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Cloud-Based Learning Management System

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Abstract: A Cloud-Based Learning Management System (LMS) is an advanced digital platform designed to deliver, manage, and track educational content using cloud computing infrastructure. This system eliminates the need for local servers and physical storage, offering users seamless access to learning resources from anywhere with an internet connection. With the rise of e-learning and remote education, cloud-based LMSs have become a fundamental part of the modern educational and training environment. These systems provide scalability, flexibility, and cost-effectiveness, making them ideal for institutions and organizations of all sizes. Features such as real-time collaboration, automated updates, secure data storage, and integration with various educational tools enhance the learning experience. Popular examples include Moodle Cloud, Google Classroom, Canvas, and Blackboard Cloud, each offering unique functionalities suited to different educational needs. This seminar will delve into the architecture, core components, and deployment models of cloud-based LMSs. It will also explore the role of emerging technologies like Artificial Intelligence (AI), Machine Learning (ML), and analytics in creating personalized and adaptive learning paths. The presentation will address key challenges, including internet dependency, data privacy, and user adoption, while proposing effective solutions.

Keywords: Remote learning, Digital classroom, Scalable education, Student management.

I. INTRODUCTION

A. Background

Education has always been a cornerstone of human progress, but in the 21st century, digital innovation has reshaped its delivery and accessibility. Cloud-based Learning Management Systems (LMS) exemplify this transformation, enabling students and teachers to access resources anytime, anywhere, and on any device. This shift reflects a new educational philosophy where learning is continuous, flexible, and personalized. Learners develop digital literacy skills such as online collaboration and resource management, while educators enhance their competencies through engaging, multimedia-based lessons. Hence, cloud-based LMS is more than a technological upgrade; it is a vital tool for preparing individuals for a digitally connected world [1].

The COVID-19 pandemic highlighted the importance of cloud-based LMS as a measure of educational resilience. With physical classrooms closed, cloud platforms ensured uninterrupted learning through virtual classes, digital assignments, and online assessments. Students engaged with interactive videos, presentations, and discussions, while teachers adapted quickly to these digital tools. Beyond the pandemic, these systems continue to promote active participation through quizzes, polls, and group projects, transforming cloud-based LMS from a convenient option into a necessity for modern education [2].

A defining feature of cloud-based LMS is the migration of educational storage and delivery to secure cloud servers, providing unprecedented flexibility—students can access materials anytime, and teachers can update content instantly. Integration with collaborative tools like Google Docs and Microsoft Teams further enhances efficiency. However, digital openness introduces data privacy and security challenges, requiring strong encryption and compliance with data protection laws. While offering accessibility and innovation, cloud-based LMS demands robust governance to maintain trust [3]. Cloud-based LMS supports sustainability by reducing reliance on physical infrastructure, paper, and local servers, lowering costs and environmental impact. Its scalability and subscription-based models make it cost-effective for institutions of all sizes, while automatic updates, backups, and disaster recovery ensure continuity during disruptions. Furthermore, cloud-based LMS fosters inclusivity, global collaboration, and hybrid learning models, allowing learners worldwide to interact and share resources. Ultimately, these systems promote personalized, lifelong, and equitable education, representing a vision for sustainable and innovative global learning [4].

B. Objectives

The primary objective of a cloud-based LMS is to enhance accessibility and inclusivity by removing the physical barriers of traditional classrooms. Students and teachers can access learning materials anytime and anywhere, supporting flexible learning for individuals balancing studies with work or personal commitments. This approach also strengthens digital literacy, ensuring that both learners and educators develop the competencies required for the modern digital environment [1].

Another key objective is to promote equality of educational opportunities, reaching students in underprivileged or remote areas. Cloud platforms provide access to quality education regardless of background and reduce costs associated with physical infrastructure and printed materials. Additionally, by minimizing paper use, cloud-based LMS supports sustainable and eco-friendly practices, aligning with global goals for equitable and green education [4].

Cloud-based LMS enhances teaching efficiency and instructional management. Teachers can upload and update resources instantly, automate assessments, and monitor student progress through digital analytics, reducing workload and enabling more focused and innovative instruction. Furthermore, these systems create interactive and collaborative learning environments through discussion forums, shared documents, and real-time communication, encouraging teamwork, active participation, and scalability across diverse learner groups [5].

Cloud-based LMS also supports real-time monitoring and personalized learning, allowing educators to identify students needing support and tailor interventions accordingly. The blend of synchronous and asynchronous modes promotes self-paced, flexible learning suited to diverse needs. Ultimately, the long-term objective is to prepare education systems for future demands by fostering inclusivity, collaboration, and global connectivity, bridging the gap between traditional and digital education while ensuring sustainable, adaptable, and equitable access for all learners [7].

II. LITERATURE REVIEW

The concept of Learning Management Systems (LMS) has evolved from costly, infrastructure-heavy platforms into flexible, cloud-based systems that redefine digital education. Early LMS models required expensive hardware, local software installations, and skilled IT staff, limiting adoption to large institutions. Cloud computing transformed this by shifting storage and processing to remote servers, making education more affordable, scalable, and accessible. Students and teachers could access materials from any location and device, while institutions could serve thousands of learners without performance loss. This transformation represents both technological and social advancement, promoting inclusivity, sustainability, and digital literacy across education systems [1]. Following the COVID-19 pandemic, cloud-based LMS became essential for maintaining educational continuity. Platforms like Moodle, Google Classroom, and Microsoft Teams enabled global remote learning, supporting both synchronous and asynchronous modes, fostering collaboration, and encouraging eco-friendly practices by reducing reliance on paper and physical resources [2]. Cloud-based LMS offers significant advantages over traditional systems. Teachers can instantly upload and update resources, use analytics and automated grading to enhance feedback, and save time. Students benefit from anytime access, interactive tools, and self-paced learning, improving engagement and retention. Institutions reduce costs by eliminating servers and maintenance, making cloud-based LMS a cost-effective, efficient, and high-quality solution. However, challenges such as data security, privacy, and technological resistance remain, necessitating encryption, multi-factor authentication, and training programs for educators. Despite these concerns, the benefits of scalability, inclusivity, eco-friendliness, and resilience outweigh the drawbacks, establishing cloud-based LMS as a cornerstone of modern education and a driver for sustainable, equitable access to learning [3][4].

A. Comparison

Aspect	Overview of Cloud-based Learning Management System	CBES: Cloud-Based Learning Management System for Educational Institutions
Main Idea	Explains what a cloud-based LMS is, its benefits, and problems.	Proposes a new model (CBES) with modern features for schools and universities.
Focus Area	General knowledge about cloud computing and existing LMS platforms.	Building a practical system with three layers (infrastructure, platform, application).

Style	Theoretical, descriptive, awareness-based.	Practical, solution-based, system design.
Key Benefits	Saves cost, better security, easy access, scalable, and always updated.	Digital transcripts, offline/online use, auto alerts, smart search, attendance/grades, strong admin control.
Main Problems	Hacking risks, copyright issues, slow internet, and no standard rules.	Focuses on fixing these problems with secure and user-friendly features.
Best Use	Helpful for developing countries (example: Yemen).	Helpful for universities worldwide, especially during COVID-19.
Contribution	Helps readers understand the idea of cloud LMS.	Gives a working model (CBES) that can be used in real life.
Technology Level	Explains cloud layers (IaaS, PaaS, SaaS) and deployment models (public, private, hybrid).	Shows how these layers are applied in CBES with real features for education.
Context	Written before COVID-19, more general.	Written during COVID-19, focused on remote and digital learning.
Examples Mentioned	Talks about existing LMS platforms (WizIQ, Docebo, Litmos, TalentLMS).	Does not review old platforms; instead, it presents its own model (CBES).

Table 1. Comparison Between Overview of Cloud-based Learning Management System and CBES: Cloud-Based Learning Management System for Educational Institutions.

III. METHODOLOGY

A. Overview of the Working of Cloud-Based Learning Management Systems (LMS):

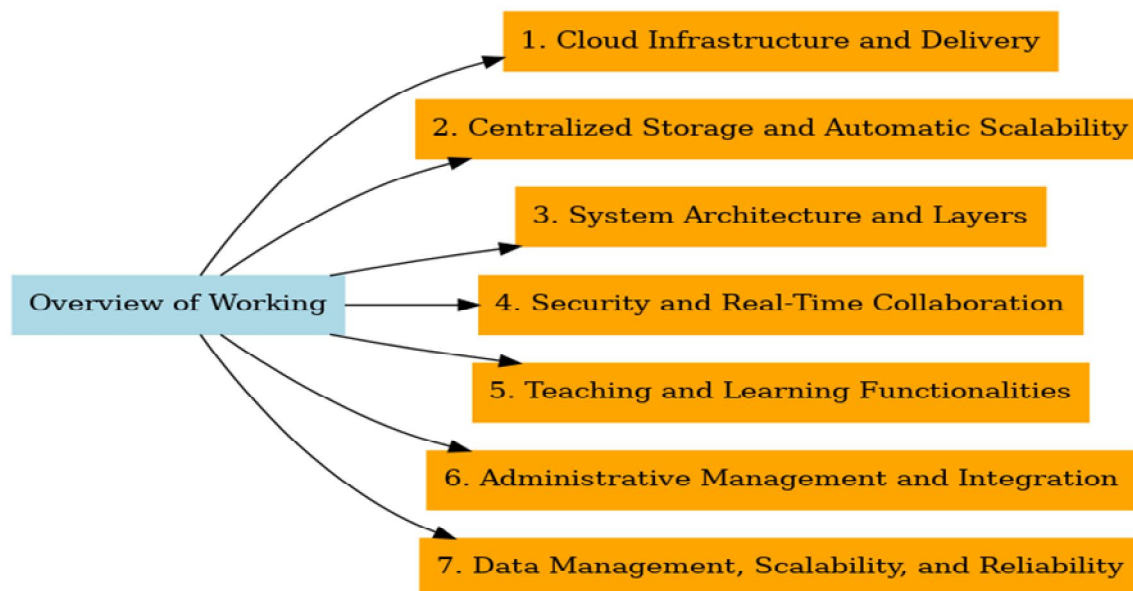


Fig 1. Overview of the Working of Cloud-Based Learning Management Systems.

- 1) *Cloud Infrastructure and Delivery*: A cloud-based Learning Management System (LMS) shifts all teaching and learning operations to cloud infrastructure. Unlike traditional LMSs that rely on local servers and complex installations, cloud-based systems are hosted on platforms like AWS, Microsoft Azure, or Google Cloud, where providers handle maintenance and security. Institutions can simply subscribe and start using the system without investing in servers or IT staff. Teachers, students, and administrators access it anytime through web browsers or mobile apps, ensuring device independence and global accessibility. For instance, a teacher can upload an assignment that students worldwide can access instantly. With centralized cloud storage, all resources and tools are delivered on demand, enabling flexible, mobile, and universally accessible learning experiences powered by the cloud [1].
- 2) *Centralized Storage and Automatic Scalability*: A key principle of a cloud-based LMS is centralized storage with automatic scalability. Unlike traditional systems requiring costly on-site servers, cloud platforms host resources remotely, making all uploaded materials instantly accessible to students. The system automatically scales its storage and processing power as user numbers grow—ensuring smooth, uninterrupted performance without manual updates or capacity planning. This elastic and efficient design guarantees reliability for institutions of any size [2].
- 3) *System Architecture and Layers*: The architecture of a cloud-based LMS has three main layers: front-end, application layer, and back-end. The front-end includes dashboards, login portals, course menus, virtual classrooms, and mobile apps for user interaction. The application layer handles core functions like course management, assignments, grading, notifications, and integrates external tools such as Zoom, Teams, or Google Docs. The back-end manages servers, databases, authentication, and data encryption to ensure security and performance. These layers work seamlessly—for instance, a submitted assignment passes from front-end to application layer to back-end storage, updating teacher dashboards in real time. This modular structure makes the LMS scalable, secure, and user-friendly.
- 4) *Security and Real-Time Collaboration*: Security and collaboration are crucial in a cloud-based LMS. All data, from student profiles to exam results, is protected using encryption (SSL/TLS for transmission, AES for storage) and authentication methods like OAuth, SSO, and multi-factor authentication. Compliance with standards such as GDPR and FERPA ensures data safety. At the same time, real-time collaboration is supported through video conferencing, instant messaging, and group workspaces, allowing live classes, project discussions, and instant quizzes. This integration of security and collaboration makes digital classrooms both safe and interactive, enhancing the overall teaching and learning experience.

- 5) **Teaching and Learning Functionalities:** The core strength of a cloud-based LMS is its teaching and learning functionalities. Teachers can create full courses, upload lecture notes, quizzes, assignments, and multimedia content like videos and animations. Automated grading saves time, allowing more focus on student engagement. Students can access materials anytime, participate in forums, collaborate on projects, and submit assignments digitally. The system supports both synchronous (live classes) and asynchronous (self-paced) learning, catering to diverse preferences. Built-in analytics help teachers track progress, identify weak areas, and provide personalized feedback, making learning dynamic and student-centered.
- 6) **Administrative Management and Integration:** Administrators are essential to a cloud-based LMS, managing accounts, assigning roles, and ensuring compliance with standards. Role-based dashboards and automation tools simplify tasks like bulk enrolling students and granting course access. They also integrate third-party apps (e.g., Zoom, Google Docs, plagiarism checkers) via APIs, monitor system performance, track usage, and generate reports for informed decisions. Additionally, administrators ensure accessibility features like screen readers and translations, making the LMS inclusive. Overall, they provide the backbone for smooth, compliant, and scalable system operations.
- 7) **Data Management, Scalability, and Reliability:** Data management and scalability are key aspects of cloud-based LMS. Advanced cloud databases handle large volumes of structured and unstructured data efficiently, while regular backups and disaster recovery prevent data loss. The system automatically scales computing power and storage to accommodate user surges, ensuring uninterrupted service. Digital hosting reduces reliance on paper and physical resources, promoting eco-friendly practices and green IT. Overall, cloud LMS ensures reliable, scalable, and sustainable education accessible to all.

B. Technologies used in Cloud-Based Learning Management System (LMS):

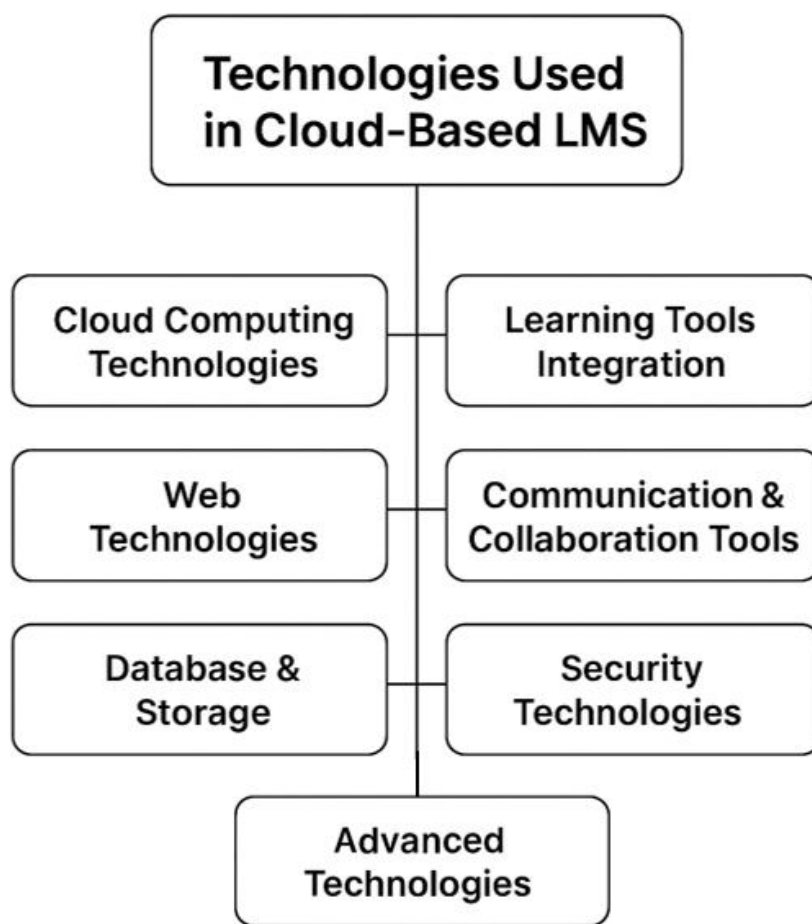


Fig 2. Technologies used in Cloud-Based Learning Management System.

- 1) *Cloud Computing Technologies*: Cloud computing serves as the backbone of a cloud-based LMS, eliminating the need for costly local infrastructure and allowing institutions to pay only for what they use. It operates through three main service models: IaaS, which provides virtual machines and storage on demand (e.g., AWS EC2); PaaS, which offers a ready environment for developing or customizing LMS platforms (e.g., Azure App Services); and SaaS, which delivers ready-to-use educational applications like MoodleCloud or Google Classroom without local installation.
- 2) *Web Technologies*: The functionality of a cloud-based LMS relies on strong web development frameworks. The front end uses technologies like HTML5, CSS3, and JavaScript frameworks (React, Angular, Vue.js) to create responsive, interactive interfaces such as drag-and-drop submissions or dashboards. The back end employs languages like PHP, Python, Java, or Node.js to manage data and system logic. Additionally, APIs and web services (RESTful APIs, GraphQL) enable integration with external tools like Google Drive or video conferencing platforms, enhancing the system's connectivity and usability.
- 3) *Database & Storage*: All course materials, user data, and analytics in a cloud-based LMS are stored securely using cloud databases and storage systems. Relational (MySQL, PostgreSQL) and non-relational (MongoDB, Firebase) databases manage structured and unstructured data, while object storage services like Amazon S3 or Google Cloud Storage handle large multimedia files. Additionally, automated backup systems ensure data safety and prevent loss during system failures.
- 4) *Learning Tools Integration*: Cloud-based LMS platforms integrate global e-learning standards to ensure compatibility and seamless functionality. SCORM enables standardized packaging and delivery of courses across platforms, xAPI (Tin Can API) tracks learner activities across devices and environments, and LTI (Learning Tools Interoperability) allows easy integration of external tools, such as embedding simulation or assessment apps directly within the LMS.
- 5) *Communication & Collaboration Tools*: Engagement in cloud-based LMS is enhanced through live and interactive tools. Video conferencing APIs like Zoom, Teams, and Google Meet enable real-time virtual classes, WebRTC supports peer-to-peer audio/video calls and instant messaging, and discussion forums and group workspaces facilitate asynchronous collaboration on assignments and projects.
- 6) *Security Technologies*: Security in cloud-based LMS protects sensitive data like grades and personal information. Authentication methods such as OAuth 2.0, SAML, and SSO provide secure logins, encryption (SSL/TLS for data in transit, AES for stored data), safeguard information, role-based access control ensures only authorized users can view or edit data, and regular security updates from cloud providers maintain system safety.
- 7) *Advanced Technologies*: Modern cloud-based LMS platforms include advanced smart features. AI powers chatbots, adaptive learning, and automated grading (e.g., Coursera's personalized course recommendations). Machine Learning analyzes student behavior to predict outcomes, such as identifying at-risk learners. Big Data & Analytics track performance and guide teaching decisions. Mobile technologies (Flutter, React Native, native apps) enable learning anytime, anywhere. Cloud AI services like AWS AI or Google Cloud AI provide tools such as speech-to-text and sentiment analysis for enhanced interactions.

IV. APPLICATIONS

A. Education Sector (Schools, Colleges, Universities)

Cloud-based LMS has become a cornerstone in modern education.

- 1) *Digital Classrooms*: Teachers can upload lessons, assignments, and quizzes online. Students access them anytime, from anywhere, which removes the limitation of physical classrooms.
- 2) *Blended & Flipped Learning*: Teachers combine classroom sessions with digital learning. For example, students may watch recorded lectures at home and use classroom time for discussions.

B. Corporate Training & Workforce Development

Businesses increasingly rely on cloud LMS for employee learning and professional growth.

- 1) *Onboarding Programs*: New employees learn company policies, culture, and tools through structured online modules.
- 2) *Skill Development*: Companies provide training in technical, leadership, and soft skills via LMS platforms like TalentLMS, SAP SuccessFactors, or Docebo.

C. Government and Public Sector

Governments use cloud LMS to train employees and also educate citizens.

- 1) *Civil Service Training*: Online modules train government employees in administration, digital services, and policy implementation.

- 2) **Citizen Awareness:** Public campaigns (like digital literacy, tax filing, and voting awareness) are delivered through online platforms.

D. Healthcare and Medical Training

The healthcare industry uses cloud LMS for both professionals and patients.

- 1) **Medical Staff Training:** Doctors, nurses, and technicians learn about new procedures, drugs, and safety protocols online.
- 2) **Compliance & Legal Training:** Staff undergo mandatory certifications (e.g., HIPAA in the US) to ensure compliance.

E. Military and Defence

Military organizations adopt cloud-based LMS for secure and continuous training.

- 1) **Simulation-Based Training:** AR/VR integrated with LMS provides battlefield and emergency simulations.
- 2) **Continuous Skill Development:** Soldiers learn new strategies, cyber defence, and technical skills through LMS modules.

V. ADVANTAGES

- 1) **Accessibility and Flexibility:** Learners and teachers can access content from anywhere using any device with internet connectivity. It supports self-paced, hybrid, and distance learning models. Updates made by teachers are instantly visible to all users. This flexibility benefits working professionals and remote learners.
- 2) **Cost-Effectiveness:** Eliminates the need for expensive hardware, servers, and IT teams. Institutions use a subscription or pay-as-you-go model, reducing operational costs. Students save money on printed materials and commuting. It makes digital education affordable for schools and organizations of all sizes.
- 3) **Scalability and Reliability:** Automatically scales to handle a few users or thousands without affecting performance. Cloud providers ensure high uptime, often 99.9%, avoiding system downtime during peak usage. Institutions can expand or reduce resources based on enrolment needs.
- 4) **Collaboration and Communication:** Integrates video calls, chat systems, discussion forums, and collaborative workspaces. Enables students and teachers to interact in real time from different locations. Promotes teamwork, global participation, and knowledge sharing.
- 5) **Multimedia and Interactive Learning:** Supports videos, audio, animations, quizzes, and gamification features. Enhances engagement and knowledge retention by making content interactive. Helps learners practice and apply concepts effectively.
- 6) **Automatic Updates and Maintenance:** All system updates, security patches, and bug fixes are managed by the cloud provider. Ensures the platform runs smoothly without manual intervention. Reduces the burden on institutional IT teams.

VI. DISADVANTAGES

- 1) **Internet Dependency:** Requires a stable internet connection; learning is disrupted in areas with poor connectivity.
- 2) **Data Security Concerns:** Sensitive data (grades, personal details) may be vulnerable if cloud security measures are weak.
- 3) **Limited Customization:** Some platforms restrict customization options compared to locally hosted systems.
- 4) **Subscription Costs Over Time:** Although setup is cheaper, recurring subscription fees may increase long-term costs.
- 5) **Technical Issues:** Downtime or server outages from the cloud provider can affect access temporarily.

VII. CONCLUSION

Cloud-based Learning Management Systems (LMS) have transformed education and training by providing accessible, flexible, and scalable learning solutions while overcoming the limitations of traditional server-based systems through cloud storage and management. They enhance teaching and learning with multimedia content, real-time collaboration, and analytics, making them valuable for remote education, corporate training, and professional skill development. Despite offering advantages such as reduced infrastructure, eco-friendliness, and seamless updates, they face challenges like internet dependency, data security, and ongoing subscription costs, which can be mitigated with robust cybersecurity, proper planning, and user training. Overall, cloud-based LMS serves as a vital digital ecosystem that promotes inclusive, efficient, and sustainable education in a technology-driven era.

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