of Small Group Trial Responses on Aspects of Ease of Use and Navigation

Aspect Number	Quantity	Maximum Score	Percentage Keidealan (%)	Category
1	54	60	90%	Very Practical
2	55	60	91.6%	Very Practical
3	55	60	91.6%	Very Practical
4	57	60	95%	Very Practical
5	57	60	95%	Very Practical
<b>Average Percentage of Ideality</b>			<b>92.64%</b>	<b>Very Practical</b>

**Table 6.** Frequency Distribution Aspects of Ease of Use and Navigation

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 5, it is known that the learning media developed is reviewed from the aspect of ease of use and navigation 92.64% of 12 respondents are of the opinion that the media is easy to understand, the structure of the media is logical, the instructions in the media are clear, concise and easy to follow, the media is equipped with sufficient examples and exercises, and provides guidance in completing learning tasks and activities so that the media can be categorized as "very practical".

**Table 7.** Results of Small Group Trial Responses on Display and Graphic Aspects

Aspect Number	Quantity	Maximum Score	Ideality Percentage	Category
6	56	60	93.3%	Very Practical
7	55	60	91.6%	Very Practical
8	56	60	93.3%	Very Practical
9	57	60	95%	Very Practical
10	57	60	95%	Very Practical
<b>Average Percentage of Ideality</b>			<b>93.64%</b>	<b>Very Practical</b>

**Table 8.** Display and Graph Aspect Frequency Distribution

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 7, it is known that the Media developed is reviewed from the aspect of display and graphography, 93.64% of the 12 respondents are of the opinion that the design and layout of the Media is attractive and informative, the images, illustrations, and diagrams are clear and easy to understand, the use of colors and fonts is consistent and comfortable to read, the page layout facilitates comfortable reading, the display and graphics support the learning process so that the Media can be categorized as "Very Practical".

**Table 9.** Results of Small Group Trial Responses on Engineering Quality Aspects

Aspect Number	Quantity	Maximum Score	Ideality Percentage	Category
11	55	60	91.6%	Very Practical
12	54	60	90%	Very Practical
13	54	60	90%	Very Practical
14	55	60	91.6%	Very Practical
15	56	60	93.3%	Very Practical
<b>Average Percentage of Ideality</b>			<b>91.3%</b>	<b>Very Practical</b>

Table 9 shows that the developed media is reviewed from the technical quality aspect 91.3% of respondents are of the opinion that the content of the media is accurate, up-to-date and in accordance with the learning material, the language is communicative and easy to understand, the media is well structured, references are presented, then the media can be categorized as "Very Practical".

**Table 10.** Frequency Distribution of Engineering Quality Aspects

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

**Table 11.** Results of Small Group Trial Responses on Utility Aspects

Aspect Number	Quantity	Maximum Score	Ideality Percentage	Category
16	56	60	93.3%	Very Practical
17	55	60	91,6%	Very Practical
18	56	60	93.3%	Very Practical
19	56	60	93.3%	Very Practical
20	56	60	93.3%	Very Practical
<b>Average Percentage of Ideality</b>			<b>92.96%</b>	<b>Very Practical</b>

**Table 12.** Frequency Distribution of Benefit Aspects

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 11, it is known that the Media developed is reviewed from the aspect of usefulness 92.96% of respondents are of the opinion that the use of Media helps improve understanding and ability, helps complete assignments and practice questions, helps prepare for exams and practicums, is useful in the application of the world of work, makes learning easier, so that Media can be categorized as "Very Practical". Based on the elaboration of the tables above, it can be concluded that the media received a positive response which was categorized as "Very Practical", meaning that the learning media could be tested in the field.

**b. Large Group Trials (Field)**

The same field trial was carried out by filling out an assessment questionnaire. This field trial was carried out on 65 students of the Department of Electrical Engineering Education in the 6th semester, the questionnaire data obtained is presented in Table 13, the aspects of ease of use and navigation are as follows:

**Table 13.** Results of Responses to Large Group Trials on Aspects of Ease of Use and Navigation

Aspect Number	Quantity	Maximum Score	Percentage of Ideality (%)	Category
1	303	325	93.23%	Very Practical
2	309	325	95,07%	Very Practical
3	308	325	94.76%	Very Practical
4	308	325	94.76%	Very Practical
5	307	325	94.46%	Very Practical
<b>Average Percentage of Ideality</b>			<b>94.45%</b>	<b>Very Practical</b>

Based on Table 13, it is known that the learning media developed is reviewed from the aspect of ease of use and navigation 94.45% of 65 respondents are of the opinion that the media is easy to understand, the structure of the media is logical, the instructions in the media are clear, concise and easy to follow, the media is equipped with sufficient examples and exercises, and provides guidance in completing learning tasks and activities so that the media can be categorized as "Very Practical".

**Table 14.** Frequency Distribution Aspects of Ease of Use and Navigation

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

**Table 15.** Results of Large Group Trial Responses on Display and Graphic Aspects

Aspect Number	Quantity	Maximum Score	Percentage of Ideality (%)	Category
6	308	325	94.76%	Very Practical
7	307	325	94.46%	Very Practical
8	309	325	95.07%	Very Practical
9	309	325	95.07%	Very Practical
10	311	325	95.69%	Very Practical
<b>Average Percentage of Ideality</b>			<b>95.01%</b>	<b>Very Practical</b>

**Table 16.** Display and Graph Aspect Frequency Distribution

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 15, it is known that the Media developed was reviewed from the aspect of display and graphography, 95.01% of the 65 respondents were of the opinion that the design and layout of the Media was attractive and informative, the images, illustrations, and diagrams were clear and easy to understand, the use of colors and fonts was consistent and comfortable to read, the page layout facilitated comfortable reading, the display and graphics supported the learning process so that the Media could be categorized as "Very Practical".

**Table 17.** Results of Large Group Trial Responses on Engineering Quality Aspects

Aspect Number	Quantity	Maximum Score	Percentage of Ideality (%)	Category
11	305	325	93.84%	Very Practical
12	304	325	93.53%	Very Practical
13	308	325	94.76%	Very Practical
14	308	325	94.76%	Very Practical
15	311	325	95.69%	Very Practical
<b>Average Percentage of Ideality</b>			<b>94.51%</b>	<b>Very Practical</b>

**Table 18.** Frequency Distribution of Engineering Quality Aspects

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 17, it shows that the Media developed is reviewed from the technical quality aspect 94.51% of respondents are of the opinion that the content of the Media is accurate, up-to-date and in accordance with the learning material, communicative and easy-to-understand language, the Media is well structured, references are presented, then the Media can be categorized as "Very Practical".

**Table 19.** Results of Large Group Trial Responses on Utility Aspects

Aspect Number	Quantity	Maximum Score	Percentage of Ideality (%)	Category
16	309	325	95.07%	Very Practical
17	307	325	94.46%	Very Practical
18	307	325	94.46%	Very Practical
19	309	325	95.07%	Very Practical
20	311	325	95.69%	Very Practical
<b>Average Percentage of Ideality</b>			<b>94.95%</b>	<b>Very Practical</b>

**Table 20.** Frequency Distribution of Benefit Aspects

Interval (%)	Frequency	Percentage (%)	Category
81-100	5	100%	Very Practical
61-80	0	0%	Practical
41-60	0	0%	Quite Practical
21-40	0	0%	Less Practical
0-20	0	0%	Impractical
<b>Quantity</b>	<b>5</b>	<b>100%</b>	

Based on Table 19, it is known that the Media developed is reviewed from the aspect of usefulness 94.95% of respondents are of the opinion that the use of Media helps improve understanding and ability, helps complete assignments and practice questions, helps prepare for exams and practicums, is useful in the application of the world of work, makes learning easier, so that Media can be categorized as "Very Practical".

## 2. Evaluation Stage

This stage aims to evaluate the validity, practicality, and effectiveness of learning media. The results of the analysis showed that the developed media had a high level of effectiveness. Based on quantitative data from validators and student responses, media is considered very interesting, easy to use, and relevant to artificial intelligence material. Furthermore, the effectiveness analysis was carried out through pretest and posttest tests on 40 students. The results of the t-test showed a significance value of  $0.000 < 0.05$ , which indicated a significant improvement in learning outcomes after the use of web-based learning media through LMS. Thus, the media is stated to be effective in improving student understanding. After the implementation stage, an assessment of learning media is carried out which includes aspects of practicality and effectiveness. The practicality aspect was measured through a questionnaire of student and lecturer responses, while the effectiveness aspect was reviewed from the results of the posttest scores obtained by students.

**Table 21.** Student Questionnaire Score Recapitulation

Nu.	Aspects	Total
<b>A.</b>	<b>Ease of Use and Navigation</b>	
1.	The media is easy to understand and use.	303
2.	The media structure is logical and easy to understand.	309
3.	Instructions in the medium are clear, concise, and easy to follow	308
4.	The media is equipped with enough examples and exercises to help students understand the material.	308
5.	The media provides adequate guidance for completing learning tasks and activities	307
<b>B.</b>	<b>Display and Graphics</b>	
6.	The design and layout of the book media is interesting and informative	308
7.	Drawings, illustrations, and diagrams are clear and easy to understand.	307
8.	Use of consistent colors and fonts and is comfortable to read	309
9.	The page layout and overall design facilitate comfortable reading	309
10.	The overall appearance and graphics of the book media support the learning process	311
<b>C.</b>	<b>Technical Quality</b>	
11.	The content of the media is accurate, up-to-date, and in accordance with the learning material.	305
12.	The language used in the media is easy to understand and communicative.	304
13.	Well structured and logical media	308
14.	References or sources of information presented	308
15.	There are examples and exercises that are relevant and useful	311

Nu.	Aspects	Total
<b>D. Benefits</b>		
16.	Media helps improve understanding and ability in Refrigeration Maintenance courses.	309
17.	Book media helps in completing assignments and practice questions.	307
18.	The media helps in preparing for exams and practicums.	307
19.	Book media is useful in applications in the world of work	309
20.	The use of media makes it easier for lecturers in the learning process	311
<b>Total</b>		<b>6158</b>
<b>Average</b>		<b>307.9</b>
<b>Average Presentation</b>		<b>94.73%</b>

Based on Table 21, it is known that the results of the response questionnaire of 65 students with an average percentage of 94.73%, so that the Media category is "very practical".

Table 22. Recapitulation of Lecturer Questionnaire Scores

Nu.	Aspects	Total
<b>A. Ease of Use and Navigation</b>		
1.	The media is easy to understand and use.	10
2.	The media structure is logical and easy to understand.	10
3.	Instructions in the medium are clear, concise, and easy to follow	9
4.	The media is equipped with enough examples and exercises to help students understand the material.	8
5.	The media provides adequate guidance for completing learning tasks and activities	10
<b>B. Display and Graphics</b>		
6.	The design and layout of the book media is interesting and informative	9
7.	Drawings, illustrations, and diagrams are clear and easy to understand.	10
8.	Use of consistent colors and fonts and is comfortable to read	9
9.	The page layout and overall design facilitate comfortable reading	9
10.	The overall appearance and graphics of the book media support the learning process	9
<b>C. Technical Quality</b>		
11.	The content of the media is accurate, up-to-date, and in accordance with the learning material.	9
12.	The language used in the media is easy to understand and communicative.	9
13.	Well structured and logical media	10
14.	References or sources of information presented	10
15.	There are examples and exercises that are relevant and useful	9
<b>D. Benefits</b>		
16.	Media helps improve understanding and ability in Refrigeration Maintenance courses.	10
17.	Book media helps in completing assignments and practice questions.	9
18.	The media helps in preparing for exams and practicums.	9
19.	Book media is useful in applications in the world of work	10
20.	The use of media makes it easier for lecturers in the learning process	9
<b>Total</b>		<b>187</b>
<b>Average</b>		<b>9.35</b>
<b>Average Presentation</b>		<b>93.5%</b>

Based on Table 22, it is known that the results of the questionnaire responses of 2 lecturers of the Department of Electrical Engineering Education with an average percentage of 93.5%, so that the Media is in the "very practical" category.

Table 23. Paired Test Test Results

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Hours of deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PreTest Control – PostTest Control	54.15 0	12.733	2.013	50.078	58.222	26.896	39	.000

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Hours of deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PreTest Experiment – PostTest Experiments	65.50 0	8.035	1.270	62.930	68.070	51.556	39	.000

Based on the results of the Paired Samples Test in Table 23, both the control group and the experiment showed a significant increase in values from pretest to posttest. The control group saw an average increase of 54,150, while the experimental group saw a mean increase of 65,500, which showed a higher improvement in the experimental group. The significance value (Sig. 2-tailed) of  $0.000 < 0.05$  and a 95% confidence interval that did not include zero confirmed that the improvement in both groups was statistically significant. Nonetheless, the larger standard deviation in the experimental group showed a higher variation in improvement. Overall, these results indicate that the intervention in the experimental group was more effective in improving learning outcomes than the control group.

Table 24. Descriptive Statistical Table of N-Gain Values in Control Class and Experimental Class

Classes	N	Minimum	Maximum	Mean	Hours of deviation
Control	40	1.40	6.67	3.7242	1.27851
Eksperimen	40	3.20	7.00	5.2758	0.87851
Valid N (listwise)	40				

Based on Table 24, it is known that the experimental group had a higher average N-Gain value (5.2758) compared to the control group (3.7242), which generally indicates an improvement in better learning outcomes in the experimental group. However, some statistical figures such as the N-Gain value need to be reviewed to ensure the accuracy of the calculation and interpretation, especially in determining the scale, category, and suitability of the N-Gain value range used in the analysis. In addition, although the standard deviation in the experimental group (0.87851) was lower than in the control group (1.27851) which indicated a smaller variation in values, the interpretation of the form of data distribution such as skewness could not be ascertained based only on the mean value and standard deviation, so further statistical analysis was needed to strengthen the conclusions. Therefore, although descriptively the experimental group appeared to be superior and more consistent than the control group, the results still needed to be re-examined in more depth so that conclusions about the effectiveness of the intervention could be expressed more accurately and statistically accountable.

### c. Dissemination

At the dissemination and implementation stage, web-based learning media is distributed to lecturers and students through application links and introduced with a brief explanation of several ways to use it. After the process of disseminating information, the media is applied to the experimental class as part of the artificial intelligence learning activities. Students take advantage of the materials, and adaptive quizzes to learn independently and guided. During implementation, the researcher observed student involvement, ease of use of media, and its compatibility with the needs of pretest and posttest data collected to see an improvement in learning outcomes after media use. This stage ensures that the media is not only feasible and practical, but also makes a real contribution to students' understanding and learning experience.

## DISCUSSION

### 1. Media Development Results

The research on the development of web-based interactive learning media was carried out by combining three development models, namely 4D, ADDIE, and Borg & Gall, which were then simplified into five stages: needs analysis, design, development, evaluation, and dissemination and implementation. At the needs analysis stage, the researcher identified the main problems in artificial intelligence learning, including the limitations of conventional media devices, as well as students' need for interactive media that can display simulations and web-based exercises. The design stage involves creating a system flow, interface design, material structure, and adaptive question model. The development stage produces web-based media that contains artificial intelligence materials, practice questions, and LMS-based recommendation features. Furthermore, the media is tested through expert validation, practicality tests, and effectiveness tests to ensure its quality before being applied to students.

The results of this development are in line with national research by Yuliantari et al., (2023), Fikri & Edidas (2023), and Ferdiansyah et al., (2021), which found that ADDIE, 4D and R&D development models are effective in producing interactive learning media that is ready to be used in learning vocational. Internationally, research Yu et al.,

(2025) and Mohammed Rida et al., (2026) also shows that the use of systematic development flows is based on Instructional design Improve the quality of the media web-based learning. These findings confirm that the media development process carried out by researchers has followed international development standards and is able to produce high-quality media in the field of engineering.

## 2. Media Expert Validation Results

Validity is carried out in the first stage of the development process. Validation is assessed directly by material and media (design) experts. Validation is said to be high if the results can be used appropriately and can provide the desired results. This means that the desired results in the media can be a reference material in learning and improve student learning outcomes. Media is said to be valid if it has gone through several stages such as validation by experts (Hutabri, 2022). The results of this study were declared valid by the material validator, because it contained material that was in accordance with the learning outcomes described in the course learning achievement indicators. According to Irma, (2022) The media has met the content qualifications if it includes suitability with the curriculum, scientific structure, actuality and breadth of the material. In the preparation of materials, this media refers to the learning outcomes that have been set in the curriculum.

The results of the study were declared valid by the media validator (design) because the learning media developed was considered to have met the media quality elements. The Ministry of Public Works and Public Housing states that to produce learning media that is able to function and play its role in learning, media needs to be designed and developed by paying attention to several elements that require it, namely format (columns, paper and icons), organization, appeal (cover, content, and tasks that are arranged as attractive as possible), shape and font size (selection of easy-to-read letters, proportional letter comparison, accuracy in the use of letters), space (use of spaces, borders, spacing between columns, alternations between paragraphs and chapters) and consistency. In designing the appearance of the product, the media is adjusted to an attractive appearance and related to the teaching material presented. This is evidenced by the results of validation from media experts (design).

## 3. Practicality Test Results

The practicality test was carried out through two stages, namely small groups, and large groups. The purpose of the practicality test is to determine the level of ease of use of navigation, display and graphics, technical quality, and usefulness. The results of the trial showed that students gave a very positive response to the media. In the individual trial, the average score reached 80% who were in the feasible category. In small groups, the practicality score increased to 92.63%, indicating that the media can be used well in group learning. Meanwhile, in the large group, the assessment increased significantly to 89.97%, which is included in the very feasible category. The increase in scores from each stage shows that the media is easier to understand, has clear navigation, and is able to attract students' interest in learning independently. These findings are in line with national research by Dewi et al., (2025) which shows a level of practicality of 83% on computer network learning media, research by Pratama & Hambali (2020) with a practicality value of 85% on basic electronic media, and a study by Wahyuni (2021) which reported 88% on web-based learning media. At the international level, studies by Latha et al., (2022) and Migunani (2026) It also reports that web-based interactive media is considered very practical because it is flexible to access, easy to navigate, and supports self-learning. Thus, the practicality test in this study is consistent with other studies and shows that the developed media is very feasible to use in vocational education.

## 4. Effectiveness Test Results

The effectiveness test in this study was carried out using two methods, namely the learning effectiveness questionnaire and the learning outcome test through pretest and posttest. These two methods are used to provide a more comprehensive picture of the extent to which artificial intelligence interactive learning media is able to improve student understanding and learning performance.

### a. Effectiveness Based on Student Response Questionnaire

The effectiveness questionnaire was given in two stages: small groups, and large groups. The results of the questionnaire showed an effectiveness value of 92.63%, and 89.97%, all of which were in the very effective category. This shows that understanding is still in the category of very effective, skills in the use of navigation and student learning motivation. Nationally, these results are consistent with research Migunani (2026) that reported the effectiveness of interactive media in the range of 80-90%, research Ferdiansyah et al., (2021) in electronic materials that showed an effectiveness of 82%, as well as research Yuliantari et al., (2023) which obtained 85% effectiveness in mobile learning-based media. At the international level, research by Liang & Chou (2025) and Oramah (2023) It also concluded that web-based interactive media and simulative visualization significantly improved motivation and learning outcomes. Thus, the effectiveness questionnaire in this study reflects consistent results nationally and globally.

b. Effectiveness Based on Pretest and Posttest Results

The results of the pretest-posttest analysis using paired sample t-test showed a significance value of  $0.000 < 0.05$ , which means that there was a significant increase in learning outcomes in the experimental class after the use of media. Improvements are seen in the basic understanding of artificial intelligence, the ability to read and create ladder diagrams, and the analysis of control logic. Compared to the control class, the increase in the experimental class was much greater, so the media proved to have a strong positive impact.

The results of this study are in line with national findings reported by [Kartika et al., \(2024\)](#) through a meta-analysis that shows that the use of interactive media in engineering learning has effect size tall ones. In addition, research conducted by [Safitri & Sukardi \(2025\)](#) and [Rahma et al., \(2025\)](#) It also indicates a significant increase in learning outcomes based on pretest-posttest tests. At the international level, the study [Yi et al., \(2025\)](#) It also strengthens that the use of web-based simulations and interactive technology is effective in improving understanding of engineering concepts and control logic. Thus, the findings in this study are consistent with the results of previous research, both on a national and international scale, and confirm that interactive media has high effectiveness in the context of engineering and vocational education.

In general, the results of the study show that the development of web-based interactive learning media in the Artificial Intelligence course has succeeded in reaching the category of valid, practical, and effective. However, if analyzed more critically, the success is not only influenced by the use of a structured development model, but also by the suitability of the media with the characteristics of Artificial Intelligence material which is abstract and requires systematic visualization. These findings reinforce the assumption that interactive multimedia-based learning is more suitable for materials that demand conceptual and simulative understanding than conventional presentation-based learning.

From the aspect of validity, the results of the study show that the media is considered very valid by material experts and media experts. Nonetheless, the high validity not only indicates the feasibility of the content and display, but also indicates that the medium has met the standards of good learning design. Theoretically, this supports the principle of instructional design that emphasizes the suitability between objectives, materials, and learning media. However, it should be noted that validity is a subjective assessment from experts so that it still has limitations in representing real effectiveness in the field.

In terms of practicality, the results show that the media is in the category of very practical based on student responses. However, critically it can be seen that the high level of practicality is also influenced by the novelty effect, namely the initial interest of students in the use of new web-based media. Therefore, practicality should not only be understood as ease of use, but also need to be tested over a longer period of use to see the consistency of the student's learning experience.

Furthermore, in the effectiveness test, the results of the pretest and posttest showed a significant improvement in the experimental class compared to the control class. However, analytically, the increase is not only caused by learning media, but can also be influenced by other factors such as student learning motivation, digital readiness, and differences in class characteristics. Therefore, even if it is statistically significant ( $p < 0.05$ ), the interpretation of the results still needs to consider confounding variables that are not fully controlled in the quasi-experimental design.

If reviewed from previous studies, this study is indeed in line with various findings that show the effectiveness of web-based media and LMS in improving learning outcomes. However, some of the references used are still general and not completely specific to the context of Artificial Intelligence. This shows that the contribution of this research lies more in the context of implementation in AI learning at the university level, rather than in the development of new theories. Thus, theoretically, this research strengthens the concept of technology-enhanced learning, while practically providing an alternative learning media that can be used in computational and algorithm-based courses.

The limitation of this study lies in the quasi-experimental design that does not use randomization, so that the generalization of results is still limited to the context of the research subject. In addition, the measurement of effectiveness is still dominated by cognitive aspects through pretest and posttest, so it has not fully evaluated the affective aspects and long-term skills of students. Another limitation is that there has not been a long-term implementation test to see the sustainability of the use of media in Artificial Intelligence learning.

## CONCLUSION

Based on the results of research and development that has been conducted, it can be concluded that web-based Artificial Intelligence learning media developed through the integration of 4D, ADDIE, and Borg and Gall models produces learning products that meet the criteria of being very valid, very practical, and empirically effective. The main scientific contribution of this research lies in the development of a structured and integrated web-based learning model for Artificial Intelligence courses in higher education, which not only provides interactive learning media, but also

accommodates the need for visualization of abstract concepts such as machine learning and artificial neural networks in a single LMS-based system.

Measurably, the level of media validity is in the very high category based on the assessment of material experts and media experts which includes aspects of content, language, presentation, and technical feasibility. The practicality of media is also in the very high category based on the responses of students and lecturers who show ease of use, clarity of navigation, and benefits in supporting independent learning. In terms of effectiveness, the results of the pretest-posttest showed a significant increase in learning outcomes in the experimental class with a significance value of  $< 0.05$ , as well as a higher N-Gain value than the control class, which indicates that the developed media is able to improve students' conceptual understanding more optimally.

Based on these findings, this research provides a practical contribution in the form of a web-based learning media model that can be implemented in computational and algorithm-based courses, especially Artificial Intelligence, and can be used as an alternative to learning innovations in higher education. In addition, theoretically, this research strengthens the technology-enhanced learning approach that emphasizes the importance of digital media integration in improving the quality of learning in the era of digital transformation.

The recommendation of this study is that lecturers and educational institutions can adopt web-based learning media as part of blended learning strategies to increase student independence and engagement. Further research is recommended to develop media with a wider scope of material, integrate adaptive learning system features, and test its effectiveness in various contexts of different courses and levels of education.

However, this study has limitations, including the use of quasi-experimental designs without full randomization that can affect the external validity of the research results. In addition, effectiveness measurement still focuses on cognitive aspects through pretest and posttest, so it has not fully evaluated the affective and psychomotor aspects of students. This study has also not conducted a long-term (longitudinal) test to see the sustainability impact of media use in the learning process. Therefore, the results of this study need to be interpreted within the limits of the research context that has been determined.

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**\*Khofifah Al Mukarramah (Corresponding Author)**

Universitas Negeri Makassar,

Jl. Bonto Langkasa, Kampus UNM Gunungsari Baru, Makassar – 90222, Indonesia

Email: [khffhalmkrrmh.hr@gmail.com](mailto:khffhalmkrrmh.hr@gmail.com)

**Udin Sidik Sidin**

Universitas Negeri Makassar,

Jl. Bonto Langkasa, Kampus UNM Gunungsari Baru, Makassar – 90222, Indonesia

Email: [udin.sidik.sidin@unm.ac.id](mailto:udin.sidik.sidin@unm.ac.id)

**Sanatang**

Universitas Negeri Makassar,

Jl. Bonto Langkasa, Kampus UNM Gunungsari Baru, Makassar – 90222, Indonesia

Email: [sanatang@unm.ac.id](mailto:sanatang@unm.ac.id)

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