Design and Development of an Android-Based Application for Hydroponic Introduction and Learning Media

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ABSTRACT
Learning media will make it easier for people to learn hydroponic vegetable planting material compared to books because there are visualizations of images and videos so that it will be understood more quickly than just reading. Android is one of the open-source programming languages that allows makers to modify and distribute the results of making applications freely and freely. Developing learning media for hydroponic vegetable planting using Android will make it easier for readers because this application can be used anywhere without carrying more weight than books. In this learning media to be built, the advantages of this application are the visualization of attractive graphics, and simple decision support features related to the implementation of hydroponic farming, which includes capital and available land, as well as suitable plant species. The application has been successfully made, and based on the test results, it can be concluded that it can be appropriately used and produce results according to the design. The suggestions from this research are related to the application's appearance, which can still be developed to be more attractive.

Keywords : Android, Hydroponics, Learning Media.

INTRODUCTION

The trend of growing vegetables in urban areas is skyrocketing among urbanites. This vegetable-growing activity for urban communities is used to channel hobbies and as a source of income. In urban areas, vegetable farming often faces a significant obstacle: the limited land available for farming. This is due to the high level of urbanization that causes land conversion into settlements, offices, and other infrastructure, resulting in less green open space. As a result, urban communities must find alternative farming methods that are more efficient and adaptive to limited environmental conditions (Giyarsih, et al., 2023). hydroponic cultivation, aka planting without soil. Hydroponics is a planting method that utilizes a small area of land and grows without needing soil as a growing medium (Rajalakshmi, Manoj, & Manoj, 2022).

Learning media is any material, tool, or method used in the learning process to support the effectiveness of educational interactions between educators and students. The use of this media aims to improve the efficiency and quality of learning so that the process of delivering material can take place optimally per the educational objectives set (Kanthed, Soni, Dive, & Sharma, 2024). The utilization of learning media in learning hydroponic vegetable growing techniques can improve understanding compared to the use of conventional textbooks. This is

due to the visualization in the form of images and videos that allow the presentation of information more concretely and interactively. Thus, the cognitive process of understanding hydroponic concepts becomes more effective than text-based learning methods alone. Android is an open-source programming language that allows creators to modify and distribute the results of making applications freely and freely (Fukawa, Zhang, & Erevelles, 2021).

The development of Android-based learning media for hydroponic vegetable growing can increase ease of access for users. This application allows for more flexible learning as it can be used in various locations without additional devices such as physical books. In addition, using digital technology in learning also contributes to increasing efficiency and convenience in obtaining information interactively (Buhari & Sari, 2022). Some research on the theme of android learning media has existed but tends only to include material on how to grow hydroponics, videos on how to grow crops, and quizzes (Kurnialensya, 2019) (Novianto, 2018), while the advantages of the application of this research are the visualization of attractive graphics and simple decision support features related to the implementation of hydroponic farming which includes capital and available land, as well as suitable plant types. This research aims to build a learning media application about hydroponics. This application is expected to attract users' attention in hydroponic farming through smartphone facilities

METHODS

The research methodology applied results from combining and adapting various commonly used software development methods. This approach ensures that the research process follows systematic and structured principles to obtain optimal results and can be implemented effectively. This research begins with a literature study to collect and expand insights into hydroponic-themed mobile applications. The next stage is needs analysis, where various aspects required to develop hydroponic learning applications are identified. After the needs are defined, the application design process is carried out based on the results of the previous analysis. The next stage includes the application's implementation and testing, primarily focusing on functionality testing to ensure the application operates according to the designed specifications. The final stage of this research is evaluating and analyzing the developed and tested application to assess its effectiveness and quality of use. Figure 1 presents the stages of the research to be conducted.

Figure 1. Research Methodology

The literature study stage is to conduct a literature study to obtain theories about learning, especially around the field of hydroponics, as well as simple observations of farming activities using the hydroponic method.

To develop a practical hydroponic learning media application, an in-depth understanding of the problems and characteristics related to hydroponic activities is required. This process is carried out at the needs analysis stage, where data is collected to identify and determine the

profile of potential application users. In addition, interviews with hydroponic practitioners were conducted to gain a more comprehensive insight into the needs and challenges in hydroponic practice so that the application developed could better suit users' needs.

The design stage in this research adopts the Rapid Application Development (RAD) method, which is an object-based approach to system development. The RAD method accelerates application development by emphasizing rapid iteration and collaboration between developers and users. This approach is designed to shorten the processing time and ensure that the implementation of software systems can be carried out efficiently and appropriately in a shorter time (Ikwunne, et al., 2021). This method emphasizes active user participation in the analysis and design process, thus enabling the development of systems more in line with user needs. With this approach, the resulting system can be more optimal in meeting user expectations, which ultimately contributes to increasing satisfaction in using the system.

Figure 2. RAD Method

Explanation of the steps of the RAD method:

1. Planning

   The design stage in the Rapid Application Development (RAD) method begins with the identification of the project requirements and the determination of its scope. At this stage, the main goal is to ensure that the project has a clear direction with a well-defined scope. Activities include identifying the needs of farmers such as monitoring pH, temperature, and humidity, determining the main features, selecting the mobile application technology to be applied, estimating the time and cost of making the application. This stage is an important foundation for the next development process, because the decisions made will affect the smoothness and success of the project as a whole (Carrillo, et al., 2022).

2. User Design

   The User Design stage in the Rapid Application Development (RAD) method involves end users directly in the system design process through an iterative approach and prototyping. At this stage, developers create an initial prototype based on the requirements that have been collected, then test and refine it by considering feedback from users. Create a mockup of the application, test it with farmers, such as inputs for example, button size, indicator color, and then refine the design and flow of use (Pinem, et al., 2020).

3. Construction

   The Construction phase in the Rapid Application Development (RAD) method is the phase where the development team starts building the application based on the previously agreed prototype. At this stage, the coding process is carried out to develop the main features of the application, ensuring that the system can function according to the needs that have been designed. Creating application modules to read input from users, setting up knowledge bases and databases, testing each feature e.g. notifications,

integrating with databases, and fixing bugs found (Gomero-Fanny, Bengy, & Andrade-Arenas, 2021).

4. Implementation

   The Implementation stage in the Rapid Application Development (RAD) method is the final stage where the system that has been developed is applied to the production environment. Before the system is actually used, final testing is carried out to ensure that all features function properly and according to user needs. Test the application by users, especially hydroponic farmers, training farmers on how to operationally use the application, monitor the use of fix problems that arise at the beginning (Daraghmi & Daraghmi, 2022).

The design stage in this research includes several steps that serve as a model or system design of the application being developed. This design process includes modeling system flow or data flow represented through use case diagrams, flowchart design, user interface design, and the development of visual elements used in the application. This stage aims to ensure that the system developed has a clear structure and can be implemented effectively.

After the design stage is complete, the next step is to implement the program code in accordance with the design created in the previous stage. After the program code implementation, the application will be tested against potential users to evaluate its functionality and suitability to the predetermined needs.

To ensure functionality and improve the quality of the application, a series of tests were conducted covering various aspects, ranging from the suitability of the user interface flow to how the application is used. This test uses the black-box testing method, which does not consider the system's or component's internal mechanism but focuses on the output generated based on the response to the given input and execution conditions. In this research, black-box testing is applied with a system testing approach conducted on the entire system to evaluate the suitability of its functionality with predetermined specifications.

RESULTS

In this design stage, a design is made for how users can use this hydroponic learning application. In general, users will be able to use this application for hydroponic farming activities. Then, users can calculate the nutrients and land area needed along with the types of plants that are suitable, and finally, users can find out how to maintain hydroponic farming. The design is also carried out on the application interface. The results of the design can be seen in Table 1 and Figure 3.

Table 1. Fittur Design

No	Features	Description
1.	Nutrient Calculator	Contains information about the amount of nutrients needed based on input from users
2.	Plant Types	Contains information about what hydroponic plants can be cultivated
3.	Care Methods	Contains information about how to care for hydroponic plants as well as how to care for the hydroponic media used

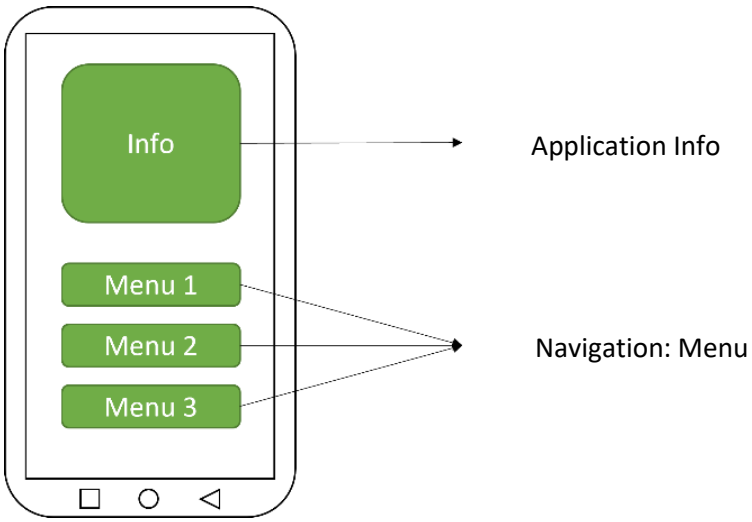

Figure 3. App Interface Design

This hydroponic application was made using the MIT appinventor tool. After going through the design stage, the application was made in accordance with the design. This application, which is basically an application that contains information, takes sources about hydroponics, both from the Internet and literature books. The results of making the application can be seen in Figure 4.

Testing using Blackbox focuses on the functional specifications of the software, where the functions that have been available in the application will be run, and it can be known whether or not it can display the appropriate results. The hydroponic application used as the primary function is on 3 features: the nutrition calculator, the type of plant, and how to care.

Figure 4. App view

Table 2. Black Box Results

Tested Modules	Testing Procedure	Enter	Expected Output	Results Obtained	Conclusion
Nutrient Calculator	Calculating nutrients	Nutrient Amount, Crop Type, Land Area, and more	Displays the results of nutrient calculations	Correct nutrient calculation results	Successful
Plant Types	Choosing a	Click on the	Displays	Plant types	Successful

	plant name	available options	appropriate plant types	displayed accordingly	
Maintenance Method	Choosing a care method	Choose a treatment method	Displays appropriate maintenance information	Maintenance information displayed accordingly	Successful

The blackbox test results presented in table 2, which test for all three features, are successful, indicating that the application can function properly.
In addition to the function test, a usability test was also conducted which took 20 farmers as respondents.

Table 3. Results of Usability Test Recapitulation 20 Respondents

No.	Statement	Average Score (1-5)
1	The app is easy to install and run.	4,6
2	Attractive and pleasing to the eye.	4,2
3	Information is clear and easy to understand.	4,4
4	Navigation between menus is easy to use.	4,3
5	Nutrient calculator is useful.	4,5
6	Plant type list is quite complete.	4,1
7	Maintenance information is easy to follow.	4,3
8	Helps to understand the concept of hydroponics.	4,6
9	Helps in making farming decisions.	4,4
10	Overall satisfied using the app.	4,5

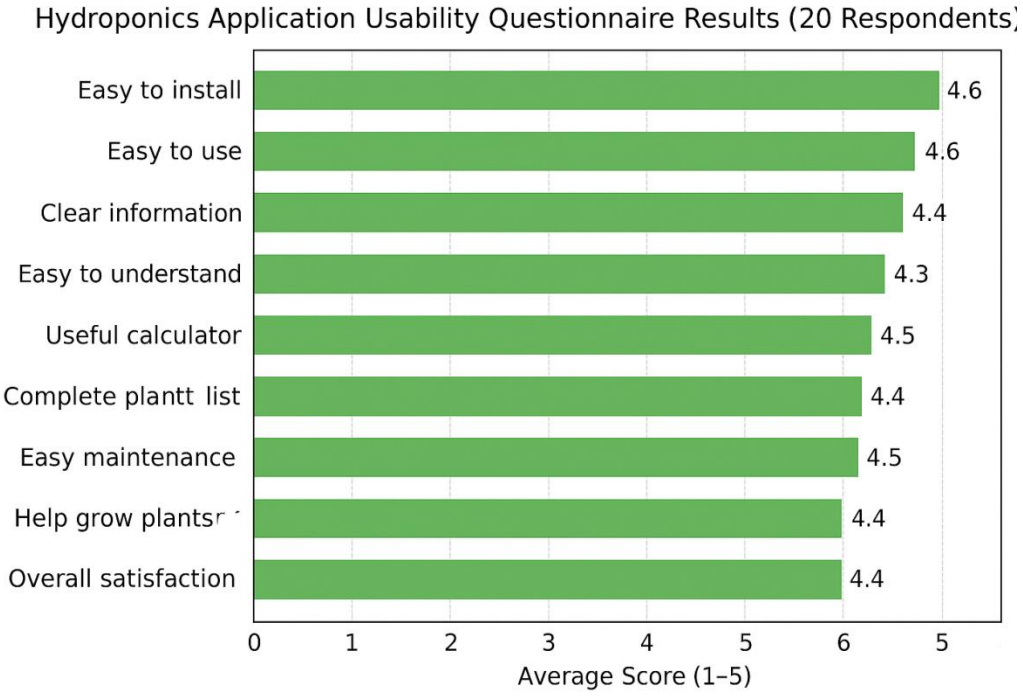

Figure 5. Bar Graph of Usability Test Questionnaire Results

CONCLUSION

The Android-based hydroponic learning media application developed in this research supports the learning process and practice of hydroponic farming, especially for beginners and urban communities with limited land. This application not only presents information in text but also includes interactive features such as a nutrition calculator, plant type recommendations, and maintenance guidelines, making it easier for users to make practical decisions in the field. The test results show that the application can function as designed, provide accurate output, and make it easier for users to independently understand the concept and practice of hydroponics. With graphical visualization and decision support features, this application acts as an educational tool and a companion for farming practices that are easily accessible through mobile devices.

Some suggestions related to this research are adding video tutorials, step-by-step animations, or interactive simulations to help users understand the hydroponic process in more depth and developing integration with pH, temperature, and humidity sensors for real-time condition monitoring so that the application not only provides recommendations but can also be a hydroponic garden control tool.

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