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DESIGN OF MATLAB-BASED LEARNING SIMULATION MEDIA FOR SOIL FERTILITY DETECTION

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Abstract:
This research aims to design MATLAB-based learning simulation media for soil fertility detection. Soil fertility is an essential factor in modern agriculture that affects crop productivity and success. However, accurately and efficiently detecting soil fertility can be complicated and time-consuming. Therefore, developing effective learning simulation media can help farmers and researchers understand and test various soil fertility detection methods. In this research, learning simulation media was created using the MATLAB programming environment. The media was designed to give users practical experience understanding and applying soil fertility detection methods. The simulation engages users in the steps of soil fertility detection, including soil sampling, laboratory analysis, and interpretation of results. The results of this study indicate that this MATLAB-based learning simulation media is effective in helping users understand soil fertility detection concepts and techniques. Using this media, users can test and compare various soil fertility detection methods quickly and efficiently. This simulation tool is expected to contribute to improved understanding and practical application in soil fertility detection, which in turn can enhance agricultural productivity and crop success.

Keywords: Simulation_Media; modern_agriculture; MATLAB

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INTRODUCTION

Soil fertility is essential in agriculture as it affects crop productivity(Jat et al., 2024). Efficient determination of soil fertility levels can help farmers optimize resource use and increase crop yields. Traditional methods can be time-consuming and costly. However, there are more efficient methods to determine soil fertility, such as soil analysis and laboratory tests to determine the nutrient content and pH of the soil. Use of Sensors: Advanced sensors can detect soil fertility quickly and accurately (Archbold, Parra, Carrillo, & Mouazen, 2023). Computer Modelling: Computer models can predict soil fertility based on historical data and current conditions. In recent decades, computer technology and software advances have opened up new opportunities in education and simulation (Okoye et al., 2024).
Software-based computer learning simulations such as MATLAB have effectively supported learning and problem-solving processes in various fields, including

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agriculture.(Tian, Wang, Liu, & Qiao, 2020) This research aims to design MATLAB-based learning simulation media for soil fertility detection. The simulation media was created to provide learners with practical experience in understanding and applying soil fertility detection methods quickly and efficiently (OECD, 2019). The simulation tool will allow users to change parameters and perform experimental variations to study their impact on soil fertility detection results. In addition, it will provide graphical visualizations and results in reports that can assist users in understanding and analyzing the data generated.

Simulation media is a powerful cognitive tool that provides a learning experience. Simulation has an experiential and reflective process, where the experiential process occurs when someone gets an experience like reality, and the reflective process occurs when the simulator becomes one of the ways to overcome high-value or expensive actions in the real world (Rahmaniar, Agus Junaidi, 2022). Simulation is an essential tool that can shape how we communicate and solve problems. In computer-based learning, any system can be simulated if its attributes can be represented in an algorithmic model (Rahmaniar, Khairul, Agus Junaidi, 2023).

Cognitive transactions occur in the learning process where there is a change of information received by learners into knowledge; this condition can strengthen the theory in research in the field of artificial intelligence, where simulation capabilities obtained from the cognitive process of learners are an approach to information management. The development of application technology continues to grow in the industrial world, such as the use of Artificial Intelligence (AI); in other words, it can be mentioned as artificial intelligence application technology, where computer behavior can imitate decision-making activities by going through a process in accordance with human behavior. Artificial Intelligence has several branches of application, one of which is fuzzy logic. Fuzzy is an application with input and output processes where this process has no certainty, so using fuzzy logic can overcome that decision-making in this uncertainty. Artificial intelligence in education is the development of computational learning designed as a learning medium so that learners have valuable experiences that align with real-life experiences in the field with cognitive sites—personified modeling by harmonizing learners' skill levels with learner-centered learning methods. MATLAB (Matrix Laboratory) is an application with several blocks that function to analyze, design, and simulate fuzzy logic systems by configuring inputs and outputs with type 1 and 2 fuzzy inference system rules. Fuzzy inference systems can evaluate fuzzy logic systems that can be designed in MATLAB and Simulink; fuzzy systems are supporting systems for AI-based black-box models and can generate self-executable data with IEC 61131-1 structured text in the evaluation and implementation of fuzzy systems as seen in figure 1:

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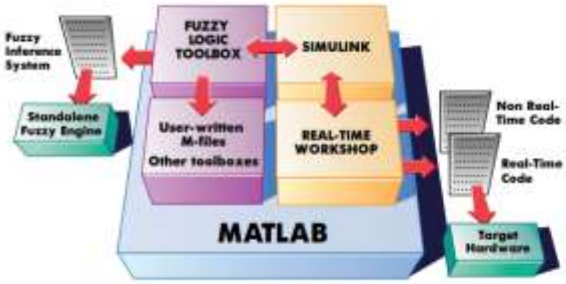

Figure 1. Fuzzy Logic Toolbox (Gulley, 1997)

Integration in MATLAB adapts to users' needs in designing tools by combining the fuzzy Logic Toolbox with other toolboxes. The Fuzzy Logic Toolbox can be adjusted by determining and configuring inputs, outputs, membership functions, and system rules. Evaluation of the logic system can be done on Simulink. The fuzzy inference system is a support system categorized as AI-based modeling (Moreno-cabezali, 2020).

METHOD

Research and development was used as a method. Stages passed, such as development design, design testing, validation testing of development media (Brown, 2023).

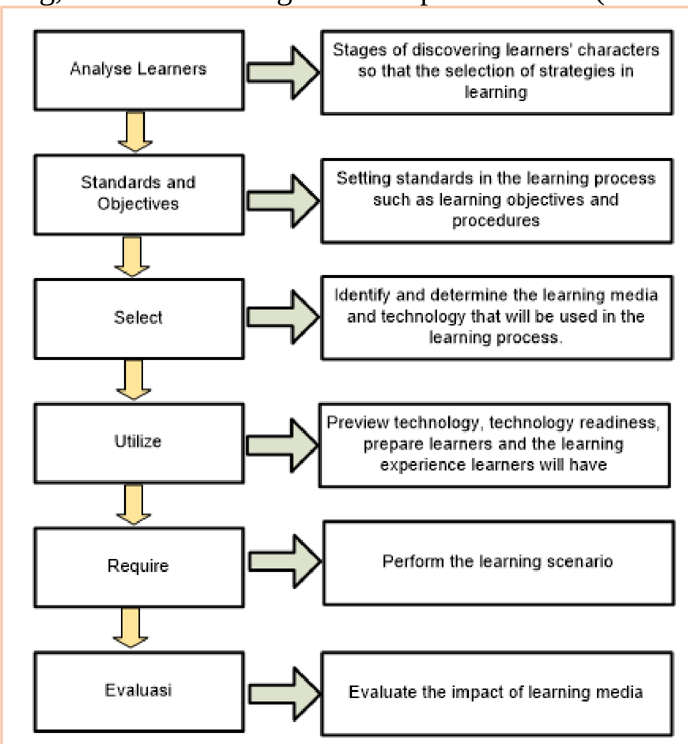

Figure 2.Steps to achieve a successful learning process

Data collection includes identifying and selecting soil samples for testing from various locations, soil types, and agricultural situations, sampling using established methodologies, and quadrants with balanced volumes. Data collected in the laboratory include soil parameters, pH, and moisture to develop soil fertility status. The development of simulation media starts with planning the user interface and user response to MATLAB

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simulation designing algorithms and mathematical modeling underlying the simulation when detecting soil fertility and then implementing algorithms and models in Fuzzy logic simulation media, with predetermined usage procedures by considering the average absolute error.

The research data collection uses three types, namely, data collection from the results of field observations. Students will go directly to the field to obtain data on the fertility of four soil types and conduct tests in the agricultural laboratory at Pembangunan Panca Budi University. Data collection from the results of interviews and data collection through questionnaires was carried out by involving two learning and simulation media experts and two material experts, including electrical engineering lecturers and agrotechnology lecturers. Interviews on the results of using simulation media were conducted with electrical engineering students in the power system application course. Data is collected to determine the results of using technology and learning media.

RESULT AND DISCUSSION

This research produces learning products in the form of simulation media using MATLAB using Fuzzy logic, as shown in Figure 2 below.

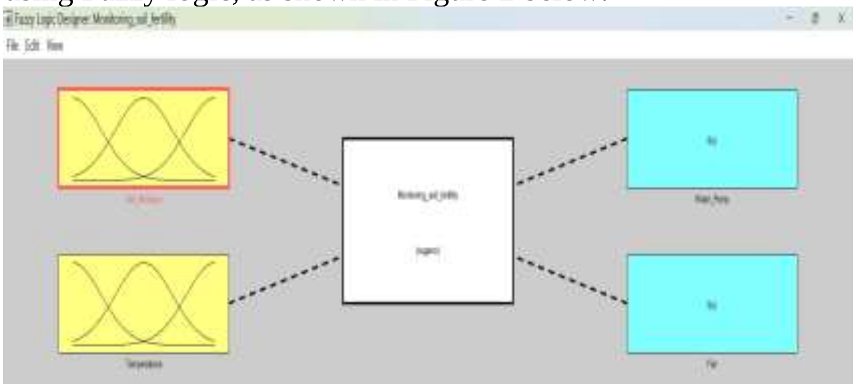

Figure 3. Simulation design using fuzzy logic

The simulation media designed using fuzzy logic has two outputs. Both outputs show the value of the time duration needed to maintain soil fertility with soil moisture and temperature parameters. The fuzzy settings can be seen in the following figure 4:

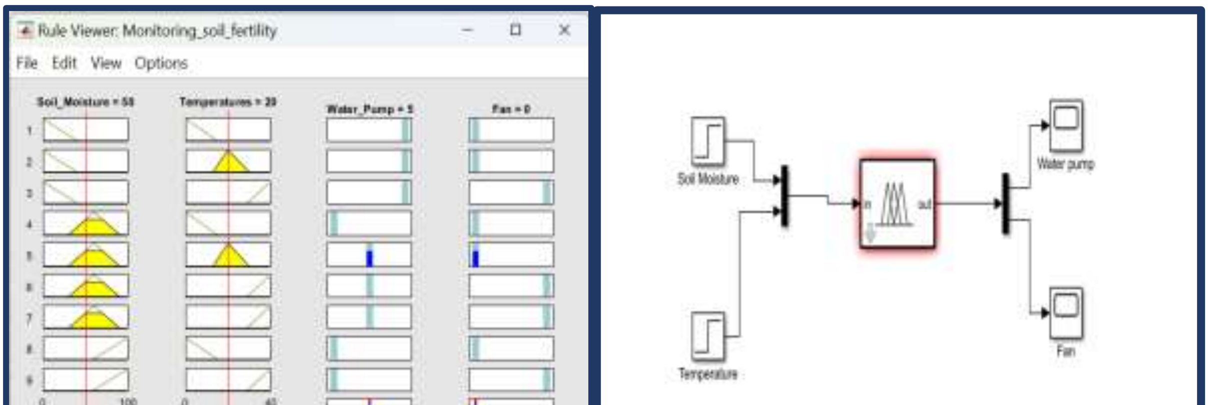

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Figure 4. Fuzzy settings of soil fertility monitoring

Fuzzy settings in the form of graphs are designed based on input, process, and output rules where inputs are selected soil conditions, namely, dry soil, moist soil, and wet soil; soil conditions are presented with hot, average, and cold conditions. The soil fertility scenario using fuzzy logic has nine rules that are inputted as actual conditions, with a success rate of 90%.

The development of simulation learning media using MATLAB has been tested on the practicality of simulation media using four validators consisting of two electrical engineering lecturers and two agrotechnology lecturers; the results of the simulation media practicality test can be seen in Figure 5 below:

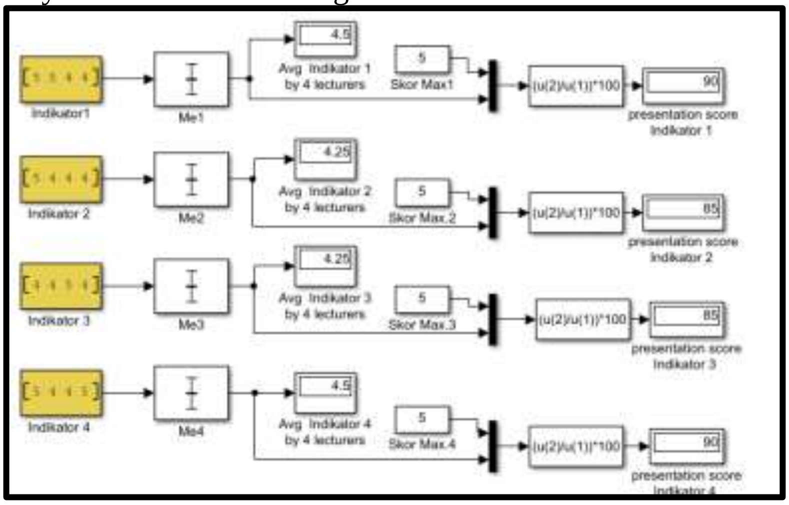

Figure 5 Practicality of Simulation Media

Analyzing the practicality test of simulation media is modeled using simulation. Practicality results were obtained with efficient indicators with a percentage value of indicator 1 of 90%; indicator 2 was worth 85%; indicator three was declared practical with a presentation value of 80%; and indicator 4 had a value of 85%. The average obtained from the practicality value is 85%.

From the pre-test and post-test scores of each student in the limited class trial, the difference between the pre-test and post-test scores can be seen in Figure 6.

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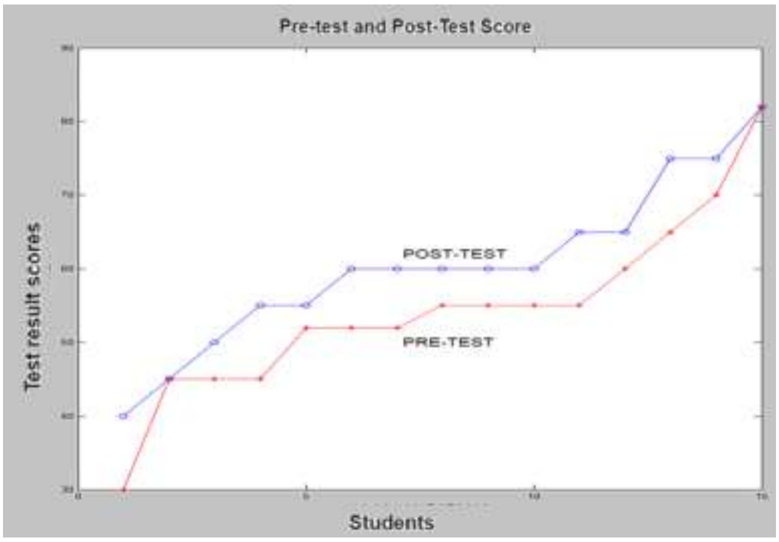

Figure 6. Characteristics of Pre-test and Post-Test Score

Figure 6 shows the difference in pretest and posttest scores in computer application courses, so it can be concluded that using simulation media can improve learning outcomes and have a good influence. The difference in pretest and posttest scores has a class average difference 5.99 with increasing characteristics.

CONCLUSION

Validation of computer application learning media was carried out by calling four lecturers in the field of study consisting of two electrical engineering lecturers and two agrotechnology lecturers, with validity results averaging 85% (very feasible). The use of simulation media results in an increase in student learning motivation to improve learning outcomes with a comparative value of 5.99. From both the validation results and the characteristic value of student learning outcomes, it can be concluded that the use of simulation media in learning in the electrical engineering study program is practical and very feasible use.

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