

A Study of Cloud Computing Based E-Learning Platforms: Design and Implementation

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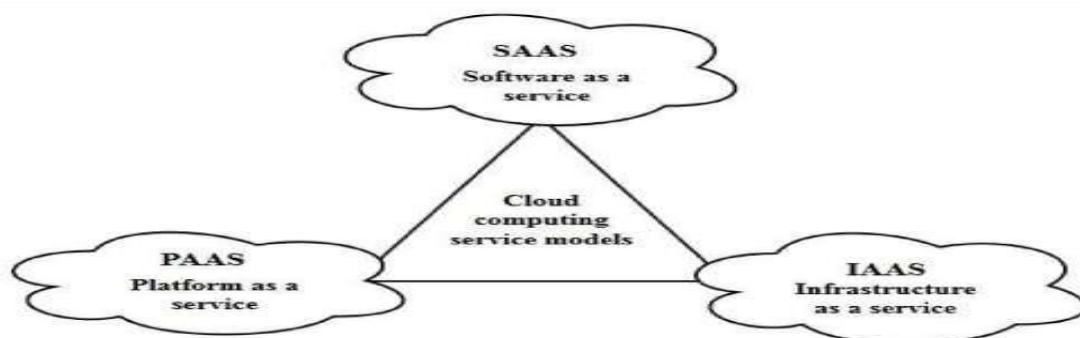
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I. Introduction

Learning is a lifelong process that starts in childhood and continues throughout a person's life. From an early age, we begin to learn essential skills like eating, crawling, recognizing people, and walking. As we grow, we continue learning through various stages, from childhood to adolescence and into adulthood, developing new skills along the way. Our experiences help us understand and learn new knowledge and skills, which support us throughout our lives. People gain knowledge by reading, studying, practicing, and observing. For instance, they read books and newspapers, watch TV, and listen to the radio to learn about specific topics. In school, students study various subjects to build their knowledge and skills. E-learning, or electronic learning, is a modern way to learn using digital tools such as the internet, computers, and other devices. This method allows people to access educational content anytime and anywhere, providing flexibility and convenience beyond traditional classroom settings. E-learning is especially helpful for people who cannot attend classes or college regularly, like those who work full-time or live in remote areas. It saves time and money by providing consistent, high-quality learning content that can be accessed anytime online. With e-learning, students can use any device connected to the internet to access educational materials whenever and wherever they need. Cloud computing has further enhanced e-learning by making learning resources available at all times, from any location. This powerful technology allows students to access lectures, assignments, and other materials beyond the boundaries of a traditional classroom. Even if students miss a class, they can still catch up by accessing the content online.

Cloud Computing Service Models

Cloud computing is quickly becoming a popular way to offer IT services as a utility, much like water, electricity, gas, and phone services. It allows users to access infrastructure, platforms, and software applications on a subscription or pay-as-you-go basis. This model provides a complete online platform with a variety of services available as needed, all delivered through the internet in a cost-effective and reliable way. By using cloud computing, organizations can save on hardware, software, and licensing costs, as these resources are rented rather than purchased. It also provides automatic backups to ensure data safety. Cloud computing offers scalable and flexible infrastructure that users can access anytime, from anywhere, on devices like laptops, smartphones, or tablets. Large data centers can be dynamically managed to handle resources effectively, making upgrades, maintenance, disaster recovery, and failover more efficient. Through Service Level Agreements (SLAs), cloud providers ensure reliable service, addressing challenges in areas like education, climate change, and economic stability.



The reference model of Buyya describes the various layers of cloud computing service models.

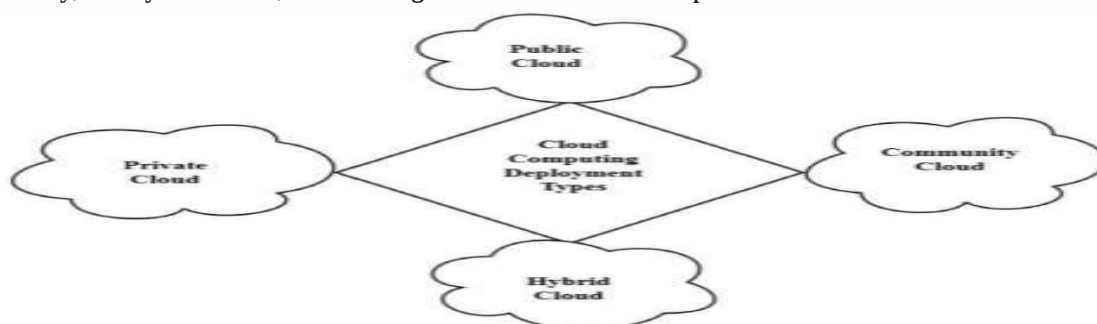
Software as a Service (SaaS) is a model that allows users to access software online instead of installing it directly on their computers. This shift from locally installed applications to cloud-based services is becoming more common. SaaS relieves users of the need to maintain and update software on their own systems, as all updates and maintenance are handled by the service provider.

Platform as a Service (PaaS) is the second layer in cloud services, designed for developers to build and deploy applications in the cloud. Programmers can work without worrying about the underlying hardware setup. PaaS offers different development environments, allowing developers to code and deploy easily. It also provides specialized services like data access and authentication, streamlining the development process.

Infrastructure as a Service (IaaS) is the third layer in cloud services, focused on managing physical resources in the cloud. It handles virtual machines and other resources that users need, providing them on demand. IaaS supports various operating systems and customized software setups, allowing users to configure servers as needed to meet different requirements.

Cloud Computing Deployment Models

Cloud computing offers several deployment models widely used today. These models include public, private, community, and hybrid clouds, each serving different user needs and preferences.



Public clouds: Public clouds are accessible to anyone on a pay-as-you-go basis, with resources hosted and managed by the cloud service provider at their facilities.

Private cloud: A private cloud is designed, managed, and used exclusively within an organization, making it inaccessible to the general public. It enables users to connect with the local data center while enjoying the benefits and interface of cloud services in a secure, internal setting.

Community clouds: Community clouds are shared by multiple organizations with similar interests or requirements. They support a specific group by providing shared resources and addressing common concerns. These clouds can be managed by a third party and may be hosted either on-site or off-site.

Hybrid clouds: Hybrid clouds combine both public and private clouds using standardized technology, allowing data and applications to move between them. This model is widely adopted by many organizations for its flexibility and adaptability.

Cloud Computing Based Learning

Cloud computing provides a flexible, scalable infrastructure that delivers services to users online. In the academic sector, it reduces IT expenses and offers resources affordably through a pay-as-you-go model. This approach supports e-learning by making online education accessible, flexible, and consistent. E-learning, or internet-based learning, involves various content formats, managed learning experiences, and online communities of learners and educators. It is praised for its accessibility, adaptability, and ease of use. Cloud computing strengthens these advantages by offering a low-cost, reliable platform with centralized storage, strong data security, and straightforward resource management. Through cloud-based e-learning, students can access courses, assignments, discussions, and more from any device or location. Educators benefit from easy content updates, tracking student progress, and analyzing knowledge trends. Cloud-based e-learning centers on the learner, creating an interactive and collaborative environment. Cloud technology also allows institutions to provide affordable education, letting students join classes, take quizzes, and engage in forums from anywhere. This system supports interactive learning, resource sharing, course tracking, and timely feedback, all of which contribute to improved educational outcomes.

II. Review of Literature

Mohammed A. Al-Zoube, S. El Seoud, M. Wyne. Cloud computing technologies are changing how applications are developed and accessed, allowing them to be run as services over the internet. Cloud computing provides a low-cost solution for academic institutions, enabling access to applications.

Z. Guoli, Wanjun Liu. The paper introduces the characteristics of e-learning and cloud computing, and describes the architecture of a cloud computing platform. The paper proposes integrating cloud computing platform architecture with e-learning in order to improve

S. E. Alptekin, E. Karsak. The study proposes a decision framework that considers multiple, potentially conflicting criteria and their interactions when evaluating and selecting e-learning products. The framework uses the Quality Function Deployment (QFD) approach to align e-l.

Alexandru Butoi, N. Tomai, Loredana Mocean. developing cloud-based mobile learning tools. The study explores strategies for effectively incorporating pedagogical principles into the software design and implementation of cloud-based mobile learning tools.

Dan Benta, G. Bologa, Ioan Dzitac. Using the Moodle e-learning platform helped motivate students and engage them in individual and collaborative homework assignments. Implementing an e-learning platform was a novel and positive teaching/learning experience for the authors' university.

Akilu Rilwan Muhammad, S. Abdulrahman. The use of ICTs, including cloud computing, is transforming teaching and learning environments in tertiary institutions. E-learning, which can be facilitated by cloud computing, is becoming increasingly popular and beneficial for

Learning environment.

Shams Tabrez Siddiqui, Shadab Alam, Z. A. Khan, A.Gupta. Cloud computing has had a significant impact on the education and IT sectors. Cloud-based e-learning systems are effective and efficient. Cloud-based e-learning is feasible and effective, and provides clarity on the benefits of cloud computing.

K. Abuhlfaia, E. de Quincey. The VLE platform used by the university performed below the average usability expectation, with a System Usability Scale (SUS) score of 62.52. Thematic analysis of student comments revealed very negative views of the VLE as well as areas for improved.

P. Hendradi, M. Khanapi, S. N. Mahfuzah. The authors propose a cloud computing-based e-learning system architecture that is designed to meet the needs of Education 4.0. The proposed architecture is intended to serve as a guideline for developing cloud-based e-learning systems for the Educat

Pooja Bijlani, D. Sheetlani. Cloud computing provides a cost-effective solution for e-learning implementation in resource-constrained educational institutions. Cloud computing is a suitable platform for supporting e-learning systems.

P. Hendradi, Mohd Khanapi Abd. The influence of AI is seen in the Service, Resource, and Business Application layers of the cloud-based e-learning system architecture. In the Service Layer, AI makes the cloud services more dynamic and aligned with Education 4.0.

E. K. Agormedah, Eugene Adu. Students had a positive response to online learning, were familiar with some online learning platforms, and were willing to use various devices for online learning.

R. Bernatova, M. Bernat, J. Poracova. The NESVL method, which uses graphical visualization of the logical structure of the curriculum, was more effective in improving student performance compared to traditional teaching methods. Students taught using the NESVL method showed better performance.

Zhi-qin Liu, E. Dorozhkin, N. Davydova, N. Sadovnikova. Co-learning technologies did not negatively impact the quality of learning and assimilation, and students in the digital environment performed even better. The percentage of students with the most correct answers on the test was much higher.

L. Tarkhova, Sergey Tarkhov, M. Nafikov. Students struggle with creating high-quality infographics, making common mistakes like not clearly conveying the key idea, focusing on irrelevant details, using inappropriate graphics, and not including necessary text. Using interactive infographics.

Mariia Zabolotniaia, Zhichao Cheng. The Moodle LMS can be used to simulate professional actions and train advanced specialists with both hard and soft skills. The study developed a model for assessing the subjective perceptions and attitudes of students and faculty towards the implement.

Zi-Yu Liu, N. Lomovtseva, E. Korobeynikova. Consultations with 40 university teachers highlighted the advantages of online learning platforms, including greater freedom of access, lower prices, modular course content, flexibility, and ability to define assessment criteria.

Lin Ma, Zhuangzhuang Lan, R. Tan. The entrepreneurial intention of college students has a significant positive correlation with their attitude toward IE and perceived behavioral control, but an insignificant positive correlation with subjective norms.

A. Owais, Suzan Alabidi, Zaydoon Mohammad Hatamleh, E. Hussein. There is a positive and significant relationship between teachers' technology integration, teacher training programs, accessibility to technical resources/equipment, and the mission and vision of technical and vocational institutes.

Zi-Yu Liu, E. Chubarkova, Marina Kharakhordina. The study involved two experimental groups and a

control group, with a total sample size of 948 students. The two experimental groups were taught using different STEM education methodologies, "amalgam" and "interconnect", which differed in the degree.

Objective of the article

To examining current e-learning platforms and conducting a comparative evaluation.

Current E-Learning Platforms

E-learning platforms serve as interactive online spaces where students and educators can connect beyond the limits of traditional classrooms. These systems are designed to deliver educational content and training programs through the internet, making learning more flexible and accessible. Whether it's academic courses, professional development, or skill-based training, e-learning platforms provide a wide range of learning materials such as videos, presentations, reading content, and interactive modules. They also include built-in features like quizzes, assignments, discussion forums, and messaging tools, which help in tracking progress, encouraging participation, and promoting effective communication between teachers and learners. By combining convenience with functionality, these platforms have become a vital part of modern education and training.

Some of the most widely used e-learning platforms today include:

Moodle

Type: Open-source LMS (Learning Management System)

Key Features: Customizable, supports quizzes, assignments, forums, and SCORM content

Used By: Universities, colleges, and training institutions

Google Classroom

Type: Cloud-based platform integrated with Google Workspace

Key Features: Easy file sharing, real-time collaboration, integration with Google Docs, Sheets, and Drive

Used By: Schools and higher education for blended and remote learning

Canvas

Type: Commercial LMS

Key Features: Clean user interface, robust analytics, integration with third-party tools

Used By: K-12, higher education, and corporate training

Blackboard

Type: Commercial LMS

Key Features: Course management, virtual classrooms, grading tools

Used By: Colleges and universities worldwide

Coursera / edX / Udemy (MOOCs – Massive Open Online Courses)

Key Features: Offer individual courses, professional certificates, and degree programs

Used By: Individual learners, professionals, and academic institutions

Comparative Evaluation Table

Feature	Moodle	Google Classroom	Canvas	Blackboard
Type	Open-source LMS	Cloud-based (free)	Commercial LMS	Commercial LMS
Content Support	SCORM, video, files	Google Docs, video	Video, quizzes	Rich media, files
Assessments	Yes	Basic quizzes	Robust tools	Comprehensive
Communication Tools	Forums, messaging	Comments, email	Messaging, chat	Messaging, forums
Customization	High	Limited	Moderate	Moderate
Integration	High	Google only	High	High
Cost	Free (hosting cost)	Free	Paid	Paid

III. Conclusion

In conclusion, choosing the right e-learning platform depends largely on the specific goals and requirements of the institution or learners. Each platform brings its own strengths to the table—Moodle is well-suited for those seeking a flexible and customizable learning environment, while Google Classroom works best for schools already integrated with Google tools. For larger institutions needing advanced features and dedicated support, platforms like Canvas and Blackboard provide comprehensive solutions. Meanwhile, MOOCs such as Coursera and edX cater to individuals looking for self-paced learning and skill enhancement. Ultimately, the best platform is the one that aligns seamlessly with the users' educational objectives and technical environment.

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