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E-Learning-Based Cloud Computing Environment: A Systematic Review, Challenges, and Opportunities

Prof. S. S. Medhe[1], Shruti Gore[2], Aarti Sonawane[3], Akanksha Kardile[4]
Department of Computer Engineering[1-4]
Adsul Technical Campus Chas Ahilyanagar, Maharashtra India

Abstract: *New technologies drive educational shifts, transforming offline to online learning. This study investigates e-learning and cloud computing integration to understand synergies and their potential impact. The motivation behind this study is to investigate the intricate relationship between e-learning and cloud computing. By analyzing 154 scientific papers, the study delves into the specifics of this integration, highlighting trends and areas that have received more attention. The study examines e-learning in a cloud computing environment, focusing on architecture (27%), general topics (21%), software (19%), and performance (18%). Virtual environments have fewer security issues, while storage and network focus are more prevalent. Cloud computing services are mainly all services, with software as a service (18%), infrastructure as a service (17%), and platforms as a service (10%). Most studies are based on public clouds (74%), all other models (11%), and hybrid clouds (3%). The study examines e-learning integration in cloud computing, highlighting limitations in hybrid and private clouds, specialized infrastructure, and a gap in platforms and infrastructure offerings..*

Keywords: Cloud computing, e-learning, environment, educational, e learning based cloud computing, systematic

I. INTRODUCTION

COVID-19 made us realize the importance of e-learning in f illing the gap in the education process during lockdown. This resulted in the introduction of numerous e-learningAs the world moves toward digital transformation, technology continues to redefine educational standards, improve inclusivity, and support lifelong learning. This report explores these transformations and their long-term implications. platforms that assist students and institutions in accessing and managing educational resources and real-time virtual classrooms. Simultaneously, the cloud computing environ ment has improved and is the standard for such applications. Cloud computing has changed the traditional web-based e-learning environment by providing internal or external pro grams that organize academic performance in a cloud-based environment and providing full software support and sub stantial computing resources implemented anywhere and anytime as the educational institution desires. Cloud com puting improves e-learning performance. It is for higher institutions such as institutes and universities, and it is called Cloud Campus, as it reduces the infrastructure and is more f lexible in technology [1]. In recent years, e-learning and cloud computing have become increasingly prevalent in educational environments, offering new opportunities for online learning and collabora tion [2], [3]. E-learning, which refers to the use of electronic technologies to deliver educational content, has been shown to offer flexibility and accessibility to learners. In contrast, cloud computing, which involves using remote servers to store, manage, and process data, can provide scalability and cost effectiveness for educational institutions [4]. However, there is still

To address this knowledge gap, this study analyzed the impact of e-learning in a cloud computing envi ronment by reviewing 154 related scientific papers. The study focused on research questions about the effects of e-learning and cloud computing services and models, including architecture, software, performance, security, hard ware, network, and virtualization. By examining existing research in this area, this study provides insights into the current state of e-learning in a cloud computing environ ment. It highlights potential areas for future research and development.

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Therefore, it focuses on detecting the dimension of the empirical use of cloud computing environments to build E-learning platforms. This systematic study method was used to answer the research questions. The results show that most selected studies focus on architecture, fol lowed by general topics such as software, performance, security, storage, network, hardware, control, manage ment, and virtualization.

The objectives of this study are as follows: To present a comprehensive and systematic review of e-learning based on cloud computing simultaneously with their advantages and challenges.

1) To review most methods in e-learning cloud-based and associated characteristics and drawbacks.
2) To specify the supplementary services and models cloud computing can provide to e-learning.
3) To discuss the challenges of integrating e-learning into cloud technologies.

II. FUTURE TRENDS

Cloud computing has contributed to finding solutions to many e-learning problems. For example, there were limitations in practical application and access to remote laboratories and a need to adapt some materials in practical application. During the survey, many studies provided feasible and practical solutions.Figure Captions

III. LIMITATIONS

In this study, we analyzed an e-Learning cloud computing environment. The study has some limitations, such as the selection of database sources. There are many sources for publishing scientific papers. However, this study focused on only four reliable sources to collect articles (Springer, IEEE Xplore, A.C.M., and Elsevier). Many terms related to e-learning, such as mobile learning, massive open online courses (MOOC), continuing learning, micro-learning, and types of e-learning, are added to the tech niques used with e learning and are focused on the e-learning environment. Several factors may impact the findings, such as whether the contents were only partially analyzed or the study's researchers. The study's research questions focused on the impact of e-learning and cloud computing services and models in scientific papers related to the subject. This limited scope may have excluded other potential research questions that provided additional insights into the topic. The study only analyzed papers written in English, which may exclude relevant research published in other languages. This could limit the generalizability of the findings or miss essential insights. While the study analyzed a range of topics related to e-learning and cloud computing, it may have over looked specific topics or issues relevant to particular contexts or stakeholders. For example, the study did not mention the role of teachers or instructors in e-learning environments or the impact of e-learning on

STRUCTURAL DESIGN OF E-LEARNING SYSTEMS

The structural design of e-learning systems refers to the organization, architecture, and framework that underlie the development and functioning of digital learning environ ments. It encompasses various elements and components designed to facilitate effective online education. Many studies discuss the structure of e-learning in cloud computing. Study [6] provided a standard proposal or model of three layers. The first-layer Cloud Management System contains subsystems that enable content delivery, resource management, and content creation, as well as evaluation and monitoring, with which users interact via the Internet using user interface software. These condlayerisa service provided via the cloud (software, platforms, and infrastructure). The third layer represents the hardware componentsofcomputers, networks, central processing units, and memory [7]. Fig.1 shows these layers in detail.

IV. CONCLUSION

Since the direction is now for online learning as the development of the technology, on the other hand, with its on-demand, metered access to computing resources (Process, Memory, Storage, etc.), cloud computing is a new paradigm that is fostering technical advancement and enabling dispersed applications across different geographies. Therefore, this study reviewed an e-learning-based cloud computing environment. The study extensively examined the integrationof e-learning and cloud computing from 2010 to 2022, analyzing 154 scholarly works. The potential for remote engagement in education and employment is emphasized. The reliance on literature reviews signals a need for practical implementations and comprehensive integration of hardware, software, security, and other facets. While public cloud

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computing offers cost efficiency, data security remains pivotal, particularly for sensitive information like student grades. Cloud computing's role in shaping e-learning is recognized, yet challenges necessitate ongoing innovation for a comprehensive educational environment. Cloud computing's role in shaping e-learning is recognized, yet challenges necessitate ongoing innovation for a comprehensive educational environment.

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