

An Empirical Investigation of Usability Measurement in Canvas Educational Applications

A Case Study at the University of North Texas

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Abstract—A Learning Management System (LMS) is a computer software that enables teachers and students to become more actively involved in their studies and learn more effectively. The Canvas LMS is one of the best examples in this field as it is a widely adopted LMS. It is extensively utilized throughout a range of educational institutions, involving K-12 schools as well as universities. The platform has received recognition for its intuitive user interface and comprehensive selection of impacts educational resources. This study is conducted on computer science students at the University of North Texas because this sample of students is more familiar with the terminologies used in the study regarding gauging usability in Canvas applications. This is done in accordance with the Jacob Nielsen usability factors study. The goal of this study is to identify the most significant problems with the usability of the Canvas application. This study simultaneously examines and classifies them according to several aspects, and then determines how to address and improve the responses for each of these factors. This methodologies adopted in this study serve as a tool for the main investigation, and the 104 students successfully completed it. The overall scale in the study had a Cronbach's alpha rating of 0.969, which shows that the reliability and consistency of the questionnaire in this study are quite high. The survey's framework was built upon the principles outlined by Jacob Nielsen for mobile usability. During the pilot testing phase of the survey, the results revealed a substantial percentage of reliability and validity. Despite minor fluctuations, the findings consistently demonstrated a commendable level of reliability. These results open the door for further investigations.

Keywords—Usability; Human-Computer Interaction; Learning Management Systems; User Reviews; Mobile Application Platform.

I. INTRODUCTION

During the COVID-19 pandemic, the evolution and enhancement of Learning Management Systems (LMS) have been notably pronounced, with Canvas emerging as a prominent example. Canvas LMS boasts a comprehensive set of features that benefit both students and instructors, contributing to the positive development of online education during this challenging period [1]. The Canvas app is one of the most significant LMS applications [2]. These platforms offer a variety of functions and resources to help in managing courses, distributing content, and grading students. The ease of use and

steep learning curves of these platforms greatly influence their efficiency. A LMS is highly useful when it is simple for users to use, efficient, and requires minimal effort on their part to fulfill tasks. The value of the Canvas app has been examined in a few of studies [1][3] when compared to other educational apps, the usefulness of the Canvas application is proven to be high. It is discovered that students using Canvas scored higher on its navigation easiness and friendly layout.

Mobile learning has a lot of educational potential. The most recent iteration of mobile technology makes it simple to provide digital material using portable wireless mobile devices. Because of the inherent limitations of mobile devices, such as their small screens, lack of input capabilities, and low computing capacity, creating mobile learning applications is not an easy task [4].

In a separate investigation, Hossain [5] conducted a survey involving college students, revealing a paradox in their perceptions of Canvas. While they granted Canvas high marks for its usability, their assessment of the platform's search features and mobile usability was notably unfavorable. In addition to these studies, a collection of articles and blog posts also underscores the apparent simplicity of using Canvas. Similarly, within the domain of educational technology, a blog post emphasized Canvas's adaptability and functionality compared to Blackboard (another widely used LMS), further affirming the significance of customization and usability within different LMS platforms [6].

One notable tool that contributes to enhancing the user experience of educational apps, such as Canvas, is the utilization of app reviews. As the usage of smartphones and tablets by students surges, mobile usability becomes an increasingly crucial aspect determining the performance of mobile apps. The usability of an app on mobile devices pertains to its ease of use and its efficient functionality. A mobile application is considered user-friendly when it is intuitive, performs seamlessly, and minimizes user effort. In 2023, the task of identifying high-quality educational apps appears to be a challenging endeavor, particularly considering the staggering number of over 567,000 educational apps available [7]. Thus, instead of

relying solely on app reviews, this study opted for a more empirical approach by conducting a usability survey for the Canvas app. The rest of this paper is organized as follows. Section II highlights the recent research endeavors related to the scope of this study. Section III presents the main core of the methodology adopted. Section IV presents the results and discussions achieved. Section V discusses the correlation between the variables, and finally Section VI concludes this paper and presents recommendations for future work.

II. RELATED WORK

Related work is investigated on two levels. One is addressing the mobile application usability in general, while the other is focusing on education apps usability specifically.

A. Mobile Application Usability

Building upon Shackel's model, Nielsen [4] in 1993 presented his own conceptualization of usability. Initially encompassing four attributes (Learnability, Effectiveness, Efficiency, and Satisfaction). Nielsen subsequently revised this by eliminating 'Effectiveness' and introducing 'Memorability' and 'Errors', culminating in a five-attribute framework. This conceptualization garnered substantial recognition within the Human-Computer Interaction (HCI) community, particularly due to its emphasis on users' perceptions of the system and aspects of recall, as highlighted by the inclusion of 'Satisfaction' and 'Memorability'[8] [9].

Usability in mobile applications is delineated based on the International Standards Organization's (ISO) definition, characterizing it as the degree to which a designated user can employ such an application to realize predetermined objectives with accuracy, proficiency, and contentment within a given usage context [10] [11]. Usability studies focus on how system features and user interactions interact when placed within particular activities and expected results. Due to the fact that many software products have been found to be less than ideal in meeting user needs, a variety of thorough study projects that go under the general heading of "usability" have been started. These efforts aim to promote more profound understanding and relevant measurement, with the goal of capturing all relevant phenomena in a single framework or model [12].

B. Education Apps usability

Several academic studies have been conducted to evaluate the effectiveness of educational applications. A recent investigation employed deep learning models to discern usability issues within mobile applications in the education applications [13]. This research has focused a lot on how application functionality and design affect student learning results [14]. Mobile learning offers a paradigm wherein educational acquisition is untethered from traditional spatial and temporal constraints. Instead of being confined to established settings like classrooms or predefined schedules, it facilitates pedagogical engagement across diverse locales and at any chosen moment[15].

This literature review delves into pertinent insights extracted from recent research concerning the usability of educational applications. Earlier investigations have primarily focused on appraising the efficacy of employing educational apps for instructing young children [16] [17]. Their analysis culminated in the observation that the efficacy of educational apps predominantly hinged on factors such as the quality of the user interface, the ease of navigation, and the capacity to engage with content. In a similar vein, Perera and Yacef's investigation underscored that student motivation and engagement were profoundly impacted by the visual and experiential aspects inherent in educational app design [18]. Tailoring learning experiences to individual students stands as another pivotal attribute of educational apps, contributing to their user-friendliness. In this context, Lee et al. examined the influence of personalized learning approaches on the ease of utilizing educational apps[19]. Their findings underscored students' inclination toward personalized learning features, particularly adaptive content and feedback mechanisms. These attributes emerged as effective tools for sustaining student interest and motivation [20]. The usability of educational apps presents a multifaceted and intricate challenge, encompassing numerous elements that influence student engagement, motivation, and learning achievements. Through the adoption of a comprehensive perspective encompassing app design and functionality, coupled with the integration of attributes that foster personalization and usability, developers can elevate the overall usability of educational apps and thereby elevate the quality of student learning experience [21].

Based on the Jakob Nielsen factors, the scope of this study can be formulated as follows: For the Canvas LMS application, and as outlined by Nielsen's study, to what extent are the interrelationships between the different usability factors observable, and what are their effects?

III. METHODOLOGY

To comprehensively understand the usability factors of the Canvas LMS application in light of Nielsen's criteria, we adopted a structured approach. This section delineates the methods we used, starting with a foundation in the information background, followed by an exploration of the general challenges users encounter.

A. Information Background and General Challenge

In Table 1 valuable insights into the Information Background and General Challenges encountered by users of Canvas within the study. The breakdown of users by educational level indicates a majority of Graduate students (72.1%), followed by Undergraduate (23.1%) and Doctoral (4.8%) students. This diversity of academic levels engaging with the LMS is noteworthy.

The duration of usage of the Canvas mobile app displays an even distribution, with a significant portion of respondents (30.8%) using it for 6 months to 1 year and 19.2% for 1 year to 2 years. This result suggests a moderate level of familiarity with the platform. Interestingly, fewer users have used the app

for longer durations, implying that turnover among users could impact the interpretation their experiences and challenges. Within the Computer Science Engineering (CSE) department, a considerable number of respondents (92.3%) are enrolled in various programs, with Computer Science (62.5%) emerging as the predominant academic department. This concentration highlights the potential for tailoring Canvas features to address this department’s specific needs and requirements. Notable representation is also seen from other departments, such as Computer Engineering (13.5%), AI (16.3%), and Cybersecurity (4.8%), underscoring the platform’s adaptability across diverse fields of study. These findings emphasize the importance of comprehending the CSE department’s educational backgrounds, usage patterns, and program enrollments. Such understanding can guide the enhancement of Canvas to better serve the distinct needs and challenges faced by users at different academic stages and within various fields of study. These demographics are visually represented in Figure 1.

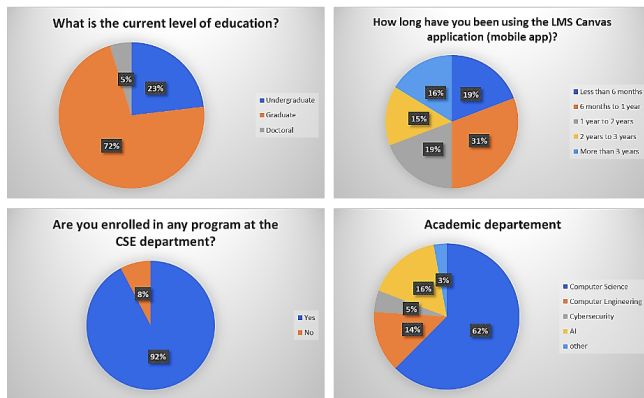


Fig. 1. Information Background for Canvas Users in the Study

TABLE I
INFORMATION BACKGROUND FOR CANVAS USERS IN THE STUDY

Items	N	%
What is the current level of education?		
Undergraduate	24	23.1%
Graduate	75	72.1%
Doctoral	5	7.8%
How long have you been using the LMS Canvas app on mobile?		
Less than 6 months	20	19.2%
6 months to 1 year	32	30.8%
1 year to 2 years	20	19.2%
2 years to 3 years	15	14.4%
More than 3 years	17	16.3%
Are you enrolled in any program at the CSE department?		
Yes	96	92.3%
No	8	7.7%
Academic departement		
Computer Science	65	62.5%
Computer Engineering	14	13.5%
Cybersecurity	5	4.8%
AI	17	16.3%
other	3	2.9%

B. Reliability analysis

In Table 2 the Cronbach alpha levels of the study variables concerning the Canvas users is presented. The conducted reliability analysis on the Canvas user study variables offers a comprehensive evaluation of the key factors influencing user satisfaction and experience. The Cronbach’s alpha values assigned to each variable serve as internal consistency and measurement reliability indicators, thus shedding light on the robustness of the study’s conclusions. Remarkably, the notably high Cronbach’s alpha values for several variables such as Visibility of System Status (0.920), Aesthetic and Minimalistic Design (0.900), and User Control and Intuitiveness (0.911) underline the robust reliability and interconnectedness of these aspects. While certain variables exhibit somewhat lower Cronbach’s alpha values, such as Recognition Over Recall (0.737) and Realistic Error Management (0.667), they still indicate a reasonable level of reliability.

Furthermore, Consistency and Standards, Efficiency of Use and Performance, and Alignment Between System and Real-World Context display satisfactory Cronbach’s alpha values of 0.772, 0.798 and 0.777, respectively. Finally, Cronbach’s alpha level for the total scale in the study was 0.958, indicating that this questionnaire has excellent reliability and consistency.

TABLE II
THE RELIABILITY ANALYSIS OF THE FACTORS IN THE STUDY

Variable	No. of items	Cronbach alpha
Visibility of System Status	2	0.920
Match Between System and Real World	2	0.777
Aesthetic and Minimalistic Design	2	0.900
Recognition Rather than Recall	2	0.737
Effective Design to Lesson User’s Workload	2	0.870
Flexibility and Efficiency of use	2	0.680
User control and obviousness	2	0.911
Realistic error management	2	0.667
Consistency and standards	3	0.772
Efficiency of use and performance	2	0.798
Total scale	21	0.958

C. Validity Analysis

Table 2 exhibits the outcomes of the validity analysis conducted on the factors within the Canvas user division. The validity of the factors was determined via a Pearson correlation analysis. To establish their construct validity, each item of the scale was correlated with the entire scale. All items showcased an immensely significant positive correlation with the entirety of the scale they are associated with. Thus, the essential items sufficiently established the concept of the factors and effectively expressed their significance in assessing the impressions of Canvas users.

IV. DESCRIPTIVE STATISTICS ANALYSIS

Table 3 and Figure 2 show the descriptive statistics, including mean, standard deviation, and the agreement levels of the Canvas users factors in the study. The "Visibility of System Status" factor reflects a positive user sentiment. The users

TABLE III
USABILITY MEASUREMENT SCORES

Factor	Mean	Std. Dev.	Level
Visibility of System Status			
The status of icons is clearly indicated in the application.	4.36	1.153	Agree
Graphical user interface menus make obvious whether deselection is possible.	4.11	1.187	Agree
Visibility of System Status mean score	4.23	1.126	Agree
Match Between System and Real World			
The selected colors correspond to common expectations about the color codes.	4.22	0.996	Agree
Function keys labeled clearly and distinctively, even if this means breaking consistency rules.	4.06	1.153	Agree
Match Between System and Real World mean score	4.14	0.974	Agree
Aesthetic and Minimalistic Design			
Field labels are brief, familiar, and descriptive.	4.32	1.138	Agree
The large objects, bold lines, and simple areas have been used to distinguish icons.	4.32	1.193	Agree
Aesthetic and Minimalistic Design mean score	4.32	1.112	Agree
Recognition Rather than Recall			
The system provides mapping: do the relationships between controls and actions appear to the user?	4.19	1.176	Agree
There is a good color and brightness contrast between image and background colors.	4.32	1.099	Agree
Recognition Rather than Recall mean score	4.26	1.013	Agree
Effective Design to Lesson User's Workload			
A simple design canvas is easy to navigate and understand and it can significantly reduce the amount of cognitive load required to complete a task.	4.40	1.030	Agree
Feedback and error messages can help users quickly identify and correct mistakes, reducing the time and effort needed to complete a task.	4.27	1.193	Agree
Effective Design to Lesson User's Workload mean score	4.34	1.048	Agree
Flexibility and Efficiency of use			
The canvas supports both beginner and expert users, are multiple levels of error message detail available.	4.34	1.151	Agree
Canvas offer "find next" and "find previous" shortcuts for database searches.	3.99	1.364	Agree
Flexibility and Efficiency of use mean score	4.16	1.098	Agree
User control and obviousness			
Canvas has design and services which make it customizable and easy to use	4.28	1.177	Agree
Canvas is customizable and simple to use because to its design and service features.	4.21	1.163	Agree
Realistic error management			
Canvas is providing clear and concise error messages that communicate what went wrong and how the user can fix it.	3.72	1.282	Agree
Realistic error management mean score	3.93	1.059	Agree
Consistency and standards			
Canvas symbols, icons, and symbolism should be consistent.	4.38	0.818	Agree
When users interact with content on Canvas categories, they should expect a clear and familiar experience	4.54	0.743	Agree
Consistency and standards mean score	4.45	0.706	Agree
Efficiency of use and performance			
The Canvas application offers specific features and tools that can help users to quickly locate the information they need, potentially making it more efficient than other learning management systems.	4.22	1.109	Agree
Efficiency of use and performance mean score	4.18	1.026	Agree
Other Considerations			
Users may be accessing the device in a variety of settings, such as while walking, standing in a crowded area, or sitting in a quiet space.	4.40	1.091	Agree

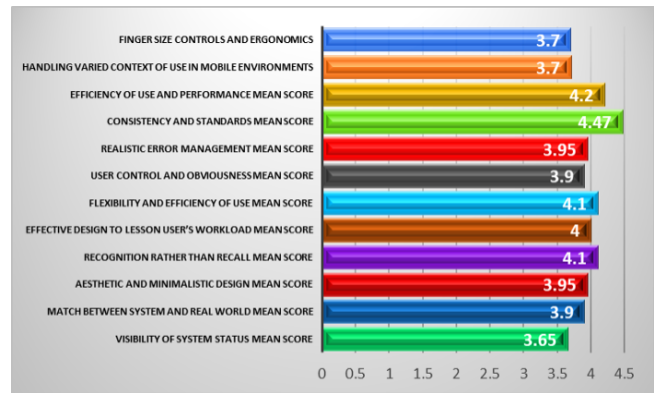


Fig. 2. All Canvas Users' Factors Mean in The Study

agree that icons are clearly indicated ($M= 4.36$, $SD = 1.153$), and the graphical user interface menus clarify deselection ($M= 4.11$, $SD = 1.187$). The whole mean score factor was 4.23, indicating a high agreement of the Canvas users toward its Visibility of System Status. Similarly, the factor "Match Between System and Real World" garners agreement, with users finding that selected colors align with common expectations ($M= 4.22$, $SD= 0.996$) and function keys are distinctly labeled ($M= 4.06$, $SD= 1.153$). Also, the overall mean score of this factor was 4.14, reflecting the higher matching between the Canvas system and the real world.

In terms of "Aesthetic and Minimalistic Design," users appreciate the use of brief, familiar, and descriptive field labels ($M= 4.32$, $sd= 1.138$) and the incorporation of large objects and bold lines to distinguish icons ($M= 4.32$, $SD= 1.193$). Likewise, the overall mean score of this factor was also 4.32. Furthermore, the "Recognition Rather than Recall" factor emphasizes user-friendly design, with users recognizing the presence of mapping between controls and actions ($M= 4.19$, $SD= 1.176$) and appreciating good color and brightness contrast ($M= 4.32$, $SD= 1.099$). The overall mean score of this factor was 4.26, indicating the increased agreement from the Canvas users toward this factor.

In addition, the "Effective Design to Lessen User's Workload" factor suggests that a simple design reduces cognitive load ($M= 4.40$, $SD= 1.030$), and users find feedback and error messages helpful ($m= 4.27$, $SD= 1.193$) in streamlining tasks. The overall mean score showed a high agreement degree with a mean score of 4.34. similarly, the "Flexibility and Efficiency of Use" factor demonstrates Canvas's support for both beginner and expert users ($M= 4.34$, $SD= 1.151$), although the "find next" and "find previous" shortcuts receive slightly lower agreement ($M= 3.99$, $SD= 1.364$). However, the overall mean score of this factor was high (4.16), indicating the flexibility and efficiency of the Canvas use by the participants in the study.

Moreover, the "User control and obviousness" factor underscores Canvas's customizability and ease of use ($M= 4.28$, $SD= 1.177$), aligning with users' positive perceptions of its design and services ($M= 4.21$, $SD= 1.163$). In this context,

the User control and obviousness mean score was 4.24. In terms of "Realistic error management," users agree that Canvas provides clear error messages (M= 3.72, SD= 1.282) and emphasizes plain language over technical jargon (M= 4.14, SD= 1.160). Although this factor has the lowest overall mean score (3.93) among other factors, it still has an agreement level of response.

On the other hand, The "Consistency and standards" factor reflects users' positive reactions to consistent symbols and icons (M= 4.38, SD= 0.818), familiar interaction experiences (M= 4.54, SD= 0.743), and a navigational design standard on the homepage (M= 4.41, SD= 4.41). The overall mean score was consistent with these variable scores, with 4.45. Lastly, the "Efficiency of use and performance" factor highlights Canvas's potential efficiency in locating information (M= 4.22, SD= 1.109) and the potential workflow improvements brought by shortcuts (M= 4.14, SD= 1.142). The overall mean score of this factor was 4.18, suggesting a highly effective use and good performance of the Canvas application.

Overall, these results indicate a generally positive perception of Canvas, with users agreeing on its effectiveness in delivering a user-friendly, efficient, and consistent experience. The findings offer actionable insights for further enhancing the platform's usability and addressing specific areas for improvement.

V. CORRELATIONS BETWEEN VARIABLES

Figure 3 show the correlation analysis among the variables within the Canvas user scale. It yields valuable insights into the connections between different facets of user experience and system functionality. The matrix of correlation coefficients presents a glimpse into the interrelationships of these variables, illuminating potential patterns and interdependences.

All the variables in the scale show a positive significant correlation with each other, indicating a high interconnection between these factors. Where, X1= Visibility of System Status mean score, X2= Match Between System and Real World, X3= Aesthetic and Minimalistic Design, X4= Recognition Rather than Recall, X5= Effective Design to Lessen User's Workload, X6= Flexibility and Efficiency of use, X7= Handling varied contexts of use in mobile environments, X8= User control and obviousness, X9= Realistic error management, X10= Consistency and standards, X11= Efficiency of use and performance. Also, P-value calculated by a Pearson correlation test.

VI. CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

As for the research question addressed in this study, and following the discussion of the significance of The validity analysis of the factors pertaining to Canvas user division is presented herein. A questionnaire was implemented on 104 CSE students to evaluate the different usability factors. To ascertain the validity of each factor, a Pearson correlation analysis was employed. Construct validity was gauged by correlating each item on the scale with the totality of the scale. Notably, all items exhibited a robust and statistically significant positive

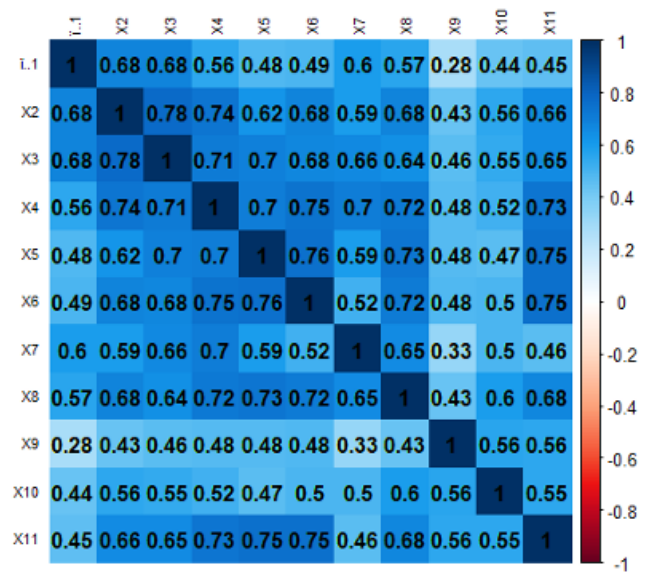


Fig. 3. The Heat Correlation Map of the Variables within the Canvas User Scale

correlation with their respective scales. Consequently, these items are deemed competent in representing the conceptual underpinnings of the factors and are pivotal in assessing the perceptions of Canvas users. An explanation of the interactions between the elements is made possible by Figure 3, which clearly shows the correlations among them.

The achieved results open the door for further comparative examination between the components in the investigated Canvas LMS and other apps such as the Blackboard application.

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