



UX/UI design of online learning platforms and their impact on learning: A review

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ABSTRACT

The Covid-19 pandemic, a catalyst in embracing the online mode of learning, is one of the key motivating factors for a paradigm shift in curriculum development due to the increased focus and reliance on technology. For the effective education of tertiary students globally, a revised curriculum development integrated with the Learning Management Systems and other eLearning platforms or tools that support asynchronous learning play a key role. This study seeks to determine the influence that user experience and user interface design of e-learning platforms have on learning experience in higher education. A systematic review of studies regarding usability of e-learning platforms at tertiary institutions was conducted to determine the common issues and successes. A snapshot of research over the last five years was used in a systematic review to determine the influence of UX/UI on eLearning with reference to higher education. Using the ERIC and Google scholar databases of journals, and specific criteria for selection of publications, 25 articles were examined in this study. Findings indicate that focused attention on interface design and user experience of eLearning systems for effective learning is crucial.

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Introduction

In the last decade, researchers have shown an increased interest in the user experience and user interface design of software systems. The recent COVID-19 outbreak has heightened this interest since working with digital and interactive systems have become mainstream in our lives.

One of the sectors that have endured the greatest impact is the education sector. Over 91% of all tertiary students internationally have been affected due to the closure of educational institutions (Adeoye et al., 2020), forcing countries to make a profound shift in the education sector. To counteract the effects of COVID-19 with minimal disruption to the goal of developing the current generation for the future (Aboagye et al., 2021), making this shift from the conventional way of teaching to the online mode of teaching and learning was enacted. This shift is particularly eminent in tertiary education. With tertiary institutions being forced to adopt e-learning as the only mode of learning in such a short space of time, students have found adapting to the use of e-learning platforms extremely difficult for several different reasons (Dhawan, 2020).

The shift to the online mode of learning is one of the biggest motivating factors for a paradigm shift in curriculum development due to the increased focus and reliance on technology for tertiary students globally (Elmunyah et al., 2020). It is safe to say that with this refreshed curriculum development, the use of Learning Management Systems and other software tools that support asynchronous learning play a vital role in education. Therefore, the development and implementation of these online learning curriculums and platforms need to take User Experience/User Interface (UX/UI) design into consideration to reach desired learning outcomes (Elmunyah, et al., 2020). With tertiary students experiencing many different challenges, engaging with, and adopting online learning

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also pose challenges. This study seeks to highlight the challenges brought about by UX/UI design of the system and how UX/UI design impact students' learning outcomes.

This paper is divided into five sections. The first section contextualizes the research by providing background information related to covid-19, the second section reviews the related literature, the third section discusses the specific methods by which the research and analyses were conducted, and the fourth section presents the findings of the research focusing on the research questions. Finally, the last section concludes the paper focusing on the main findings and implications for practice.

Literature Review

Tertiary students are confronted with several barriers when using online learning and these barriers are dependent on several factors ranging from the economic state of the country to a student's technical aptitude due to their exposure to technology (Panigrahi, Srivastava & Sharma, 2018). Many studies suggest that blended learning is the best way to move forward in terms of successfully integrating online learning into the tertiary education sector. It is agreed that blended learning is a combination of traditional teaching techniques and the use of technology that promotes both synchronous and asynchronous learning for students to reach desired learning outcomes. This means that along with traditional learning where the educator engages with the student during class hours and vice versa, it is equally important that a student engages with learning material alone and in their own time using a learning management system platform, such as Moodle among other platforms (Bryson & Andres, 2020). Some of the identified challenges and barriers experienced during covid-19 are, among others, student socio-economic factors, human and pet intrusions, lack of digital competence, integrity of assessments, efficient supervision, and the use of the technology or online platform in use (Adedoyin & Soykan, 2020). Online learning depends on the internet and technological devices (Heng & Sol, 2021). However, what is not known is how user experience and user interface design impacts online learning. With asynchronous learning playing such an important role in reaching the desired learning outcomes of e-learning, it is critical to understand the challenges that confront learners when it comes to engaging, adopting, and benefitting from the use of online learning platforms. Gregg et. al. (2020) argued that a poor UX due to an accessibility issue when using a specific LMS and use of multiple UIs can be confusing and hence counterproductive to the learning experience.

Therefore, UX/UI design is an important aspect to consider when designing the user interface. User experience applies to all forms of end-user engagement with an application or service such as the internet, computer programs, mobile apps, or online platforms (Mustafa & Karimi, 2021). Hence, it is extremely important that the quality of said software is of a high standard. In their study, Adedoyin and Soykan (2020) identified accessibility problems due to instructions that were difficult to follow on a specific educational program. This can be viewed as a barrier to successful online learning. Moreover, Bryson and Andres (2020) affirm that the shift from contact classes and proximate learning to online distance learning has been problematic. Therefore, this study focuses on the influence that UX and UI design has on the shift from contact classes to online learning as asynchronous learning relies heavily on a student's use of software and technology. A recent study (Alipio, 2020) suggests that students of higher education from developing countries experience a different set of challenges and barriers than students from developed countries. Using a sample of 880 students from the Philippines, he found that most of the students from private higher education institutions responded with a 'No' when asked if they were ready to partake in online learning (Alipio, 2020). Students in less economically developed countries must deal with other challenges even before adopting online learning, thus indicating the adverse circumstances these students are faced with before the adoption of online learning is successfully embraced. In his study, Alipio (2020) further identifies the challenges that students from less developed countries face – ranging from lack of adequate finance for the required technological equipment, to a lack of digital skills, and access to internet connection, including appropriate software.

A similar study conducted in Nigeria (Adeoye, Adanikin, & Adanikin, 2020) advocates the need for the rapid transition to online learning in the education sector that was compounded by the negative effect COVID-19 have had on students internationally. Despite the negative challenges experienced, some institutions within the same country maintain that the pandemic has prompted them in the right direction.

Furthermore, it has been argued that the transition to online learning not only adversely affected students from less developed countries, but also students from developing and developed countries as well. Hence, it can be inferred that being from a more developed country does not necessarily mean the journey of adopting online learning and reaching desired learning outcomes is an easy one.

There are other issues that do not necessarily have any correlation to one's country's economic status. These issues can still act as a barrier to the adoption of online learning and reaching desired learning outcomes. Issues pertaining to technical factors, E-Learning software system quality, culture, self-efficacy and trust are examples of these barriers (Almaiah, Al-Khasawneh & Althunibat, 2020). In a related study, Toquero (2020) argued that tertiary students who transitioned from contact classes to total online learning may affect their satisfaction with the learning process. Hence, the lens is placed on blended learning. This means that the experience students once obtained from contact classes need to be emulated to a certain degree within the online learning platform to have a similar effect on their learning outcomes. Herein lies the importance of the user interface for students learning using online platforms.

The next two sections thus, present the user interface and experience in general and its role on online learning platforms.

UX/UI Design in General

A software application's UI is one of the very first screens a user sees before engaging with content (Muslim et al., 2019). They state that "With a good UI, users can use existing features well and getting good UX" (Muslim et al., 2019, p2). The ease with which a user can access existing features immediately after being greeted by an application's UI lends itself to principles of effective navigation and hence contributes to good UX. In another context (Alsswey & Al-Samarraie, 2021), it was shown that taking into consideration culture of the users in the design of the UI resulted in high satisfaction among Arab users in a health sector. This usability feature, for "group-specific cultural preferences and values" (p2) can be used in designing meaningful user interface designs to suit the needs of users. In another recent study (Bakos, 2019) regarding a business website, feedback from the users indicated (among others) that navigation on the website should be more flexible and that the "hamburger menu" would be more suitable on a mobile phone. Hence, excellent product experience tends to start with UX design that leads to a UI design as both are required for the success of a digital product or website (Bakos, 2019).

In 2020, studies showed that approximately 68% of all e-commerce users exit a website due to bad UX design, 44% of online shoppers will make the effort to share their negative experience, and 62% will come back to the website if the UX is desirable (Nguyen, 2020).

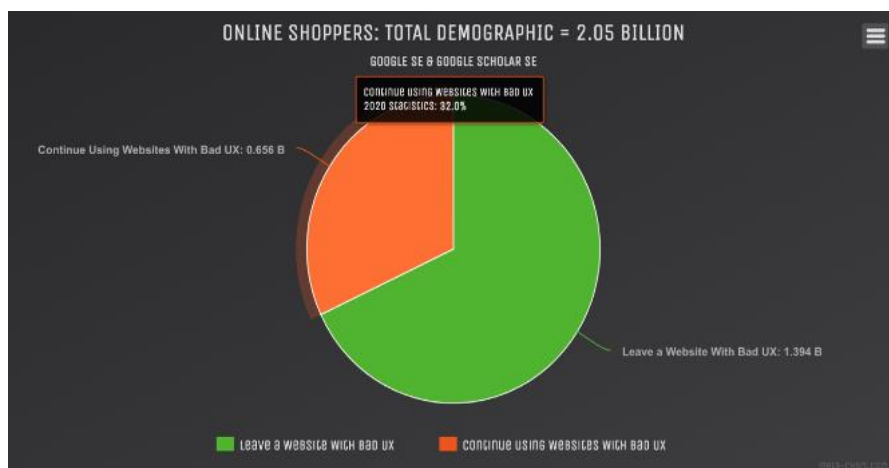


Figure 1: E-Commerce User's Web Behaviour

Figures 1 and 2, provide a visual representation of data communicating the online behaviour of approximately 2.05 billion online shoppers for the year of 2020, an online user approximation provided by the Google Search Engine. This data shows that approximately 1.394 billion users leave a website with bad UX. This is a considerable number of people and should act as motivation for the further investigation on whether this pattern carries on over to the use of e-learning platforms.

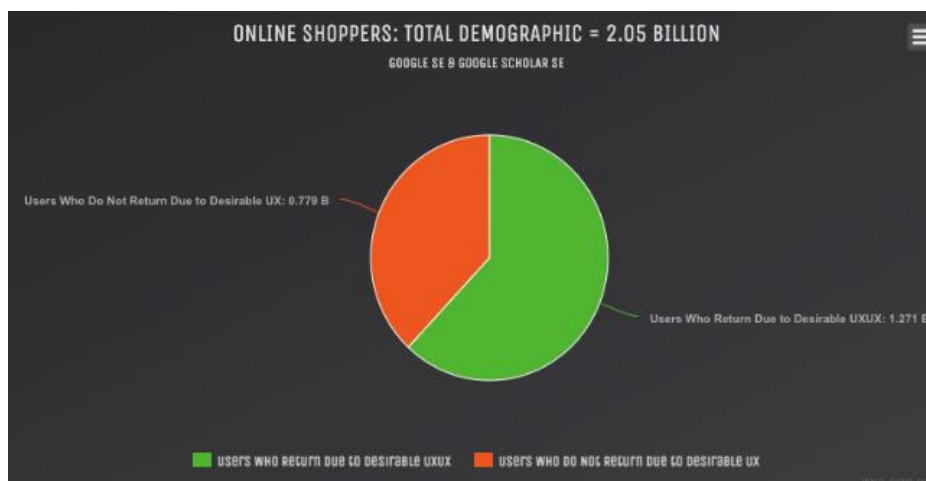


Figure 1: E-Commerce user's Reaction to Bad UX

UX/UI Design and Online Learning

Tools such as LMS (Learning Management Systems) are an extremely important part of the online learning process as they function as a hub or repository for most academic material a tertiary student may need. They also can support social constructivism as they

provide a platform for students to engage with one another and communicate concepts and practice critical thinking within forum spaces (Nichols, 2016). In another study, Santoso et al. (2016) support the use of LMS by educators for posting material such as PowerPoint slides, several types of consumable media, and links to learning resources. It is worth noting the importance of the interaction between students and software in engaging online learners to reach the desired learning outcomes. With software playing such an important part in the online learning process, one would expect user interface and user experience design to play a significant role in the effectiveness of the interaction. This effectiveness is evident in the development of an internal LMS referred to as iQualify that was developed purely from a user-experience perspective to obtain optimal online learning experience (Nichols, 2016). The decision to develop this software was made after the realization that traditional LMS was not efficient enough due to the lack of development that allowed for the genuine enhancement of online-only student experiences.

To enhance engagement in the learning process, one can apply game-like elements or activities to teaching. It is no secret that gamification is a technique or strategy used in learning environments to promote both fun and entertainment while improving a learner's gaming and learning skills through the implementation of gaming elements (Pamudyaningrum et al., 2020). With that, using educational games, the interface is the first interaction that students have with the system (Pamudyaningrum, et al., 2020). They believe that the interaction is key to satisfaction and is the reason many students or users find games interesting and engaging. Furthermore, Pamudyaningrum et al., 2020 found that when students of higher education were given the option to choose among three types of questions (Multiple choice interface, drag and drop, and true or false) for one of their tests, the students chose 'drag and drop' because of its ease of use as this type of question interface eliminates typing errors. Clearly, user interface and user experience design play a crucial role in online learning, influencing how students interact with online learning software. Students also tend to have preferences and seem to benefit from user experiences and different types of user interface designs. Benefits of any choice usually aid in reaching the desired outcome of that choice. Hence, it is safe to say that the use of desired user experience (UX) and user interface (UI) design serve to help students reach their desired learning outcomes. However, there is a lag in research efforts regarding UX when it comes to online learning, which can be attributed to the fact that the focus of online courses is learning and not necessarily student satisfaction (Reid et al., 2016). In not giving attention to student satisfaction regarding the software platform for teaching and learning, can be counterproductive to students learning experiences. Confusion and non-intuitive interfaces can affect students' learning experiences and satisfaction (Reid, et al., 2016). Similarly, in their study, Gray and DiLoreto (2016) hypothesized that a student's interaction and engagement on online learning platforms can and will have a statistically significant impact on perceived student learning and student satisfaction, further justifying the need for this study.

In his comparative study of the experiences of two student groups using the traditional LMS and the user-centered LMS, iQualify, Nichols (2016) found that more students preferred using iQualify to the traditional Moodle. That is Moodle was considered a "difficult system that needs replacing entirely".

There has been a surge of interest on students' perspectives of online learning by educational researchers since the pandemic. Troop et al. (2020) believe that students who have enjoyed their experience using online learning software have benefitted from a platform that is conducive to their learning. It can be inferred that there exists an ideology that good UX/UI design contributes positively to a student's learning outcomes. To this end, this study examines the literature regarding the usability of the online learning platform for satisfaction and influence.

Research Methodology

To provide a tangible and thorough understanding of UX/UI in online learning platforms, we conducted a systematic literature review (SLR) to identify, select and gather relevant research material related to the research questions. The PRISMA model (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was followed to conduct the systematic literature review. This study is part of a larger study that was submitted as part of a project of the first author. The process included the following steps (Kitchenham, 2004):

- i. Formulating research questions
- ii. Search criteria for the database(s)
- iii. Inclusion/Exclusion criteria
- iv. Selection of studies
- v. Analysis and extraction of data
- vi. Summary and interpretation of findings

Research questions

The approach used relies on intuitive, logical, and empirical knowledge. However, this study also contains a subjective perspective as the concept of user experience relies on the opinion of everyone using a particular piece of software i.e., Learning Management Systems.

The following research questions were developed to guide the review:

How does the user interface of e-learning platforms affect the user experience?

How does UX/UI design (usability) influence online learning from a tertiary student's perspective?

Database Search Method

This systematic literature review (SLR) enabled a search of an electronic database and the web search engine for scholarly studies and academic resources.

To uphold the study's reliability, only peer-reviewed articles were included. The Eric database, containing studies related to education in a range of disciplines in many different education journals, was searched since this review is rooted in higher education. Using the EBSCOhost Research Databases interface, the advanced search option was selected to include the database: ERIC. Applying limitations to suit the study was enabled by using the automation search strategy. The general data source, Google scholar was also searched to enable a more specific aspect related to usability and the technical aspects of interface design, which generally fell out of the scope of the education journals, but which had specific relevance to this study. Considering terms with similar meaning is necessary to improve the number of articles collected in an SLR. The terms used in the search string included basic concepts that align with the research topic and research questions such as "online learning, e-learning, User experience, user interface design and UX/UI, as well as synonyms. A string was created using Boolean operators within the string expression for each database. The search string, ("online learning OR e-learning") AND ("User experience OR user interface design OR UX/UI or usability") AND (higher education), was used for Google scholar, while the search string used for ERIC was (online learning OR e-learning) AND (User experience OR user interface design OR UX/UI or usability). Although a plethora of research on online learning experiences emerged in the last two years, not much research specifically explored UX/UI in the learning process. Hence the database ERIC timeline was expanded from the year 2021 to the period of 2017-2021. The Google Scholar data source also yielded numerous results that fell broadly on the technical aspect of interface design without specifically focusing on e-learning in universities or post-secondary students. Hence, specific criteria for inclusion and exclusion in the dataset of studies for analysis were applied to obtain an optimal set of studies for this research.

Inclusion/Exclusion Criteria

Inclusion

The study must be (quantitative, qualitative, or mixed methods).

The study was conducted in the higher educational environment.

The article is a peer-reviewed article.

The article is published from 2017 to 2021. To include e-learning practices with new interactive technologies that emerged during the covid-19 pandemic, we considered studies from 2017.

Exclusion

The study is not written in English.

The study is only published as an abstract.

The study dealt with UX/UI for enterprises other than higher education students.

Selection of Studies - Review Process

The initial search results in both databases produced a total of 157 articles. These articles were screened for duplicates, published date, and relevance of title and abstract. 96 articles were excluded. The remaining 61 were scoped for further insights. A further 25 studies that did not include the specific user experience and interface design aspects were excluded. Four articles were not retrieved. Thirty-two full text articles were assessed for eligibility. Seven of these did not meet the eligibility criteria.

The data collected also had to be about tertiary students as opposed to students in all stages of their education. This is because the study focuses specifically on online learning from a tertiary student's perspective. Papers that had a focus on user satisfaction as well as the UX/UI design of LMS were used to answer the first question. Papers that mentioned how UX/UI design affects learning outcomes as well as user satisfaction were used for the second research question.

Analysis and extraction of data

The remaining 25 articles were carefully reviewed with relevance to our criteria and research question(s). Each article was read multiple times to understand its content, approach, methods used, and findings for accuracy. The PRISMA process that we followed is depicted in Figure 1.

Summary and interpretation of results

The 25 articles that comprised the final dataset were included in the systematic review (Table 1). In some instances, the context was taken verbatim from the article under review so as not to distort the meanings.

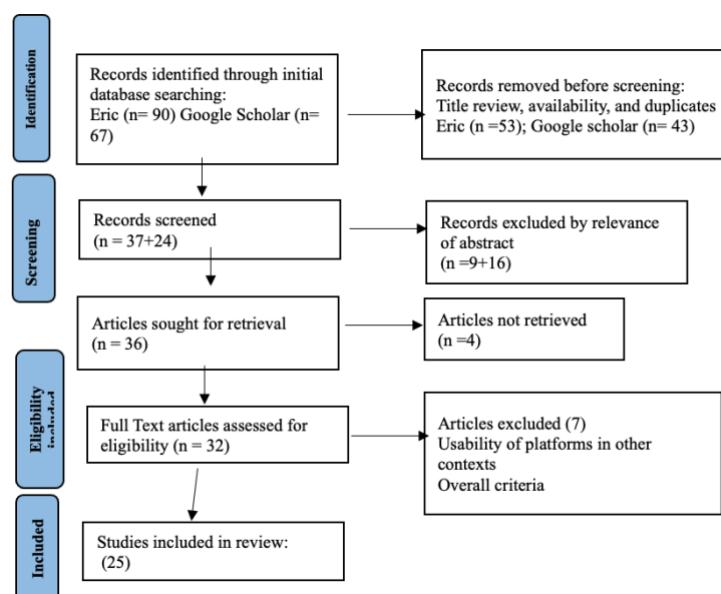


Figure 3: Process followed to obtain studies

Data Analysis and Findings

To address the research questions, the keywords were explored to determine the most frequent use of themes or words and its relevance to the research at hand. Thereafter the final set of studies identified for analysis, were examined for the context, intervention, and findings.

Descriptive analysis

To determine the themes or words of relevance, a cloud of keywords was developed (Figure 4). The five topmost concepts that emerged were learning system, e-learning, online, usability and education. These speak to the importance of usability in e-learning platforms.

As can be seen from Table 1, the participants came from different learning areas or specialisations at the tertiary institutions. The studies included cohorts of participants who were undergraduates (13), graduates (4) or a mixture of both, including faculty (7). Table 2 below indicates the methods or approach used, where most of the studies that were reviewed used a quantitative approach. In the mixed method, the use of SLR and quantitative data was collected. It is worth noting that some studies saw the need to develop a prototype e-platform to learn and subsequently used either quantitative or qualitative evaluations for the prototype



Figure 4: Word cloud of Keywords

These studies clearly indicated the characteristics that were needed for usability from the perspectives of the users. The other methodologies refer to systematic literature review (2) and theoretical paper (1)s, which were useful for gaining insight into the importance of usability and user experience. Although this study did not le review.

Table 1: Summary of Studies for review

No	Author(s)	Methods	Participants	Context
1	Baker, Unni, Kerr-Sims & Marquis (2021)	Quantitative	Undergraduate business students	Factors leading to students' preference and satisfaction with online courses.
2	Alshehri, Rutter, & Smith (2019)	Quantitative	undergraduates who are users of a web-based e-learning system	Examines interaction between e-learning system, Blackboard and the students who use it in Saudi Arabia.
3	Francom, Schwan & Nuatomue (2021)	Survey-Quantitative	undergraduate students	Google Classroom is compared with Brightspace.
4	Farid, Qadir, Ahmed & Khattak (2018)	SLR and empirical data used- Quantitative	undergraduate students	Empirical investigations were conducted to extract the CSFs influencing quality of e-learning systems.
5	Yoo & Jin (2020)	Prototype methodology visualization techniques	undergraduates and faculty	User experience evaluations to determine how learners and instructors perceived their interactions with the dashboards.
6	Lin, Liu & Wang (2017)	Prototype method	non-native English graduates	Design an e-learning tool with a Chinese-based interface and to evaluate its perceived usefulness on users' English academic writing development.
7	Afghani (2021)	Quantitative	undergraduate students	Assessed the strengths and weakness of Blackboard used in distance education- using students' (users') experiences.
8	Eraslan & Kutlu (2019)	Quantitative	All students	Examines the students' acceptance of LMSs in Turkey.
9	Taat & Francis (2020)	Quantitative	2nd and third year teacher education students-	Determines the level of e-learning acceptance and factors that influence.
10	Heggart & Yoo (2018)	Qualitative	Final year pre-service teachers	Examined the effectiveness of using Google Classroom in teacher education for future pedagogies at the tertiary level.
11	Moghavvemi & Salarzadeh (2018)	Qualitative	Preservice teachers-	Determined the "effects of using a Facebook group as an e-Learning tool based on students' longitudinal perceptions" in a business statistics course.
12	Ramkissoon, Belle & Bhurosy (2020)	Mixed method	600 students across three universities	Investigates the "perceptions and experiences of students in three Higher Education" Institutions (HEIs) regarding their interaction with the learning platform
13	Majid, Kamarudin & Zamin (2019)	Quantitative	Social science graduate students	Uncovers the postgraduates' perceptions of MOOCs in one of the Malaysian public universities.
14	Sadaf, Martin & Ahlgrim-Delzell (2019)	Quantitative	Graduate students	Examined student perceptions of the impact of Quality Matters- courses on students' learning and engagement in online courses based.
15	Eltahir, Al-Qatawneh, Al-Ramahi & Alsalhi (2019)	Mixed method	Students and faculty	Investigates the usability of the e-learning courses at the University using the usability evaluation questionnaire.
16	Ghazali, Nordin, Abdullah & Ayub (2020)	Quantitative	Undergraduate students	Explored two constructs in eLearning--students' MOOC-efficacy and meaningful learning. The study conceptualized students' MOOC-efficacy in four dimensions.
17	Alanazi, Frey, Niileksela, Lee, Nong & Alharbi (2020)	Quantitative	Graduate students	Investigated learners' perceived performance in a national sample of students in online learning environments through a path analysis of five constructs in the context of Task-Technology Fit theory.
18	Troop, White, Wilson & Zeni (2020)	Qualitative	2nd year students-	Aims to address whether the UXDL framework aligns with students' preferences, beliefs, and behaviours in online learning in a post-secondary context.
19	Kishabale (2021)	Quantitative	Students	Assessed interface design quality, and its predictive ability on E-learners' post-adoption behaviour in E-learning course environments.
20	Jin (2017)	Prototype method-quantitative	Undergraduate students-	Develop a visualization tool to motivate learners to participate actively in collaborative online learning communities and examine its effects on online participation, perceived learning, perceived satisfaction, team project performance, and usability.
21	Semin & Hyung-Jin (2021)	Prototype methodology	Undergraduate students	Develop a mobile application for students to conduct an analysis of their learning progress and thereafter performed a usability evaluation for "students who participated in non-F2F Arduino practice learning".

Table Cont'd

22	Oluwasegun (2018)	Theoretical	Non-empirical	Determines at what stage of system development does a system developer gives attention to user experience evaluation methods (UXEMs).
23	Alnarus and Riyanarto (2019)	Prototype methodology	Students and Lecturers	Presents the current development web-based application used by lecturers as supportive tools for implementing Project Based Learning and Lab Based education.
24	Brita and Kumar (2021)	SLR	Non-empirical	Previous research work in the field of mobile learning showed that improper design of learning elements is still present in mobile systems. Some attempts to adapt learning contents with appropriate instructional design principles are conducted.
25	Damla (2020)	Mixed method	Instructors and students	Carry out a user experience (UX) study on BigBlueButton system with the instructors and students at Yıldız Technical University School of Foreign Languages.

Table 2: Approaches used in the studies

Quantitative	11
Qualitative	3
Mixed method	4
Prototype	6
Other	2

Context and Outcomes

To determine the association of the user interface and user experience with learning, studies were examined for the context and findings regarding user satisfaction and learning in using the e-learning platform. For the 25 studies that comprised the data set from the systematic review, the outcomes are summarised in table 3. The findings in most studies are presented verbatim so as not to misrepresent the findings.

Table 3: Summary of the outcome of the studies

No	Author(s)	Findings	Outcome- Context
1	Baker,Unni,Kerr-Sims & Marquis (2021)	Satisfaction was positively related to preference for online courses.	Positive - satisfaction
2	Alshehri, Rutter, & Smith (2019)	Information quality is the most important dimension followed by, the navigation, System learnability and visual design, in order of importance of e-learning usability assessment.	Positive -information quality - Blackboard
3	Francom, Schwan & Nuatomue (2021)	Findings indicate a general preference for the Brightspace LMS for its productivity tools, and attitude toward usage and usability.	Positive -productivity tools, and attitude toward usage and usability- Brightspace
4	Farid, Qadir, Ahmed & Khattak (2018)	Of the eight critical success factors (CSF), Perceived usefulness and lack of LOs in local languages were ranked the highest for e-learning platform.	Positive- Perceived usefulness
5	Yoo & Jin (2020)	Learners' impressions - almost average. Novelty - excellent, efficiency and stimulation - good, perspicuity - above average, attractiveness, and dependability - below average. Instructors' impressions - excellent, except attractiveness. Both groups found the learning analytics dashboards to be creative and innovative (novelty). Confirmed that the dashboards were efficient in helping them.	Both groups -mostly positive
6	Lin, Liu & Wang (2017)	Participants considered the system useful and helpful while learning English academic writing and extract the design principles derived from the empirical results. Usability is an important criterion for students' satisfaction of the system	positive - e-learnng tool with Chinese -based interface
7	Afghani (2021)	Differences in the experiences of e-learning by students in different academic years, academic departments and those who have received prior training in e-learning and those who did not	Mostly positive-differentiated between different groups.
8	Eraslan & Kutlu (2019)	Intention to use a LMS is affected from perceived usefulness, perceived ease of use and social norm. At the same time, perceived usefulness is affected from	Positive - UID affects PEOU and PU

Table Cont'd

		perceived ease of use, social norm and user interface design and perceived ease of use is affected from user interface design and computer self-efficacy.	
9	Taat & Francis (2020)	The key factors influencing the acceptance of e-learning among the students are usability, lecturer characteristics, system quality, the information provided, and available technical support.	Positive – usability
10	Heggart & Yoo (2018)	Revealed concerns around pace and user experience. Data used to develop a framework to evaluate the use of online platforms; it identifies four concepts (pace, ease of access, collaboration, and student voice/agency) that explore the usefulness of other online learning platforms, as well as pedagogical practice.	Positive
11	Moghavvemi & Salarzadeh (2018)	“Students were more familiar with the usability of the Facebook group after learning for a few weeks, and their intention to use and use of e-Learning via Facebook subsequently increased.”	Positive- usability of Facebook
12	Ramkisson, Belle & Bhurosy (2020)	“68.4% of respondents used WhatsApp compared to only 23.6% of them who used the e-learning platform, Moodle. Students preferred WhatsApp due to its facility for knowledge sharing and construction, its interactivity, its usability, respect for privacy and instant communication.”	Positive - use of Whatsapp
13	Majid, Kamarudin & Zamin (2019)	There is a need for MOOC to align with the needs of the postgraduate students who are adult learners in determining MOOCs' attributes, learning process, and learning outcomes.	Positive - MOOC usability
14	Sadaf, Martin & Ahlgrim-Delzell (2019)	Among the eight categories, students rated Course Activities and Learner Interaction to have the highest impact on both student learning and engagement.	Positive- interaction-UCD
15	Eltahir, Al-Qatawneh, Al-Ramahi & Alsulhi (2019)	Attitude of most were positive toward the usability of e-learning courses. Viewed the e-learning courses as being a user-friendly interface. First-year students vacillate in expressing a definite opinion about the usability. Students' perspective varied by gender (women were more favorable) and college type (students in the Business Administration College were more positive).	Positive
16	Ghazali, Nordin, Abdullah & Ayub (2020)	Students' MOOC-efficacy was positively associated with meaningful learning. Students' MOOC-efficacy explains 67% of the variance in meaningful learning. The finding offers added understanding of what is functional and successful in an open online education. These insights may help to be used to meet the needs and preferences of studnets.	Positive - MOOC usability
17	Alanazi, Frey, Niileksela, Lee, Nong & Alharbi (2020)	The "Ease of use," "relationships between users," and "technology satisfaction" had weaker relationships with performance. Believe that all organisations should stress usability when designing LMSs if the goal is to boost learners' performance and satisfaction.	Negative - ease of use and technology satisfaction with performance
18	Troop, White, Wilson & Zeni (2020)	Qualitative analyses uncover 4 major themes in online design that students find effective: (1) Accessible, (2) Useful, (3) Intuitive, and (4) Desirable	Positive
19	Kishabale (2021)	The four factors were found to be statistically significant predictors of E-learners' satisfaction; and in-turn, satisfaction impacted learning agility, on interface designs and end-user post adoption with E-learning interventions.	Positive
20	Jin (2017)	Two types of visualization tools have significant effects on the perceived satisfaction, perceived learning, and team project performance. Learners reported that the visualization tool motivated them to participate in online learning.	Positive
21	Semin & Hyung-Jin (2021)	Usability scores between 3.53 and 4.42, indicate that the learning progress self-diagnostic was essential and that mobile applications were useful in non-F2F practice learning. They would like to use it for all their subjects.	Positive – Arduino
22	Oluwasegun (2018)	There is a “need for system developers to embrace UX evaluation methodology to ensure effective usability, accessibility, and efficiency of a designed system.”	positive (non-empirical)
23	Alnarus and Rianarto (2019)	Most benefited from the use of the supportive tool. Log metric users on average complete a designated task in just less than 5 minutes. The online tool is easy to use and reveals the effectiveness of the tools.	Positive
24	Brita and Kumar (2021)	Significantly reduce complexities that exist in mobile learning platforms and promote an enhanced mobile learning experience.	positive (non-empirical)
25	Damla (2020)	Negative attitudes towards the distance education system and distance education concept. The usability test and post-use survey data showed that the system has problems in areas such as error prevention and recovery, feedback delivery, undo option, and the use of clear icons, and they negatively affect the user experience.	Negative- error prevention and recovery, feedback delivery, undo option, and the use of clear icons.

Even though some studies did not measure specifically the usability of the e-learning system in place, most studies homed in on the satisfaction criterion as preference for online learning platforms. The following themes were found that relate to satisfaction.

Information Quality

Three studies (Alshehri, Rutter, & Smith, 2019; Farid, Qadir, Ahmed & Khattak, 2018; Taat & Francis, 2020) highlight the importance of information quality as one of the factors influencing the acceptance of e-learning systems. Information quality is one of the criteria of usability.

Interface design

Two of the studies (Francom, Schwan & Nuatomue, 2021); Eraslan & Kutlu, 2019) have used TAM to measure the acceptance and usefulness of the system. Eraslan and Kutlu (2019) found that interface design influenced perceived ease of use and perceived usefulness, which in turn influenced the behavioral intention to use the system. In Francom, Schwan and Nuatomue (2021), they found that usability was a critical factor in the acceptance of the system. Several platforms were examined in the reviewed studies, namely Moodle, WhatsApp, Facebook, BigBlueButton, Google classroom, Blackboard, and developed tools to assist in the learning process. The different e-learning platforms used in these studies, showed strongly that usability of the system was vital to the engagement and learning process. In three of the reviewed studies, two platforms were compared for its usability, showing how navigation and accessibility are key aspects of usability.

Personalization or user context

What has emerged is that eLearning platforms should be personalized to their needs to be most effective. This then points to the criticality of user experience and user centered design. For example, in Yoo and Jin (2020), both students' and faculty 's experiences and perceptions of the dashboard system varied in three out of the five dimensions (novelty, efficiency, stimulation, perspicuity, and attractiveness and dependability). Overall, both the instructors and the learners acknowledged that the learning analytics dashboards was novel. In Afghani's study (2021) the usability of the system varied among the different cohorts of students, e.g., academic years, academic departments, and those with prior training in e-learning and those without.

Usability

Fifteen of the 17 studies that mentioned usability, maintain that designers of e-learning platforms should weigh heavily on usability if satisfaction and performance are the end goals. While other studies do not use specifically, the term "usability", other constructs, such as ease of use, satisfaction, interface design and user experience, are used to determine users' acceptance and positivity towards the e-learning platform. Many of these constructs are part of the usability assessment criteria.

ser experience

In one of the two non-empirical studies, Oluwasegun (2018) theorized that system developers should conform to user experience evaluation methods at some stage of the development process for enhanced usability, efficiency, and accessibility. In the second non-empirical study, Brita and Kumar's (2021) systematic literature review showed that user experience is also necessary for other learning platforms, namely the mobile learning platform.

System Issues-Negativity

Two studies (Damla, 2020; Alanazi et al., 2020) showed a negative attitude towards the e-learning platform. The usability test revealed that there were system issues as follows: - error prevention and recovery, feedback delivery, undo option, and the use of clear icons. In Alanazi et al. (2020) study, Ease of use, relationships between users, and technology satisfaction indicated a weak relationship with performance. This may be attributed to the system being poorly developed with regards to usability.

Conclusion

This study set out to determine the influence of user experience and user interface design on students' learning in higher education. The term usability appeared to be the driving factor in most studies that affect learning and acceptance of an eLearning platform. The implications for user-centered design highlighted several design considerations that have been supported empirically. The study has some limitations. In this systematic literature review, several decisions were made that created limitations. Hence, a small number of publications (25) were eligible for review in the period specified. The database searched was restricted to ERIC and the Google Scholar web search. Although the current study is based on a small sample, this work offers valuable insights into the important role user interface design plays in enhancing the user experience. There is no doubt that user interface design influences the user experience of an eLearning platform and hence is crucial to the overall usability of the system. Usability, in turn enhances the learning process.

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