Journal of Information System Exploration and Research

https://joiser.shmpublisher.com

p-ISSN 2964-1160 | e-ISSN 2963-6361

Usability Evaluation of the Portal Bali Malajah Virtual Class Application Using Performance Measurement, System Usability Scale, and Heuristic evaluation Methods

I Made Aris Satia Widiatmika[1*], I Made Candiasa[2], I Made Gede Sunarya[3]

[1,2,3]*Department of Magister Computer Science, Universitas Pendidikan Ganesha, Indonesia*

DOI: https://doi.org/10.52465/joiser.v4i3.110

Received 17 July 2026; Accepted 31 July 2026; Available online 04 August 2026

Article Info

Keywords:

Usability evaluation;
LMS;
Performance measurement;
System Usability Scale;
Heuristic evaluation

Abstract

The Portal Bali Malajah Virtual Classroom application is an innovative educational service that functions as a Learning Management System (LMS) to facilitate the teaching and learning process in Bali Province. However, since the application was first used, users have encountered obstacles, and a usability evaluation has not been conducted. This study evaluated the application using performance measurement to measure effectiveness and efficiency, a System Usability Scale (SUS) to measure user satisfaction, and a heuristic evaluation to identify interface issues. Data collection using performance measurement and heuristic methods was conducted through direct observation of respondents. Heuristic testing involved three experts to assess the application interface. The SUS questionnaire was distributed online to the entire study population. The performance measurement test showed a very effective category with an effectiveness of 98%, and an efficiency of 98.99%. The SUS score resulted in a user satisfaction level of 80.9. The heuristic evaluation identified interface issues with cosmetic and minor usability problems. The Bali Melajah Portal Virtual Class has met the aspects of effectiveness, efficiency, and user satisfaction well, but needs some improvements to the user interface. Improvement recommendations are compiled based on heuristic aspects to produce more targeted recommendations.

1. Introduction

The post-COVID-19 pandemic has dramatically changed the educational landscape, shifting from face-to-face learning to distance or online learning systems [1]. The use of technology in learning has been widely adopted by educational institutions, for example, through a Learning Management System (LMS) as the main platform for implementing online and blended learning [2], [3]. An LMS is an

* ***Corresponding Author:***

I Made Aris Satia Widiatmika,
Department of Magister Computer Science,
Universitas Pendidikan Ganesha,
Udayana Street No. 11, Singaraja, Bali 81116, Indonesia.
Email: aris.satia@undiksha.ac.id

application used for administration, documentation, reporting, automation, and delivery of the learning process [4]. Online learning is now an integral part of the modern education system, with technology playing a key role in delivering materials, facilitating teacher-student interactions, and evaluating learning outcomes. The use of LMS has a positive impact on academic achievement and improves the quality of learning by providing meaningful learning activities, particularly through an interactive, digital learning environment that can enhance student learning outcomes [5]. The use of LMS has proven that online learning can improve student learning efficiency [6]. Therefore, LMS can be an innovation in flexible, interactive, and integrated digital learning services to improve the quality of learning [7], [8]. However, when adopting an LMS, it is important to consider whether the application is easy to use, understand, and enjoyable for users.

The Portal Bali Malajah Virtual Class is an LMS application specifically designed to support learning activities in schools in Bali Province. The Portal Bali Malajah Virtual Class was introduced in 2022 as an LMS application that can be used free of charge, so that educational units at the high school (SMA), vocational school (SMK), and special needs (SLB) levels that do not yet have an LMS can use it. With the Portal Bali Malajah Virtual Class, learning is no longer limited by space and time, so it can be done anytime and anywhere, making the learning process more effective and efficient, and addressing the shortage of teachers and learning spaces. However, since the Portal Bali Malajah Virtual Class application has been operating as a service in the Bali Provincial Government, problems have still been encountered in its use, and to date there has never been an academic evaluation of the system's usability. Therefore, it is necessary to review whether the system is functioning properly and to identify potential interface problems that have not been identified or systematically measured. Usability evaluation is important to determine the level of success of an application. If a usability evaluation is not carried out, developers and policymakers will not have an objective database to assess whether the system can truly be used according to its function and is satisfactory for its users [9]. Based on an interview with the Head of the Bali Provincial Educational Technology Development Center (UPTD), no evaluation has been conducted to determine the success of the Portal Bali Malajah Virtual Class application used by teachers and students in Bali Province.

Therefore, usability evaluation is crucial to determine the level of system usability and user satisfaction, as well as to identify areas that need improvement [10]. Usability determines whether a system is easy to use and beneficial to its users. According to ISO 9241-11, three aspects serve as benchmarks for measuring the usability of an application: effectiveness, efficiency, and satisfaction [11], [12]. Effectiveness refers to the user's ability to achieve the desired goal in a specific usage context, efficiency refers to how accurately and completely the user can complete tasks when using the application. Satisfaction refers to the user's level of satisfaction with the application. This approach aims to identify the level of system usability, as well as aspects that need improvement or development to enhance the user experience of the Portal Bali Malajah Virtual Class application.

Selecting an appropriate and comprehensive method for evaluating system usability is key to producing accurate findings. Various studies have shown that each method has its own advantages and limitations [13]. In this study, three complementary methods were chosen: performance measurement, System Usability Scale (SUS), and heuristic evaluation. The performance measurement method allows for objective measurement of effectiveness and efficiency based on actual user behavior when interacting with the system through indicators such as task completion rate, task completion time, and error rate [14], [15]. The SUS, developed by John Brooke in 1986, has become the de facto standard instrument for quantitatively measuring usability perceptions [16], [17], [18]. Furthermore, the SUS is used to quantitatively measure user perceptions of system usability using a standard instrument that has been widely used in usability research [19]. The advantages of the SUS are that it is a faster and easier-to-understand test for respondents, can be implemented with small samples, and produces reliable results [20], [21]. Heuristic evaluation, an inspection method developed by Jakob Nielsen, allows the identification of usability problems based on 10 proven heuristic principles, thus detecting problems that might not be identified through regular user testing [22], [23].

Research conducted by [24] evaluated the usability of the Qualitiva application as a digital educational platform using the SUS and heuristic evaluation methods. The results showed that users generally accepted the application, but it still needed improvement. In addition, the heuristic evaluation identified several usability issues and recommended interface design improvements to enhance the user experience. Similarly, research conducted by [25] evaluated the usability of the SIMATRA UKI Toraja Academic Information System using the heuristic evaluation and SUS methods. The results

showed that the heuristic evaluation successfully identified several interface problems. Meanwhile, the SUS results showed that the system had good usability and was acceptable to users.

Previous research has generally not integrated performance measurement, the SUS, and heuristic evaluation methods into a single usability evaluation framework. Therefore, this research provides more comprehensive findings on the level of system usability [26] and interface issues that affect users' use of the Portal Bali Malajah Virtual Class application in Bali. This research is also novel because it is one of the few studies to use three integrated usability evaluation methods on a government-owned LMS, specifically the Bali Provincial Government, applying performance measurement, System Usability Scale (SUS), and heuristic evaluation. The results of this research are expected to benefit not only the Province of Bali but also other regions implementing a similar LMS, making a positive contribution to the use of technology in education.

2. Literature Review

Usability evaluation is a crucial step in information system development because it aims to identify the level of ease of use, efficiency, effectiveness, and user satisfaction with a system. Various studies have shown that relying on a single evaluation method often fails to provide a comprehensive picture of a system's usability. Therefore, some researchers combine various evaluation methods to obtain more comprehensive results.

Research conducted by Giri et al [16] evaluated the website of the Bali Province Social, Women's Empowerment, and Child Protection Office using a combination of cognitive walkthrough, performance measurement, and the System Usability Scale (SUS). This research began by identifying various usability issues that formed the basis for developing the website interface. The evaluation results indicated that the website fell into the effective and efficient category according to performance measurement. All respondents completed task scenarios using the cognitive walkthrough method. At the same time, the SUS measurement yielded an average score of 92.36, well above the standard score of 68, indicating a very high level of user satisfaction.

In contrast to this study, Pradiktha et al [26] evaluated the Ministry of Transportation's e-Correspondence application using the System Usability Scale (SUS) and heuristic evaluation methods. The SUS test results obtained an average score of 42.2, which falls into the Grade F (Poor) category, indicating that the application is not yet acceptable to users. Furthermore, the heuristic evaluation identified various interface issues based on Nielsen's ten heuristic principles. These findings were then used to develop recommendations for application development.

Recent research conducted by Putra et al [14] evaluated the Universitas Pendidikan Ganesha's Correspondence Management System using a combination of performance measurement, concurrent think aloud, and mouse tracking. The results showed that the system achieved an effectiveness rate of 81.5% and relatively short task completion times. However, the think aloud method identified 14 usability issues, including slow navigation, unresponsive menus, a hard-to-find logout button, and a lack of a letter revision feature. The mouse tracking analysis also revealed several points of user frustration, identified through heat maps and cursor movement patterns, leading the researchers to recommend improvements to the interface layout and feature optimization.

In general, these four studies show that usability evaluation has evolved from a single method to a multi-method approach. Performance measurement is widely used to gauge effectiveness and efficiency in task completion, while the SUS is used to measure user perception, satisfaction, and experience quantitatively. Meanwhile, heuristic evaluation, cognitive walkthrough, think aloud, and mouse tracking help identify usability problems that cannot be explained solely by quantitative data. Thus, combining several evaluation methods can produce more accurate system development recommendations than using a single method.

However, these studies have not integrated Performance Measurement, SUS, and heuristic evaluation into a single evaluation framework. These three methods have complementary characteristics in measuring effectiveness, efficiency, and user satisfaction, as well as comprehensively identifying interface issues. Therefore, this study combines these three methods to evaluate the Bali Melajah Portal Virtual Classroom Application owned by the Bali provincial government, producing a more comprehensive usability evaluation.

3. Method

This study employed an evaluative, quantitative approach. This study descriptively analyzed the use of the Bali Malajah Virtual Class Portal application and reviewed it based on usability aspects. The research stages are shown in Figure 1.

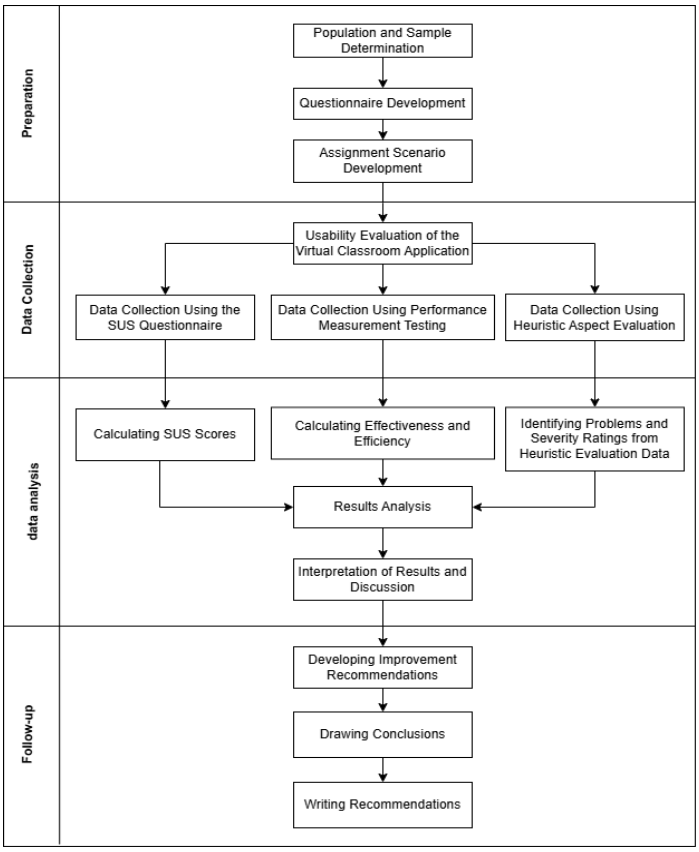

Figure 1. Research flow

The research procedures are divided into four parts: preparation, data collection, data analysis, and follow-up. The following explains each procedure.

3.1. Preparation

The preparation stage is the initial stage of the research that aims to prepare all research requirements, starting with determining the number of samples used for data collection through direct observation of 40 respondents, consisting of 20 teachers and 20 students, and involving 3 expert evaluators. The number of samples involved in online data collection using the SUS method was determined based on the minimum and maximum population range of 622 people. The minimum sample size was calculated using the Slovin formula, resulting in 76 teachers and 77 students. The maximum sample size was 305 teachers and 317 students. If the number of valid data collected exceeds the minimum number, all data will be used to improve the quality of the representation of the research results. Next, compile a task scenario that respondents must complete during the usability testing process and a system interface assessment instrument based on 10 heuristic aspects, and compile a SUS questionnaire consisting of ten statements assessed on a 5-point Likert scale.

3.2. Data collection

The data collection phase involved distributing questionnaires to a sample of the research population online via Google Forms [18], as well as collecting data through instruments and screen recordings during live testing on a predetermined sample [27]. The results of this data collection will then be used in the data analysis phase.

1. The task scenarios used in this study were divided into two: one for teachers and one for students. The teacher scenario was designed to emphasize teaching activities, while the

student scenario emphasized learning activities. The task scenarios used in this study are shown in Table 1 and Table 2.

Table 1. Task scenarios for teachers

No	Task
1	Log in by entering your username and password, then select the Teacher role to access the Teacher dashboard.
2	Create a new class based on the class you teach, starting from grade level to class name.
3	Set grades with percentages for attendance (10%), assignments, mid-term exams, and final exams (30% each).
4	Create an online attendance list with the "flexible" filling type, set a deadline of 2 hours, then select "share attendance list now."
5	Now you want to add learning materials to your class. Add materials by "uploading new materials" and then selecting "share now."
6	Now you want to create assignments for your students. Select the KKM assessment method. Create multiple-choice questions, then select "Share Now."
7	Now you want to teach online using the live teaching feature with the Bali Malajah livekit service. Set the duration to 90 minutes and schedule it now.
8	Now you want to add your learning materials to the Material Bank menu.
9	Now you want to add your questions to the Question Bank menu.
10	Once you're finished using the application, you'll want to log out of the virtual classroom application.

Table 2. Task scenarios for student

No	Task
1	Please log in by entering your username and password, then select the student role to access the student dashboard.
2	Update your address information on your profile.
3	You now want to see who is in one of the classes you have enrolled in.
4	You now want to use the class chat feature to send a message.
5	You now want to complete the online attendance list created by your teacher.
6	You now want to read the learning materials shared by your teacher.
7	You now want to work on the assignments shared by your teacher.
8	You now want to participate in live teaching on the Bali Malajah LiveKit service prepared by your teacher.
9	You now want to read one of the learning materials available in the material bank menu.
10	After you have finished using the application, you now want to exit/log out of the virtual classroom application.

2. Online data collection through research instruments using the SUS questionnaire standard that has been adapted into Indonesian. The questionnaire consists of 10 statements regarding user satisfaction with the Portal Bali Malajah Virtual Class application, using a Likert-scale assessment technique to measure respondents' perceptions and attitudes toward the statements. The assessment scale has five levels, and respondents are asked to score the statements or questions on the questionnaire using a value range of 1 to 5 [20]. The criteria and values of the Likert scale are shown in Table 3.

Table 3. Response criteria and likert scale scores

No	Response Criteria	Score
1	Strongly Agree (SS)	5
2	Agree (S)	4
3	Neutral (N)	3
4	Disagree (TS)	2
5	Strongly Disagree (STS)	1

The following is the questionnaire used in this study, as shown in Table 4.

Table 4. SUS questionnaire

No	Respondent	Score				
		STS	TS	N	S	SS
1	I am considering using this virtual classroom application again.					
2	I find this virtual classroom application too difficult or complex to use.					
3	I find this virtual classroom application easy to use.					
4	I need help from another person or technician to use this virtual classroom application.					
5	I believe that the functions/features available in this virtual classroom application are well-conceived and well-designed.					
6	I believe that there are too many inconsistencies in this virtual classroom application.					
7	I expect many people will quickly understand how to use this virtual classroom application.					
8	I find this virtual classroom application very difficult and confusing to use.					
9	I feel very confident using this virtual classroom application.					
10	I need to acclimate myself before using this virtual classroom application.					

3. Data collection using heuristic evaluation aims to generate quantitative data regarding the interface design of the Portal Bali Malajah Virtual Class system. This technique involved three expert evaluators to test the application interface, assess it, and provide recommendations and severity ratings using the prepared research instrument. Respondents such as teachers and students were also involved by filling out the questionnaire directly. The questionnaire was created based on 10 heuristic aspects assessed by teacher and student respondents using a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree." The results were then converted into a severity rating of 0–4 to determine the level of interface problems. According to Jakob Nielsen, ten aspects of heuristic evaluation can be used as a basis for creating a questionnaire [28]. These ten aspects are summarized in Table 5.

Table 5. Heuristic aspects

No	Heuristic	Description
1	Visibility of System Status	The system informs users about what is happening, including what is being done, where it is, and what is happening, through timely feedback.
2	Match Between System and the Real World	The system provides information in a language that is familiar and easy for users to understand.
3	User Control and Freedom	The system provides users with ease and freedom in using the interface.
4	Consistency and Standards	A consistent design makes it easier for users to recognize features, thereby reducing hesitation when using certain features.
5	Error Prevention	Errors or bugs in the system are unprofessional if they are visible to users. However, this can be replaced with error messages in the design.
6	Recognition Rather Than Recall	The system's design patterns are easily recognizable. This allows users to use it without having to remember the steps to follow.
7	Flexibility and Efficiency of Use	New users will naturally learn the system first. Especially if the system has many features, users will need more time to learn. Therefore, the system must be flexible and efficient.
8	Aesthetic and Minimalist Design	A good layout design should be pleasing to the eye through appropriate color contrast, positioning, and harmonious arrangement. A minimalist design combined with appropriate

No	Heuristic	Description
		whitespace (spacing between elements) will make the application look more elegant.
9	Help Users Recognize, Diagnose, and Recover from Errors	A good and user-friendly design is certainly not complete without error handling. When an error occurs, the application should not only display an error message but also provide a solution.
10	Help and Documentation	Users' expectations when using a system or application are, of course, to be able to solve problems and tasks. To assist in solving problems or tasks, it is necessary to provide help features and documentation regarding possible errors during use.

3.3. Data analysis

The data analysis phase of this study was based on the results of three evaluation methods: performance measurement, which collected visual and numerical data, which was then used to calculate the application's effectiveness and efficiency when used by users. The SUS method generated a SUS score for each respondent and an overall average score. These scores were then used to determine user satisfaction with the system. The heuristic evaluation method was used to collect data based on ten heuristic aspects. The results revealed usability issues in the interface design and assigned severity ratings, allowing improvements to be made based on their severity. The results served as the basis for developing recommendations for improvements in the next stage. The following is an explanation of each data analysis method used.

3.3.1. Performance measurement

Performance measurement was used to measure effectiveness and efficiency. Effectiveness was calculated based on the number of respondents who completed a task. The task completion result was assigned a binary value of "1" if the respondent completed the task and "0" if the respondent failed. Respondents were deemed to have failed if they did not complete the assigned task correctly or did not complete the task at all. The following is the formula for calculating the system's effectiveness level, as shown in Equation (1) [29].

$$Effectiveness = \frac{Number\ of\ task\ complete\ successfully}{Total\ Number\ of\ task\ undertaken} x\ 100\% \quad (1)$$

The effectiveness values obtained were then interpreted based on the 1991 Ministry of Home Affairs Research and Development Reference Standards, as shown in Table 6.

Table 6. Respondent effectiveness scores

No	Effectiveness Ratio	Achievement Level
1	< 40%	Very Ineffective
2	< 60%	Ineffective
3	< 80%	Fairly Effective
4	≥ 80%	Very Effective

Efficiency is calculated using the overall relative efficiency formula [30], which is the total time for tasks completed by each user divided by the total time spent on all tasks by each user. The following is the formula for calculating the system efficiency level, as shown in Equation (2).

$$Overall\ Relative\ Efficiency = \frac{\sum_j^R = 1\ \sum_i^N = 1\ nij\ tij}{\sum_j^R = 1\ \sum_i^N = 1\ tij} X\ 100\% \quad (2)$$

N is the total number of tasks completed, R is the number of respondents, nij is the result of task i by respondent j, valued at 1 if successful or 0 if unsuccessful, and tij is the time taken by respondent j to complete task i.

3.3.2. System Usability Scale (SUS)

The SUS questionnaire was used to obtain data on user satisfaction levels when using the application [31]. The SUS questionnaire calculation procedure is as follows.

For each odd-numbered question (1, 3, 5, 7, 9), the respondent's score is subtracted by 1. For each even-numbered question (2, 4, 6, 8, 10), the respondent's score is subtracted by 5. Next, the results for each question are added together and multiplied by 2.5 to produce a final score ranging from 0 to 100. The SUS score is not a percentage, although it ranges from 0 to 100. Finally, the average is calculated across all respondents. All scores are summed and divided by the number of respondents.

The final SUS score is categorized based on acceptability ranges, grade scales, and adjective ratings. Acceptability ranges are categories that determine whether the system or product being evaluated is acceptable to users. If the average score obtained is > 70, then the user can be said to be satisfied using the system [20]. This categorization scale is visually represented in Figure 2.

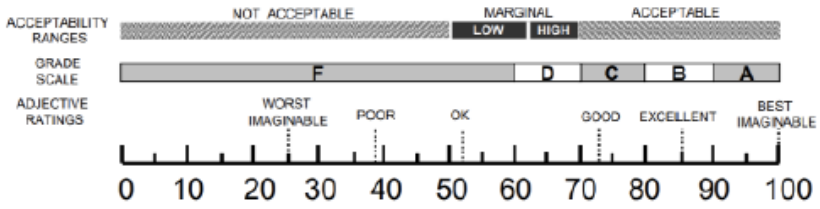

Figure 2. Rating scale SUS

3.3.3. Heuristic evaluation

The heuristic evaluation involved 3 expert evaluators in the field of system interfaces, who were asked to complete an assessment instrument for 10 heuristic aspects, identify problems and their severity, and provide recommendations for improvement. Respondents such as teachers and students were also involved by filling out a questionnaire directly based on 10 heuristic aspects, using a Likert-scale assessment technique to measure respondents' perceptions of the statements in the research questionnaire. The Likert-scale scores were converted to severity ratings; the first step was to determine the severity rating for each heuristic sub-aspect. The severity rating calculation was carried out using Equation (3) [32].

$$SR = \frac{\sum A}{n} \tag{3}$$

SR is the severity rating result for heuristic aspects, $\sum A$ is the total rating score for heuristic sub-aspects within each heuristic aspect, and n is the number of heuristic sub-aspects within each heuristic aspect.

Severity Rating is a scale used to measure the severity of usability issues found during a heuristic evaluation [33]. The severity rating classification for heuristic evaluation method is shown in Table 7.

Table 7. Severity rating

Severity	Category	Description	Recommendation
0	Don't Agree	The observed item does not pose any usability issues.	No action required.
1	Cosmetic Problem	An issue that only affects aesthetics without interfering with usability; users can adapt.	Fix it when they have time.
2	Minor Usability Problem	An issue that slows users down but doesn't prevent them from completing a task.	Medium priority; needs to be fixed.
3	Major Usability Problem	An issue that significantly hinders users and has the potential to cause task failure.	High priority; important to fix.
4	Usability Catastrophe	An issue that prevents users from completing a task at all.	Requires fixing before release.

3.4. Follow-up stage

The follow-up stage involves developing recommendations for improvement and drawing conclusions based on the evaluation results using the three methods. This allows the system's effectiveness, efficiency, and user satisfaction to be assessed, as well as any identified issues. These recommendations can then be used in future decision-making by policymakers and application developers.

4. Results and Discussion

The results and discussion section evaluates the usability of the Portal Bali Malajah Virtual Class application based on effectiveness, efficiency, and user satisfaction. It also identifies issues with the application interface and provides recommendations for improvement and suggestions for future development.

4.1 Performance measurement

The performance measurement results showed varying levels of effectiveness among the 20 respondents (both teachers and students) in completing the assigned task scenarios. Respondents were divided into two categories: advanced and beginner, to determine the effectiveness of the system tested based on these categories. Comparative data on the effectiveness of each respondent category are shown in Table 8.

Table 8. Respondent effectiveness scores

No	Respondent	Percentage
1	Advanced Teacher	98%
2	Beginner Teacher	86%
3	Advanced Student	98%
4	Beginner Student	89%

The effectiveness score for the advanced teacher respondents was 98%, while for the beginner teacher respondents it was 86%. The effectiveness score for advanced student respondents was 98%, and for beginner student respondents, 89%. The average effectiveness score for each respondent indicates that most tasks in the Portal Bali Malajah Virtual Class application were completed, though not with 100% effectiveness. The reasons for the failures encountered by the teacher respondents when working on the assignment scenarios were that the teachers' understanding of the assigned tasks was not optimal, and that beginning teachers had difficulty understanding how to create materials in the material bank menu. Meanwhile, the causes of failure encountered by student respondents when completing assignment scenarios included difficulty understanding system notifications or warnings during attendance and novice respondents failing to complete assignments.

The effectiveness scores obtained were then interpreted based on the 1991 Ministry of Home Affairs Research and Development Reference Standards [27]. Overall, the effectiveness of the Portal Bali Malajah Virtual Class application, as reported by both advanced and novice respondents, was above 80%, indicating a very effective level.

Efficiency was measured using the overall relative efficiency calculation, comparing the total time for tasks completed by respondents to the total time required to complete all tasks. The data processing results for each respondent category are shown in Table 9.

Table 9. Respondent efficiency score results

No	Respondent	Percentage
1	Advanced Teacher	98.99%
2	Beginner Teacher	83.17%
3	Advanced Student	97.73%
4	Beginner Student	93.84%

The efficiency score obtained from the overall relative efficiency measurement for advanced teacher respondents was 98.99%, while for beginner teacher respondents, it was 83.17%. The effectiveness level for advanced student respondents was 97.73%, and for beginner student

respondents, it was 93.84%. The efficiency score results were analyzed to determine why the efficiency achieved did not reach 100%. An influential factor was that respondents needed to adapt to using some features of the new application. As a result, the assigned task scenarios did not align with their actual work, leading to less efficient use of the system.

4.2 System Usability Scale

User satisfaction was measured using the SUS questionnaire, which consists of 10 statements rated on a Likert scale. The scores calculated for each respondent category are shown in Table 10.

Table 10. User satisfaction results

No	Respondent	SUS Score
1	Advanced Teacher	77.6
2	Beginner Teacher	69.4
3	Advanced Student	80.9
4	Beginner Student	74.8

The user satisfaction scores calculated using the SUS questionnaire for the advanced teacher respondents were 77.6 SUS points, while the user satisfaction score for the beginner teacher respondents was 69.4. The advanced student respondents received a score of 80.9, while the beginner student respondents received a score of 74.8. The SUS score standard for an application is said to be acceptable to its users if it is above 70 SUS points [31]. The SUS scores obtained by the beginner teacher respondents show that the acceptability ratings have not yet entered the acceptable category, meaning users have not accepted them. The grade scale obtained is at grade D. The adjective ratings obtained are included in the Ok category. The results of the SUS assessment scale for beginner teacher respondents remain low compared with other respondents, influenced by user background factors and length of use.

4.3 Heuristic evaluation

The heuristic evaluation results were used to analyze interface issues in the Portal Bali Malajah Virtual Class application. Teachers and students evaluated the interface's performance using a questionnaire based on 10 heuristic aspects. The severity ratings for the ten heuristic aspects are compared in Table 11.

Table 11. Summary of HE scores

Respondent	Severity Rating									
	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
Advanced Teacher	1	1	1	1	1	1	1	1	1	2
Beginner Teacher	0	1	0	1	1	1	1	1	1	3
Advanced Student	1	1	1	1	1	1	2	1	1	2
Beginner Student	1	1	1	1	1	1	1	1	1	2
Average	1	1	1	1	1	1	1	1	1	2

The summary results from teacher and student respondents show that most of the heuristic aspects received a score of 1, indicating a cosmetic problem. Some received a score of 2, indicating a minor usability problem. A score of 3 indicates a major usability problem that interferes with system use and requires high-priority improvements [32]. The heuristic evaluation of the Portal Bali Malajah Virtual Classroom application also involved three expert evaluators with backgrounds related to application interface design and development. A comparison of the severity ratings obtained by the three expert evaluators is shown in Table 12.

Table 12. Expert evaluator HE scores

Respondent	Severity Rating									
	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
E1	1	1	2	1	1	1	1	0	1	2
E2	1	1	2	1	2	2	1	1	2	3
E3	1	1	2	0	2	1	1	1	2	3
Rata-rata	1	1	2	1	2	1	1	1	2	2

The expert evaluators' severity ratings showed that most obtained an average score of 1, indicating a cosmetic problem, and a score of 2, indicating a minor usability problem. This indicates potential difficulties in using the system that require improvement but are low priority.

Recommendations for improvement are provided for all heuristic principles based on the evaluation results of the three expert evaluators of the application interface, as shown in Table 13.

Table 13. Recommendations for improvement

Heuristic Aspect	Recommendations for Improvement by Evaluators
Visibility of System Status	1. The loading status in the view material feature is not sufficiently informative on slow connections. Add a process indicator and a clear "loading" caption so users know the system is still working. 2. Add clearer status indicators for each class activity, such as labels like "no assignments today," "no live teaching sessions yet," or "when was the last material distributed"
Match Between System and the Real World	1. Some terms need to be made more natural for school users. For example, "Timeline" could be replaced with "Class Activity" or "Class Timeline." The term "Material Bank" is already quite familiar, but a brief description such as "Collection of learning materials" could be added.
User Control and Freedom	1. On the material detail page, provide a clear back button to the material or class list so users don't rely solely on browser buttons.
Consistency and Standards	1. Consistently display the active menu status using orange. Ensure consistency across all pages, such as the "Materials," "Attendance List," and "Assignments" tabs.
Error Prevention	1. Prevent input errors by adding placeholders in the description and thumbnail fields, for example, "fill in with instructions for reviewing the material provided." 2. Validation can be improved by guiding users before they make mistakes, especially when entering data and uploading files.
Recognition Rather Than Recall	1. Incomplete activities are not easily recognized. Add a summary to the homepage: attendance list, assignment materials not yet distributed, and a tooltip with instructions for completing drafts.
Flexibility and Efficient of Use	1. Access to frequently used classes or materials may not be quick for active users. Provide a favorite/pin class feature, a history of recent accesses, and a resume button on the dashboard.
Aesthetic and Minimalist Design	1. Button placement, card size, and text density should be maintained for ease of reading, for example, in material and assignment details. Place buttons for easy access, limit the amount of text on the card, and use summaries.
Help Users Recognize, Diagnose, and Recovers from Errors	1. Failures due to device settings, file size, or file format are more helpful if presented with a solution. Show the cause of the failure and a direct solution, for example, compress the file, change the format, check the connection, and follow the instructions to activate the camera. 2. When data is empty, a message such as "There are no assignments for today" is fine, but it could be improved with further instructions, such as "Please check the class schedule or contact the teacher if there are assignments." This helps users understand what needs to be done.

Heuristic Aspect	Recommendations for Improvement by Evaluators
Help and Documentation	1. Add brief help or tooltips to certain features, such as "Class Chat," "Copy Link," "Lesson Attachments," and "Filter Material Bank." This help should be short text so new users can quickly understand the function of each feature. 2. For issues that cannot be resolved through the guide, add human assistance such as displaying admin/helpdesk contact information, service hours, a problem report form, and report follow-up status.

5. Conclusion

The evaluation results indicate that the Portal Bali Malajah Virtual Class application can be categorized as very effective, with the highest effectiveness value of 98% among advanced-category teacher respondents and the lowest of 86% among beginner-category teacher respondents. The highest efficiency value obtained was 98.99%, and the lowest was 83.17% among beginner-category teacher respondents, indicating obstacles in use that require further handling. The level of user satisfaction, as measured by the SUS questionnaire, produced the highest score of 80.9 in the advanced category among student respondents, which falls within the acceptable category. At the same time, the lowest was obtained in the beginner category among teacher respondents at 69.4, indicating users did not accept it. The SUS assessment results among beginner teacher respondents remain low compared with other respondents, influenced by user background factors and length of use. and. The results of the heuristic evaluation among teacher respondents, students, and expert evaluators identified cosmetic problems and minor usability problems, along with recommendations for improvement for each heuristic aspect. The evaluation results are expected to be a reference for further improvement and development of the Portal Bali Malajah Virtual Class application.

Credit Authorship Contribution Statement

I Made Aris Satia Widiatmika : Conceptualization, Methodology, Software, Project administration. **I Made Candiasa**: Software, Writting – original draft. **I Made Gede Sunarya**: Writing – review & editing, Validation, Supervision.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request

Use of Artificial Intelligence

Generative AI tools were used solely to assist with language editing and manuscript formatting. The ideas, study design, data processing, analysis, and conclusions are entirely the authors' original work. All AI-assisted content has been reviewed and approved by the authors, who bear full responsibility for the scientific accuracy and publication ethics of this manuscript.

References

[1] H. Kusuma, F. S. Rue, R. Y. Rumagit, and G. D. Pratama, “Usability evaluation of Ruangguru online learning mobile application using heuristic method,” *Procedia Comput. Sci.*, vol. 245, pp. 176–184, 2024, doi: 10.1016/j.procs.2024.10.241.

[2] A. R. Novianto and S. Rani, “Pengembangan Desain UI/UX Aplikasi Learning Management System dengan Pendekatan User Centered Design,” *J. Sains, Nalar, dan Apl. Teknol. Inf.*, vol. 2,

no. 1, 2022, doi: 10.20885/snati.v2i1.16.
[3] R. I. Platonova, N. A. Orekhovskaya, S. B. Dautova, E. V. Martynenko, N. I. Kryukova, and S. Demir, "Blended Learning in Higher Education: Diversifying Models and Practical Recommendations for Researchers," *Front. Educ.*, vol. 7, no. July, pp. 1–11, 2022, doi: 10.3389/feduc.2022.957199.
[4] M. N. Rahmadani, T. A. Sandy, N. K. Ni'mah, W. L. Rohmania, and S. N. Sari, "Assessing learning effectiveness through Learning Management Systems: trends from the last five years," *Indones. J. Curric. Educ. Technol. Stud.*, vol. 12, no. 1, pp. 57–68, 2024, doi: 10.15294/ijcets.v12i1.13238.
[5] A. Haikal, N. Azahra, and A. A. Awalia, "Kajian Literatur: Efektivitas Learning Management System (Lms) Dalam Meningkatkan Kemandirian Dan Hasil Belajar Siswa Di Era Digital," *Paedagogie*, vol. 20, no. 2, pp. 343–352, 2025, doi: 10.31603/paedagogie.v20i2.15324.
[6] J. Jiang, P. D. Simon, and L. K. Fryer, "Capturing students' LMS experience: measurement invariance across Chinese and English versions," *J. Comput. High. Educ.*, vol. 37, no. 1, pp. 419–441, 2025, doi: 10.1007/s12528-024-09402-8.
[7] C. T. X. Lien, "Benefits and challenges of using LMS in blended learning: Views from EFL teachers and students at a Vietnamese public university," *Int. J. TESOL Educ.*, vol. 3, no. 3, pp. 78–100, 2023, doi: 10.54855/ijte.23335.
[8] Oktri Wulandari and Ahmad Tohir, "Penggunaan Learning Management System (LMS) dalam Meningkatkan Kualitas Pembelajaran Daring di Perguruan Tinggi," *J. Rev. Pendidik. dan Pengajaran*, vol. 7, no. 3, pp. 10490–10496, 2024, doi: 10.31004/jrpp.v7i3.31682.
[9] A. T. A. Putro, A. Wibowo, and S. Sutikno, "Evaluasi Usability pada Aplikasi Sistem Pencatatan Pegawai Menggunakan Metode Usability Testing dan USE Questionnaire," *J. Masy. Inform.*, vol. 15, no. 2, pp. 125–148, 2024, doi: 10.14710/jmasif.15.2.67263.
[10] M. Mu'min Azis, M. Martanto, and U. Hayati, "Analisis Usability Testing Menggunakan Metode System Usability Scale Pada Aplikasi Open Data Kabupaten Cirebon," *JATI (Jurnal Mhs. Tek. Inform.*, vol. 7, no. 6, pp. 3238–3243, 2024, doi: 10.36040/jati.v7i6.8154.
[11] I. G. M. S. Dwipayana, I. M. Candiasa, and L. J. E. Dewi, "Usability Evaluation of Lecturer Information System in ITB STIKOM Bali," *Sinkron*, vol. 9, no. 1, pp. 149–159, 2025, doi: 10.33395/sinkron.v9i1.14315.
[12] M. Villamañe and A. Alvarez, "Facilitating and automating usability testing of educational technologies," *Comput. Appl. Eng. Educ.*, vol. 32, no. 3, 2024, doi: 10.1002/cae.22725.
[13] P. E. Parianthana, G. Indrawan, and I. G. A. Gunadi, "Aplikasi Smart Bina Taruna Wiratama Menggunakan Heuristic evaluation Dan," *J. Ilmu Komput. Indones.*, vol. 7, no. 1, pp. 21–33, 2022, doi: 10.36002/jutik.v8i2.1900.
[14] I. G. P. A. A. Putra, I. M. Candiasa, and I. N. Sukajaya, "Usability Evaluation of the Undiksha Letter Management System Website Using Performance Measurement, Think Aloud, And Mouse Tracking Methods," *J. Nas. Pendidik. Tek. Inform.*, vol. 14, no. 3, pp. 616–624, 2025, doi: 10.23887/janapati.v14i3.100659.
[15] J. M. Ferreira, F. D. Rodriguez, A. Santos, O. Dieste, S. T. Acuna, and N. Juristo, "Impact of Usability Mechanisms: A Family of Experiments on Efficiency, Effectiveness and User Satisfaction," *IEEE Trans. Softw. Eng.*, vol. 49, no. 1, pp. 251–267, 2023, doi: 10.1109/TSE.2022.3149586.
[16] I. G. Putu, Y. Giri, L. Joni, E. Dewi, and I. M. G. Sunarya, "Architecture and High Performance Computing The Evaluation of Usability and Website Development using Cognitive Walkthrough , Performance Measurement , and System Usability Scale Journal of Computer Networks , Architecture a," *Journal of Computer Networks*, vol. 5, no. 2, pp. 503–514, 2023, doi: 10.47709/cnahpc.v5i2.2511.
[17] M. Hertzum, "System Usability Scale: A Meta-Analysis of How SUS Relates to Workload, Task Time, and Error Rate," *Int. J. Hum. Comput. Interact.*, vol. 0, no. 0, pp. 1–14, 2026, doi: 10.1080/10447318.2026.2625260.
[18] K. Y. Sarasmayana, L. Joni Erawati Dewi, and I. M. G. Sunarya, "Usability Evaluation Of The Academic Information System Using The Concurrent Think-Aloud, Webuse, And Sus Methods" *J. Comput. Networks, Archit. High Perform. Comput.*, vol. 6, no. 2, pp. 903–912, 2024, doi: 10.47709/cnahpc.v6i2.3977.
[19] A. A. Gede Yudhi Paramartha, K. A. Seputra, F. Azima, Di. P. Putra, E. Dwi, and K. Y. E. Aryanto, "Usability Evaluation of an Interactive Educational Mobile Application," *Int. Conf. Adv. Commun. Technol. ICACT*, vol. 2022-Febru, pp. 491–495, 2022, doi:

10.23919/ICACT53585.2022.9728778.
[20] Y. Widyastuti and S. Hidayatulloh, “Analisa Usability Testing Pada Aplikasi Mobile Penjualan Retail Menggunakan Metode System Usability Scale (SUS),” *Reputasi J. Rekayasa Perangkat Lunak*, vol. 4, no. 2, pp. 74–83, 2023, doi: 10.31294/reputasi.v4i2.2341.
[21] G. A. P. A. Dewi, P. D. G. R. Dantes, and P. D. D. G. H. Divayana, “Usability Testing On Inventory Application Using Performance Measurement, Retrospective Think Aloud, And System Usability Scale Technique,” *J. Comput. Networks, Archit. High Perform. Comput.*, vol. 5, no. 1, pp. 336–346, 2023, doi: 10.47709/cnahpc.v5i1.2336.
[22] I. K. Parwata, I Made Candiasa, and Dewa Gede Hendra Divayana, “Evaluasi Sistem Informasi Perpustakaan Universitas Pendidikan Ganesha Pada Aspek Usability Dengan Metode User Experience Questionnaire, Heuristic evaluation Dan Think Aloud,” *J. Pendidik. Teknol. dan Kejuru.*, vol. 21, no. 1, pp. 80–90, 2024, doi: 10.23887/jptkundiksha.v21i1.66978.
[23] I. N. G. A. Y. Putra, I. M. Candiasa, and L. J. E. Dewi, “Usability Evaluation of SIDUMAS Badung Using Think Aloud, Heuristic evaluation and SUS,” *Sinkron*, vol. 8, no. 1, pp. 368–379, 2023, doi: 10.33395/sinkron.v8i1.12034.
[24] M. Berlianti, U. Ependi, Y. Novaria Kunang, and A. Haidar Mirza, “Enhancing Usability of the Qualitiva Educational Applications: A Mixed-Methods Study using SUS and Heuristic evaluation,” *J. Ilmu Komput. dan Agri-Informatika*, vol. 12, no. 1, pp. 79–90, 2025, doi: 10.29244/jika.12.1.79-90.
[25] H. Bilma Bunga and A. Nugroho, “Analisis Usability Testing Pada Sistem Simatra Uki Toraja Menggunakan Heuristic evaluation Dan System Usability Scale,” *J. Pendidik. Teknol. Inf.*, vol. 8, no. 2, pp. 138–149, 2025, doi: 10.37792/jukanti.v8i2.1566.
[26] W. D. Pradiktha, L. Joni, E. Dewi, and I. M. G. Sunarya, “Usability Testing dan Rekomendasi Pengembangan E-Persuratan Dephub dengan Metode System Usability Scale dan Heuristic evaluation Abstrak PENDAHULUAN Dengan dilakukannya penerapan Work From Home (WFH), agar disposisi penugasan tetap bisa berjalan maka di,” *Teknlogi Inform. dan Komput. MH. Thamrin*, vol. 9, no. 2, pp. 1328–1340, 2023, doi: 10.37012/jtik.v9i2.1697.
[27] I. G. Putu, K. Adi, D. Ayu, and S. Dewi, “Analisis Usability Pada Website Aplikasi Viu menggunakan Performance Measurement , Retrospective Think Aloud dan User Experience Questionnaire,” vol. 2, pp. 1631–1644, 2025, doi: 10.71282/jurmie.v2i12.1485.
[28] M. M. Diani, G. R. Dantes, and M. G. Sunarya, “Evaluasi Usability Sistem Informasi Pengajuan Etik Penelitian (Sietik) Undiksha Berdasarkan Metode Usability Testing Menggunakan Teknik Concurrent Think Aloud, Heuristic evaluation Dan System Usability Scale,” *Inser. Inf. Syst. Emerg. Technol. J.*, vol. 6, no. 2, pp. 215–225, 2025, doi: 10.23887/insert.v6i2.102446.
[29] S. Ernawati and S. Rahayu, “Analisa Usability Pada Aplikasi Identitas Kependudukan Digital Menggunakan Metode Usability Testing,” *BIOS J. Teknol. Inf. dan Rekayasa Komput.*, vol. 5, no. 1, pp. 12–19, 2023, doi: 10.37148/bios.v5i1.87.
[30] A. R. Deluma, R. Maku, and S. Syahrial, "Analisis Usability Model ISO 9241-11 dengan Pendekatan Performance Measurement, Retrospective Think Aloud, dan System Usability Scale pada Sistem Informasi Kuliah Kerja Dakwah," *Jurnal Ilmu Komputer (JUIK)*, vol. 3, no. 2, pp. 25–36, 2023, doi: 10.31314/juik.v3i2.2086.
[31] A. Kusumaningtyas and P. Prihandoko, “Evaluasi Layanan Kesehatan Aplikasi Depok *Single Window* Dengan Metode *System Usability Scale* dan *Heuristic evaluation*,” *J. Teknol. Inf. dan Ilmu Komput.*, vol. 11, no. 1, pp. 167–174, 2024, doi: 10.25126/jtiik.20241117714.
[32] D. K. Wirawan, F. T. Informasi, U. Kristen, S. Wacana, H. Evaluation, and U. Interface, “Penerapan Metode Heuristic evaluation Untuk,” *J. Pendidik. Teknol. Inf.*, vol. 7, no. April, pp. 96–107, 2024, doi: 10.37792/jukanti.v7i1.1236.
[33] P. T. Wardani and A. Pratama, “Analisis Usability Menggunakan Metode Think Aloud Dan Heuristic evaluation Pada Aplikasi Jmo (Jamsostek Mobile) (Studi Kasus: Bpjs Ketenagakerjaan Binjai),” *Sisfo J. Ilm. Sist. Inf.*, vol. 7, no. 1, p. 19, 2023, doi: 10.29103/sisfo.v7i1.12102.