

Optimizing Digital Learning with a Comparative Evaluation of Cloud-Based LMS in Higher Education

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Abstract

Implementing digitalization in higher education (HE) through modern digital classrooms (DC) is progressively advancing towards Education 4.0. In conjunction with the accomplishments in this process, issues about technology and psychological variables exist. A learning management system (LMS) is a primary resource for HE, which has demonstrated improved progress for learners and superior learning outcomes globally. Numerous digital learning tools are available, each with distinct advantages and disadvantages regarding learning within DC. The number of users is perpetually rising, and the current tools are undergoing updates, redevelopment, and enhancements. This study presents a Comparative Analysis of Cloud-Based Learning Management Systems in Higher Education (CC-LMS-HE) aimed at Improving Digital Classrooms (DC) in Uzbekistan. The paper examines the key requirements and variables for selecting a CC-LMS in a Uzbek HE institution (HEI). The selected variables and associated parameters are design, technological innovations, communication standards, and knowledge didactic parameters. This paper compared

and examined the 10 most prominent CC-LMS utilized in Uzbek HE universities (Moodle, Edmodo, Brightspace, iSpring, Canvas, Docebo, Open edX, Google Classroom, Edmodo, Schoology) according to the aforementioned criteria and parameters. The platforms were chosen using the Expert Assessment (EA) methodology. According to EA, Open edX, Canvas, and Google Classroom are identified as superior systems, achieving high ratings across all criteria, thereby demonstrating their robust appropriateness for DC in Uzbek HEI.

Keywords: Cloud Computing, Digital Classroom, Uzbekistan, Expert Assessment, Learning Management Systems, Higher Education.

1 Introduction

The swift advancement of technology has transformed education, with digital competency emerging as a fundamental element of contemporary teaching methodologies. HEI is progressively utilizing internet-based tools to improve learning versatility, accessibility, and cooperation among pupils and teachers (Munna et al., 2024). These digital platforms facilitate the incorporation of rich multimedia content, participatory tools, and immediate interaction, thereby revolutionizing conventional classroom procedures.

CC has proven to be a potent facilitator of digital transformation, providing scalable and integrated solutions for managing instructional assets. The traditional limitations of infrastructure systems have been transformed with the availability of educational resources and software and their retention using CC-based systems (Ziden et al., 2023). These systems allow students and teachers to access learning materials from any device or location, making the process more flexible. Holistic educational approaches incorporate many skills and teaching methods, including face-to-face interactions, technology, and hands-on learning (Yeo & Jiang, 2023). CC-based data center systems facilitate this by incorporating tools for self and group study, collaboration, workspaces, and constant feedback provisions. These changes support higher education's development, shifting towards individualized and team-based learning (Kumar & Sharma, 2021).

Using CC-based data center systems is advantageous regarding costs, improved LMS, and increased growth potential. HEI can automate most processes, facilitate remote learning, and stimulate learner-centered pedagogy. These disadvantages claim the position of CC systems as the most important change within higher education advanced technologically. Several studies state that students get more involved and perform better academically when participating in a CC-based DC (Parini et al., 2024). The ability to share files, attend classes online, and use computers for grading has enhanced the interactivity of the learning process (Subramanian & Malhotra, 2023). These systems are tailored to different learning preferences, making advanced education equitable for all.

Though seemingly beneficial, problems still exist in implementing cloud computing-based data centers, particularly concerning data security, system dependability, and client acceptance (Soy & Balkrishna, 2024). Institutions face problems such as insufficient technological infrastructure, lack of user knowledge about the technology, and apathy towards change (Wu & Plakhtii, 2021). These obstacles must be conquered to adopt CC-based systems in higher education effectively (Bala Krishna, 2021).

The impact of cloud-based data centers on student engagement, academic performance, and institutional efficiency spans a wider understanding gap (Nagarajan & Jensen, 2010). Modern-day research usually focuses on short-term impacts, which leaves long-term outcome questions unanswered.

Answering these questions is important in measuring the efficacy of CC systems in meeting educational objectives (Salah & Thabet, 2021).

We need to learn more about the problems that come up with making CC-based data centers scalable and long-lasting in a variety of higher education settings. There is a wide range of technology, money, and users at HEIs, which makes it harder for them to set up and maintain these systems (Kondori & Peashdad, 2015). It is important to look at how things change to fix these issues. Not enough is known about combining CC-based information center systems with emerging technologies like AI and big data analytics (Chen & Almunawar, 2019). One could change how education works, do statistical analysis, and make decisions more easily with these add-ons. However, little is known about their usefulness or effectiveness (Spirin et al., 2022).

To improve the use of CC-based data centers for collaborative learning in higher education, it is important to fix these problems (Shamsudinova et al., 2025). Examining the specific impacts of these systems on diverse learning outcomes can provide valuable insights for teachers and educators. Looking into the long-term effects of using CC-based data centers will help people understand how important they are in higher education. Comprehending sustained participation, achievement, and institutional effectiveness will impact decision-making and policy development.

2 Materials and Methods

Using CC-LMS in Uzbekistan's higher education system is becoming increasingly important to make it easier to digitize, encourage personalized learning, and make organizations work better. Moodle (Cloud Edition) is a well-known open-source, multilingual LMS that is great for universities that need strong IT support and localization. Canvas by Instructure and iSpring Learn are popular because they are easy to use and set up, making them a good choice for schools that do not want a lot of technical complexity. Brightspace (D2L) and Docebo offer advanced analytics and AI-enhanced adaptive learning features for environments that rely heavily on data. However, they are more expensive and harder to set up.

Blackboard Learn is a great choice for big universities that need enterprise-level support and a lot of integration options. Open edX and Sakai are good choices for higher education institutions that want to focus on online degrees or MOOCs, especially if they have a tight budget. Platforms such as Edmodo and Schoology initially intended for K–12 education, can be advantageous for smaller courses or hybrid educational frameworks in higher education. The selection of an LMS in Uzbekistan should be determined by the institution's size, linguistic requirements, technological expertise, and strategic objectives for improving student engagement and efficient administration. Table 1 provides a comparative analysis of CC-LMS-HE to improve DC in Uzbek.

Table 1. Comparative analysis of CC-LMS-HE

| LMS | CC-Based | Mobile Support | Multilingual Support | Integration with Tools | AI/ Analytics Capabilities | Offline Access | Pricing |
|-------------------|----------|----------------|-------------------------------|--------------------------------|----------------------------|----------------|------------------|
| Moodle (Cloud) | Yes | Available | Full Uzbek/Russian/English | Available (Zoom, MS Teams) | Basic | Available | Free/Paid |
| Canvas | Yes | High | Partial Uzbek/Full English | Available (Zoom, Google Drive) | Medium | Limited | Freemium |
| Blackboard Learn | Yes | High | English/Other major languages | Advanced (LTI, APIs) | Advanced | Limited | Premium |
| Brightspace (D2L) | Yes | High | English/Major Languages | Advanced | Advanced | Limited | Premium |
| Docebo | Yes | High | English/Major Languages | Moderate | Advanced | Limited | Premium |
| iSpring Learn | Yes | High | English/Russian | Available (PowerPoint, Zoom) | Medium | Limited | Mid-range |
| Open edX | Yes | Medium | Customizable | Available (APIs, Zoom) | Medium | Available | Free/Open-source |
| Google Classroom | Yes | Medium | Customizable | Available (Basic LTI) | Basic | Available | Free/Open-source |
| Edmodo | Yes | High | English/Russian | Limited | Basic | Limited | Freemium |
| Schoology | Yes | High | English/Major Languages | Moderate | Medium | Limited | Freemium |

Considering the LMS's capabilities and the learning procedure's particularities in DCs of HEI, the parameters for choosing a CC-LMS have been established. Initially, it was essential to delineate the notion of "parameters," subject to diverse definitions by academics. Dychkivska, in her concise terminological lexicon, determines a standard as a measure that describes a product's assets (quality), which can be evaluated through an instrument of measurement or skilled evaluation. Other scholars contend that a parameter is a collection of attributes that form the foundation for evaluating conditions, processes, and outcomes of activities in alignment with established objectives.

The criteria for choosing a CC-LMS encompass the qualities, features, and attributes essential for its effective utilization in the HE process and overall productive functioning. The most pertinent CC-LMS were determined through expert assessment.

Professionals were involved in multiple phases. Initially, they assisted in identifying the most superior and efficient CC-LMS. The EA comprises administrators of faculties, heads of departments, and academicians from Ukrainian HEI, totaling 15 individuals. The derived value markedly deviates from zero, suggesting that objective consensus exists among the specialists, and the total rankings are notably objective.

In the subsequent stage, another team of experts was tasked with selecting from the most pertinent CC-LMS. The description of each selected parameter in the CC-LMS mentioned above has been assessed using an associated survey. At academic events, training sessions, seminars, specific conferences, discussion groups, and via email correspondence, a considerable number of deans, department heads, and academics from Ukraine's higher education institutions were informed about the outcomes of the CC-LMS implementation, totaling over 45 individuals, approximately. The data

regarding the definition of every parameter in the specified CC-LMS were obtained from fifteen participants.

Participants were requested to evaluate the parameters to ascertain the extent of expression for each criterion. The parameters were evaluated using the subsequent scale: 0 – the parameter is absent; 1 – the parameter is partially visible (predominantly absent); 2 – the parameter is predominantly prominent; 3 – the parameter is fully prominent. The parameter has been deemed positive if the score of the associated coefficient, defined as the calculated average of its parameters, was at least 1.25.

A parameter was deemed inadequately represented if fewer than 55% of its parameters were positive, significantly represented if 55-60% were positive, adequately represented if 60-80% were positive, and exceptionally represented if 80-100% were positive. The EA of the CC-LMS enabled us to ascertain the subsequent parameters and their respective criteria for choosing CC-LMS:

- 1) Design criteria: dependability, accessibility, multilingualism, safety, flexibility, user-friendliness, ease of management, and cost-free usage.
- 2) Technological innovation: distinction of accessibility rights, CC-data storage, interface with other cloud-based offerings, and the capability to download various data types;
- 3) Communication criteria: account registration, interaction among registered users, group creation, and establishment of forums and chats;
- 4) Knowledge-didactic criteria: organization, scheduling, evaluation of student performance, document sharing, assessments and surveys, collaborative and personal work modes, and statistics for a specific course.

The above Figure 1 represents the goal of implementing digitalization in line with higher education standards, followed by the acknowledgement and growing need for technology in educational settings. The digital transformation study helps to motivate the evaluation of cloud-based learning management systems used to improve digital classrooms. Based on the technological thesis, this research defined the psychological and technological challenges. These challenges are addressed through various issues, such as platform usability, integration, and user engagement. This also represents the multiple issues related to platform usability, integration, and user engagement. In this, an effective LMS should support both educational goals and the mental adjustment to digital learning.

Based on the research study covering the comparative analysis with the cloud-based LMS platform with higher education standards. The research employees are connected through an expert-driven evaluation approach across various platforms. This study primarily evaluates various CC-LMS platforms, selecting key variables to define effectiveness in terms of usability, functionality, security, and scalability.

Followed by the comparative analysis, this study mainly defined the top-performing LMS platforms, such as Google Classrooms. These platforms are used to meet the various standards, which pose both technological and psychological challenges. These findings are highly useful for improving digital classrooms, particularly in Uzbekistan, which has the potential to become an effective online learning environment.

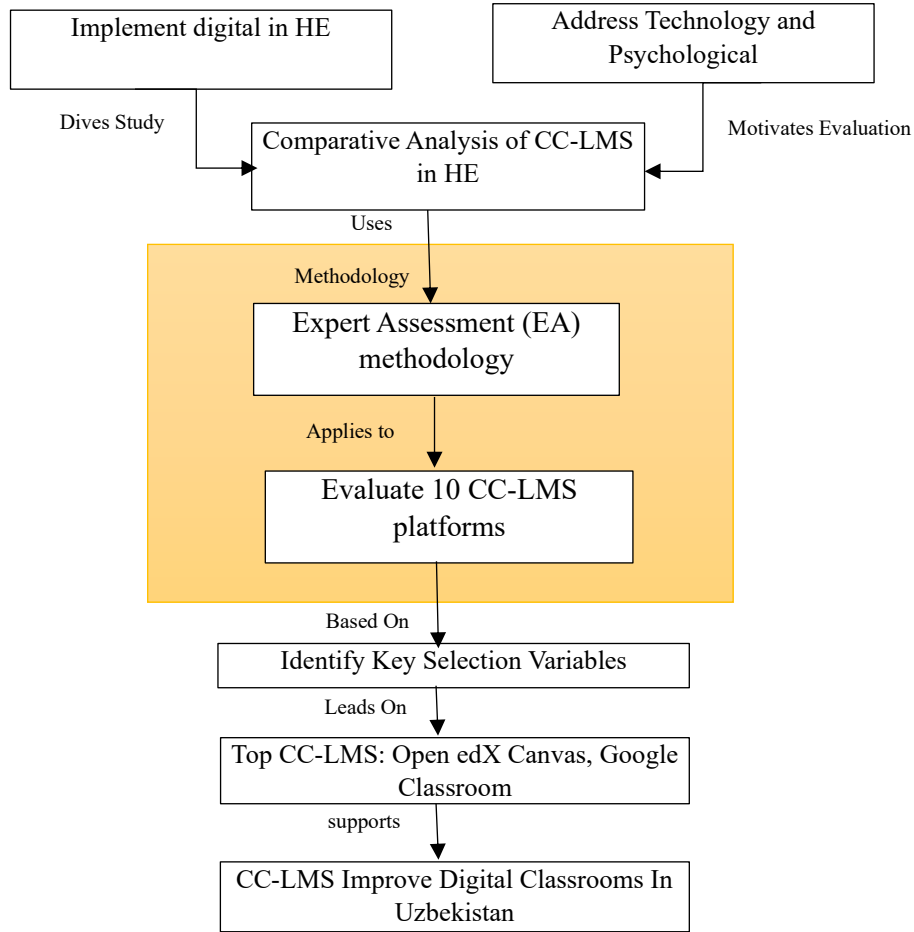


Figure 1: Flowchart of the Comparative Evaluation Methodology for Cloud-based LMS in Higher Education

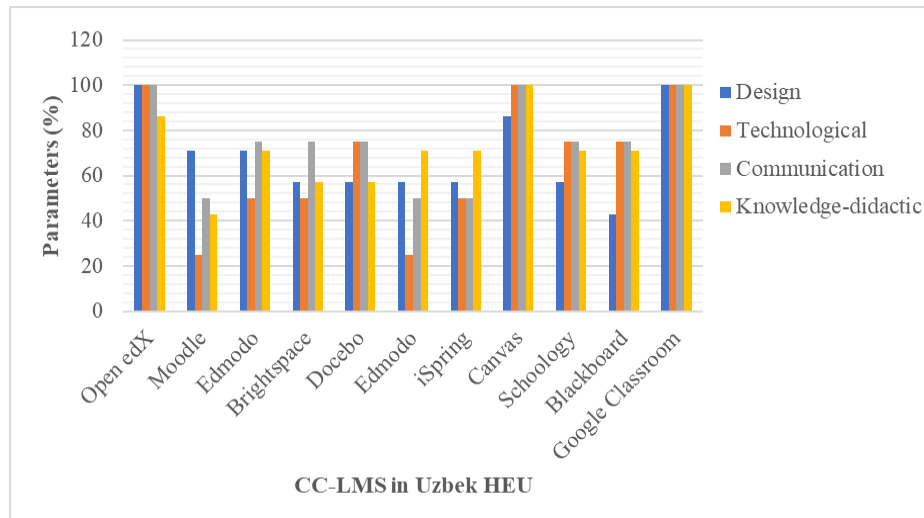


Figure 2: Parameter Evaluation Using EA for CC-LMS in Uzbek HEU to Enhance DC

Figure. 2 illustrates the parameter evaluation using EA for CC-LMS in Uzbek HEU to enhance DC. According to EA, Open edX, Canvas, and Google Classroom are identified as superior systems,

achieving high ratings across all criteria, thereby demonstrating their robust appropriateness for DC in HE. Conversely, platforms such as Docebo, Blackboard, and Edmodo exhibit comparatively lower ratings, especially in communication and design, indicating potential for enhancement. This evaluation underscores the significance of a harmonious amalgamation of technological and didactic elements to facilitate effective and engaging DC in Uzbek HEI.

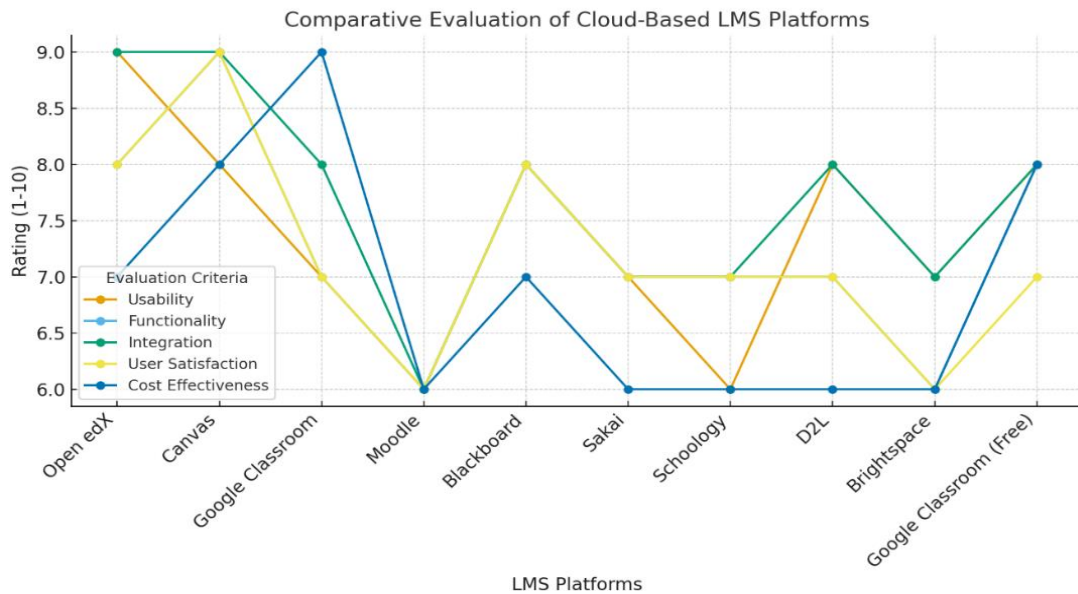


Figure 3: Comparative Evaluation of Cloud-based LMS Platforms Across Key Criteria

The above Figure 3 describes the evaluation of various performance-related aspects of LMS using criteria such as functionality, integration, user satisfaction, and cost effectiveness. Here, the multiple ranges are also defined as 1-10. The LMS platform should be used by the different categories, which analyze and provide valuable information through it and provide guidance tailored to their needs.

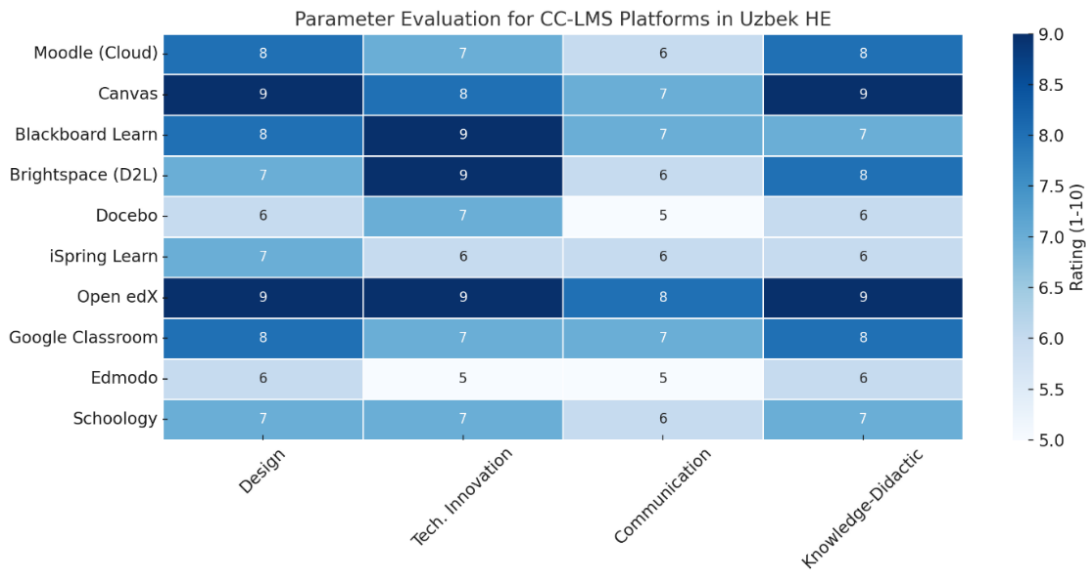


Figure 4: Heatmap of Parameter Evaluation for Cloud-based LMS Platforms in Uzbek Higher Education

The above Figure 4 presents a comparative analysis of 10 cloud analyses based on LMS, followed by the four key parameters. These parameters are named as Design, technological, communication, and Innovations. The ranges of these parameters are 1 to 10; dark blue indicates a high score. The heatmap should represent the consistency among the various parameters. Here, it is suggested that multiple technologies are used to improve service delivery through digital learning in the environment. The heatmap allows comparison of the LMS platform against the selected criteria.

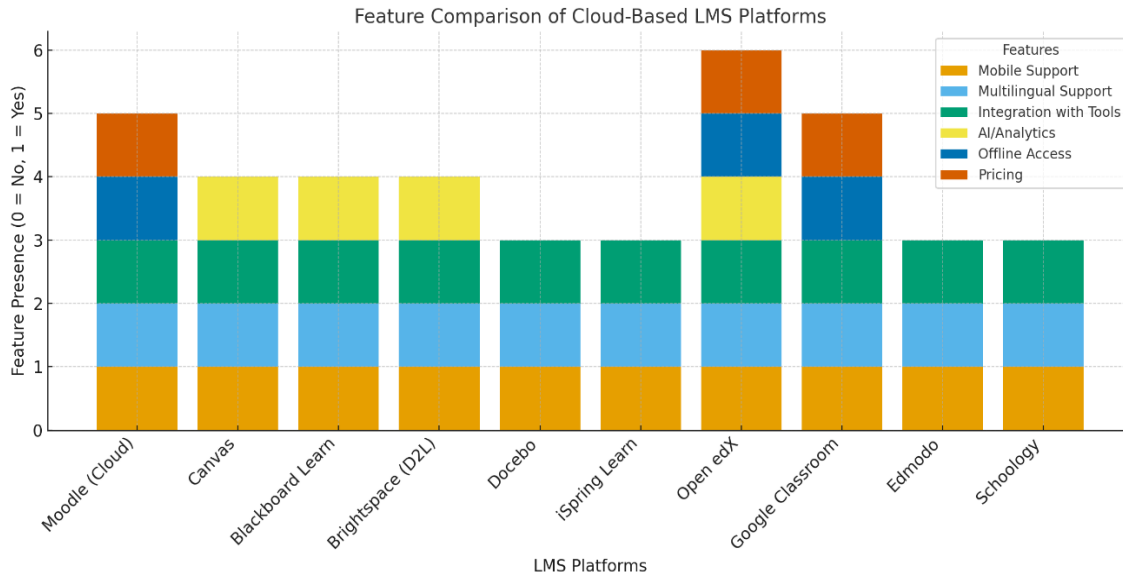


Figure 5: Feature Comparison of Cloud-based LMS Platforms

The above Figure 5 describes the various analyses among the different key features, followed by the different cloud-based learning management systems. Here are the features, including multilingual support and integration with multiple tools. These features are followed by the platform-as-a-canvas, which is one of the essential features that support the offline process. Google Classroom should support mobile use both offline and online. This analysis technique examines the various features of the LMS platform, helping educational institutions meet the specific needs for digital classrooms.

3 Discussion

Based on the comparative analysis, which provides helpful information through a cloud-based learning management system with six features, such as multilingual support and mobile support. After the evaluation, we received results that helped inform decisions about the LMS to meet various needs. The Open types of edX should be expanded, and the comprehensive platform should provide the key features. Its support for multiple languages and the software's open-source nature should be supported by a pricing model that is attractive to universities with limited budgets. Additionally, it allows for an unstable internet connection to enhance accessibility. It's the combination of various features, such as Open edX, which is a top choice for scalable, flexible online learning environments. Here, the various platforms, such as D2L, are also described, with a high-level score that highlights feature availability, specifically mentioning multilingual support and integration with multiple tools. It's the necessary steps for all types of evaluations. To integrate with the various models that include pricing, this platform in CANVA should offer multiple pricing options through the freemium model and Brightspace. This generally requires premium space along with barriers, within a limited budget.

Google Classroom and other platforms provide strong mobile support with offline access, which is also helpful in regions with inconsistent internet access. Advanced features are less effective in large-scale, data-driven educational environments. Given its limitations, Google Classroom is highly popular and cost-effective for small institutions in the early stages of digital transformation. Overall, we have highlighted the importance of selecting an LMS based on the specific needs of the institutions, followed by various factors such as feature availability, cost, and other technological aspects. Most organizations offer advanced features with accessibility tailored to student populations.

Suggestions for Future Work

Followed by future research, which should define the impacts of the LMS platform on student engagement, performance, and efficiency. Additionally, most studies should explore advanced AI and analytical tools, including platforms such as Open edX and Canvas. Both contribute to improving the educational outcomes. Based on that, LMS should be called Large-scale for digital classrooms, which also explores the integration of big data and AI-driven learning tools to provide new avenues for improving the learning experience and addressing the needs of students and educators.

4 Conclusion

This study offers a Comparative Analysis of Cloud-Based Learning Management Systems in Higher Education (CC-LMS-HE) designed to enhance Uzbekistan's Digital Classrooms (DC). The paper analyzes the essential criteria and factors for choosing a CC-LMS in a higher education institution in Uzbekistan. The chosen variables and their corresponding parameters are design parameters, technological innovations, communication standards, and pedagogical knowledge parameters. This paper analyzed and evaluated the ten most significant CC-LMS employed in Uzbek higher education institutions (Moodle, Edmodo, Brightspace, iSpring, Canvas, Docebo, Open edX, Google Classroom, Edmodo, Schoology) based on the specified criteria and parameters. The platforms were selected using the Expert Assessment (EA) methodology. EA identifies Open edX, Canvas, and Google Classroom as exemplary systems, attaining high ratings across all criteria, thus evidencing their strong suitability for DC in Uzbek HEI.

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Authors Biography



Shodiyakhon Inomkhojaeva is a prominent academic and researcher at Westminster International University, Tashkent, Uzbekistan, actively contributing to the fields of economics, education, and sustainable development. She participates in various research initiatives and conferences, sharing insights that bridge theory with practical impact. Her work aims to strengthen Uzbekistan's research culture and support the nation's evolving academic and socio-economic landscape. Her research explores the intersection of innovation, policy, and social transformation, aiming to identify strategies that foster inclusive and long-term growth. She is deeply committed to advancing academic excellence and promoting evidence-based approaches to societal challenges.



Fotima Babajanova is an accomplished academic and researcher at Gulistan State University, Uzbekistan, with expertise in education, linguistics, and social development. She is committed to advancing higher education in Uzbekistan through active engagement in research projects and academic collaborations that promote intellectual growth and community development. She strives to foster creativity, critical thinking, and lifelong learning within academic and professional communities. Through her research and dedication, Fotima contributes to shaping a modern, forward-thinking academic culture in Uzbekistan. Her scholarly work explores innovative approaches to teaching, curriculum

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Ural Abilov is an eminent medical researcher at Tashkent State Medical University, Uzbekistan. He focuses on advancing medical science, improving healthcare practices, and introducing innovation in clinical education. He conducts research that addresses critical health challenges and contributes to the development of evidence-based medical solutions. He is passionate about mentoring future healthcare professionals, fostering critical thinking, and promoting ethical medical practice. He also actively engages in academic collaborations and initiatives aimed at enhancing the quality of medical education. Through his work, he strives to build a healthier, well-informed society and inspire the next generation of medical experts.



Mansur Ongarov is an Associate Professor at the National University of Uzbekistan named after Nizami, Uzbekistan, specializing in economic theory, development policies, and financial systems. He is dedicated to conducting research that addresses contemporary economic challenges and promotes evidence-based solutions for sustainable growth. He actively bridges the gap between academic insights and real-world economic applications, contributing to both scholarly discourse and practical policymaking. Committed to nurturing future leaders, he mentors students, encourages critical thinking, and develops analytical and problem-solving skills in aspiring economists. Through his teaching, publications, and collaborative projects, he plays a pivotal role in strengthening Uzbekistan's academic, economic, and policy landscape.



Zebo Mamaraimova is a dedicated scholar and researcher at Termiz State University, Uzbekistan, with expertise in education, social sciences, or linguistics. She actively engages in research that connects theory with practical solutions, aiming to address contemporary challenges in her field. She is passionate about teaching and mentoring, fostering critical thinking, creativity, and professional development. She also participates in academic collaborations, conferences, and community initiatives, contributing to knowledge exchange and educational advancement. Through her work, she strives to strengthen Uzbekistan's academic landscape and inspire future generations of scholars and professionals.



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Tohir Haqqulov is a prominent researcher and academic at Jizzakh State Pedagogical University, Uzbekistan, with expertise in education, pedagogy, and curriculum innovation. He actively participates in scholarly collaborations, conferences, and research initiatives that foster knowledge exchange and educational development. He is committed to fostering excellence, promoting evidence-based practices, and addressing contemporary educational challenges. Through his research and professional contributions, he plays a significant role in modernizing Uzbekistan's educational system and supporting a knowledge-driven academic environment. His research explores modern approaches to teaching, learning effectiveness, and educational policy, aiming to advance evidence-based practices in education.