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Usability Testing of the Web-Based Learning Resource Center Kumatalibi.com Using the System Usability Scale (SUS) Among Preservice Biology Teachers

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ABSTRACT
Educational technology platforms and tools generally exhibit good to high usability, as measured by the System Usability Scale (SUS). Several studies indicate that usability scores are not significantly influenced by user demographics such as age, gender, or device type. However, factors like the subject matter, personality traits, and educational stage can sometimes affect perceived usability. This overview will delve into these aspects, highlighting key findings from relevant studies. This study aims to evaluate the usability of the web-based learning resource center Kumatalibi.com using the System Usability Scale (SUS) method, which consists of 10 standardized questions to assess a system's usability quality. A total of 101 preservice biology teacher students participated in the study. The results showed that the average SUS score was 73. Based on this score, the website received a grade of C, placed in the 70th percentile, categorized as "Good" in adjective rating, "Marginal" in acceptability, and classified as "Passive" based on its Net Promoter Score (NPS). These findings indicate that the learning website is generally acceptable to users; however, improvements are needed to enhance user satisfaction. Enhancing usability may lead to better learning outcomes for preservice biology teacher students.

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Introduction

The integration of technology into education has become increasingly essential in the 21st century. Digital learning platforms offer flexibility, accessibility, and interactivity, aligning with the evolving needs of students in various educational contexts (Selwyn, 2016). One prominent technological advancement in this field is the development of web-based learning platforms, which allow learners to access educational resources anytime and anywhere, thus supporting lifelong learning and personalized instruction (Means et al., 2014). Web-based learning resource centers play a crucial role in fostering self-directed and interactive learning. These platforms can serve as centralized hubs for diverse educational materials, enabling learners to explore content at their own pace, revisit complex topics, and engage in independent inquiry (Ally, 2009). For preservice biology teachers, who are expected to master both pedagogical skills and scientific content, access to effective online learning tools is particularly important. They require resources that are not only scientifically accurate but also pedagogically sound, easy to use, and aligned with their academic and professional goals.

Although a wide range of web-based learning platforms are available, not all demonstrate high levels of usability. Usability refers to the ease with which users can interact with a system, and it significantly influences the effectiveness and efficiency of learning (Nielsen, 1993). Poor usability can lead to user frustration, decreased engagement, and ultimately, reduced learning outcomes. Despite its growing use, Kumatalibi.com, a web-based learning resource designed for biology education, has not undergone systematic usability evaluation. Without empirical evidence about its usability, it is difficult to determine whether the platform meets the needs of its intended users—preservice biology teachers. Understanding their experiences is essential to ensure that the platform effectively supports their learning and teaching preparation. Kumatalibi.com was created to support the learning process as part of assessment for learning. Unlike other platforms, Kumatalibi.com serves as a centralized collection of teaching materials for biology. This means that users can find all necessary biology teaching materials in one place, making it a comprehensive resource for biology learning.

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The System Usability Scale (SUS) can be applied to various types of testing, ranging from websites, information systems, and software. Usability testing using the SUS method has been widely conducted by researchers to determine the usability quality of a system, allowing developers to evaluate the system design based on the test results. Usability testing is a critical process in the development and refinement of educational technologies. It ensures that platforms are user-friendly, accessible, and conducive to learning (Hornbæk, 2006). One of the most widely used tools for evaluating usability is the System Usability Scale (SUS), developed by John Brooke (1996). The SUS is a ten-item questionnaire that provides a quick, reliable way to measure the usability of various systems, including websites, software, and mobile applications. Its simplicity and effectiveness make it a standard in usability evaluation across industries and research domains (Bangor et al., 2008). Applying the SUS to evaluate Kumatalibi.com will provide valuable insights into its strengths and weaknesses from the user's perspective. These insights can guide future improvements, ensuring the platform is not only functional but also enjoyable and effective for users.

While numerous studies have explored the usability of general learning management systems (e.g., Moodle, Edmodo, Google Classroom), there is a lack of research specifically focused on niche platforms like Kumatalibi.com. No known studies to date have applied a quantitative usability evaluation method, such as the SUS, to this platform. This gap highlights the need for empirical data regarding the user experience of preservice biology teachers interacting with Kumatalibi.com. Addressing this gap is important for improving the platform's design and maximizing its educational potential. Moreover, understanding user satisfaction and usability issues is critical for promoting sustained use and integration into teacher education programs. Studies consistently show that educational technology platforms achieve satisfactory to high usability scores. For instance, a systematic review found that the mean SUS score for learning management systems (LMS) was 76.27, indicating a satisfactory level of usability (Orfanou, K., et al, 2015). This "satisfactory" category can be used as a reference for the continued use of a developed application or platform.

Specific platforms like Google Classroom and Microsoft Teams have been evaluated for usability, with Google Classroom receiving higher usability scores. However, user preference for Microsoft Teams, despite its lower usability score, suggests that factors beyond usability, such as functionality and integration, are also important ("Usability Evaluation of Learning Management Systems: Google Classroom, Microsoft Teams and Padlet," 2023). The usability of platforms like Edusmart and Pijar Mahir has been evaluated using SUS, with scores indicating acceptable to high usability, further supporting the general trend of good usability in educational technologies (Tsani, 2024; Laurence & Kaburuan, 2021).

This study aims to evaluate the usability of Kumatalibi.com, a web-based learning resource center, using the System Usability Scale (SUS) from the perspective of preservice biology teachers. The findings will provide empirical evidence on the platform's usability and offer recommendations for improvement to better support teacher training in biology education.

Methods

Research Design

This study employed a quantitative descriptive research design aimed at assessing the usability level of the web-based learning resource platform Kumatalibi.com based on user perceptions. This approach is effective for systematically collecting numerical data to describe the usability of Kumatalibi.com and for identifying patterns or trends in usability data (Yang & Zhang, 2023; Sun, 2020). A survey approach was used, utilizing the standardized System Usability Scale (SUS) instrument to collect data systematically.

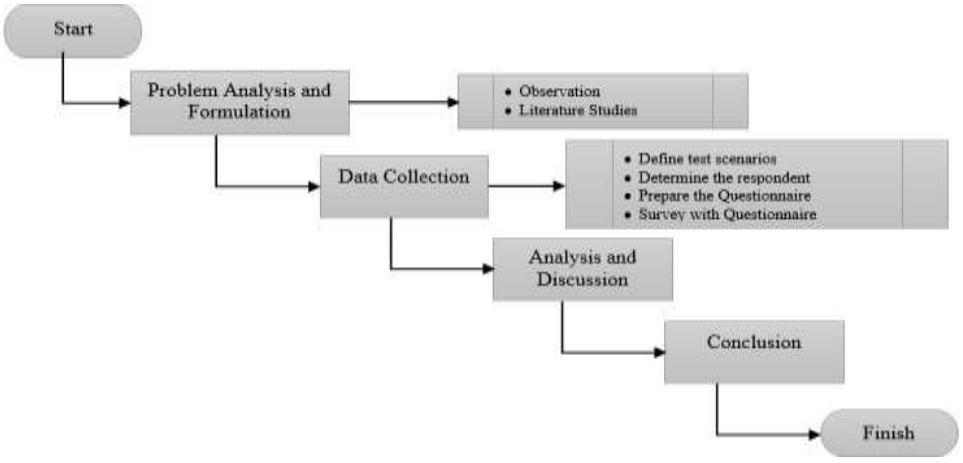

Figure 1. The Stage of The Research

Participant

The target population for this study comprised 101 preservice biology teacher students from one of the state Islamic teacher training colleges in Bandung, Indonesia. Participants were selected using a purposive (non-probability) sampling method. Inclusion criteria required participants to be actively enrolled in a biology education program and to have experience using Kumatalibi.com during the study period. Participants had access to Kumatalibi.com for one week before the usability test was administered. Usability scores are generally not significantly affected by user demographics such as age and gender. For instance, a study involving Greek teachers found no significant correlation between SUS scores and participants' age or gender (Vlachogianni & Tselios, 2021). Similarly, another review noted that age did not significantly correlate with usability scores measured by the Post-Study System Usability Questionnaire (PSSUQ) and Computer System Usability Questionnaire (CSUQ) (Vlachogianni & Tselios, 2023). Based on this, gender demographics were not a primary focus for analysis in this study.

Instrument

In studies evaluating educational platforms, the System Usability Scale (SUS) is valued for its simplicity, reliability, and ability to yield actionable insights, even with relatively small sample sizes. It is commonly used to assess websites, e-learning platforms, and other digital tools, providing developers and educators with a clear sense of how well a system supports user needs and expectations (Prasetya, et al, 2023). Researchers frequently use the SUS method for usability testing to assess a system's usability quality, enabling developers to evaluate system design based on the test findings. The SUS was the primary instrument for data collection in this study. It consists of 10 items, each rated on a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." Odd-numbered items are positively worded, while even-numbered items are negatively worded, following the standardized scoring method established by Brooke (1996). The SUS is a well-validated and reliable tool for usability evaluation, widely recognized across various fields (Bangor, Kortum, & Miller, 2008). It provides a single score on a scale of 0 to 100, reflecting the overall usability of a system. The questionnaire was compiled into a Google Form and distributed to participants for one month in April 2025.

Table 1. System Usability Scale (SUS) Statement Item ()adapted from Brooke, 2013

Code	Statement items	Scale
Q1	I thought that I would like use this media system (kumatalibi.com) again.	1 to 5
Q2	I found that the media system (kumatalibi.com) complicated to use.	1 to 5
Q3	I have found this media system easy to use.	1 to 5
Q4	I thought that I would need the support of technical person to be able to use kumatalibi.com	1 to 5
Q5	I have found that the features of this media system are functioning properly.	1 to 5
Q6	I have felt that there are many things that are inconsistent.	1 to 5
Q7	I have felt that others will quickly understand how to use this media system.	1 to 5
Q8	I have found this media system confusing.	1 to 5
Q9	I have not encountered any obstacles in using this media system.	1 to 5
Q10	I need to familiarize myself with this media system first.	1 to 5

Data Collection Procedure and analysis technique

The data collection process involved several stages. Participants were first informed about the objectives and benefits of the study. They were then instructed to use the Kumatalibi.com platform over a specified period. After this usage period, participants completed the SUS questionnaire, which was administered either online or offline. Data were collected from March to April 2025. The SUS scores were calculated using the standard scoring formula, producing individual scores on a 0–100 scale. These scores were then analyzed to generate: Average SUS score, Usability grade (A–F scale), Percentile rank, Adjective rating (e.g., Excellent, Good, OK, Poor), Acceptability range (Acceptable, Marginal, Not Acceptable), Net Promoter Score (NPS) category (Detractor, Passive, Promoter).

Descriptive statistics, including tables, charts, and narrative explanations, were used to present and interpret the findings based on established SUS benchmarks (Brooke, 1996; Bangor et al., 2009). The stages of data collection are as follows:

1. Selection of Respondents The respondents involved in this test are prospective biology teachers related to the material presented on kumatalibi.com.
2. Testing Materials and Media available on the kumatalibi.com website. The testing materials consist of a module that must be completed by respondents using testing media in the form of laptops or mobile phones. The website content includes assessments for learning and materials for studying general biology content.
3. Testing Implementation Testing will be conducted offline through face-to-face meetings and online using social media, which will be continuously monitored by the testing team.

Results and Discussions

Profil Web Based Learning Resorce center kumatalibi.com

Kumatalibi.com is an Indonesian web-based digital learning resource center specifically designed to support biology education at the secondary school level. The platform serves as a centralized repository of educational materials, including teaching resources, multimedia content, and interactive tools, all aimed at enhancing the learning experience for

both students and educators. The development of Kumatalibi.com was guided by the ADDIE instructional design model, encompassing the stages of Analysis, Design, Development, Implementation, and Evaluation. This systematic approach ensures that the platform meets educational standards and effectively addresses the needs of its users. Additionally, respondents cited the ease of operating and accessing the Kumatalibi.com platform as a key benefit. Key features of Kumatalibi.com include:

1. Comprehensive Content: The platform offers a wide range of biology topics, such as cell division, genetics, heredity patterns, and growth and development, all aligning with national curriculum standards.
2. Multimedia Integration: To facilitate diverse learning styles, Kumatalibi.com incorporates various multimedia elements, including video tutorials, infographics, and interactive modules, enhancing student engagement and understanding.
3. User-Friendly Interface: Developed using modern web technologies, the platform ensures accessibility across multiple devices, including smartphones, tablets, and computers, providing flexibility for users to access learning materials anytime and anywhere.
4. Support for Independent Learning: By offering self-paced learning resources, Kumatalibi.com empowers students to take charge of their learning journey, fostering autonomy and critical thinking skills.

The platform has undergone validation studies to assess its feasibility and effectiveness. Expert evaluations have categorized the content and technical aspects of Kumatalibi.com as highly feasible, indicating its suitability as a reliable educational resource. In summary, Kumatalibi.com stands as a significant contribution to digital biology education in Indonesia, providing accessible, high-quality resources that support both teaching and learning processes.

Figure 2 . https://kumatalibi.com/

Score SUS Web Based Learning Resorce center kumatalibi.com om

The usability of the Kumatalibi.com web-based learning platform was assessed using the System Usability Scale (SUS), which provides a quantitative measure of user satisfaction and system usability. A total of 101 preservice biology teacher students participated in this study, each completing the 10-item SUS questionnaire after interacting with the platform.

No	Repondents	Age	Original Score (Sample Data)									
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	Responden 1	21	4	2	3	2	4	3	3	3	3	2
2	Responden 2	22	4	2	4	2	5	3	4	3	4	2
3	Responden 3	23	5	1	5	2	5	2	4	2	4	2
4	Responden 4	24	4	2	4	2	4	3	4	2	3	2
5	Responden 5	25	4	2	4	2	3	3	4	3	3	2
6	Responden 6	21	4	2	4	2	4	3	4	3	4	2
7	Responden 7	22	4	4	3	2	4	3	3	2	3	2
8	Responden 8	23	4	1	4	3	4	1	4	1	3	3
9	Responden 9	24	5	2	3	2	3	3	3	3	3	3
10	Responden 10	25	4	1	4	2	3	3	4	2	4	3
11	Responden 11	21	4	2	4	2	4	3	4	3	4	2
12	Responden 12	22	5	2	4	2	5	1	5	1	4	2
13	Responden 13	23	4	2	4	2	4	2	3	2	4	3
14	Responden 14	24	4	2	3	2	4	3	3	3	3	3
15	Responden 15	25	4	2	4	2	4	2	4	2	4	2
16	Responden 16	21	5	2	4	2	3	3	2	2	3	2
17	Responden 17	22	4	2	4	2	4	2	4	2	4	3
18	Responden 18	23	4	2	4	2	4	2	4	2	3	2
19	Responden 19	24	5	3	3	3	5	3	4	3	5	2
20	Responden 20	25	4	2	4	2	4	3	4	2	4	2
21	Responden 21	26	4	2	4	2	4	3	4	3	4	3
22	Responden 22	27	4	2	3	2	4	2	3	2	3	2
23	Responden 23	28	4	2	3	3	4	2	4	2	3	2
77	Responden 77	82	4	2	4	3	4	2	4	2	4	3
78	Responden 78	83	4	2	4	2	4	3	4	2	4	2
79	Responden 79	84	5	1	5	1	5	1	5	1	5	1
80	Responden 80	85	5	2	4	3	5	1	4	1	4	2
81	Responden 81	86	5	2	5	1	5	2	4	2	4	2
82	Responden 82	87	4	3	4	2	4	3	3	3	3	2
83	Responden 83	88	4	4	2	2	4	2	4	3	3	2
84	Responden 84	89	4	2	5	2	4	2	4	2	4	2
85	Responden 85	90	5	1	5	1	5	3	5	1	5	2
86	Responden 86	91	4	2	4	3	4	2	4	2	4	2
87	Responden 87	92	4	2	4	2	4	2	4	2	4	2
88	Responden 88	93	4	2	4	3	4	2	4	2	4	3
89	Responden 89	94	5	2	5	2	5	2	5	2	2	2
90	Responden 90	95	5	1	5	3	5	2	5	2	3	3
91	Responden 91	96	5	2	4	2	4	2	5	1	3	2
92	Responden 92	97	4	2	4	2	4	2	4	2	3	2
93	Responden 93	98	4	2	4	2	4	2	4	2	4	2
94	Responden 94	99	5	2	5	2	4	1	4	1	5	3
95	Responden 95	100	4	2	4	2	4	2	4	2	4	2
96	Responden 96	101	4	3	5	1	4	2	5	2	4	2
97	Responden 97	102	4	2	4	2	4	3	4	2	4	2
98	Responden 98	103	4	2	4	2	4	2	4	2	4	2
99	Responden 99	104	4	4	4	2	3	3	4	2	4	2
100	Responden 100	105	4	1	4	3	5	2	4	1	4	2
101	Responden 101	106	4	4	4	2	4	2	4	3	4	3

Figure.3 Raw data results of usability testing on kumatalibi.com (details available at https://docs.google.com/spreadsheets/d/1OmPlKUuvXui2wD1kH_PoW4QIztRufwNMfK4BPgRI_A/edit?usp=sharing)

After collecting data from respondents, the next step involved calculating the SUS scores using the standard method to obtain the final usability score. The System Usability Scale (SUS) has specific rules to ensure accurate testing. Here's how the SUS score is calculated:

1. For odd-numbered questions, subtract 1 from the scale result (x). Odd questions = (x-1).
2. For even-numbered questions, subtract 5 from the scale result (x). Even-numbered questions = (5-x).
3. Evaluate the responses on a scale of 1-5 (1 means “Strongly Disagree” and 5 means “Strongly Agree”).
4. Sum the responses and then multiply by 2.5.
5. Determine the average score of the test instrument for all respondents.

Following these criteria, the average SUS score obtained from 101 respondents who participated in the usability testing on the Kumatalibi.com website was 73, as shown in Figure 4 below.

Skor Hasil Hitung (Data Contoh)										Jumlah	Nilai
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10		(Jumlah x 2.5)
3	3	2	3	3	2	2	2	2	3	25	63
3	3	3	3	4	2	3	2	3	3	29	73
4	4	4	3	4	3	3	3	3	3	34	85
3	3	3	3	3	2	3	3	2	3	28	70
3	3	3	3	2	2	3	2	2	3	26	65
3	3	3	3	3	2	3	2	3	3	28	70
3	1	2	3	3	2	2	3	2	3	24	60
3	4	3	2	3	4	3	4	2	2	30	75
4	3	2	3	2	2	2	2	2	2	24	60
3	4	3	3	2	2	3	3	3	2	28	70
3	3	3	3	3	2	3	2	3	3	28	70
4	3	3	3	4	4	4	4	3	3	35	88
3	3	3	3	3	3	2	3	3	2	28	70
3	3	2	3	3	2	2	2	2	2	24	60
3	3	3	3	3	3	3	3	3	3	30	75
4	3	3	3	2	2	1	3	2	3	26	65
3	3	3	3	3	3	3	3	3	2	29	73
3	3	3	3	3	3	3	3	2	3	29	73
4	2	2	2	4	2	3	2	4	3	28	70
3	3	3	3	3	2	3	3	3	3	29	73
3	3	3	3	3	2	3	2	3	2	27	68
3	3	2	3	3	3	2	3	2	3	27	68
3	3	2	2	3	3	3	3	2	3	27	68
4	3	3	2	4	4	3	4	3	3	33	83
4	3	4	4	2	3	3	3	3	3	32	80
3	2	3	3	3	2	2	2	2	3	25	63
3	1	1	3	3	3	3	2	2	3	24	60
3	3	4	3	3	3	3	3	3	3	31	78
4	4	4	4	4	2	4	4	4	3	37	93
3	3	3	2	3	3	3	3	3	3	29	73
3	3	3	3	3	3	3	3	3	3	30	75
3	3	3	2	3	3	3	3	3	2	28	70
4	3	4	3	4	3	4	3	1	3	32	80
4	4	4	2	4	3	4	3	2	2	32	80
4	3	3	3	3	3	4	4	2	3	32	80
3	3	3	3	3	3	3	3	2	3	29	73
3	3	3	3	3	3	3	3	3	3	30	75
4	3	4	3	3	4	3	4	4	2	34	85
3	3	3	3	3	3	3	3	3	3	30	75
3	2	4	4	3	3	4	3	3	3	32	80
3	3	3	3	3	2	3	3	3	3	29	73
3	3	3	3	3	3	3	3	3	3	30	75
3	1	3	3	2	2	3	3	3	3	26	65
3	4	3	2	4	3	3	4	3	3	32	80
3	1	3	3	3	3	3	2	3	2	26	65
Rata - Rata											73
STDEV											8,42

Figure 4. test results using the SUS method

The results, as shown in Figure 4, indicated an average SUS score of 73. According to Brooke's (1996) SUS scoring interpretation and subsequent refinements by Bangor et al. (2009), this score falls within the "Good" category in terms of adjective rating. This places the website in the 70th percentile, indicating that it performs better than 70% of the systems evaluated using the SUS benchmark. Despite this relatively high percentile, the SUS grade equivalent for a score of 73 is a C, and the acceptability range is classified as "Marginal." Additionally, the Net Promoter Score (NPS)—a metric indicating user loyalty and likelihood to recommend the system—categorized the user base as "Passive," implying moderate satisfaction without strong advocacy.

Quoted from an article written by Jeff Sauro on the website measuringu.com (Sauro, 2022), SUS can be interpreted in five ways, namely percentiles, grades, adjectives, acceptability, and Net Promoter Score (NPS). Figure 6 explains the details related to the assessment categories in SUS. Based on the score obtained, the kumatalibi website is included in grade B with percentiles 73, which means that 73% of the SUS score is better than 27% in the database, and can be entered into the Good category in adjective ratings, the Marginal type acceptable category and Net Promoter Score (NPS) in the Passive category. That way it can be said that the usability of the desktop and mobile versions of the kumatalibi.com website tested on respondents is in a good category and can be accepted by many people. These scores suggest that while the usability of Kumatalibi.com is acceptable overall, it has not yet reached the level of excellence that would convert users into enthusiastic promoters of the platform.

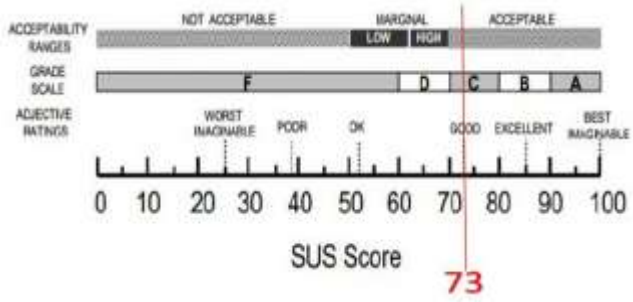

Figure 5. SUS Score Web Based Learning Resorce center kumatalibi.com

The results obtained were further supported by the feedback provided by respondents in the open-ended questionnaire. For instance, many found the Kumatalibi.com platform enjoyable, especially the game-based learning section, noting that it allowed them to "learn while playing." The System Usability Scale (SUS) evaluation indicates that Kumatalibi.com has achieved a generally acceptable level of usability among its target users. A SUS score of 73 is above the average benchmark (68), which suggests the website meets basic usability expectations for a digital learning resource. This is especially important for preservice biology teachers, who require intuitive, accessible, and pedagogically relevant tools to support both independent learning and future classroom integration. However, the designation of a C grade and a "Marginal" acceptability range highlights that certain aspects of the platform may hinder an optimal user experience. Factors contributing to this could include issues such as inconsistent navigation, interface complexity, insufficient responsiveness across devices, or a lack of personalization features. Previous studies have shown that user satisfaction with educational platforms is closely tied to factors such as clarity of content layout, visual design, responsiveness, and interactivity (Alqahtani & Mohammad, 2020; Zaharias & Poylymenakou, 2009). Furthermore, the classification of users as "Passive" in the Net Promoter Score (NPS) assessment reveals a lack of strong emotional attachment or enthusiasm toward the platform. According to Reichheld (2003), passive users are less likely to recommend a product or service and are susceptible to switching to alternative options. For a platform designed to promote engagement and long-term usage in educational settings, this signals a need for improvement in both functionality and emotional appeal. Improving usability can lead to significant benefits, particularly in enhancing student engagement, motivation, and ultimately, learning outcomes (Davis, 1989). For example, features such as progress tracking, real-time feedback, and user customization could enhance perceived usefulness and ease of use, aligning with the Technology Acceptance Model (TAM). Additionally, the incorporation of interactive content—such as simulations, quizzes, and gamification elements—has been proven to improve learner satisfaction and retention in web-based environments (Sung et al., 2017). In light of these findings, it is recommended that the developers of Kumatalibi.com conduct further usability testing with a focus on qualitative user feedback, usability heuristics, and iterative design improvements. This could help address specific user pain points and increase the platform's overall effectiveness as a digital learning tool.

A recent study by Maryanti, S. (2025) assessed the acceptance of Kumatalibi.com among prospective biology teachers using the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The findings highlighted that "facilitating conditions" (the degree to which users believe that an organizational and technical infrastructure exists to support system use) were the most influential factor in technology adoption, followed by performance expectancy, effort expectancy, and affective need. While this study did not directly measure usability via SUS, it suggests that the platform is generally well-received, with infrastructure and support being key to user acceptance.

Conclusions

This study evaluated the usability of the web-based learning resource center, Kumatalibi.com, using the System Usability Scale (SUS) method. Involving 101 preservice biology teacher students, the assessment yielded an average SUS score of 73, categorizing the website as "Good" in terms of usability and placing it in the 70th percentile. However, the platform received a grade of C with a "Marginal" acceptability rating and a "Passive" Net Promoter Score (NPS). This indicates that while Kumatalibi.com is generally usable, there's a clear need for improvements to enhance user satisfaction and engagement.

These findings underscore the importance of continuous enhancement for web-based educational platforms. By addressing identified usability issues, such as potential navigation complexity and responsiveness across devices, Kumatalibi.com can significantly improve the learning experience for preservice biology teachers. Furthermore, a more user-friendly interface coupled with personalized features could lead to greater user satisfaction and, consequently, improved learning outcomes. Future studies should focus on conducting detailed qualitative user feedback sessions and further usability testing to pinpoint specific areas for improvement, ensuring the platform effectively meets the diverse needs of its users.

While the general trend suggests good usability in educational technology platforms, it's crucial to recognize that usability is not the sole determinant of user satisfaction and preference. Other factors, including functionality, seamless

integration with existing systems, and specific user needs, also play significant roles. Additionally, while personality traits and educational stages can influence perceived usability, these factors may be less modifiable than demographic characteristics, suggesting a need for personalized approaches in educational technology design and implementation to maximize their effectiveness.

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