

Development of RWikiStat 4.0: A Multiplatform Application for Learning Basic Statistics Using the Rapid Application Development Method

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Abstract—RWikiStat is a multiplatform application developed to support the learning process of basic statistics in a more interactive and applicable way. This application is designed to help students understand statistical concepts through structured materials, practice questions, and data visualization. RWikiStat was developed using the Rapid Application Development (RAD) method which consists of four stages: Planning, User Design, Construction, and Cutover.

The test results show that RWikiStat successfully meets the functional needs of users and provides a good user experience, with a user satisfaction level of 88.26%. Testing was carried out through functional testing and usability testing to ensure that all features function properly and the system interface is easy to use. RWikiStat supports an active learning process, where users not only read the material, but also directly test their understanding through the available exercises. This application has great potential as an effective learning medium in higher education environments.

Index Terms—RWikiStat 4.0, Multiplatform application, Basic statistics, Interactive learning.

I. INTRODUCTION

In the practice of learning statistics, there are still several challenges faced by students. Starting from challenges that arise from themselves, lecturers, the environment, and facilities and infrastructure. According to Deci and Dewi [1], the facility and infrastructure factor is the most influential factor in the teaching and learning process. This is also in accordance with the statement of Wild and Pfannkuch [2] who define that the lack of teaching materials that can help students to practice and apply statistical thinking is the main problem in the practice of learning statistics. Traditional passive learning is considered less than optimal in describing the relationship between statistics and its applications in the real world. Various technologies can be utilized to assist in the learning process, such as the use of the web and mobile devices. Although various applications have been developed, many still have limitations in terms of interactivity, accessibility, and feature integration. Therefore, a solution was developed that can answer the problems in learning statistics by utilizing technology in the learning process. RWikiStat is present as a solution that combines learning modules, R compilers, chatbots, discussion forums, and customizable settings, offering a new approach to learning statistics that is more effective and efficient. RWikiStat is a statistics learning

application that is now available in website versions and mobile applications based on Android and iOS.

On the other hand, learning with the use of technology can help increase students' enthusiasm for learning, such as in Serina's research which explored the challenges in teaching statistics using Microsoft Excel as a teaching and learning tool. The statistics learning process that was carried out received a positive response and high enthusiasm from students. This illustrates the opportunity to integrate various other technologies in helping statistics learning [3]. Research conducted by Wilson using flipped classrooms and interactive class activities has also been shown to increase students' interest in learning statistics. This can happen because they can see that there are resources available to help them when needed. From this study it was also found that students prefer learning accompanied by various practice questions and practical activities in learning statistics [4].

Along with the development of technology, various platforms can now be utilized to assist the learning process, such as the use of the web and mobile devices. The use of various technologies in the world of education can facilitate the achievement of teaching objectives and enrich learning by presenting them efficiently. Research conducted by Talan using the meta-analysis method shows that the use of mobile learning with good planning can have a positive impact and can improve student learning performance [5]. Realizing the high potential of using technology to help improve learning, a solution has been developed that can increase student interest in learning statistics. Although various applications have been developed, many still have limitations in terms of interactivity, accessibility, and feature integration.

RWikiStat is present as a solution that combines learning modules, R compilers, chat-bots, discussion forums, and customizable settings, thus offering a new approach to learning statistics that is more effective and efficient. RWikiStat is a statistics learning application that is now available in website versions and Android and iOS-based mobile applications. RWikiStat was first launched as an interactive platform for statistical learning in 2010 by integrating a wiki application [6]. Development continued with the launch of RWikiStat 2.0 which is open-source and developed in the Linux environment [7]. Then in 2019, the third version was developed in the form of an Android application with a more responsive and

easy-to-use interface [8]. This development was perfected in 2024 to optimize all existing features. This version was developed in a multiplatform form in the form of a website and mobile on the Android and iOS platforms. Development in the website version for the frontend side uses Next.js and Express.js for the backend side. While the mobile version uses a combination of React Native and Expo. This version is built with a more attractive appearance and has the function of presenting statistical theory from basic to advanced levels.

II. LITERATURE REVIEW

Our research explores the various uses of technology in improving the learning process, especially in statistics learning. Various studies have shown that the use of technology has a positive impact on teaching and learning aspects [9] [10] [11]. In general, there are various applications that facilitate learning without focusing on a particular field. Examples include Google Classroom which is innovative and effective in improving student performance [12] and Kahoot which can improve interaction between students and teachers [13].

Furthermore, there are various studies that apply the use of technology with a focus on the field of statistics. One of them is a study by Quiñones et al [14] who developed EstApp, a mobile-based application to improve understanding of statistical concepts by presenting artificial intelligence-based tutor features. Then there is a math app that was developed to teach statistics at the secondary education level. The application received positive feedback from users [15]. In addition, research conducted by Blackburn [16] using e-Learning can improve the level of understanding of students.

Unlike previous studies that generally only provide learning materials and concept visualizations, RWikiStat integrates active learning features such as AI-based chatbots, discussion forums in one application, learning modules, and compilers with Shiny integration. Shiny offers a variety of user interface (UI) functions that are carefully designed to generate the HTML, CSS, and JavaScript code needed in a command. Several studies have shown the effectiveness of using Shiny in statistics education. One of them is a study by González et al. who successfully integrated Shiny to facilitate student exploration of statistical concepts through an interactive interface [17].

To realize flexibility and cross-device accessibility, RWikiStat was developed using a combination of Next.js for the frontend, Express.js for the backend, and Expo React Native for the Android and iOS mobile versions. The selection of Expo was based on its advantages, namely an open-source framework that allows the development of mobile applications that are compatible across multiple platforms [18]. Expo provides various tools that simplify the process of developing, testing, and deploying applications to Android and iOS platforms efficiently.

III. METHODOLOGY

This study uses the Rapid Application Development (RAD) method which was chosen because it focuses on application development in a short time. This method is considered to be able to support the progress and acceleration of system implementation [19]. By using this method, users can check and evaluate the system from the early stages, so they can

determine whether the system is in accordance with their needs and suggest necessary changes [20]. RAD has 4 stages, namely requirement planning, user design, rapid construction, and implementation as can be seen in Figure 1.

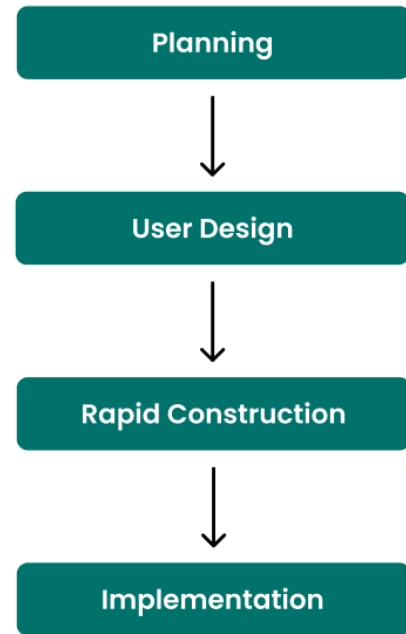


Fig. 1: Research Methodology Flow Diagram

1) Planning

In this stage, problem identification is carried out by discussing with stakeholders to determine the needs that are the basis for designing the system. These needs are the basis for designing and developing features in the application. From this process, a requirement specification is produced which includes the main features that must be present in the application. In addition, the target users for the system being developed are obtained, who are students of basic statistics courses.

In addition, at this stage, the tools to be used were also agreed upon. To develop a multiplatform application, several frameworks were used, starting from Next.js for the website version, a combination of Expo and React Native for the mobile version, and Express.js as the application backend. Next.js was chosen because it has static site generation and optimized builds result in faster page loads [21]. Because of the need for fast development with the same results on Android and iOS platforms, Expo React Native is the best answer by providing a native look and fast reload [22]. Then, to store all data so that it is well organized, Express.js was chosen to build the application backend because it allows fast and efficient development [23].

2) User Design

At the user design stage, an application prototype design is carried out based on the previous stage. The application design in the form of a user interface (UI) and prototype is created using the Figma tool. The prototype of this application will then be tested to evaluate its suitability to user desires. Then, all prototypes that have been tested will be adjusted again based on suggestions

given by the user. The final result of this stage is an application design that includes all pages, navigation, and logical flows that will be implemented for the next stage.

The design of the RWikiStat application can be seen in Figure 2 and Figure 3.



Fig. 2: RWikiStat Application Design

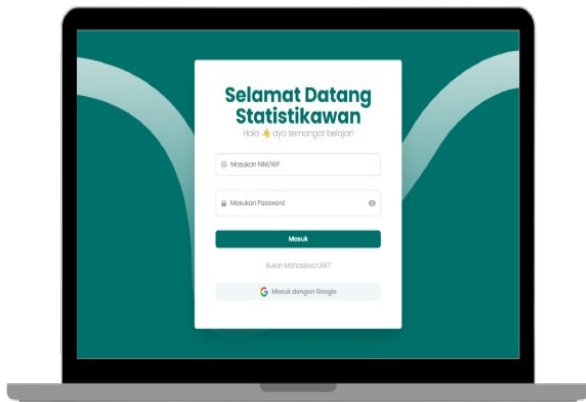


Fig. 3: RWikiStat Web Design

3) Rapid Construction

In the rapid construction stage, the previously designed system is built. The system is built using agreed languages and frameworks, starting from database development, frontend, and backend. Through this stage, the finalized design is transformed into a usable application. In this stage, feedback collection from users is also continuously carried out to ensure that the system built is in accordance with desires.

4) Implementation

At the implementation stage, a thorough test is carried out on the system to ensure that there are no errors when implementing the system that has been built. Researchers use two testing methods, namely testing the

system's functionality using black box testing to reduce the possibility of system defects and testing the system's usability using the Usability Metric for User Experience (UMUX) to measure the level of user satisfaction in using the system that has been built.

IV. RESULTS AND DISCUSSION

The statistics learning application, RWikiStat has been developed on all platforms starting from the website, Android and iOS with features that can help learning. RWikiStat provides a statistics learning module equipped with sample questions and code samples so that users can directly practice the statistical concepts that have been learned. In addition to trying the code samples available in each module, users can also access the compiler and try various statistical codes in the R language to strengthen their understanding. The compiler that has been equipped with Shiny integration allows users to try to visualize the desired statistical data. Furthermore, RWikiStat provides a discussion forum that can be used to ask or answer questions that are understood. Then there is also a chatbot feature so that users can ask about statistical problems without having to move to another platform.

To ensure that the system runs according to user desires, two testing processes are carried out, namely functionality testing and usability testing.

a. Functionality Testing

Functional testing is done using black box testing to test the application in various desired scenarios. This testing is done to see the functions in the system without requiring knowledge of how the system works internally [24]. This method provides several advantages, such as rapid test case development, efficient for large code segments, and reusable testing [25]. In this study, there were 27 test scenarios performed, with all scenarios running as expected. Some of the tests performed can be seen in Table I

TABLE I: Functional Testing Scenarios

No.	Testing Name	Scenario	Display	Result
1	Sign-in with student ID	Enter student ID and password, then press login button	Redirected to main page	Success
2	Sign-in with Google	Press 'Sign in with Google' and select account for login	Redirected to main page	Success
3	Sign-in with Apple ID	Press 'Sign in with Apple ID' and select account for login	Redirected to main page	Success
4	Access material tab	Click the "Material" icon	Redirected to material page	Success
5	Access compiler tab	Click the "Compiler" icon	Redirected to compiler page	Success
6	Access chatbot tab	Click the "Chatbot" icon	Redirected to chatbot page	Success
7	Access forum tab	Click the "Forum" icon	Redirected to forum page	Success
8	Access settings tab	Click the "Settings" icon	Redirected to settings page	Success
9	Select learning module	Select one of the module cards	Redirected to module + R compiler	Success

No.	Testing Name	Scenario	Display	Result
10	Execute R/Shiny code	Enter simple R/Shiny code to execute	Compilation result displayed	Success
11	Add question to forum	Fill topic, description, photo, then press 'Add Question'	New question is added	Success
12	Logout	Click logout icon on settings page	Redirected to sign-in page	Success

b. Usability Testing

Usability testing is done using the UMUX method to test whether the system can be understood and used by users. This method has several advantages, one of which is that this method is quite concise because it only consists of 4 questions, but still shows a high level of reliability and good validity [26]. Before conducting the test, an application test plan is first prepared which can be seen in Table II.

TABLE II: Test Plan Application

Test Plan Application
Scenario: - The user opens the application. - The user understands the appearance of the home page. - The user logs into the application. - The user accesses the learning modules. - The user reads the available learning modules. - The user downloads the available learning modules. - The user tries to compile R code. - The user tries to ask the chatbot a question. - The user tries to post a question in the discussion forum. - The user tries to answer a question in the discussion forum. - The user tries to save a post. - The user tries to like a post. - The user tries to view their post history. - The user tries to delete their own question. - The user tries to sign out of the application.
Tool: - iOS Smartphone

Respondents will run the application according to the test plan that has been made. Respondents for this test consisted of 22 students of basic statistics courses. After that, respondents were asked to fill out a questionnaire form with questions as shown in Table III.

TABLE III: UMUX QUESTION LIST [27]

No.	Question	Score
1	This application suits my needs.	1 - 7
2	I had a bad experience using this application.	1 - 7
3	This application is easy to use.	1 - 7
4	I have to spend a lot of time to use this application.	1 - 7

After testing using the UMUX method, the test result data is processed following these steps:

- Each odd-numbered item is calculated using the formula $[\text{user score} - 1]$, while even-numbered items are calculated using the formula $[7 - \text{user score}]$.
- The scores of each item filled in by the user are added up first, then divided by 24 (the maximum score value).

- The result of the division is multiplied by 100.
- Furthermore, the value is averaged for all users.
- The UMUX score obtained is assessed on a scale of 0-100, according to general assessment standards [28].

The results of the tests carried out using the UMUX method can be seen in Table IV.

TABLE IV: UMUX Testing and Evaluation Results for the RWikiStat Application

Respondent	Question Number				Final Score
	1	2	3	4	
Student 1	7	1	7	1	100
Student 2	4	1	7	1	87,5
Student 3	4	1	6	2	79,17
Student 4	7	1	7	3	91,67
Student 5	6	2	5	3	75
Student 6	7	1	7	1	100
Student 7	7	2	7	1	95,83
Student 8	7	1	7	1	100
Student 9	7	1	7	1	100
Student 10	7	2	6	2	87,5
Student 11	7	1	7	2	95,83
Student 12	7	2	5	2	83,33
Student 13	7	1	7	1	100
Student 14	5	1	7	5	75
Student 15	7	1	7	4	87,5
Student 16	7	1	7	1	100
Student 17	6	1	7	1	95,83
Student 18	5	1	7	1	91,67
Student 19	4	1	4	2	70,83
Student 20	6	2	6	6	66,67
Student 21	7	1	7	5	83,33
Student 22	6	1	6	4	75
Average					88.26

Based on the test results in Table IV, an average value of 88.26% was obtained. This shows that the RWikiStat application has an interpretation score of "Best Imaginable" with a grade of "A" using the UMUX calculation method.

V. CONCLUSIONS AND SUGGESTIONS

In this paper, we introduce an interactive statistics learning application, RWikiStat, to increase student interest in learning statistics. This application has features that can facilitate students in learning, such as the existence of learning modules equipped with sample questions along with sample codes for each material, allowing students to try it directly. There is also a discussion forum that can create interactive and interesting learning. Moreover, chatbot features and compiler features equipped with Shiny implementation to visualize data statistically are also available in this application. This allows users to understand statistical concepts in an interesting way. RWikiStat is also available for all platforms, which are websites, Android and iOS, thus expanding the scope of users who can use it. To ensure that all features run according to the plan, we have conducted functionality testing using the black box testing method. In this test, it was found that all features can run properly. In addition, usability testing was also carried

out to ensure that this application can be used easily by users. The results of this test found that the level of satisfaction of respondents who were students of introductory statistics courses was 88.26%, which indicates “Best Imaginable” with grade “A” using the UMUX calculation method.

In conclusion, RWikiStat application has proven to be user-friendly and has the potential to become a tool in the field of statistics. Further development for this application can be done by providing multi-language features and allowing offline access by users.

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