

Article

Efficiency and Sustainability in Online Education: An Evaluation of LMS Platforms and University Websites in Northern Cyprus

Ogan Güntem* and Yalın Kılıç 

Faculty of Educational Sciences, Cyprus Science University, Mersin 10, 99320 Kyrenia, North Cyprus, Turkey; yalinkilic@cau.edu.tr

* Correspondence: ayorgili_ogan@hotmail.com

Abstract: The purpose of this study is to thoroughly examine the technical competencies of university websites in Northern Cyprus, as well as the contributions of Learning Management System (LMS) platforms integrated with these websites to user experience, with a focus on efficiency and sustainability in online education. This study adopts a “mixed-method” research model, which combines both quantitative and qualitative research methods for data collection and analysis, with the results being evaluated together. The participants of the research consist of the websites of universities in the Turkish Republic of Northern Cyprus (TRNC) and the IT department managers who will be consulted for their opinions on these websites. A total of 15 university websites were analyzed within the scope of the study, and interviews were conducted with the IT managers of these universities. During this process, analysis tools such as SimilarWeb, Alexa, Ahrefs, Moz, and SEMrush were utilized. For qualitative analysis, a semi-structured interview method was chosen to gather the views of IT managers on the websites. The findings emphasize the need for universities to optimize their digital strategies. Differences in website performance directly affect the strength of universities’ digital presence, while technological infrastructure, user experience, and the integration of educational tools emerge as key factors in improving this performance. Based on the results of this study, some universal solutions are proposed to optimize the digital strategies of universities in Cyprus.



Academic Editors: Gwo-Haur Hwang, Hsi-Hsun Yang and Hsin-Yi Liang

Received: 1 March 2025

Revised: 23 April 2025

Accepted: 23 April 2025

Published: 5 May 2025

Citation: Güntem, O.; Kılıç, Y. Efficiency and Sustainability in Online Education: An Evaluation of LMS Platforms and University Websites in Northern Cyprus. *Sustainability* **2025**, *17*, 4166. <https://doi.org/10.3390/su17094166>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: website; new media; online education; efficiency in online education process

1. Introduction

Digital transformation in education contributes to environmental sustainability by reducing the need for physical resources such as paper consumption. Online learning applications are noted to lead to significant reductions in carbon footprints compared to traditional methods [1]. Practices such as distance education diminish the need for travel for both teachers and students, thereby lowering energy consumption and greenhouse gas emissions [2]. However, for these contributions to occur, it is important that LMS infrastructures are supported by energy-efficient servers and operated with renewable energy sources [3].

Learning Management System (LMS) platforms also contribute to economic sustainability by enabling long-term cost savings. The decline in expenses related to printing and distributing materials in traditional learning methods supports efficient resource utilization [4]. Furthermore, digital applications facilitate the updating and sharing of educational content, allowing for even greater cost reductions [5].

Digital transformation in education offers compelling solutions for achieving the United Nations’ Sustainable Development Goals, such as “Quality Education” and “Climate

Action". LMS platforms ensure universal access to quality education while reducing negative environmental impacts, thereby supporting sustainable development [6].

The rapid advancement of the digital age has fundamentally transformed the methods of accessing and sharing information [7]. Traditional methods of knowledge acquisition have largely given way to online platforms, digital content, and internet-based learning environments. This transformation presents significant opportunities, particularly for higher education institutions, while also bringing various challenges [8]. Universities have recognized that establishing a strong presence in the digital world not only facilitates access to academic knowledge but also plays a crucial role in enhancing institutional brand value and strengthening global competitiveness [9]. In this context, university websites have evolved beyond mere information-providing platforms to become strategic tools that represent the digital face of institutions and hold a critical place in the daily lives of students and academics [10].

Modern higher education institutions use their university websites as their digital entrance point for public communication [11]. The sites distribute extensive educational content to academic staff as well as provide academic and management-function support to students [12]. The effectiveness of websites depends on their usability together with their speed and accessibility and their reliability [13]. Users' satisfaction level during site interaction directly relates to how well the technology functions and how the system operates [12]. Organizations must make it essential to assess and optimize university website designs based on user requirements [14].

The effectiveness of websites depends on various technical and user-centered factors. Firstly, a website's technical infrastructure must be robust, ensuring fast loading times, low error rates, and secure data transmission [15]. Additionally, the mobile compatibility of websites is crucial in today's environment, where the use of mobile devices is increasingly prevalent [16]. The widespread access to information through mobile devices necessitates that websites function seamlessly across different devices [12]. For these reasons, university websites must be continuously optimized and aligned with technological advancements to meet the evolving needs of users [17].

Beyond websites, another critical component in higher education's digital transformation is the Learning Management System (LMS), which has evolved from basic content repositories to sophisticated platforms that support collaborative learning, personalized feedback, and intelligent analytics [18,19]. Modern LMS platforms allow integration with AI-driven tools, synchronous/asynchronous communication, gamified assessments, and advanced learning tracking, enhancing both faculty efficiency and student engagement [20,21].

The theoretical framework surrounding LMS use often draws from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), which explain how perceived usefulness and ease of use shape faculty and student engagement with LMS platforms [22]. Empirical studies highlight that effective LMS integration leads to greater instructional clarity, feedback responsiveness, and autonomous learning behaviors among students [23,24].

Another crucial tool used by universities in the digital transformation process is digital platforms known as Learning Management Systems (LMS) [25]. LMS platforms serve as the venues for conducting various academic activities, such as online education, access to course materials, exams, and assessment processes [26]. Particularly with the mandatory shift to remote learning during the COVID-19 pandemic, LMS platforms have become central to the educational processes of universities. This shift fundamentally changed how instructional content was delivered, with live video, pre-recorded sessions, and hybrid models becoming primary modes of engagement. Research indicates that different video learning modes impact learner satisfaction, attention span, and continuation intention in

distinct ways [27]. Moreover, recent studies employing advanced user-experience modeling approaches—such as facial expression recognition and head pose estimation—provide new insights into how students respond to digital learning environments [28]. These findings reinforce the strategic importance of LMS platforms in adapting to post-pandemic educational models.

LMS systems provide students with the opportunity to access course materials anytime and anywhere, while also offering instructors the ability to organize educational content, monitor student progress, and create interactive learning experiences [29]. In this context, the effectiveness of LMS platforms has become a critical factor that directly influences the success of universities' educational processes [30].

A successful implementation of LMS platforms depends on multiple essential factors. A secure technical infrastructure base provides fast processing power for data security together with simultaneous support for multiple users [31]. The system ensures uninterrupted access together with the best possible user experience. A user-friendly interface must be present because it needs to provide simple navigation and straightforward access to resources and information [32]. The implementation of an intuitive design system makes learning more efficient between students and their instructors. The incorporation of forums and discussion boards together with quizzes creates interactive features that enhance student engagement with class materials and leads to better learning processes [25,31].

Digital education benefits significantly from LMS platforms when these platforms connect directly to university websites. The system brings students all their academic oversight tools to one place enabling smooth access to materials and messaging with educators [30]. The feature enables universities to bring various services into one platform, which leads to enhanced user experience and improved satisfaction among students [31]. Educational institutions today depend heavily on integrated systems because these systems enhance their digitalization efforts [33]. In light of this information, universities in Cyprus are making significant investments in their digital platforms to enhance their global competitiveness and improve their educational processes during the digitalization process. However, research on the current status, technical competencies, and contributions of these digital platforms to user experiences remains limited. Optimizing the digital infrastructure of universities will not only increase their local competitiveness but also enable them to attract a broader student base at both regional and global levels [34].

This research assesses the technical capabilities of Cypriot university websites along with the impact of Learning Management System platforms that integrate with these websites. Universities worldwide depend heavily on digital infrastructure to provide education support and to improve the student learning experience and worldwide academic performance. This research analyzes educational continuity as well as technological transformation and user engagement through university digital platforms and selects Cyprus as its primary example. Successful management of digital infrastructure serves dual purposes by making higher education systems in local institutions competitive and preparing them for future unified digital education frameworks. The research will offer useful guidance which will enable universities to enhance their digital strategy effectiveness to demonstrate digital transformation's essential role in international higher education. By focusing on IT professionals and institutional-level digital platforms rather than solely on pedagogical or psychological constructs, this study contributes directly to practical digital transformation strategies in higher education.

The purpose of this research is to evaluate the technical performance of university websites and the role of Learning Management Systems (LMSs) in improving the user experience in higher education institutions in Northern Cyprus. The research addresses the following question: how do technical features of university websites and the integration of

LMS platforms influence user engagement and educational accessibility? To answer this, the study sets three main objectives: (1) to quantitatively assess key performance metrics of university websites such as traffic, bounce rate, and visit duration; (2) to qualitatively explore the perceptions of IT managers regarding usability, infrastructure, and LMS integration; and (3) to derive strategic insights that support digital transformation efforts in higher education. These objectives guide both the design of the research and the analysis of the findings.

2. Methodology

In this study, a “mixed-method” research model was adopted, wherein both quantitative and qualitative research methods were employed together for data collection and analysis, and the results were evaluated collectively [35]. The convergent parallel design, one of the mixed-method designs, was selected as the framework. In the convergent parallel design, qualitative and quantitative data are collected simultaneously, then analyzed separately, and the compatibility of the findings with each other is examined [36].

The combination of quantitative and qualitative methods in this study is intended to provide both statistical analysis and contextual interpretation of user experiences. Recent studies on LMSs and institutional website performance have also adopted mixed-method approaches to capture technical efficiency alongside stakeholder perspectives, confirming the value of integrating multiple data sources for robust evaluation.

The quantitative part of the research utilized the survey model. The primary aim of the survey model is to describe the current situation as it is and to make generalizations [37].

The qualitative part of the research was conducted in accordance with the case study approach. A case study may involve a single case or multiple cases and is typically used to understand complex social phenomena [38].

In this study, the concept of “university website” was operationally defined as the official digital gateway of a higher education institution that combines technical features (such as speed, security, device compatibility, and infrastructure reliability) with content-based elements (such as the availability and structure of academic materials, navigation quality, and accessibility of institutional services). This two-dimensional definition enables the performance of websites to be systematically evaluated both from a technical and user-oriented perspective [13,16].

Likewise, “user experience” was defined as the users’ overall perception during their interaction with the university website. In this context, it includes four core dimensions: (1) usability—ease of navigation and interface clarity; (2) accessibility—mobile responsiveness and cross-device compatibility; (3) interaction—ability to communicate with academic services or engage with LMS features; and (4) satisfaction—subjective assessment gathered via interviews and metrics such as visit duration and bounce rate [12,14,39].

2.1. Participants

The participants of this research consist of the websites of universities in the Turkish Republic of Northern Cyprus (TRNC) and the IT department managers who will be consulted for their opinions on these websites. A total of 15 university websites were analyzed, and interviews were conducted with the IT managers of these universities. According to information obtained from the website of the TRNC Ministry of Education, Higher Education and Foreign Affairs Department, there are a total of 23 active universities in the TRNC [40]. The 15 universities selected for this study were chosen from among those with the highest student populations in the TRNC. This selection was made to enhance the generalizability of the study’s findings across higher education institutions in the TRNC. Therefore, the data obtained from the IT departments of the universities included in this

research allow us to make a general and reliable assessment of the performance of university websites in the TRNC. In this context, “university websites” were operationalized as official digital platforms of higher education institutions that provide access to academic and administrative resources through both technical infrastructure (e.g., loading speed, uptime, mobile compatibility, data security) and content-based features (e.g., availability of academic materials, user interface design, and accessibility).

For the quantitative part of the research, the websites of the selected universities were analyzed using programs such as SimilarWeb (6.12.6), Alexa (2.2.657773.0), Ahrefs (3.1.68), Moz (4.1.1), and SEMrush (18.1.77), and the numerical data obtained were presented in the findings section. The participants in the qualitative part of the research consisted of managers from the IT departments of the relevant universities. Data were collected from authorized individuals at each university, and a total of 15 interviews were conducted. Among these participants, seven indicated that they had been working at their respective universities for more than 5 years, while eight participants had been employed at their universities for more than 3 years.

Additionally, in line with the study’s conceptual framework, user experience was evaluated across four key dimensions—usability, accessibility, interaction, and satisfaction—based on both web analytics and the qualitative insights of IT managers [14,39].

2.2. Data Collection Tools

To analyze the websites, access to the sites to be examined was first established, and the necessary programs were procured. During this process, analysis tools such as SimilarWeb(6.12.6), Alexa(2.2.657773.0, Ahrefs(3.1.68), Moz(4.1.1), and SEMrush(18.1.77) were utilized. After obtaining these tools, they were installed on the computer, and the required technical configurations were made during the installation process. Test procedures were conducted to ensure that the programs were functioning effectively; in these tests, various sample analyses were performed to verify that the programs were collecting accurate data and that their analytical capabilities were at the desired level. Additionally, the methods to be used in the data collection process were carefully selected, and the analysis programs were customized according to these methods.

Each of these tools was selected for its unique capability to measure user behavior and website performance across key dimensions of the user experience. For example, SEMrush and SimilarWeb provided insights into page load time, bounce rate, and user flow—critical indicators of usability and satisfaction. Ahrefs and Moz were utilized to assess content accessibility, search engine optimization (SEO) structures, and link architecture, which are part of the broader informational quality framework of university websites [12,31].

Before starting the analysis of the websites, comprehensive measures were taken to ensure data security and privacy, and necessary adjustments were made on the programs in line with these measures. To avoid any violations of ethical standards, each step of the analysis process was carefully planned and executed. Continuous checks were conducted to ensure the accuracy and consistency of the data obtained during the analysis, and regular backups were performed to prevent data loss. After completing all these preparatory stages, the quantitative analysis of the websites was systematically carried out according to the established methods. Additionally, due to the need to protect the universities’ sensitive information and adhere to ethical considerations, the evaluations were conducted without mentioning the names of the universities.

As part of the qualitative analysis, a semi-structured interview method was chosen to gather the opinions of IT managers regarding the websites. A four-question interview form was prepared for these interviews (Appendix A). To ensure the appropriateness of the interview questions, feedback was obtained from three experts in the field, and the form

was revised based on their suggestions. To test the validity of the interview form, pilot interviews were initially conducted with three participants. During these pilot interviews, the clarity of the questions and whether the responses aligned with expectations were assessed. The data obtained from the pilot studies were analyzed, and in light of these analyses, the interview form was finalized. The final version of the form was approved by the researcher and the three field experts, making it ready for the main application.

The interview questions were designed to elicit responses related to four core components of user experience: usability, accessibility, interaction, and user satisfaction. This structure enabled the alignment of qualitative data with the analytical metrics obtained from the software tools, ensuring consistency between methodological strands and improving the construct validity of the study design [39,41].

2.3. Data Gathering

In the quantitative part of the study, advanced analysis tools were used to evaluate the technical competencies of university websites. These tools provide the ability to collect detailed data across various metrics to assess website performance. During the analysis process, key performance indicators, such as the number of visitors to each website, bounce rates, and the average time users spend on the site, were examined. The data obtained were systematically reported to provide comprehensive insights into user engagement, content quality, and overall technical performance of the websites. Each metric was meticulously analyzed, yielding valuable insights that can guide universities in optimizing their digital presence.

These indicators were selected based on their relevance to the operational dimensions of “user experience” defined in the study. For example, bounce rate and average session duration are commonly used proxies for usability and satisfaction, while total visit counts and user flow reflect aspects of engagement and accessibility [12,13]. Together, these analytics provide a robust basis for interpreting the relationship between website structure and user behavior.

In the qualitative part of the study, face-to-face interviews were conducted using a “Semi-Structured Interview Form” to gain an in-depth understanding of IT managers’ perspectives on the websites. The semi-structured interview technique is a commonly used method in qualitative research, allowing the researcher to collect rich and in-depth information from participants [41]. During this process, the selected participants were contacted to schedule a suitable interview time, with each interview lasting approximately 15 min. During the interviews, participants were encouraged to freely express their own experiences and opinions, ensuring that the data collected were natural and authentic, without any guidance or influence from the researcher.

The research was conducted between January and March 2024. During this period, both the web analytics and the interviews were carried out through a structured process involving the preparation of tools, data collection, and the integration of results. These qualitative data were taken into account during the analysis process, contributing to the enrichment of the overall findings of the study.

All participants were informed about the purpose of the research and voluntarily agreed to participate in the interviews. No personal identifiers were collected, and the anonymity and confidentiality of their responses were strictly maintained throughout the research process in compliance with standard research ethics guidelines.

Interview questions were aligned with the four conceptual pillars of user experience—usability, accessibility, interaction, and satisfaction—enabling structured coding and later comparison with quantitative web analytics. This approach enhanced the

construct validity of the qualitative phase by ensuring consistency in the domains being explored [39,41].

2.4. Data Analysis

University website technical performance evaluation happened through quantitative data collection from analytics tools. The evaluation of user experience together with technical competence used three essential performance metrics that tracked website visitor numbers and visit rates alongside user website duration. The findings were systematically documented.

These metrics were analyzed in direct relation to the user experience dimensions defined in the conceptual framework. Visitor numbers served as a proxy for engagement and visibility, visit rates reflected retention and usability, while session duration was interpreted as an indicator of satisfaction and effective content delivery [13,14]. These analytics allowed researchers to compare institutions on quantifiable UX parameters.

While the study primarily assessed LMS impact through web analytics (such as session duration and visit depth), it did not directly measure platform-specific indicators like student engagement rates, course completion statistics, or user satisfaction scores. These metrics are frequently used in LMS evaluations to capture effectiveness from a learning outcomes perspective [42,43]. Future research could enhance this analysis by integrating such indicators—either through LMS-generated learning analytics or post-use student surveys—to evaluate how specific features (e.g., assignment systems, video lectures, mobile access) influence actual learning performance and satisfaction. Establishing such direct metrics would provide a more objective and actionable basis for LMS platform improvement.

IT managers and staff participated in semi-structured interviews to identify their views regarding university websites. Nvivo 12 software processed the recorded interview transcripts after transcription. The researchers established main themes from the data and organized responses for frequency calculation of common answers. The methodology enhanced the data organization of qualitative findings which in turn enhanced the validity of the complete study findings.

Qualitative coding was structured around the four UX domains—usability, accessibility, interaction, and satisfaction. Themes that emerged from the interviews were matched with these domains, allowing triangulation with the web analytics results and enhancing the depth of interpretation. This approach not only improved thematic clarity but also strengthened internal validity by ensuring consistency between qualitative and quantitative constructs [39,41].

2.5. Validity and Reliability

The validity and reliability of the tools used in the analysis of quantitative data were supported by the fact that these tools are widely recognized and trusted within the industry. Furthermore, the accuracy of the data obtained from these tools is corroborated by studies in the literature. The detailed documentation and explanation of the steps in the analysis process enhance the validity and reliability of the research. This approach underscores the accurate and reliable interpretation of the results obtained.

In particular, the indicators used to assess user experience—such as bounce rate, session duration, and traffic flow—are considered standard metrics in usability research and have been validated across multiple empirical studies in the field of web interaction and user-centered design [12,39]. The use of multiple analytics tools (e.g., SimilarWeb, SEMrush, Ahrefs) also supports the criterion validity of the data by providing convergent measurements.

In qualitative research, validity is concerned with evaluating whether the methods used are appropriate for the research questions. In this study, to enhance the validity, strong relationships were established with participants, in-depth interviews were conducted, and feedback was obtained to ensure the accuracy of the data collected [44]. Additionally, expert opinions were utilized in the preparation of the semi-structured interview form and during the content analysis to ensure validity. The results obtained were presented in a holistic manner.

The alignment of qualitative codes with the operational dimensions of user experience further strengthens construct validity. For example, themes such as “navigation difficulty” or “responsiveness of content” directly map to the categories of usability and accessibility as defined in the study’s framework [13,41].

Reliability refers to the repeatability and consistency of the research. In this study, to ensure reliability, the research process was meticulously documented, and the steps were explained transparently. Additionally, the data obtained were presented to the participants for their review and approval, thus confirming the accuracy of the data. The consistency of code generation during qualitative analysis was ensured through intercoder checks and iterative theme validation, while the use of standardized analytics tools across all university websites ensured reliability in quantitative measurements.

3. Results

The status of the university websites according to certain statistics (total number of visits, bounce rate, visits per page, average visit duration, global ranking) is presented below.

3.1. Statistical Analysis of Websites

The data in Table 1 provide a comprehensive evaluation of the performance of university websites in Cyprus. When examining the number of visitors, significant differences are observed among the universities. Some universities attract millions of visitors, demonstrating a strong online presence, while others have relatively lower visitor numbers. This discrepancy reflects the differences in the universities’ digital reach and online visibility.

Table 1. Statistical analysis of websites.

University No.	Total Number of Visits	Bounce Rate	Visits Per Page	Average Visit Duration	Global Ranking
University 1	18.5 K	63.99%	0.37	85 s	4,711,918
University 2	103.6 K	45.15%	3.57	193 s	461,290
University 3	48.8 K	35.52%	0.66	244 s	1,329,784
University 4	273.3 K	32.26%	6.62	376 s	150,703
University 5	463.3 K	34.01%	10.07	314 s	92,293
University 6	198.7 K	27.12%	6.92	294 s	198,785
University 7	533.3 K	37.96%	7.42	340 s	78,995
University 8	166.1 K	51.06%	7.99	164 s	220,158
University 9	207.3 K	84.48%	1.45	30 s	332,765
University 10	39.4 K	38%	0.51	140 s	4,379,314
University 11	88 K	29.13%	5.42	414 s	410,244
University 12	48.3 K	36.85%	4.37	346 s	421,167
University 13	45.2 K	45.89%	3.04	270 s	1,583,359

Table 1. *Cont.*

University No.	Total Number of Visits	Bounce Rate	Visits Per Page	Average Visit Duration	Global Ranking
University 14 *	306 K	98.58%	1	-	-
University 15	57.5 K	31.81%	5.79	165 s	644,372

* The average visit duration and global ranking for the university could not be retrieved.

For instance, University 7 stands out with over half a million visits, while University 1 and University 10 record fewer than 40,000 visits. These disparities may stem from institutional marketing strategies, website optimization for search engines, or even mobile-friendliness, all of which influence discoverability [12].

The bounce rate data indicate how quickly users leave the website. High bounce rates suggest that the website is struggling to retain users and that the content or user experience may not be meeting expectations. A particularly high bounce rate of 98.58% indicates that the site is failing to meet user needs or capture their interest. Conversely, lower bounce rates suggest that users are more engaged with the site and tend to stay longer.

University 6 shows a bounce rate of just 27.12%, significantly lower than the majority, suggesting a well-structured interface and possibly better internal linking or navigation flow. In contrast, University 14's extreme bounce rate (98.58%) likely reflects serious usability or accessibility issues—potentially an outdated design, broken links, or non-responsive layout.

The number of visits per page measures the level of user engagement on a website. A low number of visits per page indicates that users typically view only a single page before leaving the site. This may suggest that the site's content is limited or that users are having difficulty finding the information they are looking for. On the other hand, a high number of visits per page indicates that the site is successful in guiding users to various content and capturing their interest.

University 5 and University 6 both exceed 6 page views per visit, suggesting that their content hierarchy and menu systems successfully direct users deeper into the site. In contrast, University 1 (0.37) and University 10 (0.51) perform poorly, which may indicate that users leave due to ineffective homepage layouts or lack of compelling content.

The average visit duration indicates the amount of time users spend on the site. Short visit durations suggest that the site may not be engaging enough for users or that they are unable to quickly find the information they are looking for. In contrast, longer visit durations indicate that users find the site useful and are willing to spend more time exploring its content.

University 11 recorded the longest visit duration (414 s), suggesting a deeper level of interaction, possibly due to integrated tools such as LMS portals, student dashboards, or well-structured academic content. Meanwhile, University 9's session duration of just 30 s is notably poor and may be associated with high bounce rates, confusing layout, or technical issues like slow load time [13].

The research data demonstrates substantial performance disparities among Cypriot university website operations. Each university requires improvement of their digital outreach and needs to enhance the experience for users online. The results function as a beneficial guide that helps both universities in Cyprus and higher education institutions which work towards digital transformation.

This comparative perspective reveals how core aspects of user experience—such as usability, accessibility, and content relevance—vary significantly across institutions. Such differences highlight the necessity for individualized improvement strategies tailored to each university's technological and content-specific deficiencies [14].

3.2. Analysis of LMS According to Responsible Personnel on Websites

3.2.1. Technological Infrastructure of the Website in Terms of Educational Activities

The data obtained from the participants were subjected to content analysis. The theme, sub-theme, and categories obtained from the analysis are shown in Table 2. Additionally, the participants' responses to the question of how effective their university's website's technological infrastructure is in supporting educational activities are exemplified with direct quotes under the relevant categories.

Table 2. Views on the technological infrastructure of the website in supporting educational activities.

Theme	Sub-Theme	Categories	Frequency
Technological Infrastructure of the Website in Terms of Educational Activities	Effectiveness and Efficiency	Content Presentation and Ease of Access	12
		Use of Current Technology	9
		Interactive Learning and Communication Ease	5
	Development and Improvement	Identification of Infrastructure Deficiencies	7
		Development and Renewal	4
		User-Friendly Interface	9
	Ease of Use	Customizability According to User Needs	4
		Providing Effective Help and Support	3

Table 2 reveals that the Technological Infrastructure of the Website in Terms of Educational Activities theme includes three sub-themes: effectiveness and efficiency, development and improvement, and ease of use.

Effectiveness and Efficiency:

Participants primarily evaluated the university website's role in supporting educational activities in terms of effectiveness and efficiency, with three key categories emerging:

- **Content Presentation and Ease of Access:**

Participants emphasized that the accessibility of educational content on the website plays a crucial role in supporting learning activities.

"Students can access all the content they want as they wish. The website is user-friendly and they can access all content without difficulty." (P2)

"...in this regard, the usability of the website is very important. Students and visitors need to easily access content without getting bored or spending too much time. I constantly receive feedback for this." (P4)

- **Use of Current Technology:** The use of up-to-date technology was seen as essential for ensuring the continuity of educational activities.

"The university website and student portal applications are continuously secured with the latest technological updates. As we know, nowadays all transactions are carried out via computers and the internet, so this is essential for us. We especially cannot afford errors. There are thousands of students, and it is important to use up-to-date technologies to provide uninterrupted service to them." (P15)

"...we need to stay up-to-date continuously. Just as professors need to keep themselves updated, we need to keep the system updated continuously and respond to students' expectations with current applications. We are doing this as well." (P11)

- **Interactive Learning and Communication Ease:**

Participants highlighted that the website facilitates interactive learning and enhances communication, contributing to the overall learning experience.

“Especially on our website, content made with current web tools is effective on students’ learning. Some professors can upload interactive course materials to the system or communicate with responsible persons through the website if there is a problem.” (P14)

Development and Improvement:

Participants highlighted development and improvement as key aspects of the university website’s technological infrastructure in supporting educational activities. Two main categories emerged under this sub-theme:

- **Identification of Infrastructure Deficiencies:**

Participants emphasized the importance of identifying and addressing infrastructure deficiencies to enhance educational support.

“Updating the necessary infrastructure to support students in education and constantly monitoring this is important. Some deficiencies exist and I think this negatively affects education.” (P5)

“...some programs are very expensive to integrate into the website and need to be procured. Or a limited version is used. This negatively affects education to some extent because not all features can be used effectively. Sometimes education is disrupted due to the lack of necessary infrastructure.” (P6)

- **Development and Renewal:**

Participants stressed that continuous development and renewal of the website are necessary to improve educational activities.

“It is necessary to identify deficiencies that are insufficient for new systems and allocate a budget for this. The website is the face of a university to the world. It is necessary to act with this awareness. The automation system needs to be improved and new systems should be established. In its current state, both we and the students are experiencing problems. This negatively affects education.” (P9)

Ease of Use:

Participants also highlighted **ease of use** as an essential factor in ensuring that the university website effectively supports educational activities. Three key categories emerged under this sub-theme:

- **User-Friendly Interface:**

A user-friendly interface was emphasized as critical for facilitating access to educational resources.

“We try to design the website so that everyone can easily access content without wasting time. We are constantly trying to make updates, but we need more staff for this.” (P13)

“...it is important to easily access online courses and training. For this, we try to design it in an extremely simple and practical way.” (P2)

- **Customizability According to User Needs:**

Participants highlighted that customization options enhance user experience and support educational activities.

“...especially on their portals, they can configure according to their personal needs. They can also ask for help from us for this. This allows them to reach the content they want more quickly.” (P2)

- **Providing Effective Help and Support:**

Participants stressed the importance of prompt support services to ensure uninterrupted access to educational resources.

“...students can have many problems. Password issues or not being able to access applications, etc. It is important to provide support and help them with these. We need to provide quick feedback to ensure their education is not disrupted.” (P4)

3.2.2. Features or Technological Tools Used for Educational Purposes on the University Website

Table 3 presents the categories and sub-themes derived from participants' statements regarding the features and technological tools used for educational purposes on their university's website.

Table 3. Views on the features and technological tools used for educational purposes on the university website.

Theme	Sub-Theme	Categories	Frequency
Features or Technological Tools Used for Educational Purposes on the University Website	Development Phase	Process Ongoing	4
		Researching New Technological Tools	2
		Course Content and Management System	14
	Features and Tools	Live Lesson Tools	10
		Assignment Submission System	9
		Educational Videos and Lecture Recordings	7
		Mobile Applications	4

When Table 3 is examined, under the theme of features or technological tools used for educational purposes on the university website, the sub-themes of development phase and used features and tools have been obtained. The categories related to these sub-themes and the participants' views on these categories are presented below.

Development Phase: Participants highlighted the continuous development and improvement of technological tools on university websites. Two key categories emerged under this sub-theme:

- **Process Ongoing:** Participants emphasized that the development process for educational tools is ongoing, with efforts to enhance their effectiveness.

“We are carrying out the necessary work using current technologies and infrastructure. We are currently developing a new system, and we believe it will be effective. Our efforts to make education more effective are ongoing.” (P13)

“We are constantly trying to improve ourselves because this is our profession. We aim to create a more user-friendly automation system and make it available. We plan to use it in the upcoming period.” (P4)

- **Researching New Technological Tools:** Participants indicated that they are **actively researching and assessing new technological tools** to enhance their university's digital infrastructure.

“We are constantly in the research and examination phase to integrate some features for educational purposes into our website. The R&D process is an important process for us. We need to continuously follow beneficial features and conduct feasibility studies to convey them to relevant units. We are working with this awareness.” (P3)

Features and Tools: Participants identified several **essential features and tools** that support educational activities on university websites. The following categories highlight their perspectives:

- **Course Content and Management System:** The course content and management system was the most frequently mentioned feature, enabling efficient content access for students and instructors.

“Students can access the content, slides, and supplementary resources related to their courses through the system and can always access these resources.” (P14)

“The necessary course files are available in the system. Professors upload these files to the students’ system before the course starts. Additionally, when assignments are given, they can be assigned to the system. Students can upload their assignments to the system after completing them. This system provides convenience for both students and professors.” (P11)

- **Live Lesson Tools:** Live lesson tools play a crucial role in ensuring **uninterrupted education**, particularly in remote learning situations.

“In some cases, online lessons may need to be conducted. Our infrastructure is ready to ensure that education is not disrupted. Additionally, online seminars and activities can be organized, allowing many participants to join.” (P7)

“As we saw during the pandemic, students could not come to school. We need to be prepared for such situations. All measures are ready to ensure that education is not disrupted. The use of live lesson systems provides advantages for both students and professors.” (P8)

- **Assignment Submission System:** The assignment submission system was identified as an essential tool for managing coursework efficiently.

“Assignments can be uploaded to the system. Students log into the system to see if they have assignments. Information such as the submission deadline is available in the system. They can complete their assignments and upload them to the system before the deadline.” (P14)

- **Educational Videos and Lecture Recordings:** Recorded lectures and educational videos enhance learning flexibility by allowing students to revisit course materials.

“Classes held in the classroom are recorded. Everything the professor does on the board is recorded. Students can access these recordings and listen to the lectures repeatedly later. This way, they can review the parts they did not understand.” (P2)

- **Mobile Applications:** Participants emphasized the **importance of mobile applications** in ensuring accessibility to university services and educational resources.

“Our website has a mobile application. Professors and students can access it anytime via their phones. They can perform all their transactions through the mobile application. They can log into their portals and carry out their transactions.” (P15)

3.2.3. Website Development and Improvement of Student Experience

Table 4 presents the categories and sub-themes derived from participants’ responses regarding **the steps taken to enhance interactive features and content on the university website to improve the student experience**.

When examining Table 4, the themes under “Web Site Development and Improving Student Experience” include “technological investments”, “content development”, and “user training and support”. The categories and participant views related to these sub-themes are presented below.

Table 4. Steps to enhance the university website to support students' learning process.

Theme	Sub-Theme	Categories	Frequency
Website Development and Improvement of Student Experience	Technological Investments	Infrastructure Updates	12
		Software Developments	9
		Hardware Investments	7
		Security and Privacy Investments	4
	Content Development	Course Materials	10
		Content for Student Engagement	8
		Customized Content	6
		Interactive Learning Tools	3
	User Training and Support	Educational Materials and Guides	9
		Technical Support and Help Desk	8
		Training Sessions and Seminars	7
		User Feedback and Improvement	4

Technological Investments: Participants emphasized various technological investments aimed at improving university websites. The following categories highlight their perspectives:

- **Infrastructure Updates:** Participants noted ongoing **infrastructure updates** to enhance website performance and student experience.

"There have been visible improvements in the performance of the university website. The process is ongoing. We are working to make pages load faster and experience fewer interruptions..." (P4)

"...Recent infrastructure updates have made the website interface more user-friendly. Students can access information more easily, reducing unnecessary browsing time. This update process is ongoing, with continuous feedback and requests guiding our work." (P1)

- **Software Developments:** Software enhancements were seen as essential for improving website functionality and accessibility.

"...With software improvements on the website, compatibility has increased. It works more seamlessly with various browsers and devices, making it easier for students to access course materials and reducing error rates." (P11)

"...Software updates for interactive course materials have made this section more user-friendly. Especially regarding interactive tests and assignments, it's now easier and faster to receive feedback. The process continues based on feedback and needs." (P12)

- **Hardware Investments:** Participants highlighted hardware investments aimed at supporting both website infrastructure and educational environments:

"...Hardware investments are being made to enhance both the website and the educational process. Orders have been placed for smart boards or new projectors for classrooms, and new investments have been made in web networks..." (P7)

- **Security and Privacy Investments:** Enhanced security and privacy measures were implemented to protect sensitive student data.

"Recent security investments have ensured better protection of sensitive information on the website. Now, stronger encryption and authentication methods keep personal data more secure." (P2)

Content Development: Participants identified content development as a crucial aspect of improving university websites. The following categories illustrate their insights:

- **Course Materials:** Updates to course materials were emphasized to ensure diverse and effective learning resources.

“The updated course materials offer a variety of content that caters to different learning styles, enriching the learning experience. For example, we can now provide a wider range of visual and auditory learning materials to students.” (P6)

“Course instructors update their materials and resources at the beginning of each term, ensuring students have access to current resources for their studies. . .” (P9)

- **Content for Student Engagement:** Participants stressed the importance of engaging content that promotes active learning.

“...Especially on the website, virtual labs and experiments are being implemented for the new term. This is to provide students with new experiences and interactive learning opportunities. . .” (P15)

“Content is continuously updated to make the learning experience more personalized. Students can now select content according to their learning pace and preferences, making the learning process more effective.” (P11)

- **Customized Content:** Customization was highlighted as a key factor in improving the personalization of learning experiences.

“Customized content is being created for students. Each student can access these contents through their portal, offering a broader learning experience by selecting content that fits their interests and learning styles.” (P10)

- **Interactive Learning Tools:** The use of interactive tools was seen as a way to make learning more engaging and effective.

“Interactive learning tools give students the chance to learn course materials in a more engaging and interesting way. Interactive videos and visual stories, in particular, capture students’ attention and can increase their learning motivation.” (P12)

User Training and Support: Participants emphasized user education and technical support as essential elements for improving the student experience.

- **Educational Materials and Guides:** Guides and instructional materials were developed to assist both students and instructors in effectively using the website.

“Educational materials and guides that support the use of the website ensure that both students and instructors use the website correctly, making the learning process more orderly. Particularly, explanatory guides and step-by-step instructions help guide students and instructors, simplifying the learning process.” (P4)

“Training videos and guides on how to access certain content and use specific applications have been prepared on the website. These help users utilize the website more efficiently.” (P1)

- **Technical Support and Help Desk:** The establishment of technical support services was seen as crucial in ensuring uninterrupted access to educational resources.

“More technical support is provided for students and instructors. Additionally, a help desk available during working hours is planned to offer immediate assistance, ensuring students always have accessible support. This will help quickly resolve any issues related to the website.” (P14)

“Our number of technical support staff is currently low. We aim to increase the number of personnel to provide faster solutions to all problems. This way, we can offer quicker support to students and instructors facing issues.” (P8)

- **Training Sessions and Seminars:** Training programs were introduced to help users navigate the website efficiently.

“...Training sessions and seminars on using the website are organized for students and instructors, particularly at the beginning of the term. These seminars offer practical experiences and help users utilize the website more effectively.” (P5)

- **User Feedback and Improvement:** Participants highlighted the importance of user feedback in shaping ongoing improvements.

“User feedback plays a crucial role in the ongoing development of the university website. Improvements made based on student feedback ensure the website is user-friendly and meets students’ needs. We continue our work in this direction.” (P1)

3.2.4. The Role and Effectiveness of the Website During the Pandemic

Table 5 presents the categories and sub-themes derived from participants’ views on the role and effectiveness of the university website in ensuring continuity of education during the pandemic.

Table 5. Participants’ views on the contribution of the university website to the continuity of education during the pandemic.

Theme	Sub-Theme	Categories	Frequency
The Role and Effectiveness of the Website During the Pandemic	Continuity of Education	Online Lessons	15
		Course Materials	10
		Exams and Assessments	9
	Communication and Interaction	Student–Teacher Communication	10
		Student–Student Interaction	7
		Feedback	5

Table 5 reveals that under the theme of the role and effectiveness of the website during the pandemic period, two sub-themes were identified: “continuity of education” and “communication and interaction”. The categories and participant views related to these sub-themes are presented below.

Continuity of Education: Participants emphasized the website’s role in maintaining education during the pandemic. The following categories illustrate their insights:

- **Online Lessons:** The website played a crucial role in facilitating online lessons and ensuring uninterrupted learning.

“Online lessons conducted through the website helped us maintain the continuity of classes, even if they couldn’t fully replicate the in-person interaction. This allowed education to continue without interruption. Although the website wasn’t initially ready for online lessons, it was quickly adapted.” (K11)

“Online lessons were regularly held, which had some advantages. The recordings of online lessons conducted through the website provided a significant advantage for students who missed classes. They could access these recordings anytime.” (K7)

- **Course Materials:** The availability of course materials on the website significantly supported students’ learning during the pandemic.

“During the pandemic, the course materials shared by the instructors through the website allowed students to study without feeling the lack of face-to-face education. All notes and presentations were regularly uploaded to the website.” (K3)

“In addition to the regular lecture slides or documents, video materials were also added to the website. This helped students benefit from these concrete materials, leading to more permanent learning. In other words, various materials were used to support the lessons.” (K12)

- Exams and Assessments: The website provided **various assessment methods** that facilitated remote exams and evaluations.

“The exams conducted through the website during the pandemic allowed students to showcase their skills through various assessment methods. Methods such as online quizzes, open-ended questions, and project-based assessments were used.” (K4)

“Online exams conducted through the website were easy to evaluate. This saved time and reduced workload. I think announcing the exam results quickly through the website provided significant convenience for students in receiving feedback.” (K15)

Communication and Interaction: Participants highlighted the website’s role in facilitating communication and interaction between students and instructors during the pandemic.

- Student–Teacher Communication: The website **enabled direct interaction between students and instructors**, supporting continuous engagement.

“During the pandemic, maintaining constant and regular communication between teachers and students increased students’ motivation and interest in classes. The website served as an effective platform for this communication.” (K1)

“The messaging and forum features on the website allowed students to easily reach out to their teachers and ask questions. This facilitated effective communication despite the physical distance imposed by the pandemic. Additionally, students who couldn’t attend in-person classes could participate in online lessons and communicate with their teachers.” (K9)

- Student–Student Interaction: The website helped students stay socially connected and collaborate on academic and extracurricular activities.

“The social media integrations and student club pages on the website enabled students to interact socially and organize virtual events during the pandemic.” (K10)

“The forums and discussion boards on the website allowed students to discuss course-related topics and help each other. This helped maintain social interaction during the pandemic.” (K6)

- Feedback: The website facilitated feedback mechanisms, helping instructors understand students’ needs.

“Surveys conducted on educational materials and course content helped us understand students’ needs and expectations. This allowed us to better shape course content and methods.” (K4)

4. Conclusions, Discussion, and Recommendations

4.1. Conclusions

The compliance of university websites with accessibility standards, as examined in this study, contributes significantly to social sustainability. Adherence to these standards strengthens the role of digital education in promoting social sustainability. Features such

as subtitles, screen readers, and keyboard navigation are considered crucial in creating inclusive learning environments, as they greatly facilitate access to education for visually and hearing-impaired students through LMS platforms [45]. However, as highlighted by Van Dijk [46], challenges faced by low-income students in accessing the internet and obtaining necessary devices—exemplified by the case of Northern Cyprus—may exacerbate the digital divide.

On the other hand, the increased energy consumption and electronic waste generated by digital transformation present notable concerns. Within the framework of sustainable development goals, particularly the objective of “responsible consumption and production”, universities must prioritize “green computing” policies [47].

This study reveals significant disparities in the digital performance of university websites in Cyprus, highlighting varying levels of online communication, visitor retention, and user engagement. While universities with a strong digital presence and intuitive navigation retain visitors longer, those with higher bounce rates and lower engagement struggle to maintain user interest. The quality of digital strategies, website content, and ease of navigation play a fundamental role in ensuring a positive user experience. This conclusion is supported by statistical findings, particularly the contrast between University 5 and University 1, where significantly different session durations and bounce rates reflected the impact of platform quality and navigation design. Given that students primarily conduct academic activities through digital platforms, optimal website design is essential for improving accessibility, engagement, and overall usability. These findings provide valuable insights for universities undergoing digital transformation, emphasizing the need for continuous improvements in web-based services to enhance their online presence. This is aligned with existing literature on digital platform usability, which emphasizes that perceived ease of use and system quality are strong predictors of user satisfaction and learning outcomes [42,48].

The study further demonstrates that the technological infrastructure of university websites significantly impacts their effectiveness in supporting educational activities. Key factors such as Content Presentation and Ease of Access, Use of Current Technology, and Interactive Learning and Communication Ease enhance the learning experience. However, Infrastructure Deficiencies and the need for Development and Renewal present major challenges, highlighting the necessity for continuous technological improvements. Additionally, a User-Friendly Interface, Customizability According to User Needs, and Effective Help and Support are crucial for ensuring seamless access to educational resources. These aspects align with the ISO 9241-210 framework, which identifies system usability, accessibility, and learnability as central components of effective user experience design [39]. These findings underscore the importance of prioritizing infrastructure enhancements and usability improvements to create efficient and student-centered digital learning environments.

The role of Features or Technological Tools Used for Educational Purposes on the University Website was also identified as a critical factor in enhancing digital learning experiences. The ongoing development of new technological tools ensures that university websites remain adaptable and effective. Participants emphasized the importance of Course Content and Management Systems, Live Lesson Tools, Assignment Submission Systems, Educational Videos and Lecture Recordings, and Mobile Applications in enriching students’ academic experiences. The integration of these tools enables seamless content access, improved communication, and uninterrupted learning processes, particularly in remote education settings. This observation is consistent with studies showing that LMS integration, particularly when combined with asynchronous video content and mobile app support, increases student satisfaction and engagement in hybrid and remote settings [49,50]. There-

fore, universities must prioritize continuous technological advancements to optimize digital learning platforms and improve educational accessibility.

The findings also highlight the importance of website development in enhancing the student experience. Technological investments, such as infrastructure updates, software developments, hardware investments, and security and privacy investments, are essential for improving website performance and accessibility. Additionally, content development—through course materials, student engagement content, customized content, and interactive learning tools—plays a crucial role in making digital education more effective and engaging. Furthermore, user training and support, including educational guides, technical support, training sessions, and user feedback mechanisms, enhances the usability of digital platforms. These findings mirror global practices in UX-driven platform design, where continuous feedback loops and support structures have been shown to increase learning efficiency and reduce user drop-off [51]. These results underscore the necessity for universities to continuously invest in their website infrastructure and develop user-centered support systems to create an interactive and efficient learning environment.

Lastly, the study highlights the crucial role university websites played in ensuring educational continuity during the pandemic. Online lessons, course materials, and exams and assessments facilitated remote learning, allowing students to access resources and complete evaluations without disruption. Additionally, communication and interaction, particularly through student–teacher communication, student–student interaction, and feedback mechanisms, ensured ongoing engagement and reduced the negative effects of physical distance. These outcomes are directly observable in the performance of institutions with well-integrated LMS platforms, such as University 6 and University 7, where low bounce rates and long session durations suggest effective student engagement during remote delivery. These results indicate that universities must continue strengthening their digital platforms to provide flexible, resilient, and adaptable learning environments, ensuring uninterrupted education in future crises. Beyond digital performance indicators, the proposed strategies carry clear educational benefits that align with the broader goals of higher education. Enhanced digital access reduces learning barriers for geographically distant or time-constrained students, thereby promoting equitable access to knowledge [52]. Personalized learning is supported through modular content delivery, progress tracking dashboards, and mobile-compatible platforms, enabling students to learn at their own pace and revisit materials as needed. Furthermore, integrated communication tools such as forums, real-time messaging, and feedback systems enhance student–teacher and peer-to-peer interaction—factors shown to positively influence academic motivation and engagement [32]. These features collectively illustrate how optimized digital strategies go beyond efficiency and directly contribute to improved educational quality and student success.

Despite the valuable findings, this study faced several limitations. The sample was restricted to 15 universities in Northern Cyprus, which may affect the generalizability of the results. In the quantitative phase, web analytics tools relied on publicly available data, which varied in accuracy across institutions. In the qualitative phase, scheduling interviews with IT managers was logistically challenging, and some participants expressed reservations about sharing institutional processes due to confidentiality concerns. Acknowledging these limitations helps contextualize the findings and guide future research efforts.

In conclusion, the effectiveness of university websites in digital education depends on their technological infrastructure, user-friendly design, and ability to integrate advanced educational tools. The study underscores the necessity for continuous technological improvements, usability enhancements, and content development to create an engaging, accessible, and efficient digital learning experience. By prioritizing these elements, uni-

versities can strengthen their online presence, enhance student engagement, and ensure long-term success in digital education.

4.2. Discussion

Web portals of universities perform as critical digital frameworks which directly modify user participation levels, website accessibility, and student learning quality. University websites with natural navigation and relevant content supported by interactive elements succeed in retaining visitors better than those that experience high bounce rates which indicate unsuccessful user interaction. Research shows that universities having an organized digital service platform obtain stronger institutional standing with better student retention ratios and increased accessibility for users [50,53]. Academic activities shifting toward digital platforms highlights the essential task for universities to enhance their web-based services for developing strong online competitiveness and engagement [54].

The relationship between infrastructure quality and user experience is grounded in widely recognized models such as the Technology Acceptance Model (TAM) and ISO 9241-210. According to these frameworks, a user-friendly and fast-loading platform increases perceived ease of use and satisfaction, which in turn improves engagement and loyalty [39,48]. Improvements in load speed, mobile compatibility, and interface simplicity positively affect bounce rate and average session duration, two critical indicators used in this research.

Educational activities depend heavily on technological infrastructure for the effectiveness of university websites. Institutions that unify learning management systems (LMS) with real-time collaboration tools and adaptative digital resources obtain better outcomes through inclusive learning [50]. The ability to achieve digital learning depends on restoring outdated technology and fixing infrastructure gaps, and this requires ongoing investments in infrastructure renewal along with new technology adoption [55]. Research shows universities need to put their focus on digital learning environment improvement through usability enhancements, mobile-friendly design, and adjustable digital resources [2]. The research shows that successful content management systems (CMSs) serve as fundamental tools for organizing online learning spaces through which educational contents are distributed and collaborative learning resources become accessible [54].

However, findings from this study revealed notable differences between Cypriot universities in terms of session duration and page interaction levels. These discrepancies may be attributed to differences in platform structure, integration of academic services, and the presence or absence of features like single sign-on (SSO), LMS syncing, or multilingual support. Such elements contribute to usability and perceived usefulness—core constructs in user acceptance theory [56].

Although the current research focuses exclusively on universities in Cyprus, comparative findings from international studies suggest that the identified success factors—technological infrastructure, LMS integration, and user-centric design—are similarly associated with digital performance in other higher education contexts. For example, a cross-university analysis by [57] comparing institutions in Germany, the UK, and the Netherlands found that responsive LMS platforms with mobile access, real-time communication tools, and personalized content delivery significantly increased student engagement and learning outcomes. Likewise, an extensive study in the United States by [58] emphasized that high-performing university websites typically integrate LMS platforms that support blended learning, feedback mechanisms, and seamless navigation. These similarities lend credence to the generalizability of our findings, though future research should empirically compare Cypriot universities with institutions abroad to better assess contextual differences and identify best practices for global adoption.

The implementation of educational tools within university websites generates transformative effects on the academic achievements of students. Enhanced learning engagement results from interactive content in courses together with live lesson tools alongside mobile applications and digital assessment systems; these features particularly benefit remote and hybrid education students. The research shows that student academic performance and motivation rise when they develop technical adaptability along with digital learning tools as suggested by Wu [50]. Supporting engaging digital education practices heavily depends on the ability to customize content management and deploy interactive learning approaches [55].

While the integration of advanced LMS platforms and user-centric digital tools clearly enhances engagement, flexibility, and centralized learning experiences, these advancements also present notable challenges. High licensing fees, infrastructure demands, and ongoing technical support requirements can create financial and operational burdens, especially for institutions with limited resources. Furthermore, integration issues, staff resistance to change, and the need for ongoing training may hinder successful adoption. To ensure sustainable implementation, universities must evaluate both the pedagogical potential and the organizational readiness for such technologies [42].

In our study, universities that offered integrated LMS platforms with features such as real-time quizzes, asynchronous video lectures, and direct messaging between students and instructors showed markedly higher engagement metrics. For example, University 5, with one of the highest visit durations and page depth, demonstrated a strong correlation between LMS accessibility and user retention. These real-life examples confirm prior findings that well-integrated LMS tools directly enhance perceived learning effectiveness and digital satisfaction [42].

While the integration of advanced LMS platforms and personalized digital tools presents clear educational and operational advantages—such as improved engagement, flexibility, and centralized learning management—these innovations are not without challenges. Financial constraints, especially for smaller institutions, may limit the adoption of cutting-edge platforms due to high licensing and maintenance costs. Additionally, technical barriers such as system compatibility, server capacity, and user training requirements can create friction in implementation. Therefore, while digital transformation is necessary, universities must evaluate scalability, sustainability, and institutional readiness before widespread deployment of such technologies [33].

Widespread technological improvement along with extensive user assistance must be present for a website to function effectively as a university portal. Reliable scalable digital education platforms require infrastructure upgrades with software development and security expenditure [53]. Digital learning environments become more usable when user training programs and technical assistance work with structured feedback mechanisms to help students and faculty achieve maximum results from available educational technologies according to Mahadalkar [59].

Moreover, the presence of adaptive dashboards and personalization features has emerged as a critical differentiator in user satisfaction. Universities that incorporate modular design, language switching, and mobile-optimized UX report fewer drop-offs and higher student return rates. These findings echo global research on LMS design and digital learning retention [51].

Throughout the COVID-19 pandemic, university websites emerged as critical tools for sustaining educational operations. The online learning platforms provided students with transparent access to educational resources and distant assessment tools and communication channels which resolved issues from physical separation. The quick transition to digital

education by universities proves the necessity of developing robust flexible educational systems which can continue regular education when faced with future emergencies [55].

The rapid LMS scaling during the pandemic further highlighted the importance of prior infrastructure investments. While this study confirms that infrastructure quality and user experience are central to digital performance, it does not directly assess their impact on educational outcomes such as student retention, academic achievement, or course completion. However, existing research strongly supports these links. For instance, refs. [42,60] found that higher usability and system quality significantly correlate with learning effectiveness and user satisfaction in LMS environments. Future studies should expand on this work by incorporating academic performance metrics to more precisely determine the educational value of digital infrastructure investments. Institutions that had pre-existing LMS integrations adapted more effectively to remote learning, while those lacking such tools experienced student disengagement and logistical breakdowns. This underscores the strategic role of LMSs as resilience mechanisms in higher education systems [49].

As universities increasingly rely on LMS platforms and website analytics to improve digital learning environments, ethical and privacy concerns become critical. The collection and processing of user data—such as location, browsing behavior, and academic activity—pose potential risks if not managed with strict data protection policies. Institutions must establish transparent practices regarding data usage, ensure student consent where appropriate, and implement secure systems to prevent breaches. Including a discussion on data governance, especially within the framework of international privacy standards, is essential for responsible digital education management.

4.3. Recommendations

To further enhance the effectiveness of digital education strategies, universities should prioritize the integration of artificial intelligence (AI) systems that enable personalized learning. These systems can support student success by identifying learning patterns, predicting potential risks, and tailoring academic content based on individual performance. Alongside AI, blockchain technologies should be adopted for securely managing academic records, issuing verifiable certificates, and maintaining permanent records of micro-credentials.

Cloud-based infrastructure must be expanded to allow seamless access across platforms, while edge computing should be used to reduce system latency and improve real-time responsiveness. Augmented reality (AR) and virtual reality (VR) technologies should be utilized not only for interactive simulations but also for replicating laboratory environments, enabling practical training in virtual formats.

To promote inclusivity, integrated LMS platforms should be equipped with AI-powered tutoring assistants, voice control, and gesture recognition technologies to support students with disabilities. The implementation of 5G networks will also be essential in enhancing real-time services such as AI-based transcription and translation, facilitating uninterrupted global access to education.

Furthermore, universities should explore the use of holographic simulations and intelligent virtual assistants to improve course planning, performance monitoring, and group collaboration. While adopting these technologies, ethical considerations and data security must be carefully evaluated to prevent bias and ensure student privacy. Finally, institutions should investigate scalable strategies to implement AI, blockchain, and immersive technologies across multiple academic disciplines, ensuring equitable benefits for all students.

In addition, future research should examine how the use of emerging technologies—particularly AI and blockchain—can further improve the effectiveness and

scalability of LMS platforms. Another valuable direction would be to explore the long-term impact of digital strategies on underrepresented student groups, including those with disabilities, learners from rural areas, or students facing digital accessibility challenges. These areas of inquiry will support more inclusive and evidence-based digital transformation in higher education.

Author Contributions: Supervision, Y.K.; writing—original draft preparation, O.G.; writing review and editing, O.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Cyprus Science University Ethics Committee on 20 March 2024.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available upon reasonable request from the corresponding author.

Acknowledgments: The authors would like to thank all participants who agreed to participate in the study.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The questions in the semi-structured interview form prepared are as follows:

How effective is the technological infrastructure of your university's website in supporting your educational activities?

What features or technological tools are used for educational purposes on your university's website?

What steps are being taken to enhance the interactive features and content on your website to support students' learning processes?

What are your thoughts on the role and effectiveness of the website in ensuring the continuity of education during the pandemic?

References

1. Roy, R.; Potter, S.; Yarrow, K. Designing low carbon higher education systems: Environmental impacts of campus and distance learning systems. *Int. J. Sustain. High. Educ.* **2008**, *9*, 116–130. [CrossRef]
2. Andrews, T.; Swanson, L. The carbon footprint of higher education: How emissions vary by mode of delivery. *J. Clean. Prod.* **2016**, *112*, 1014–1024.
3. Berkhout, F.; Hertin, J. De-materialising and re-materialising: Digital technologies and the environment. *Futures* **2004**, *36*, 903–920. [CrossRef]
4. Bates, A.W. *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning*; BCcampus: Victoria, BC, Canada, 2015.
5. Weller, M. *25 Years of Ed Tech*; Athabasca University Press: Athabasca, AB, Canada, 2020.
6. UNESCO. Education for Sustainable Development: A Roadmap (ESD for 2030). 2021. Available online: <https://unesdoc.unesco.org/ark:/48223/pf0000374802> (accessed on 30 January 2025).
7. Castells, M. *The Rise of the Network Society: The Information Age: Economy, Society, and Culture*; Wiley-Blackwell: Oxford, UK, 2010.
8. Garrison, D.R.; Anderson, T. *E-Learning in the 21st Century: A Framework for Research and Practice*; Routledge: New York, NY, USA, 2003.
9. Rowley, J. Remodelling marketing communications in higher education institutions: Implications for website design and content. *Int. J. Educ. Manag.* **2001**, *15*, 324–331.
10. Hemsley-Brown, J.; Oplatka, I. University choice: What do we know, what don't we know, and what do we still need to find out? *Int. J. Educ. Manag.* **2015**, *29*, 254–274. [CrossRef]
11. Sultan, P.; Wong, H.Y. An integrated-process model of service quality, institutional brand and behavioural intentions: The case of a University. *Manag. Rev.* **2019**, *31*, 65–80. [CrossRef]
12. Nielsen, J.; Loranger, H. *Prioritizing Web Usability*; New Riders: Berkeley, CA, USA, 2006.

13. Garrett, J.J. *The Elements of User Experience: User-Centered Design for the Web and Beyond*; New Riders: Berkeley, CA, USA, 2011.
14. Lazar, J.; Feng, J.H. *Universal Usability: Designing Computer Interfaces for Diverse User Populations*; John Wiley & Sons: New York, NY, USA, 2017.
15. Mossberger, K.; Tolbert, C.J.; McNeal, R.S. *Digital Citizenship: The Internet, Society, and Participation*; MIT Press: Cambridge, MA, USA, 2007.
16. Marcotte, E. *Responsive Web Design*; A Book Apart: New York, NY, USA, 2011.
17. O'Reilly, T. What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software. *Commun. Strateg.* **2013**, *65*, 17–37.
18. Hong, M.Y. The impact of online learning on Malaysian higher education institutions during the COVID-19 pandemic. *Educ. Adm. Theory Pract.* **2024**, *30*, 501–519.
19. Qachar, A.; Fifani, S.; Rabhi, D. Exploring the role of interpersonal skills and educational technologies in higher education: Perspectives from teachers and students. *Multidiscip. Rev.* **2025**, *8*, e2025332.
20. Morgado, L.; Oliveira, M.T.S.; Afonso, A.P. Exploring the role of digital assistants and chatbots as learning companions in open and distance learning. In Proceedings of the EDULEARN24, Palma, Spain, 1–3 July 2024.
21. Wahid, A.; Syamsuri, A.S.; Nasrun, N. Exploring the impact of learning management systems on learning processes: Insights from pre-service PPG students. *J. Pendidik.* **2024**, *57*, 469–479.
22. Aladesusi, G.A.; Monsur, I.A.; Linus, A.A. Perceived usefulness, ease of use, and intention to utilize online tools for learning among college of education students. *Indones. J. Educ. Technol.* **2024**, *5*, 41–52.
23. Kontio, J.P. From reactive to proactive: Leveraging Learning Management Systems for a more accessible learning experience. In Proceedings of the 2025 ACM SIGUCCS, Denver, CO, USA, 6–9 April 2025.
24. Sharma, A.M.; Mathur, P. Exploring the impact of LMS adoption on online learning: An educator-centric perspective. In Proceedings of the IEEE International Conference on Innovation, Kyoto, Japan, 17–21 April 2024.
25. Ellis, R.K. *A Field Guide to Learning Management Systems*; ASTD Learning Circuits: Alexandria, VA, USA, 2009.
26. Watson, W.R.; Watson, S.L. An argument for clarity: What are learning management systems, what are they not, and what should they become? *TechTrends* **2007**, *51*, 28–34.
27. Zhang, H.; Wang, C.; Lee, M. Understanding learner continuance intention: A comparison of live video, pre-recorded, and hybrid learning during the COVID-19 pandemic. *Comput. Educ.* **2022**, *184*, 104514.
28. Liu, X.; Zhu, Y.; Lin, Z. Orientation cues-aware facial relationship representation for head pose estimation via transformers. *Pattern Recognit.* **2023**, *137*, 109291. [[CrossRef](#)] [[PubMed](#)]
29. Dalsgaard, C. Social software: E-learning beyond learning management systems. *Eur. J. Open Distance E-Learn.* **2006**, *9*, 1–13.
30. Coates, H.; James, R.; Baldwin, G. A critical examination of the effects of learning management systems on university teaching and learning. *Tert. Educ. Manag.* **2005**, *11*, 19–36. [[CrossRef](#)]
31. McGill, T.J.; Hobbs, V.J. How students and instructors using a virtual learning environment perceive the fit between technology and task. *J. Comput. Assist. Learn.* **2008**, *24*, 191–202. [[CrossRef](#)]
32. Hrastinski, S. A theory of online learning as online participation. *Comput. Educ.* **2009**, *52*, 78–82. [[CrossRef](#)]
33. Selwyn, N. *Digital Technology and the Contemporary University: Degrees of Digitization*; Routledge: New York, NY, USA, 2014.
34. Weller, M. *The Digital Scholar: How Technology Is Transforming Scholarly Practice*; Bloomsbury Academic: London, UK, 2011.
35. Maxwell, J.A.; Loomis, D. Mixed Methods Design: An Alternative Approach. In *Handbook of Mixed Methods in Social and Behavioral Research*; Tashakkori, A., Teddlie, C., Eds.; SAGE Publications: Thousand Oaks, CA, USA, 2003; pp. 241–271.
36. Fraenkel, J.R.; Wallen, N.E.; Hyun, H.H. *How to Design and Evaluate Research in Education*; McGraw-Hill: New York, NY, USA, 2012.
37. Karasar, N. *Bilimsel Araştırma Yöntemi: Kavramlar, İlkeler, Teknikler*; Nobel Yayın Dağıtım: Ankara, Turkey, 2009.
38. Yin, R.K. *Case Study Research: Design and Methods*; SAGE Publications: Thousand Oaks, CA, USA, 2014.
39. ISO 9241-210; Ergonomics of Human-System Interaction—Human-Centred Design for Interactive Systems. International Organization for Standardization: Geneva, Switzerland, 2019.
40. Kuzey Kıbrıs Türk Cumhuriyeti Milli Eğitim Bakanlığı Yüksek Öğrenim ve Dış İlişkiler Dairesi. KKTC Üniversiteleri. Available online: <http://yobis.mebnet.net/kategori/kktc-universiteleri> (accessed on 25 August 2024).
41. Merriam, S.B. *Qualitative Research: A Guide to Design and Implementation*; Jossey-Bass: San Francisco, CA, USA, 2009.
42. Al-Fraihat, D.; Joy, M.; Sinclair, J. Evaluating E-learning systems success: An empirical study. *Comput. Hum. Behav.* **2020**, *102*, 67–86. [[CrossRef](#)]
43. Sun, P.-C.; Tsai, R.J.; Finger, G.; Chen, Y.-Y.; Yeh, D. What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Comput. Educ.* **2008**, *50*, 1183–1202. [[CrossRef](#)]
44. Smith, J.A.; Osborn, M. Interpretative Phenomenological Analysis. In *Qualitative Psychology: A Practical Guide to Research Methods*; Smith, J.A., Ed.; SAGE Publications: London, UK, 2008; pp. 53–80.

45. Seale, J. *E-Learning and Disability in Higher Education: Accessibility Research and Practice*, 2nd ed.; Routledge: New York, NY, USA, 2013.
46. Van Dijk, J. *The Digital Divide*, 2nd ed.; Polity Press: Cambridge, UK, 2020.
47. Blevis, E. Sustainable interaction design. In Proceedings of the CHI 2007, San Jose, CA, USA, 27 April–3 May 2007; pp. 503–512.
48. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* **1989**, *13*, 319–340. [[CrossRef](#)]
49. Rapanta, C.; Botturi, L.; Goodyear, P.; Guàrdia, L.; Koole, M. Online university teaching during and after the COVID-19 crisis: Refocusing teacher presence and learning activity. *Postdigital Sci. Educ.* **2020**, *2*, 923–945. [[CrossRef](#)]
50. Wu, J. E-Learning Management Systems in Higher Education: Features of the Application at a Chinese vs. European University. *J. Knowl. Econ.* **2024**. [[CrossRef](#)]
51. Kumar Basak, S.; Wotto, M.; Bélanger, P. E-learning, M-learning and D-learning: Conceptual definition and comparative analysis. *E-Learn. Digit. Media* **2018**, *15*, 191–216. [[CrossRef](#)]
52. Means, B.; Toyama, Y.; Murphy, R.; Bakia, M.; Jones, K. The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teach. Coll. Rec.* **2013**, *115*, 1–47. [[CrossRef](#)]
53. Cutajar, M. Digital technologies used in course implementations. In *Socially Engaged Arts Curricula for Teacher Training Programmes*; Vella, R., Ed.; Frederick University: Nicosia, Cyprus, 2024; pp. 153–170.
54. Tapkir, P.V.; Bhakt, V.U.; Hande, N.H. A comprehensive review of pharmacy college websites as content management systems: Trends, challenges, and opportunities. *Libr. Prog.-Libr. Sci.* **2024**, *44*, 55–81.
55. Li, C.; Yin, H.; Zhang, L.; Ma, Q.; Niu, Z. Research on the construction method of virtual mapping digital twin system for substation. *J. Phys. Conf. Ser.* **2024**, *2788*, 012034. [[CrossRef](#)]
56. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User acceptance of information technology: Toward a unified view. *MIS Q.* **2003**, *27*, 425–478. [[CrossRef](#)]
57. Islam, A.N.; Kim, P.S.; Kwon, Y. Student satisfaction with online learning: A comparative study between European higher education institutions. *Internet High. Educ.* **2022**, *55*, 100862.
58. Porter, W.W.; Graham, C.R. Institutional drivers and barriers to faculty adoption of blended learning in higher education. *Br. J. Educ. Technol.* **2016**, *47*, 748–762. [[CrossRef](#)]
59. Mahadalkar, I.A. Unlocking Insights: A Modular Approach to Data Visualization Education with the Data Visualization Capacity Tool. Master's Thesis, Purdue University, Purdue Hammer Repository, West Lafayette, IN, USA, 2024.
60. Liaw, S.-S. Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. *Comput. Educ.* **2008**, *51*, 864–873. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.