

Advancing Statistical Education with RWikiStat 4.0: A Comprehensive Multi-Platform Learning Application

Hizir Sofyan

Statistics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
hizir@usk.ac.id

Munawar

Statistics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
munawar@mhs.usk.ac.id

Muhammad Subianto

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
subianto@usk.ac.id

Kurnia Saputra*

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
kurnia.saputra@usk.ac.id

Naufal Mas Adha

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
naufal@mhs.usk.ac.id

Affan Ian Amara

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
affan@mhs.usk.ac.id

Muhammad Nurifai

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
nurifai@mhs.usk.ac.id

Akhyar

Informatics Department
Universitas Syiah Kuala
Banda Aceh, Indonesia 23111
akhyar1@mhs.usk.ac.id

Abstract—RWikiStat 4.0 is a multi-platform learning application designed to enhance the teaching and learning experience in statistical education. Building on the strengths of its predecessors, RWikiStat 4.0 addresses the limitations of accessibility, interactivity, and collaboration by introducing features such as Shiny-based interactive data visualization, discussion forums, AI-powered chatbot, and R language compilers. Developed for web, Android, and iOS platforms, this version ensures cross-device compatibility and improved user experience. Testing results demonstrate high usability and user satisfaction, highlighting its potential as a comprehensive and innovative tool for statistical education. This application empowers students and educators to engage in dynamic, flexible, and interactive learning, setting a new standard in the field of statistical education.

Index Terms—RWikiStat 4.0, Statistical Education, Multi-Platform Learning, Shiny Visualization, Interactive Learning.

I. INTRODUCTION

Statistics is a compulsory subject that many students consider difficult. Especially if the teaching method provided is too rigid and uninteresting. In recent decades, research in statistical learning has changed the structure of learning, namely by considering innovative pedagogical instruction, educational technology, and abundant Web resources [1]. In the GAISE guidelines, it is recommended that statistics teaching focus on projects, lab exercises, and group discussions rather than traditional lectures to improve students' understanding of the material [2]. One statistical learning system that implements this is RWikiStat.

RWikiStat is an example of a digital learning system that has had a positive impact in the field of education. This application has been developed in 3 versions, namely in 2010, 2012, and 2019. RWikiStat was initially developed in the form of a website in 2010 with the name Rweb to support users in inserting compiled R code to produce graphic or numerical output. Then, after being integrated with the wiki

application, this application was finally known as RWikiStat [3]. The second version of RWikiStat was developed on the Linux operating system and is open source. In this version, users can edit web content, access it offline without requiring prior installation, as well as develop Live DVDs to ensure the application remains safe [4]. In 2019, RWikiStat 3.0 was developed as an Android application [5].

However, all three versions of RWikiStat are still simple and have limitations, especially in terms of interface design and functionality. This application does not have an attractive and effective interface in presenting information, making it difficult for users to use and access various information. Poorly organized navigation makes it difficult for users to find features. Apart from that, the available features also cannot support dynamic learning. Real time collaboration features and discussion forums are not yet available to support learning. Then, there is no adaptive support, such as AI-based assistance to answer questions from users. This application also does not integrate features such as Shiny to visualize data in an attractive way for users.

To overcome these problems, this research aims to develop version 4.0 of the RWikiStat application to optimize previous versions. RWikiStat 4.0 was developed in a multi-platform form in the form of a website and mobile on the Android and iOS platforms with a more attractive appearance and has the function of presenting statistical theories from basic to advanced levels. RWikiStat 4.0 has several features, including features such as providing a statistics learning module, a compiler for the R language, discussion forums and chatbot features, as well as interactive graphic presentations with Shiny. The shiny package provides a collection of user interface (UI) functions that have been carefully selected and designed to generate the HTML, CSS, and JavaScript code required in commands. This step is expected to resolve problems existing in previous versions to improve user experience on various platforms.

*Corresponding Author

II. RELATED WORK

This research is a continuation of the development of the statistics learning application, RWikiStat, which was previously developed to version 3.0. The first version of RWikiStat was developed in 2010 under the name RWeb in the form of a website-based application. RWeb initially only focused on solving statistical problems using R alone to produce graphical or numerical output, then changed to RWikiStat after being integrated with wiki technology [3]. In 2012, this application was developed with the same function but on the Linux operating system using Live CD/DVD [4]. Both versions have several drawbacks such as a complicated interface, inefficient features, and lack of mobility. The next version of RWikiStat was developed as an Android application with a more responsive and easy-to-use interface [5]. However, these three versions still require improvement because they still have several shortcomings, such as still using Rweb (web interface for R statistical software) and Wiki media. Not yet using more modern interactive media.

One interactive media that can be used is Shiny. Shiny is a package in the R programming language that allows users to easily create rich and interactive website-based applications [6]. The Shiny package offers a variety of user interface (UI) functions that are carefully designed to generate the HTML, CSS, and JavaScript code needed in a command. In 2017, six Shiny web applications were developed for students in introductory statistics or data analysis classes at Humboldt-Universität zu Berlin. These applications cover topics such as cluster analysis, regression, and data visualization, and demonstrate technical implementation and iterative improvements. Evaluation of an application's usability plays an important role in its development, and future additions and improvements are also discussed [7]. Shiny was also integrated into research developed by Satyahadewi et al. This research succeeded in developing a web-based application using Shiny for inferential statistics, showing that this framework is effective in supporting the development of statistical learning applications [9]. Research conducted by González et al. also successfully integrated Shiny to facilitate students' exploration of statistical concepts through an interactive interface [9].

III. DESIGN AND IMPLEMENTATION

A. System Architecture

RWikiStat 4.0 is designed with a multi-platform architecture that allows access across a variety of devices, including web, Android, and iOS. For mobile application development, Expo React Native is used, while the web version uses Next.js as the frontend framework. Both platforms, both mobile and web, share the same backend, which was developed using Express to ensure data consistency and server management efficiency.

This application is built with a client-server architecture, where the client side, both on the web and mobile platforms, is responsible for handling user interaction and data presentation. The server side developed using Express is responsible for heavy tasks, such as statistical analysis and data processing, with extensive R library support. This architecture ensures applications are modular, scalable, and

easy to maintain, and allows for consistent updates across all platforms.

B. User Interface and User Experience Design

The UI/UX design in RWikiStat 4.0 focuses on improving experiences that are attractive and easy to understand for users, both on web and mobile platforms. The web version is built with a clean and responsive layout that adapts to various screen sizes. Meanwhile, the mobile version provides a similar experience with adjustments to the interface and touch interactions for Android and iOS devices. Users can easily access the features provided on various platforms. An application interface that prioritizes ease of use, grouping each component logically and with clear navigation.

The following is a interface of the RWikiStat 4.0 application interface on various platforms, which illustrates the implementation of the design in the web and mobile versions:

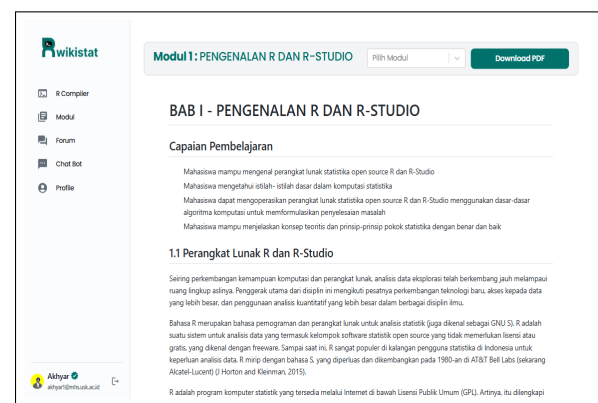


Fig. 1. Web Module Screen

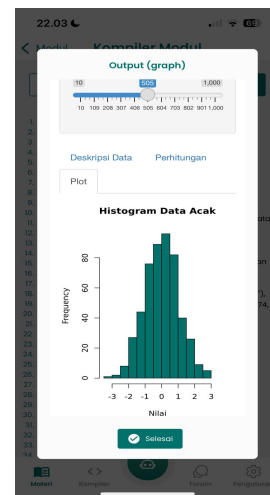


Fig. 2. Mobile Shiny Screen

C. Main Features

RWikiStat 4.0 develops several new features to enhance the statistics learning experience for users. One of its main features is the use of Shiny to visualize data in an attractive and interactive way. This visualization includes common statistical diagrams, such as histograms, scatter diagrams, and box plots, which can be customized based on user preferences. With this feature, users can understand the data more

deeply, because of the visualizations displayed. This also helps users understand complex statistical concepts through direct interaction.

The next important feature is the discussion forum, which supports dynamic learning. This feature allows users to engage in discussions, ask and answer questions, and share insights related to statistical problems to the forum. Another important feature is the sample code for each learning module. In addition to improving user understanding of the material, this feature also makes learning more interesting. Users can immediately try the examples and exercises provided in the module.

In this version, there is also an AI-based chatbot feature that can provide guidance in understanding statistical concepts to users. Users can ask various questions about statistics, such as data analysis, functions in R, and various theories about methods in statistics. With the chatbot feature, users will get direct help without having to leave the application to search first. This makes the learning experience more efficient and enjoyable.

IV. RESULTS AND DISCUSSION

The RWikiStat application provides a satisfactory impact for both web and mobile versions. This is proven by the results of tests that have been carried out previously. Testing was carried out using the black box testing method and the Usability Matrix for User Experience (UMUX). The app runs smoothly, with fast response times and easy-to-access interactions, both on web and mobile devices. Test results using black box testing can be seen in table I below

TABLE I
BLACKBOX TESTING RESULTS

No.	Testing Name	Scenario	Display	Result
1	Sign-in with student ID	Enter student ID and password in the text input, then press the login button	Redirected to the main page	Success
2	Sign-in with Google	Press the 'Sign in with Google' button and select a Google account for login	Redirected to the main page	Success
3	Select learning module	Select one of the module cards	Redirected to a page containing the module and R compiler	Success
4	Execute R / Shiny code in compiler	Enter sample R / Shiny code to execute	Compilation results of the R code appear	Success
5	Add new question in forum	Fill in the topic title, description, and photo, then press the 'Add Question' button	A new question is added	Success
6	Access learning materials	Click the materials icon	The main module page appears	Success
7	Access compiler feature	Click the compiler icon	The main compiler page appears	Success
8	Access forum feature	Click the forum icon	The main forum page appears	Success
9	Access profile settings	Click the settings icon	The main settings page appears	Success
10	Log out of the app	Click the logout icon on the settings page	User is redirected to the sign-in page	Success

In the table I can be seen that all test results were successful, starting from logging in, trying various available features, to logging out again. Then testing using the UMUX method can be seen in table II and III below

TABLE II
UMUX QUESTION LIST [10]

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

Based on the test results using the UMUX method that has been carried out above, the average test results for the RWikiStat Application received a score of 85.4% It can be seen that the application that has been built has an interpretation score of "Very usable" based on the final calculation of the UMUX method. Overall, the development of RWikiStat 4.0 brings significant changes in the way users interact with statistics learning materials. With more advanced interactive features

TABLE III
UMUX TESTING AND EVALUATION RESULTS FOR THE RWikiStat APPLICATION

Respondent	Question Number				Final Score
	1	2	3	4	
Statistics Student 1	7	2	7	2	91.6
Statistics Student 2	7	1	7	1	100
Statistics Student 3	6	2	6	2	83.3
Statistics Student 4	6	2	5	4	70.8
Statistics Student 5	6	1	7	3	87.5
Statistics Student 6	7	2	6	1	91.6
Statistics Student 7	7	1	6	3	87.5
Informatics Student 1	6	4	5	5	58.3
Informatics Student 2	7	1	7	1	100
Informatics Student 3	6	2	7	3	83.3
Average					85.4

and better multi-platform capabilities, this application is ready to provide a more flexible learning experience, allowing users to learn anywhere and anytime.

V. CONCLUSION

RWikiStat 4.0 is an innovative multi-platform statistics learning application, designed to increase accessibility and user engagement on the web, Android, and iOS. With features like interactive data visualization using Shiny, dynamic discussion forums, and AI-based chatbot, the app creates a comprehensive and responsive learning environment. Testing demonstrated reliability and user satisfaction with an average UMUX score of 85.4%, categorized as "Highly Usable." RWikiStat 4.0 successfully bridges the gap in statistics education through advanced technology and innovative design, providing a flexible, interactive, and efficient learning experience to support the exploration and understanding of statistical concepts anytime and anywhere.

REFERENCES

- [1] Tishkovskaya, Svetlana, and Gillian A. Lancaster. "Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform." *Journal of Statistics Education* 20.2 (2012).
- [2] Roseth, Cary J., Joan B. Garfield, and Dani Ben-Zvi. "Collaboration in learning and teaching statistics." *Journal of statistics education* 16.1 (2008).
- [3] Subianto, Muhammad, and Hizir Sofyan. "Interactive statistics learning with RWikiStat." 2010 International Conference on Networking and Information Technology. IEEE, 2010.
- [4] Sofyan, Hizir, Edi Muttaqin, and Muhammad Subianto. "RWikiStat 2.0: a Web Based Statistical Learning System (Session 1B (IASC-ARS))." *Proceedings of the symposium of Japanese Society of Computational Statistics* 26. Japanese Society of Computational Statistics, 2012.
- [5] Sofyan, Hizir, et al. "Analisis Kepuasan Pengguna Aplikasi RWikiStat 3.0." *Journal of Data Analysis* 2.2 (2020): 80-87.
- [6] Wickham, Hadley. *Mastering shiny*. "O'Reilly Media, Inc.", 2021.
- [7] Gärtner, Jonas. *Programming and evaluation of Shiny applications for lectures*. Humboldt Universitaet zu Berlin (Germany), 2017.
- [8] Satyahadewi, Neva, and Hendra Perdana. "Web Application Development for Inferential Statistics using R Shiny." 1st International Conference on Mathematics and Mathematics Education (ICMMEd 2020). Atlantis Press, 2021.
- [9] González, José A., et al. "Assessing Shiny apps through student feedback: Recommendations from a qualitative study." *Computer Applications in Engineering Education* 26.5 (2018): 1813-1824.
- [10] Lewis, James R. "Measuring perceived usability: The CSUQ, SUS, and UMUX." *International Journal of Human-Computer Interaction* 34.12 (2018): 1148-1156.