Sparking Inter-usability: How Can Instructors Align Learning Management Systems within Online Learning Ecosystems?

Feifei Pang
University of Cincinnati
pangfi@mail.uc.edu

Rob Grace
Texas Tech University
rob.grace@ttu.edu

Hari Priya Ponnakanti
University of Cincinnati
ponnakha@mail.uc.edu

Kijung Lee
University of Cincinnati
lee2kj@ucmail.uc.edu

Jess Kropczynski
University of Cincinnati
kropczjn@ucmail.uc.edu

Abstract

During the COVID-19 pandemic, global higher education institutions turned to learning management systems (LMS) such as Canvas for emergency online teaching. However, existing studies have focused on the usability of individual LMS applications rather than their inter-usability with other technologies. This study, therefore, examines the inter-usability of Canvas from the perspective of faculty who used it alongside other technologies to cope with the pandemic. Results show that issues of continuity, consistency, and composition limited the inter-usability of Canvas when supporting the transition from in-person to online instruction. Based on these findings, the study identifies specific design implications that can improve the inter-usability of Canvas and other LMS by aligning them within the ecosystem of applications and devices demanded by contemporary in-person and online education during periods of stability and crisis.

Keywords: Learning management system, inter-usability, user experience, COVID-19, online education

1. Introduction

The COVID-19 pandemic placed higher education in an unprecedented situation. A majority of U.S. universities were forced to shut their doors and shift to an online-only format overnight. As instructors struggled to redesign courses for effective synchronous and asynchronous online learning, Learning Management Systems (LMS) emerged as vital platforms, serving as hubs within ecosystems of digital tools that students and instructors integrated together while learning and teaching from home.

Consequently, studies recognize the COVID-19 pandemic as an important context for evaluating LMS usability (El-aasar & Farghali, 2022; Mohammadi et al., 2021; Pal & Vanijja, 2020; Salman et al., 2022), which can be understood as the extent to which students and instructors perceived these platforms to be effective, efficient, and satisfying to use (Nielsen, 1994). Existing studies show that LMS often failed to support effective transitions to online learning during the pandemic (Alhadreti, 2021), and draw implications for the design of future LMS that can support in-person and online learning in contexts of crisis and stability (Mohammadi et al., 2021; Pal & Vanijja, 2020). However, existing studies focus on students' and instructors' experiences with a single application (i.e., LMS) and describe usability issues limited to the use of LMS in isolation. As a result, despite students' and instructors' use of multiple applications and devices during the COVID-19 pandemic (Mohammadi et al., 2021), prior studies overlook LMS *inter-usability* within the ecosystems of familiar and newly adopted technologies students and instructors used to switch from in-person to online learning (Denis & Karsenty, 2004).

To address this gap, our study investigates the inter-usability of the LMS Canvas from the perspectives of faculty teaching at U.S. higher education institutions to address the following research question: *How do instructors perceive the inter-usability of Canvas when transitioning from in-person to online learning during the COVID-19 pandemic?* Our results highlight three aspects of inter-usability—continuity, consistency, and composition—that offer design implications for LMS and instructional design. By doing so, our study explores the implications of the COVID-19 crisis for the effective design and delivery of in-person, online, and hybrid courses within the ecosystems of technologies

HICSS

that define the "new normal" of the post-pandemic world.

2. Background

This section discusses prior work to highlight a gap in LMS usability studies that recommends the focus on inter-usability we advance in this research.

2.1. LMS Use in Higher Education

LMS are digital software applications specifically designed to help instructors build learning content and facilitate instructional activities in both in-person and online courses (Blecken et al., 2010). Since their first appearance in the 1990s, LMS have been widely adopted among U.S. higher education institutions to aid instructors in managing courses, including content delivery and evaluation feedback (Dahlstrom et al., 2014). Various LMS products are available in the educational market, and each has its unique set of qualities. The most popular LMS products include Canvas, Blackboard, and Moodle.

In this study, we focus on Canvas which, according to the company's website[1], offers a variety of features to assist instructors in creating, managing, and delivering in-person and online courses. These include course creation utilities, such as Syllabus, Modules, and Pages; assessment tools such as Assignments, Gradebook, and SpeedGrader; communication tools like Discussions and Announcements; and a suite of collaborative learning tools such as Collaborations, Conferences, and Groups. Moreover, Canvas provides an integrative environment that accommodates third-party applications (e.g., Zoom, Vimeo) to expand the site's functionality. Canvas includes customization features that allow instructors to tailor their online course sites to meet specific course requirements. Lastly, Canvas showcases a minimalist user interface (UI) in its web-based application (Almaiah et al., 2020; Endozo et al., 2019).

2.2. Online Learning in Higher Education during the COVID-19 Pandemic

The demand for online learning in higher education had been on the rise before the COVID-19 pandemic which accelerated this trend in U.S. institutions (Zhou et al., 2022). However, the impacts of the rapid adoption of online learning have been far-reaching, ranging from financial repercussions for higher education institutions (Burki, 2020), changes in student life and academic performance (Gonzalez et al., 2020), and commitments

to diverse visions of future in-person, online, and hybrid learning modalities for the post-pandemic "new normal" (Neuwirth et al., 2020). Amid these changes, many studies have examined instructors' and students' experiences transitioning from in-person to online learning (Alfonsin & Punyanunt-Carter, 2022; Ferri et al., 2020; Marinoni et al., 2020; Mishra et al., 2020; Raza et al., 2021).

For instructors, the transition to online learning in response to COVID-19 required the (re)design and delivery of online instructional materials and learning experiences for students. Unfortunately, faculty members often experienced obstacles when redesigning their courses for online learning, including a lack of time and technology support, incompatibility of in-person curriculum and activities for online modalities, and numerous demands to support student success while maintaining the quality expected of in-person instruction (Almaiah et al., 2020; Asgari et al., 2021). It is important to note that while technology has been a driving force for the growth and evolution of online education, it has also amplified instructors' workload due to the increased time commitment required for mastering instructional technology and creating effective materials when compared to familiar in-person formats (Almaiah et al., 2020). Consequently, researchers have looked to improve the usability of instructional technology such as LMS to support instructors in the design and delivery of sustainable, high-quality online learning during periods of crises and stability (Mishra et al., 2020; Raza et al., 2021).

2.3. LMS (Inter-)usability during the COVID-19 Pandemic

Traditionally, usability has described the extent to which a "system is good enough to satisfy all the needs and requirements of the users and other potential stakeholders," by measuring attributes of system use such as learnability, efficiency, memorability, error tolerance, and user satisfaction (Nielsen, 1994). Critical to a system's usability is its UI, as usability measures assess users' perceptions and responses to the appearance and behavior of interactive systems (Bodker, 2021; Nielsen, 1994). By assessing attributes of user behavior and experience, usability studies can identify issues people encounter when using technology, such as pain points, that offer implications for design (Nielsen, 1994; Tham & Grace, 2020).

Studies have often examined LMS usability (Blecken et al., 2010), including multiple studies that examine the usability of LMS during the COVID-19 pandemic (Alhadreti, 2021; El-aasar & Farghali, 2022;

---

[1] https://community.canvaslms.com/

Mohammadi et al., 2021; Pal & Vanijja, 2020; Salman et al., 2022). These studies typically employ traditional usability instruments such as the System Usability Scale or Website Analysis and Measurement Inventory to understand students' and, less often, instructors' experiences using LMS during the pandemic (Pal & Vanijja, 2020; Salman et al., 2022), and observe various ways that LMS such as Blackboard failed to support effective and efficient transitions to online learning (Alhadreti, 2021). In particular, these studies report issues relating to LMS learnability (Salman et al., 2022), inconsistency in the design of LMS features (Alhadreti, 2021), student dissatisfaction resulting from poor instructional design (El-aasar & Farghali, 2022), and the impacts of organizational issues, such as policy, on LMS adoption and use at higher education institutions (Mohammadi et al., 2021).

However, despite the attention given to LMS use during the COVID-19 pandemic, two gaps characterize this literature. First, studies tend to focus on instructors' experiences using a single application, i.e., LMS, during transitions to online learning. Second, and as a result, prior studies reach design implications that attempt to improve the usability of LMS in isolation, despite the multiple applications and devices instructors use alongside these platforms when switching between instructional modalities (Mohammadi et al., 2021).

Given these gaps, an *inter-usability* (Denis & Karsenty, 2004) approach stands to highlight instructors' experiences using LMS within the ecosystem of applications and devices students and instructors needed to switch from in-person to synchronous or asynchronous online learning during the COVID-19 pandemic. In this context, inter-usability can be defined as the ease with which instructors can facilitate learning activities across applications and devices when switching between learning modalities. In addition to measuring "ease of use" in terms of Nielsen's five usability factors, LMS inter-usability can be examined with respect to three factors (Wäljas et al., 2010): *Continuity*: To what extent do LMS allow instructors to integrate functionality with applications and devices used to switch between instructional modalities? *Consistency*: To what extent do LMS allow instructors to reuse knowledge and skills with the UI design patterns of applications and devices used to switch between instructional modalities? *Composition*: To what extent do LMS allow instructors to organize functionality across applications and devices used to switch between instructional modalities? In the next section, we outline our approach to answering these research questions.

3. Methodology

In this section, we outline the research methods employed to examine the inter-usability of Canvas during the COVID-19 pandemic. Overall, the study involved recruitment and screening of potential participants, semi-structured interviews with ten instructors, and transcription and thematic analysis of the interview data.

3.1. Participant Recruitment and Data Collection

After securing IRB approval (2022-0039), we identified potential participants among full-time faculty members employed prior to the start of the 2019-2020 academic year at two Midwestern universities. We then distributed an online questionnaire to the potential participant population as a preliminary screening instrument to collect basic demographic and LMS usage information and gauge their willingness to participate in individual interviews.

Ten respondents who expressed interest in the study were selected for participation in a one-hour individual interview. This selection was not random, but deliberately constructed to encompass diverse teaching disciplines, ages, and genders (Table 1). Additionally, preference was given to instructors who had only taught face-to-face classes before the pandemic forced them to switch to online classes. This recruitment strategy allowed us to ensure diversity in the sample and address issues among new users of Canvas for online learning.

As dialogue serves as the foundation of UX design (Wright & McCarthy, 2010), our data collection centered on ten semi-structured, in-person interviews designed to probe faculty members' experiences with Canvas and other technologies when transitioning to online learning. The interviews addressed participants' teaching backgrounds, experiences with Canvas before and during COVID-19, transitions to online learning during the pandemic, and their overall perceptions of Canvas. During the interviews, we also explored their experiences using Canvas alongside other applications and devices, both prior to and during the pandemic. Following data collection, all interview recordings were transcribed verbatim by the researchers.

3.2. Analysis of Canvas Inter-usability

To answer the three research questions introduced in Section 2.3, we conducted a thematic analysis of the interview transcripts. The analysis followed Braun and Clarke's (2006) six-phase process. Using the concepts of continuity, consistency, and composition as

Table 1. Participant Profiles

Participant ID	Age Group	Gender	Years of Canvas Use	Teaching Field
P1	60+	M	2.5 years	Information Technology
P2	50-59	F	10+ years	Teacher Training (English Education)
P3	60+	M	10+ years	Art History
P4	60+	M	2.5 years	Secondary Education
P5	50-59	F	2.5 years	Instructional Design and Technology
P6	40-49	F	2 years	Early Childhood Education
P7	40-49	M	3.5 years	Game Design
P8	30-39	M	2.5 years	Sports Administration
P9	40-49	F	2 years	Early Childhood Education
P10	50-59	F	2.5 years	Information Technology

*M=Male, F=Female

sensitizing concepts, the data was inductively coded, allowing sub-themes to emerge from the transcribed interview dialogue. These sub-themes were generated by highlighting significant statements, expressions, or ideas in the transcripts, as they reflected participants' experiences and perceptions of Canvas's inter-usability. Overall, to ensure the validity of our findings, we focused on triangulating emergent themes across participants and, while working independently, across authors involved in thematic coding, e.g., investigator triangulation (Onwuegbuzie & Leech, 2007). In Section 6.1, we return to these issues when discussing the limitations of our study.

4. Results

In this section, we present the inter-usability issues of continuity, consistency, and composition that instructors experienced when transitioning between instructional modalities during the COVID-19 pandemic. We also identify the Canvas features and third-party applications that instructors highlighted when discussing these and traditional usability issues.

These results provide insight into how future LMS can support changes in instructional modality through their deliberate integration within the ecosystems of applications and devices instructors and students use across face-to-face and online instructional activities.

4.1. Inter-usability Issues with Canvas

For the instructors we interviewed, the switch from face-to-face to online instruction during the COVID-19 pandemic was abrupt. As P7, a junior faculty member concluded, *"the transition was difficult because it was so rapid."* Central to this transition was the use of Canvas, which 8 of 10 instructors adopted because the LMS (i.e., Blackboard) they used for face-to-face

classes did not provide the capabilities or institutional support required to move their courses online. While the other two instructors were already using Canvas in the fall of 2019, the transition to online instruction saw them adopt LMS features they never used when teaching face-to-face.

Overall, user experiences with Canvas varied among the instructors we interviewed. *"Overall, it is a lot better than what Blackboard had to offer"* concluded one faculty member (P8). For others like P7, it was a journey of learning: *"I had not had any experience with Canvas and I was a new professor."*

4.1.1. Continuity. Issues of continuity arose when instructors discovered that Canvas lacked native functionalities they needed to teach online and attempted to use third-party applications they already used for face-to-face learning or those they adopted for online instruction (Table 2). As a result, instructors and students looked to Canvas, like other LMS, as a hub for instructional activities within an ecosystem of applications that students and instructors accessed from multiple devices to switch from face-to-face to online learning during the COVID-19 pandemic.

Instructors experienced a lack of continuity when designing learning activities that required integrating Canvas with third-party applications and resources, e.g., documents, they typically used for face-to-face instruction. These challenges were amplified during the rapid transition to remote instruction after the onset of the pandemic. For example, instructors wanted to quickly import or create rubrics based on the Word and PDF documents they were already using in their courses in fall 2019: *"I wish they would figure out a better way that you could just import your own [rubric]. It's like if you have a Word document that is your rubric then you would put in the syllabus. There should be some way to import that into Canvas instead of creating a*

rubric from scratch. Because our works are very, very specific for each assignment" (P6). Another instructor described similar frustrations: *"Canvas doesn't allow me to upload preset rubrics... I also can't create a generic rubric, upload it to Canvas, then revise it a bit there. It is really limiting what I want to do in that class. It prevents me from achieving my teaching outcomes. The technology actually is limiting me"* (P2). One example of many, the frustration instructors experienced with rubrics underscores the desire for LMS inter-usability within an ecosystem of applications and resources that faculty use across face-to-face and online instructional modalities.

For students, lack of continuity arose as interruptions to learning activities that required moving from Canvas to third-party applications, and vice versa, which they accessed from desktop and mobile devices. For instance, instructors relied on third-party applications like Microsoft's Flip (formerly FlipGrid) to support asynchronous, video-based group discussion, but soon learned students had difficulty moving between Canvas and the app and between desktop and mobile devices: *"But what we found was that made it harder for them to [switch between applications]... like they couldn't always just go into FlipGrid, like on their phone if they had it as an app because it would say 'Nope, this is private from a course.' So, they'd have to go into Canvas on their phone and then find that assignment then go [to FlipGrid]"* (P9). These interruptions to learning activities that took place across applications were exacerbated by unequal access to the internet and devices among students: *"Sadly, we have students who don't have really good access to broadband. We had a student who participated in class using only her phone and her phone data, which is hardly efficient"* (P3).

Other issues of continuity arose when applications instructors integrated with Canvas did not integrate with other applications students incorporated into learning activities. For instance, instructors used Kaltura, a screen-recording tool, to track student viewing of pre-recorded lectures but the application could not effectively track viewing if students were using other programs at the same time: *"And we found out that if they had [the lecture] playing but they were actually working on something else, [Kaltura] didn't register them as viewing it even though they were listening to it. And probably, you know, maybe they had [the lecture] on a different screen. They were watching it, but it wasn't like the main thing. They might have been typing up a paper or something at the same time. [Kaltura] didn't register them"* (P9). These and other examples highlight instructors' (and likely students') expectations of inter-usability when using Canvas within an ecosystem of applications and devices introduced by instructors and students when designing and engaging in learning activities, respectively.

4.1.2. Consistency. Instructors identified inter-usability issues that resulted from differences in Canvas's look and feel compared to third-party applications they were familiar with using when teaching face-to-face or online before the pandemic (Table 3). These issues of consistency created inefficiencies and pain points for instructors as they attempted to transfer knowledge and skills learned using one application, e.g., Blackboard, to another, e.g., Canvas. As instructors and students adopted multiple, unfamiliar applications during the pandemic, issues of consistency were a primary source of frustration voiced during the interviews.

First, instructors described differences in the feel, or interactive behavior, of Canvas UI compared to other, more familiar applications: *"Initially when we were switching, I really, really, really hated Canvas. Uh, largely because I learned Blackboard and then it forced me to do things differently"* (P3). Another instructor similarly described the difficult experience of learning to use a new LMS during the pandemic: *"I think for faculty who have been here a long time and got used to using Blackboard, they have a kind of a mental model of how a LMS should work and Canvas is just, it's almost easier to learn if you don't have all this prior knowledge of the other system, because you don't have to unlearn things"* (P5). While learnability is a familiar usability issue, instructors' experiences learning to use multiple, different applications at the same time, created unique inter-usability challenges during the pandemic.

Second, instructors described differences in the look, or visual design, of the Canvas UI compared to other applications they used before the pandemic. Some instructors were critical: *"That's a look and appearance issue...I think it's way too basic. It's boring and doesn't highlight things that should be highlighted"* (P4). Another instructor critiqued the *"The layout of the discussion board...it doesn't have a lot of indenting"* (P5).

Together, differences in the look and feel of Canvas compared to other applications resulted in inefficiencies and user frustration. Regarding the discussion boards, for example, an instructor explained that: *"If I post something and then someone replies to me or it's a little hard to tell easily that there's a reply versus a new post. If you set up the discussions using channels on Teams, you have students post in those channels and it's very clear who's replying"* (P5). Another instructor reported similar experiences: *"I think the discussion boards are*

Table 2. CONTINUITY: Seamless interaction with third-party applications across devices

Feature	Description*	Usability Issue	Usability Factor
Flip (formerly FlipGrid)	A free app from Microsoft where educators create safe, online groups for students to express their ideas asynchronously in short video, text, and audio messages	Inconsistent accessibility to third-party applications	Errors
Honorlock	Honorlock monitors each student's exam session and alerts a live, US-based test proctor if it detects any potential problems.	Lack of security and privacy	Satisfaction
Kaltura	A screen recording application	Inaccurate tracking	Errors
Turnitin	An Internet-based similarity detection service	Inability to use plagiarism check tools within Quizzes	Efficiency
Word/PDF	Word processing program and document formats	Lack of document editing capabilities	Efficiency
Rubrics	Rubrics are a way to set up custom or outcome-based assessment criteria for scoring	Restrictions on uploading/downloading documents for rubric development	Efficiency
Course catalog	Listing of course information at educational institution	Absence of class offering information for LMS courses	Efficiency

* The descriptions presented in this table were sourced directly from the respective product websites.

really clunky...in some of my classes I have 42 students and trying to scroll through that many discussion board posts was so tedious" (P6).

4.1.3. Composition. Lastly, instructors highlighted some issues organizing functionalities across Canvas and third-party applications employed to transition from face-to-face to remote instruction (Table 4). Whereas inter-usability issues of continuity arose as instructors attempted to facilitate instructional activities by integrating Canvas with other applications, including those accessed by students on multiple devices, inter-usability issues of composition arose when instructors attempted to coordinate the use of these applications across multiple instructional activities over the course of the semester. As such, composition extends traditional usability issues such as learnability and discoverability to the ecosystem of applications and devices used by instructors and students for online education during the pandemic.

In particular, all ten instructors mentioned issues coordinating the use of collaboration tools, including video conferencing applications, for different synchronous learning activities, such as class lectures and group discussions, and asynchronous learning activities such as group project work. Again, issues of composition began with a lack of native functionalities needed to support online learning. *"I wish they had more collaborative tools"* (P7), remarked an instructor who adopted Canvas for the first time during the pandemic. Other instructors pointed to difficulties with Canvas's Collaborations feature that offers students opportunities to work together on the same Google doc (after registering a Google account in their Canvas settings): *"If someone was in Collaborations, no one else could get in. So there were like it was like only one person at a time could seem to be in there...To me, collaboration sounds like a lot of people could be doing something at once, but it seemed like only one person could get in there at a time"* (P9).

As a result of the lack of functionality or usability issues with Canvas's Collaborations feature, instructors integrated more familiar applications into their courses but then faced difficulties coordinating the use of these applications for specific learning activities. *"If they were not able to use Zoom, they had to switch between different conferencing tools. Some never used those apps before"* (P6), explained one instructor who used Zoom for synchronous class lectures and discussion but used Teams for long-term project work. *"As far as I know, you can't find the chat of the meeting [in Zoom]. Like after the meeting is over, you don't have [asynchronous] chat... So, in Teams, you had a team title, and the chat for every meeting will always be there. This is a real problem with Zoom, so if they can figure out a way to save the chat for future access, it will be good"*.

However, the resulting need to coordinate the use of different applications for different activities was often made more challenging because different instructors used different sets of tools for similar activities: *"I know a lot of our instructors. I think our students were very confused because some instructors used Webex for their class. Some others used Zoom. Most used either Webex or Teams. And some of the professors that used Teams put a lot of their class stuff in Teams instead of in Canvas. And, you know, students would get confused like, 'wait, is this class in Teams or is it in Webex? Do I go to Canvas and click in Webex from there?'"* (P9).

Table 3. CONSISTENCY: Familiar look and feel as third-party applications

Feature	Description	Usability Issue	Usability Factor
Blackboard	A learning management system	Challenging shift from Blackboard to Canvas	Learnability
Student View	Instructors can view a course the same way that students view the course through Student View.*	Incomplete replication of student perspective	Satisfaction
User Interface	The space where human-machine interactions occur	Outdated UI	Satisfaction
		Unsuitable UI for mobile devices	Efficiency

* The description was sourced directly from the official Canvas website.

4.2. Usability Issues with Canvas

In addition to the inter-usability issues of continuity, consistency, and composition, we also observed usability issues limited to instructors' uses of specific Canvas features. Although outside the scope of the results, these issues are summarized in Table 5 and considered in the design implications discussed in the following section.

5. Design Implications for LMS Inter-Usability

Extending prior work on LMS usability (Alhadreti, 2021; El-aasar & Farghali, 2022; Mohammadi et al., 2021; Pal & Vanijja, 2020; Salman et al., 2022), our results highlight the need to examine LMS inter-usability within online learning ecosystems consisting of third-party applications and devices that instructors and students integrate into online learning activities. In the following discussion, we explore the implications of our results for LMS and instructional design that can support inter-usability across contexts of crisis and stability.

5.1. Continuity

To address inter-usability issues of continuity, designers should support seamless interactions between an LMS like Canvas and the ecosystem of third-party applications and devices that instructors and students use across learning modalities. Our findings suggest a couple ways they might do so. First, from the standpoint of LMS design, platforms of Canvas can provide additional functionalities needed by instructors while, at the same time, refining existing integrations with third-party applications. For instance, instructors often requested native document editing capabilities. This improvement would lessen the need for external editing tools and enhance the continuity of instructors' experiences uploading, editing, and sharing documents that facilitate various learning activities. At the same time, LMS designers can refine the interoperability between an LMS and third-party tools and between those tools and other applications. This can, for example, address interruptions to learning activities that occur when tools like Kaltura stop tracking student engagement because of other applications students incorporate into learning activities. However, designers need to understand this ecosystems of tools before addressing such inter-usability issues.

5.2. Consistency

To address inter-usability issues of consistency, designers should give an LMS like Canvas a familiar look and feel as the third-party applications that instructors and students regularly use across learning modalities. They can do so by ensuring the LMS interfaces are user-friendly and recognizable across different applications and devices. One representative example is the difficulty in transferring content from other LMS platforms, such as Blackboard, to Canvas. This challenge poses a substantial hindrance for instructors who are familiar with other platforms and need to migrate their content to Canvas. The absence of a streamlined migration process creates additional work and cause notable frustrations for instructors, especially in crisis situations where swift transitions become essential. If the UI of LMS were designed in accordance with the contemporary design trends seen in popular third-party applications, this would help instructors adapt to a new LMS working environment more quickly. The familiarity provided by a UI that mirrors commonly used applications could potentially enhance the learnability of the LMS, thereby reducing the cognitive load on instructors and facilitating a smoother transition. In addition, LMS platforms should employ an accessible UI design which is mobile-friendly, considering students who have to access online learning mainly through their smartphones. This implies the need for a responsive design framework that adapts well to smaller screens, facilitating easy navigation, readable typefaces, and evident visual hierarchy.

Table 4. COMPOSITION: Organization of functionality across applications and devices

Feature	Description	Usability Issue	Usability Factor
Video conferencing applications	Software such as Zoom, Microsoft Teams, and Cisco Webex that allow groups to hold video-based meetings and text-based discussions remotely via the internet.	Lack of integration and difficulty coordinating the use of multiple conferencing tools	Satisfaction

Table 5. USABILITY: Problems with Canvas functionality

Feature	Description*	Usability Issue	Usability Factor
Announcements	Announcements allow instructors to communicate with students about course activities and post interesting course-related topics.	Restrictions on multiple attachments	Efficiency
		Restrictions on sending the same announcement to multiple classes	Efficiency
Assignments	Assignments include online submissions (i.e. files, images, text, URLs, etc.)	Absence of submission notifications for group assignments	Satisfaction
		Complexity in assigning individual grades within group assignments	Efficiency
		Inefficient navigation	Efficiency
		Default "No Submission" setting causes confusion	Efficiency
Discussions	Discussions allow both instructors and students to start and contribute to as many discussion topics as desired. Discussions allows for interactive communication between two or more people.	Inefficient navigation	Efficiency
Gradebook	The Gradebook stores all information about student progress in the course, measuring both letter grades and course outcomes.	Inability to search for pre-defined student groups	Efficiency
Modules	Modules allow instructors to organize content to help control the flow of the course. Each module can contain files, discussions, assignments, quizzes, and other learning materials.	Inefficient navigation	Efficiency
Quizzes	A graded quiz is the most common quiz and rewards students points based on their quiz responses.	Inability to provide in-text feedback	Satisfaction
Rubrics	Rubrics are a way to set up custom or outcome-based assessment criteria for scoring, which are typically comprised of rows and columns.	Absence of automatic total score calculation	Efficiency

* The descriptions presented in this table were sourced directly from the respective product websites.

5.3. Composition

To address inter-usability issues of composition, designers should allow instructors to customize LMS environments by organizing functionalities across native and integrated third-party application features. They can do this by expanding with a broader selection of third-party applications within the LMS platforms and, more importantly, employing instructional design strategies that support student learnability and memorability. Our interviews with faculty show diverse deployments of collaboration and video conferencing tools to support online learning activities in their classes. Frustration arose among instructors and students as they juggled multiple third-party applications and managed instructional files scattered across different locations. From an instructional design perspective, there is a clear need to incorporate a user-centered design approach by focusing on students' needs and observed behaviors as they learn and remember how to use these tools over the duration of a course. Consequently, while greater instructor control over the customization and organization of functionalities of native and third-party applications is required, it is the precondition, rather than the solution, for the effective instructional design of online learning environments that support student user experience and learning.

5.4. Traditional Usability

Lastly, designers can support transitions between instructional modalities by identifying and addressing the kinds of traditional usability issues (e.g., learnability, efficiency, etc.) that instructors experienced with Canvas during the COVID-19 pandemic.

In addressing traditional usability issues within LMS, efficiency is the primary consideration based on our interview data. In online learning, faculty members' reliance on LMS intensifies, particularly

during a crisis, as it serves as the major system for creating and distributing instructional content. Efficient LMS features can help instructors spend less time learning or navigating in the LMS, but more time on instructional activities, such as automating routine tasks (like automatically calculating the total score in the grading systems), or enabling batch operations (sending an announcement to multiple classes simultaneously). These enhancements not only increase faculty's working efficiency but also mitigate instructional challenges, ultimately, bolstering productivity in online education. Furthermore, improving satisfaction is another important aspect to consider in LMS design. An LMS should not only be functional, but also pleasant and engaging in the entire education process. For instance, sending incorporating automated reminders of assignment due dates can significantly enhance user satisfaction. Such automation can optimize the use of time and ensure consistency in communication between instructors and students, thus contribute to overall user satisfaction with LMS.

6. Conclusion

In interviews with U.S. instructors, we examined the inter-usability issues they encountered while using the LMS Canvas with third-party applications and devices to transition from in-person to online learning during the COVID-19 pandemic. These include *continuity* issues that arose when instructors could not integrate Canvas with third-party applications they already used for face-to-face learning, *consistency* issues that arose when Canvas's look and feel differed from the UI of third-party applications that instructors were familiar with using in face-to-face classes, and *composition* issues that arose when instructors attempted to organize the use of different third-party applications for different online learning activities on Canvas. These findings suggest implications for LMS and instructional design that can improve user experience in contexts of online education that extend beyond crises to periods of stability where online learning ecosystems must support transitions between in-person, online, and hybrid learning activities.

6.1. Limitations and Future Studies

Despite the insights gained from our exploration of LMS inter-usability, our findings remain limited by a relatively selective sample of participants and a geographic focus on institutions in the U.S. Midwest. Consequently, our findings may not be generalizable to other geographic areas and institutions with differing cultural, technological, and educational landscapes (Alhadreti, 2021; El-aasar & Farghali, 2022; Mohammadi et al., 2021; Pal & Vanijja, 2020; Salman et al., 2022). Finally, we conducted the individual interviews with instructors with particular LMS use and adoption experiences that informed the nature of the (inter-)usability issues we identified though the interviews. These experiences, of course, contributed to the data we gathered related to the inter-usability of Canvas. However, to ensure the validity of our findings relative to these participants, we focused on triangulating themes that emerged across multiple interviews with participants from different institutions and teaching backgrounds. Furthermore, by working independently, we were able to triangulate emergent themes across authors involved in thematic coding (Onwuegbuzie & Leech, 2007).

Future work can thus extend this research in several key ways. Following a research-through-design approach, we aim to develop prototypes that address observed issues using Canvas with other applications for learning activities. Through exploratory usability testing we hope to identify design requirements and instructional design strategies that can improve LMS continuity, consistency, and composition in online learning ecosystems. Through these studies, we hope to further enhance our understanding of LMS inter-usability and continue our mission to improve online instructional and learning experiences for instructors and students, respectively.

References

Alfonsin, B., & Punyanunt-Carter, N. M. (2022). College students' perceptions of online learning during the pandemic. *Higher Education Implications for Teaching and Learning During COVID-19*, 23.

Alhadreti, O. (2021). Assessing academics' perceptions of blackboard usability using sus and csuq: A case study during the covid-19 pandemic. *International Journal of Human–Computer Interaction*, *37*(11), 1003–1015.

Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the e-learning system usage during covid-19 pandemic. *Education and information technologies*, *25*, 5261–5280.

Asgari, S., Trajkovic, J., Rahmani, M., Zhang, W., Lo, R. C., & Sciortino, A. (2021). An observational study of engineering online education during the covid-19 pandemic. *Plos one*, *16*(4), e0250041.

Blecken, A., Bruggemann, D., & Marx, W. (2010). Usability evaluation of a learning management system. *2010 43rd Hawaii International Conference on System Sciences*, 1–9.

Bodker, S. (2021). *Through the interface: A human activity approach to user interface design.* CRC Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77–101.

Burki, T. K. (2020). Covid-19: Consequences for higher education. *The Lancet Oncology*, *21*(6), 758.

Dahlstrom, E., Brooks, D. C., & Bichsel, J. (2014). The current ecosystem of learning management systems in higher education: Student, faculty, and it perspectives.

Denis, C., & Karsenty, L. (2004). Inter-usability of multi-device systems: A conceptual framework. *Multiple user interfaces: Cross-platform applications and context-aware interfaces*, 373–384.

El-aasar, S. A., & Farghali, G. F. (2022). Predictive study of the factors and challenges affecting the usability of e-learning platforms in the light of covid-19. *International Journal of Education in Mathematics, Science and Technology*, *10*(3), 568–589.

Endozo, A. N., Oluyinka, S., & Daenos, R. G. (2019). Teachers' experiences towards usage of learning management system: Canvas. *Proceedings of the 11th International Conference on Education Technology and Computers*, 91–95.

Ferri, F., Grifoni, P., & Guzzo, T. (2020). Online learning and emergency remote teaching: Opportunities and challenges in emergency situations. *Societies*, *10*(4), 86.

Gonzalez, T., De La Rubia, M., Hincz, K. P., Comas-Lopez, M., Subirats, L., Fort, S., & Sacha, G. (2020). Influence of covid-19 confinement on students' performance in higher education. *PloS one*, *15*(10), e0239490.

Marinoni, G., Van't Land, H., & Jensen, T. (2020). The impact of covid-19 on higher education around the world. *IAU Global Survey Report*.

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of covid-19 pandemic. *International Journal of Educational Research Open*, *1*, 100012.

Mohammadi, M. K., Mohibbi, A. A., & Hedayati, M. H. (2021). Investigating the challenges and factors influencing the use of the learning management system during the covid-19 pandemic in afghanistan. *Education and Information Technologies*, *26*, 5165–5198.

Neuwirth, L. S., Jović, S., & Mukherji, B. R. (2020). Reimagining higher education during and post-covid-19: Challenges and opportunities. *Journal of Adult and Continuing Education*, 1477971420947738.

Nielsen, J. (1994). *Usability engineering*. Morgan Kaufmann.

Onwuegbuzie, A. J., & Leech, N. L. (2007). Validity and qualitative research: An oxymoron? *Quality & quantity*, *41*, 233–249.

Pal, D., & Vanijja, V. (2020). Perceived usability evaluation of microsoft teams as an online learning platform during covid-19 using system usability scale and technology acceptance model in india. *Children and youth services review*, *119*, 105535.

Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2021). Social isolation and acceptance of the learning management system (lms) in the time of covid-19 pandemic: An expansion of the utaut model. *Journal of Educational Computing Research*, *59*(2), 183–208.

Salman, H., Al Mohsin, E., Al Rawi, A., & Shatnawi, S. (2022). Investigating hci of the lms blackboard ultra using wammi during covid-19: Usability and design interactivity. *2022 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT)*, 519–525.

Tham, J. C. K., & Grace, R. (2020). Reading born-digital scholarship: A study of webtext user experience. *Computers and Composition*, *58*, 102601.

Wäljas, M., Segerståhl, K., Väänänen-Vainio-Mattila, K., & Oinas-Kukkonen, H. (2010). Cross-platform service user experience: A field study and an initial framework. *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services*, 219–228.

Wright, P., & McCarthy, J. (2010). Experience-centered design: Designers, users, and communities in dialogue. *Synthesis lectures on human-centered informatics*, *3*(1), 1–123.

Zhou, M., Dzingirai, C., Hove, K., Chitata, T., & Mugandani, R. (2022). Adoption, use and enhancement of virtual learning during covid-19. *Education and information technologies*, *27*(7), 8939–8959.