



ORIGINAL ARTICLE

Comparing Heuristic Evaluation and Cognitive Walkthrough in Educational Management Systems: An Expert-Based Assessment

Goli Arji, Farzad Mirzakhani, Meysam Rahmani Katigari, Fathiyeh Bahramnejad*

ABSTRACT

Designing user interfaces for educational platforms is a complex yet essential process for achieving effective learning outcomes. The primary objective of this study was to compare two expert-based usability evaluation methods, heuristic evaluation (HE) and cognitive walkthrough (CW), to determine their effectiveness in identifying usability problems in the Hamava and Sipad. Four evaluators independently assessed the systems using both HE and CW methods. The two approaches were compared based on the number and severity of usability problems, as well as the overall coverage of usability aspects. A total of 173 usability issues were identified across the two systems. The most prominent

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* **Correspondence to:** Fathiyeh Bahramnejad, Sirjan School of Medical Sciences, Sirjan, Iran Email: fathiyeh.bahramnezhad@gmail.com

About the authors:

Goli Arji: Associate Professor, Health information technology, Saveh university of medical sciences, Saveh, Iran.



Farzad Mirzakhani: PhD student in Medical Informatics, Iran University of Medical Sciences, Tehran, Iran.



Meysam Rahmani Katigari: Assistant Professor, Health information technology, Saveh university of medical sciences, Saveh, Iran.



Fathiyeh Bahramnejad: MSc in Medical Informatics, Sirjan School of Medical Sciences, Sirjan, Iran.



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problems in both systems concerned memorability. There was no significant difference in performance between the two evaluation methods in either system ($P > 0.05$). CW is better suited to evaluating systems used by novice users, whereas HE is better suited to evaluating systems used by experienced users. These findings indicate that system developers should choose usability evaluation methods based on the target group and system objectives. The findings of this study can inform the adoption of more effective evaluation strategies and the selection of learning management systems with higher usability.

Keywords: User-Centered Design, Heuristic evaluation, Cognitive walkthrough, Computer-Assisted Instruction, Distance Education

INTRODUCTION

The evaluation of quality, particularly usability, is a crucial step in website development, yet it is often neglected by modern web application developers (1). Numerous studies have demonstrated that poor User Interface (UI) design discourages the use of software services (2, 3). The principal objective of e-learning systems is to proficiently disseminate knowledge, facilitate information exchange, and assist learners in their academic pursuits (1, 4).

The efficacy of information systems is contingent upon their quality, which is ascertained by attributes such as functionality, reliability, usability, and portability (4, 5). Usability represents a significant quality characteristic that evaluates the extent to which user interfaces facilitate ease of use (6). Nielsen defined usability as the combination of factors that affect the interaction between a user and a system. The metrics used to measure usability are diverse, including task completion time, error rate, subjective satisfaction, perceived workload, evaluation of work product quality, and sense of enjoyment. The International Organization for Standardization (ISO) defines usability as "*The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specific context*" (7). Based on this framework, effectiveness is related to the precision and comprehensiveness of the actions undertaken, while efficiency pertains to the quantity of resources expended. User satisfaction may reflect the ease of use and the accessibility of all system functionalities (8).

Usability evaluation aims to enhance systems by identifying and prioritizing usability problems based on their impact on users. Furthermore, it assesses the extent to which users feel comfortable while interacting with the system (9). Inadequate usability reduces the use of information systems and hinders user adoption (10). This ultimately results in declines in user satisfaction, efficacy, and efficiency, as well as in trust in information systems (11). There are different techniques for evaluating information systems. The two primary categories of these techniques are expert-based and user-based. Every usability technique has a different function in identifying issues (12). Heuristic Evaluation (HE) and Cognitive Walkthrough (CW) are two prominent expert-based methods (13). Every approach comes with its unique strengths and limitations. User-based methods are



effective at determining specific issues that hinder users from completing tasks, whereas expert-based methods excel at identifying broader user interface problems (9).

Nielsen's method utilizes 13 primary Human-Computer Interaction (HCI) components to assess information systems. These components include error prevention, adherence to consistency and standards, clarity of system status, error identification and recovery, recognition over recall, interaction and user respect, aesthetic and minimalist design, privacy and security, efficiency, and flexibility of use, help and documentation, user freedom and control, and the match between the system and the real world. The Cognitive Walkthrough (CW) offers a comprehensive analysis of the system's issues. However, it is not as widely used by researchers due to the complexity of filling out the form and the time required to complete it (14).

Jangi et al. (2021) conducted research to assess the usability of the Admission, Discharge, Transfer (ADT) system in non-educational hospitals in Iran using the think-aloud method with 11 participants. Participants were instructed to complete a predetermined scenario and subsequently identify and describe any difficulties they encountered while interacting with the system. All the issues identified were related to data entry processes (15). Montazeri et al. (2020) evaluated eight hospital information systems at Kerman University of Medical Sciences using the ISO 9241/12 standard. Data was collected and analyzed using the ISO 9241/12 checklist. Software compliance varied across different categories, with 79% compliance in information organization, 91% in graphical objects, and 58% in coding techniques. In the development of health information systems, software developers must comply with established standards because precise, up-to-date data is critical to hospital administration and because enhancing systems after implementation is difficult (8).

The usability evaluation of the Hamava and Sipad systems aims to identify the issues that lead to unsuccessful user interaction with these systems. Thus far, no studies have been conducted in Iran to identify usability problems with these systems. Previous research has focused on other information systems, primarily health information systems (8, 9, 11, 13, 16, 17). While HE and KW methods have been widely used in usability studies, their use in the context of educational management systems, in particular, has been less investigated. Educational systems present unique usability challenges due to their diverse user groups, varying levels of expertise, and complex user-driven tasks. It seems that evaluating how these systems perform on usability issues can provide useful insights and, in addition to identifying usability problems, help better understand these systems and the effectiveness of expert-based evaluation methods in educational settings. Moreover, despite the widespread use of usability methods across various fields, their application and the comparison of their effectiveness in educational management systems have received less attention. These systems have a diverse range of users, including students, faculty members, and administrative staff, each with different expertise and interaction needs. This diversity and complexity highlight the necessity of selecting and evaluating different usability methods. This study aims to provide practical insights using two methods, HE and KW. The findings of this study can contribute to a better understanding of how to apply expertise-based usability assessment methods in educational settings.



Objectives

The objective of this study was to uncover usability problems in the Hamava and Sipad educational management systems, which are widely used at various medical sciences universities. To achieve this goal, the study employed Nielsen heuristic evaluation and cognitive walkthrough. This study provides a preliminary expert-based usability assessment of educational management systems.

METHODS

Evaluation Methods

Two evaluation methods, Heuristic Evaluation and Cognitive Walkthrough, were used to evaluate educational management systems. Both methods are expert-based and were conducted without direct involvement from end users. The Heuristic Evaluation method involves experts examining and evaluating the UI based on a set of predefined tasks. This method helps to determine potential problems that users may encounter. Evaluators identify potential problems by examining the user interface design and ensuring it adheres to specified principles. In contrast, the Cognitive Walkthrough method is a structured, task-oriented method that primarily focuses on the system's ease of learning for new users. Evaluators navigate the system to perform tasks such as selecting accurately and assessing how easily new users can complete various tasks (13). Both methods assist in problem identification and enhancing the usability of learning management systems, but they have distinct approaches and objectives. This study emphasizes expert opinion-based evaluation as a preliminary step to identify the main usability problems. Expert opinion-based methods are widely used for usability evaluation at the initial stage due to their efficiency and low cost. These methods provide an initial screening of usability problems, but ideally should be supplemented with user-based assessments.

Studied Systems

To compare the HE and CW methods, two widely used educational services management systems (Sipad and Hamava) in medical universities in Iran were evaluated. These systems have three main user groups (students, professors, and teaching staff) with dedicated panels. They provide a variety of services, including educational management, management of talented students, student-to-professor evaluations, peer-to-peer evaluations, and more.

Evaluator Profile

Prior studies have shown that involving three to five evaluators is adequate for conducting HE and CW assessments (13). Therefore, for the present study, four evaluators were chosen to assess the Hamava and Sipad systems. These evaluators had backgrounds in information technology and related fields and received both theoretical and practical training in the two aforementioned methods. Specifically, four individuals with expertise in medical informatics and health information management, who had experience working with the mentioned systems and evaluating information systems, were selected to conduct the research. So, the evaluators had previous experience in usability evaluation and were familiar with educational information systems, which enabled them to identify usability problems effectively. Furthermore, all evaluators performed the same scenarios and tasks on both systems to ensure consistency and comparability of the results presented.

Data Collection Method

For the HE approach, each reviewer evaluated how well the user interfaces of the Hamava and Sipad systems adhered to Nielsen's 10 principles, using a standardized evaluation form (Table 1). Any non-compliance with these principles was considered a usability problem. Significantly, the checklist underwent translation into Persian, and its validity and reliability have been confirmed in prior research (9). In the context of the CW methodology, the system's user interface was assessed utilizing the framework advanced by Paulson and Lewis (18, 19). This evaluation involved 10 scenarios, each consisting of tasks that evaluators had to perform using the system. The scenarios were developed with experts, system designers, and end users. Examples of the scenarios and tasks are shown in Figure 1.



FIGURE 1. EXAMPLES OF SCENARIOS AND THEIR ASSOCIATED TASKS

The scenarios were designed based on users' most common tasks. To ensure content validity, the scenarios were developed in consultation with domain experts, system designers, and experienced users. The final set of scenarios was reviewed and refined to ensure clarity, relevance, and coverage of key system functions. An example scenario includes "Conducting peer-to-peer evaluations": "Select the Peer Evaluation icon from the Peer-Select the Evaluation Questionnaire-Select the answers to the questions-Save the Evaluation Form." Each scenario consisted of step-by-step tasks that reflect real user interactions.

To conduct the CW assessment, each evaluator logged into the system independently and systematically examined each task to determine any potential issues in user interaction. created a comprehensive Word document detailing the usability issues they identified. This document included thorough descriptions and relevant visual evidence in the form of screenshots. To prevent bias, the HE assessment was conducted on components of the system that also underwent the CW assessment (including 10 scenarios). To minimize potential learning effects, a one-month interval was used between assessment periods. In addition, the combination of HE, KW, and systems methods was balanced across assessors. This approach helped reduce familiarity bias and ensured that previous exposure to the tasks performed did not influence subsequent assessments.

TABLE I. NIELSEN'S TEN HEURISTIC PRINCIPLES

<i>Usability Heuristic</i>	<i>Definition</i>
<i>Visibility of system status</i>	The system should provide the user with appropriate feedback promptly to keep them informed of what is happening.
<i>Match between the system and the real world</i>	The interface should use language that is easy for the user to understand, employing familiar terminology and concepts rather than system-specific technical jargon. It should mimic real-world actions and present information naturally and logically.
<i>User control and freedom</i>	Users should be able to easily select and follow tasks, rather than the system automatically completing them.
<i>Consistency and standards</i>	Users should not be surprised by variations in wording, conditions, or actions; they should instead follow a consistent system and process.
<i>Error prevention</i>	Better than receiving a good error message is preventing a problem from occurring in the first place.
<i>Recognition rather than recall</i>	The creation of items, actions, and results should be visible. Users should not have to remember information from one place to move it to another. Instructions for using the system should be visible at all times or easily retrievable.
<i>Flexibility and efficiency of use</i>	Accelerators often overlooked by novice users can enhance expert users' interaction with the system.
<i>Aesthetic and minimalist design</i>	Conversations should not include irrelevant or rarely needed information. Each extra piece of information in a conversation competes with the important ones, reducing their visibility.
<i>Help users recognize, diagnose, and recover from errors</i>	Error messages should be written in clear and simple language without the use of codes
<i>Help and documentation</i>	Although it is ideal to use the system without documentation, there may be times when assistance and documentation are necessary.

Data Analysis Method

The data collected by four evaluators was reviewed in a joint session. To summarize the results, five main sessions, each lasting approximately four hours, were held. In these sessions, the results of assessments conducted using both Nielsen's exploratory methods

and the cognitive walkthrough were summarized. Finally, a two-hour summary session was held to determine the main problems and identify their severity. This session identified a final list of problems using both methods. The identified problems were discussed and reviewed, and in cases where there was no agreement between the evaluators, they were considered problems upon the approval of a third evaluator.

To summarize the final list of issues, the system's problems were categorized by occurrence rate, effect on the user's workflow, and persistence under similar conditions. The problems were subsequently classified into five categories: absence of problems, minor problems, small problems, big problems, and serious problems. Then, usability problems were categorized by number, severity, and coverage using two methods. The coverage was determined using the ISO standard and Nielsen's usability guidelines. The ISO standard categorizes effectiveness, efficiency, and satisfaction as key principles (13).

Nielsen proposed five usability characteristics: learning efficiency, memorability, error prevention, and user satisfaction (20). Problems were assigned to these areas using assessments, evaluator feedback, screenshots, and written descriptions. The six principles used to categorize problems are presented in Table 2. If a problem fell into multiple categories, evaluators reached a consensus on the most appropriate one. Statistical analysis was performed using SPSS version 23, employing the chi-square test to evaluate differences in the number of usability issues across methods and systems. A significance level of 0.05 was considered in this study.

TABLE II. USABILITY CHARACTERISTICS EXTRACTED FROM ISO AND NIELSEN DEFINITIONS

<i>Features</i>	<i>Definition</i>	<i>Origin (ISO or Nielsen)</i>
<i>Effectiveness</i>	To what extent can users achieve their goals using the system?	ISO 9241
<i>Efficiency</i>	How many resources (specifically time and mental effort) do users need to achieve their goals?	ISO 9241 - Nielsen
<i>Satisfaction</i>	How pleasant is it for users to work with the system?	ISO 9241 - Nielsen
<i>Learnability</i>	How easy is it for first-time users to perform basic tasks?	Nielsen
<i>Memorability</i>	How easy is it for users to regain proficiency after returning to the system after some time?	Nielsen
<i>Errors</i>	How often do users make errors while working with the system? How severe are these errors, and how well can they recover from them?	Nielsen

Ethical Statement

The study was approved by the Ethics Committee of Saveh University of Medical Sciences, Saveh, Iran (approval ID: [IR.SAVEHUMS.REC.1401.030](https://doi.org/10.22034/TJT.3.1.74))

RESULTS

In the Sipad system, the HE method identified 57 usability problems, whereas the CW method identified 24. In the Hamava system, the HE approaches identified 116 problems, and the CW approach identified 51 usability problems. Table 3 displays the number of problems identified across the six usability criteria for each method in both systems. According to the results in Table 3, the system memorability criteria had the highest number of problems identified in both systems, across both exploratory evaluation and cognitive walkthrough methods. Moreover, throughout the evaluation, the exploratory method in both systems identified more problems across all six dimensions than the cognitive walkthrough method. The difference in the number of problems determined by the two methods for the Sipad and Hamava systems across all dimensions except the satisfaction dimension was statistically significant ($p < 0.05$).

TABLE III. COMPARISON OF TWO EVALUATION METHODS BASED ON USABILITY PROBLEMS IN THE SIPAD AND HAMAVA SYSTEMS

Usability problems	Identified problems			
	Heuristic Evaluation (HE)		Cognitive Walkthrough (CW)	
	Sipad System	Hamava System	Sipad System	Hamava System
	N (57)	N (116)	N (24)	N (51)
Effectiveness	2 (3.50%)	16 (13.79%)	2 (8.33%)	6 (11.76%)
Efficiency	7 (12.28%)	12 (10.34%)	5 (20.83%)	5 (9.80%)
Satisfaction	5 (8.77%)	22 (18.96%)	2 (8.33%)	10 (16.60%)
Learnability	14 (24.56%)	17 (14.65%)	4 (16.66%)	6 (11.76%)
Memorability	19 (33.33%)	38 (75.32%)	8 (33.33%)	18 (35.29%)
Errors	10 (17.54%)	11 (9.48%)	3 (12.50%)	6 (11.76%)

Figure 2 displays the percentage of issues identified in both systems that relate to non-compliance with Nielsen usability principles. According to this figure, the Hamava system shows the highest rates of non-compliance with Nielsen principles in the following areas: help and documentation (86.95%), system status visibility (55.17%), user interaction (50%), and recognition over recall (45%). In the Sipad system, the highest rates of non-compliance with these principles were seen in help and documentation (78.26%) and skills (47.61%).

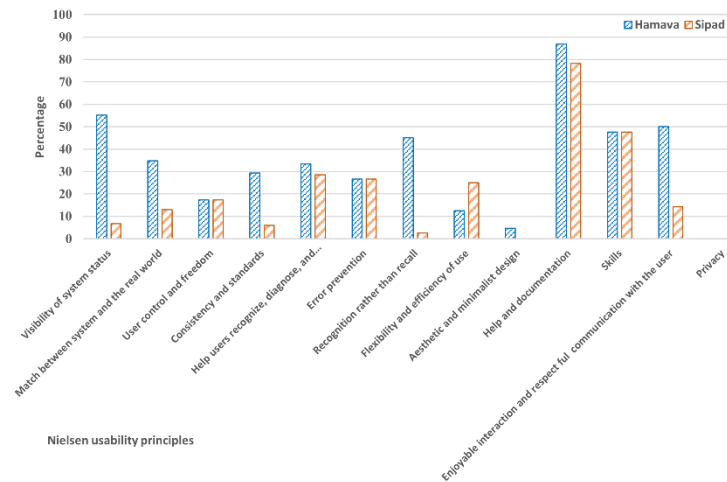


FIGURE II. COMPARISON OF NON-COMPLIANCE OF EACH PRINCIPLE IN THE TWO SYSTEMS

As shown in Figure 3, the Hamava system has more issues across all six dimensions of exploratory evaluation than the Sipad system. This suggests that the Hamava system may have more usability problems than the Sipad system. Users might encounter difficulties when using the Hamava system, such as locating necessary information, efficiently completing tasks, and feeling satisfied with the overall user experience. It's crucial to recognize that these issues were detected exclusively through exploratory evaluation methods. To confirm their validity, additional evaluation techniques, such as usability testing, should be employed. Findings suggest that the Hamava system may have usability issues that require attention. Figure 3 also indicates that the Hamava system has more problems across all six dimensions of cognitive walkthrough evaluation than the Sipad system.

The chi-square test was used to compare the two evaluation methods. The findings indicated no substantial differences between the two evaluation approaches when assessing the systems on criteria such as effectiveness, efficiency, satisfaction, learnability, memorability, and errors. ($P > 0.05$).

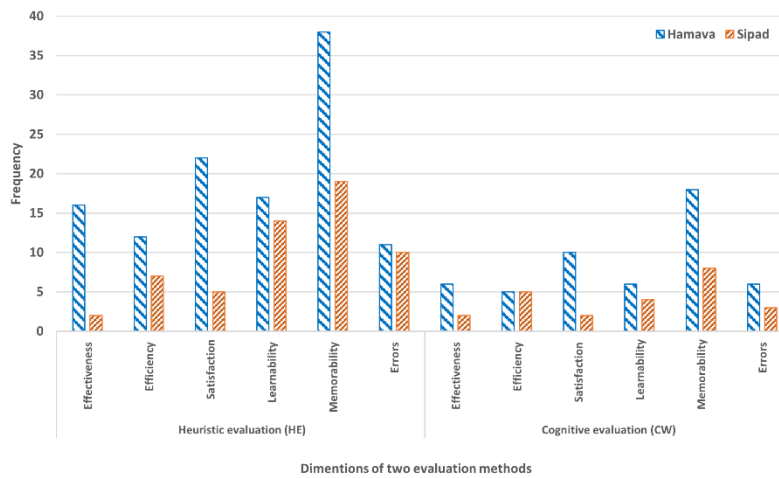


FIGURE III. ILLUSTRATES A COMPARISON OF THE ISSUES PRESENT IN THE HAMAVA AND SIPAD SYSTEMS BASED ON SIX CRITERIA

DISCUSSION

Based on the results, the number of usability problems identified by the HE and CW methods was different between the two evaluated systems. To the best of our knowledge, this is the first study to compare the HE and CW methods for evaluating educational systems in medical universities. The present study demonstrated that, when evaluated against Nielsen's principles, the Sipad system outperformed the Hamava system in several key components. These components included system visibility state, system-real-world compatibility, compatibility and standards, error prevention, recognition over recall, design aesthetics, simplicity, skills, enjoyable interaction, and respect for the user. The most prevalent issues identified in the Hamava system through heuristic evaluation and cognitive walkthrough concerned the user's ability to recall information within the system. This suggests a need for enhancements in the design and user experience of the Hamava system.

The present study revealed significant issues with the Hamava and Sipad systems in terms of human-computer interaction design principles, as assessed using the Nielsen model. These results align with previous research by Chen et al. (21) and Farzanipour et al. (22). Among the identified problems for both systems, issues that significantly impact user experience were classified as major problems and disasters (23).

Based on the results, both systems had similar problems with some principles. Nevertheless, the number of issues detected in the Hamava system was consistently higher than in the Sipad system. Throughout this study, issues such as inconsistency between the naming of terms related to each menu and the scope of user tasks, use of unrelated and unfamiliar icons, inclusion of too many items in a menu, lack of connection between colors and menus, ambiguous notifications, absence of necessary information and icons to perform activities, lack of user guides and instructions, improper display of program pages on mobile phones, lack of appropriate feedback when errors occur, and inability to cancel ongoing operations were among the most significant problems



identified in these systems. These findings align with Khajouei et al. (24). It appears that information systems should be designed to inform users of the system's status while providing appropriate feedback in various situations.

When comparing the six dimensions of the exploratory assessment method and cognitive walkthrough, the Hamava system exhibited more issues than the Sipad system in all dimensions. The exploratory assessment, being the simplest, fastest, and least expensive assessment method, is recommended for use in the first phases of clinical systems development to enhance usability before implementation in a real clinical environment (28), this finding aligns with Khajouei et al. (15). Additionally, study by Dobaldi et al., comparing the exploratory assessment method with user-centered methods, demonstrated that the exploratory method is more adept at identifying issues (29). However, the results obtained from this method largely depend on the assessors' expertise and background (30, 31).

Research by Jeffries et al, comparing four usability assessment approaches, including HE and CW, demonstrated that the exploratory assessment approaches determined a higher number of usability problems (13).

In a study by Paula et al., most of the issues identified through the heuristic evaluation approach were related to mismatches between the system and the real world, as well as to a preference for recognition over recall. In the user-based evaluation approach used in the current research, users reported problems with responding to system messages, finding instructions for printing a page, navigating to the next page, and closing the current window (17). Paul et al. also noted that heuristic evaluation can identify approximately 50% of usability problems and that this method is more effective at detecting issues experienced by novice and inexperienced users (18).

In the research conducted by Khajouei et al. (19), no statistically significant difference was observed in the average severity of the recognized issues. However, another study (3) reported a significant difference in problem identification between the two assessment approaches. Another study (1) discovered that the heuristic assessment approach determined more problems than the cognitive walkthrough method. This approach was effective in identifying major problems, including large and catastrophic issues such as inconsistencies in icons, fields, and colors, as well as the use of similar icons for various tasks.

Furthermore, this study highlights the importance of the CW evaluation method, which can effectively identify issues such as the different phases required to execute a specific task and the absence of feedback during user interaction with the system. Therefore, relying solely on one method for system evaluation may overlook the strengths of other methods. The CW method excels in pinpointing problems related to user interaction with the system, a feature lacking in the heuristic evaluation method. Given the inherent limitations of each evaluation approach, studies generally recommend using a combination of these approaches.

One notable distinction between the current paper and prior research endeavors is the nature of the assessment performed. Specifically, the present study relied on only two expert-based evaluation methods, whereas previous studies used a combination of expert-based and user-based methods. Therefore, the difference in results may be related to the type of evaluators and their level of interaction with the systems being evaluated. It has



been recommended to use a combination of expert-based and user-based approaches to identify usability problems better.

In the current study, the same group conducted both an exploratory and a cognitive walkthrough approach to avoid bias. Some studies (25) suggest that the exploratory method, which is based on principles and guides the evaluator in problem identification, is more effective at identifying system issues than the cognitive walkthrough method. On the other hand, cognitive walkthrough uses specific scenarios to guide the user towards achieving goals and performing actions in the system (18). Additionally, the cognitive walkthrough method can facilitate more accurate problem identification by providing screenshots and explanations to evaluators, as noted in the research by Tariq et al. (26). While the problems determined in both methods often align and reveal similar issues, as supported by the study by Yen et al. (16), it is important to note that these findings are consistent with each other.

There are various methods for developing information systems; some designs may be based on predefined principles and standards that emphasize layout, appearance, and compatibility with user interface design. Another approach may prioritize the tasks that the system must perform, including user actions and system responses (27). Studies have demonstrated that using evaluation methods for information systems before their deployment in real environments can help prevent the negative effects these systems may have on users' work processes (28). In other words, user-based methods can identify more usability issues, especially those related to actual user interaction and experience. The two evaluation methods, HE and KW, should be recognized as complementary methods in usability evaluation, not as substitutes for user-based methods.

Due to their structural simplicity, checklist-based evaluation methods can help evaluators focus on system problems. Therefore, using these tools is highly recommended in the early stages of system development. Additionally, these tools can also be utilized in the selection and purchase of information systems by various organizations (29).

Strengths and weaknesses

The most important advantage of this study was the use of two evaluation methods in Hamava and Sipad. The outcome of this research can be applied to improving current systems. Although the results of this study cannot be generalized to other information systems in education, they can also be used to inform the optimal design of other systems' user interfaces. Another advantage of this study is the use of two methods based on checklists and exploratory evaluation, which help identify items that may not be included in the checklist. Using the cognitive navigation evaluation approach, the largest number of problems pertinent to these two systems was identified. One of the most important limitations of this study is its reliance on expert-based evaluation methods. Involving real users of the system, such as university students and professors, can provide a more realistic assessment of emotional responses, user satisfaction, and the practical challenges associated with performing a particular task. Therefore, it is recommended that future studies integrate user-based evaluation methods with end users (students, faculty members, and staff) to achieve a more comprehensive understanding of usability problems.



CONCLUSION

Based on the results of this study, 173 usability problems were identified across the two systems. There was no significant difference between the two methods, KW and HE, in terms of the number of problems identified ($P > 0.0$). On the other hand, these two approaches differed in how they identified problem severity and usability dimensions. Most of the problems were related to the memorability dimension. These findings indicate that the HE method is better suited to experienced users, whereas the CW method is recommended for evaluating systems used by novice users. From a practical perspective, the findings of this study suggest that the HE method is useful for identifying general usability issues among experienced users. In contrast, the CW method is recommended for assessing system learnability and performance among novice users. Furthermore, addressing usability issues can reduce users' dependence on technical support and improve end-user satisfaction and efficiency. For decision-makers such as university administrators and IT managers, these results can provide guidance for more informed selection and provision of educational systems with higher usability standards. Since the two approaches used in this study are expert-based, future research should consider user-based methods to capture real user experiences and evaluate systems more comprehensively.

Declaration of the Use of Artificial Intelligence Tools

Intelligence tools (AI) were used solely for language editing and improving the clarity of the manuscript.

Contributorship Statement

Conceptualization, study design, methodology development (GA, FM), data collection, usability evaluation, interpretation of findings, data analysis (GA, FM, MR, FB), manuscript drafting, final revision (GA, FM, MR, FB). All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Declaration Of Conflicting Interests

The authors declare no conflicts of interest regarding the research, authorship, and publication of this article.

Data Availability Statements

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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