

# An Investigation of Cloud Computing and E-Learning for Educational Advancement

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## Abstract

Advances in technology have given educators a tool to empower them to assist with developing the best possible human resources. Teachers at universities prefer to use more modern technological advances to help them educate their students. This opens up a necessity to research the capabilities of cloud-based learning services so that educational solutions can be found among the available options. Based on that, this essay looks at models and levels of deployment for the e-learning cloud architecture in the education system. A project involving educators explores whether Learning Management Systems (LMS) can function well in a collaborative remote learning environment. The study was performed on how Blackboard was being used by a public institution and included research on cloud computing. This test examined how Blackboard Learn performs as a teaching tool and featured 60 participants. It is evident from the completed research that computers are beneficial to student education, especially in improving how schools administer lessons. Convenient tools for processing educational content are included as well as effective organizational strategies for educational processes and better ways to monitor and manage knowledge. In addition, this project's conclusions help highlight the advantages of rolling out cloud-based e-learning in higher educational institutions, which are responsible for creating the integrated educational product. The study showed that a shift to cloud computing can bring progress to educational material and substantial improvement to student academic outcomes, which is related to the increased use of better learning tools and methods.

## Key words:

*Cloud Computing, E-Learning, SaaS, PaaS, IaaS*

## 1. Introduction

Effective education is critical for commercial and socioeconomic success in today's society [1]. The widespread use of numerous online services, particularly social networking sites, has improved global digital literacy. As a result, current technology learning approaches, such as m - learning, are gaining popularity [2, 3]. Due to the automation of human actions and the introduction of new personnel requirements, global trends in the digital economy development have resulted in increased technological complexity and the extinction of many old occupations. The virtual environment now encompasses a considerable amount of labor interactions

and even job categories. As an outcome, new capabilities must be developed, and the entire educational structure must be restructured. Curriculum distribution has shifted from local PCs to online programs, thanks to the tremendous growth in acceptance of the Internet in educational activities. Universities have been adopting innovative educational approaches as a result of recent technological advancements. Universities and colleges now have access to a variety of intriguing tools that can be integrated to enhance the learning process [38]. Over the years distance learning, e-learning, and m - learning has emerged as a result of extensive use of technology, regularly updated content, the requirement for learners to acquire information from anywhere, and the globalization of education. The popularization of these notions is aided by wifi devices and digital devices [36]. The number of institutions implementing E-learning in Saudi Arabia. Numerous researchers have investigated the impact of E-Learning and M-Learning in various learning backgrounds [6, 7].

A key trend in higher education has been the use of LMS, which serve as a unified platform for digital interaction between students and teachers [2]. LMSs not merely facilitate effective learning resources to academia, but also enable the management and dissemination of academic skills [8]. Cloud computing is among the rising technical advances that, through its dynamic adaptability and resource utilization, has the potential to significantly impact education [37]. Virtualized e-learning model incorporates an effective approach that delegated responsibility for e-learning system construction to cloud computing operators. This enables suppliers and subscribers to develop mutually beneficial relationships. For learning, such a paradigm becomes a tool for reducing the costs associated with offering an advanced educational experience [4,5,10]. Collaborations and cost efficiency remain a benefit of cloud-based e-learning, as academic institutions are only liable for the education process, document management, and information delivery, while the supplier is responsible for the educational system's construction, preservation, improvement, and governance. The cloud-based infrastructure is compatible with a broad

range of hardware platforms and enables the development of next-generation and e-learning technologies. To interface their PCs or laptops to the website, modern consumers don't really need any understanding of cloud computing [11].

Cloud computing is marked as a paradigm for delivering on-demand networked access to servers, remote backup, programs, or resources with minimum administration effort and contacts with providers [12]. Cloud computing allows the processing of data to be transferred from individual computers to network infrastructure. A service is a term that refers to the program or software. Programs and files are stored on a variety of sites and can be accessed via any compatible device. The cloud infrastructure's transparency enables a user experience. Applications are deployed in scaled data centres with distributed shared and shareable computing resources to attain the expected scale economies [5, 13]. Cloud computing can result in significant cost savings when it comes to buying and maintaining technical infrastructure and software (servers, data transmission line segments, and power supplies), as well as minimize the need for desktop support specialists, resolve technical difficulties, and minimize engineering problems [14]. Cloud computing offers an unprecedented opportunity to enhance educational access. Together with the advancement and implementation of modern technologies, cloud computing provides an ideal potential for e-learning development. Through the Internet, students and faculty can now easily access a variety of software platforms and web-based teaching aids. An education program is not required to create a software and hardware atmosphere that is conducive to online learning or to devote substantial amounts of money, physical and human resources in developing an e-learning platform. Several of these responsibilities can be transferred to suppliers of cloud-based e-learning services. Through data dissemination, increased automation, and display of the data service, the virtualized e-learning model guarantees the highest level of data protection [15].

Numerous educational institutions are increasing the use of e-learning in their instructional methods. Due to the fact that most e-learning platforms need the intentional use of associated technology in educational procedures, cloud computing is a good solution for academia with limited resources for hosting and operating their web-based learning systems. Numerous developers and software suppliers are becoming interested in the potential of cloud technology in education, particularly in e-learning [16]. Nowadays, numerous institutions, universities, and even elementary and secondary schools have recently implemented cloud-based e-learning tools in their classroom instruction. Nevertheless, a large number use them in conjunction with their primary learning technologies such as LMS [17]. The incorporation of

cloud-based solutions into the pedagogical practices of educational institutes maintains a good necessity to examine the technological capacity of cloud computing to choose the best educational alternatives among analogs. In this connection, the current research examined the adaptability of cloud computing services for e-learning and the advantages of utilizing systems in assuring a high-quality educational practice. This objective was accomplished through the completion of the following tasks:

- i) Conduct a theoretical examination of the levels of an e-learning cloud environment and the deployment models in the educational sector. Evaluate the potential of the Blackboard Learn cloud service for interactive e-learning, community engagement, and information exchange in a virtual setting.
- ii) Examine Blackboard Learn's applicability to the cooperative remote learning approach.
- iii) Determine the main benefits of utilizing Blackboard (BB) Learn during the training process or the organization of the instruction.
- iv) Categorizing advantages to higher educational institutions from the implementation of computer-based e-learning as providers of an innovative learning product.

## 2. Cloud Computing and E-Learning

Cloud computing has emerged as the dominant technology in the modern era, as it enables unrestricted computation for a variety of social and corporate purposes [18]. Cloud technologies are cost-effective solutions that allow the development of learning quality at the current stage of education segment development [19]. E-learning cloud computing signifies a transition in the application of innovative cloud computing to the electronic learning space, hence establishing an education system equipped with all essential hardware and software computer resources [20]. Traditionally, the infrastructure of an e-learning cloud can be separated into various tiers. The e-learning infrastructure layer is positioned at the lowest possible level of cloud platform interface and comprises information systems and instructional resources [4, 21]. The term "information system" refers to the software that runs the system, the information management system, and the software and hardware that are universal. Educational resources are derived from conventional educational resources and are disseminated throughout the educational framework. With the cloud-based e-learning approach, the dedicated server, storage, and connection combine to form a virtualized group — a group of physical servers. The virtual machine and middleware comprise the software supply layer. A number of software components are merged here to create a uniform platform for developers of e-learning applications. On the basis of software resources, specialized apps are designed and incorporated in the

cloud, providing them accessible to users. The resource management interface is critical for software and hardware resources to communicate. The service layer includes three types of cloud computing technology [9]: Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and Software as a Service (SaaS).

### 2.1 PaaS

Many businesses opt to build their infrastructure, including their hardware and software for their systems [22]. However, this is expensive, inefficient, and often impossible because of all the variables to be accounted for. Luckily, PaaS, or Platform-as-a-Service, is a cloud services model that helps customers build their applications and provides an all-in-one solution for everything they need to have a robust system—hardware, software, and infrastructure—without all the burdensome responsibilities of being an application owner [23]. The Cloud vendor has their data center house everything from servers to space, with networking and operating system software thrown in for good measure [24]. Customers usually have the option of either a fixed charge, which covers a certain number of resources, and a fixed volume of traffic or pay-as-you-go billing, where they only pay for the resources that they use. Having a PaaS gives consumers a lot of benefits; it allows them to better deliver, design, construct, run, upgrade, and operate applications at a quicker and cheaper rate compared to doing so with their infrastructure.

### 2.2 IaaS

There are elements like computing applications, archives, and networking devices accessible via the Internet in pay-as-you-go sharing [22]. The design of IaaS takes into account how many resources each service needs as compared to how many resources are really in use. Because of this, the IaaS stack employs load balancers, PHP, and MySQL data centres [20]. Early in the process of developing cloud infrastructure, the standard services were SaaS, PaaS, and IaaS. But, context services like Business process as a service (BPaaS), came around later. The connection between the Artificial Intelligence (AI) role in BPaaS and the interaction between Education 4.0 and cloud-based e-learning is evident [25]. The final layer, the application server, functions through the integration of teaching resources with the cloud-computing architecture to provide dynamic programs and enable the transmission of educational content. Content production and delivery, instructional goals' formation, knowledge evaluation and control, and much more make up this process. several educational materials students need to acquire to succeed in E-Learning Platform. The cloud service model for the E-Learning platform is shown in fig 1.

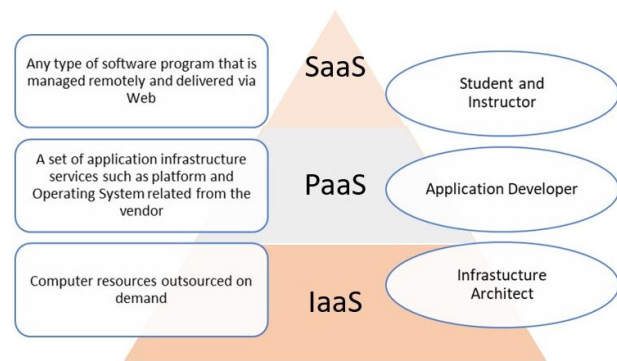


Fig. 1 Cloud service model

Public, private, and hybrid clouds, as well as community clouds, are all prevalent cloud deployment methods. Fig. 2, presents the various types of cloud deployment models.

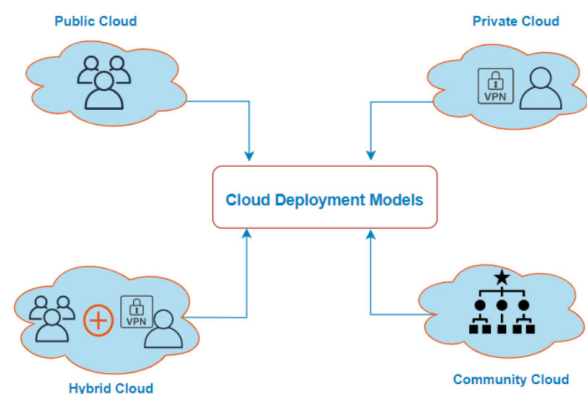


Fig. 2: Cloud Deployment Models

The flexible hardware resources, software platforms, and program services offered by cloud-based e-learning are all user-centered. From any place and at any time, digital solutions are accessible to users in the cloud [26]. While creating e-learning cloud platforms, software developers consider various educational organizations' requirements for virtualization of training resources, unified data storage, cheap operational costs, scalability, versatility, and systems' capacity to remain accessible. Thus, the cloud-based e-learning infrastructure has all of the resources and services that can be obtained via the cloud, such as the cloud management platform, hardware, and software [27].

### 2.3 SaaS

The SaaS delivery mechanism offers software applications on demand. It has cloud computing support, and it is made up of applications [28]. With SaaS users may get all sorts of software services, including email, conferencing, and enterprise programs such as Erp System, Customer Service, and Supplier Management [29]. One instance of the program is launched on the server and connected to various server services to which many end-users or consumers are connected. Dropbox, MailChimp, ZenDesk, DocuSign, Slack, Hubspot, and more fall into this category. It is also categorized as a fundamental service model due to the ability to utilize the program over the cloud [30]. The machine learning process in SaaS that is involved in machine-to-human interactions is known as artificial intelligence (AI). Hyper personalization in the form of AI components in SaaS applications. The resulting user-generated content from Mobile Learners (ML's) collaboration with the user [28] serves as a benchmark for the site's future content. The integrity, security, and accessibility of data would not be compromised by those using cloud computing. They're supposed to depend on the security protocols that cloud providers choose to employ [22]. Consequently, the reputation of the cloud service industry is mostly based on service standards, which are achieved throughout operational tasks. When running large businesses, it's standard to utilize numerous cloud services to give consumers the greatest possible experience. This is known as the Hazy Cloud method. Service providers are frequently forced to block their services, and consumers can expect to bounce between several vendors. Nonetheless, the arrival of vendor-user interactions has long complemented access to services, and both sides should work to bolster mutual security [22]. A client-focused SaaS platform increases server resources by drawing on their clients' limited input. End-users will receive a subset of embedded design over service-based operations with the client. This approach gives them a little amount of control [20, 28].

Most software companies use cloud platforms to offer their services. BB Learning is an ideal illustration of an LMS which is delivered via the cloud. E-learning platforms are also hosted on cloud platforms, such as Moodle Cloud [20]. Using BB as a resource to make education available through (LMS) in Saudi Arabia provides an entirely new quality of distance learning to Saudi universities, and therefore Majmaah University (MU) used BB for teaching purposes during the pandemic. In this inquiry, the LMS, Blackboard, was put to the test with regards to its ability to deliver an interactive remote learning experience. For the study, 60 instructors who used BB Learns were selected to determine the proficiency of BB learns in education pedagogy.

### 3. Findings

Blackboard Learn is a virtualized software dedicated to enhancing the educational experience by supplying digital learning options. When interacting with teachers in a contemporaneous setting, students have the opportunity to do so in real-time. For instance, Blackboard Collaborate, which one may use to conduct group activities, provide spontaneous lectures, and accept panel discussions, is a notable synchronous tool. Students benefit from an hourly generated calendar of notifications reminding them of impending events [28]. Blackboard Learn, a website that helps educators provide their content to students, offers students complete three sorts of course formats: all-online, blended, and traditional with additional web components. The following Table 1, displays trends of LMS over the years.

Table 1: LMS trends over the years

	1990s	2000s	2010s	2020s
Course Mode	Fully Online	Fully Online	-Fully Online -Hybrid / Blended -Web-Enhanced -In-Class Exam	-Fully Online -Hybrid / Blended -Bigdata integration
Content Type	Hybrid / Blended	Fully Online	Hybrid / Blended / Mobile Based Learning	-Fully Online / Data Analytics

Utilizing Blackboard, learners can do all sorts of activities, including checking class and assignment updates, uploading tests and quizzes, communicating, collaborating, checking at grades, and so on. Instructors have a number of benefits with the Blackboard Instructor mobile app. They may read course information, grade assignments, converse with students, and collaborate with student groups [31]. Comprehensive study has indicated that the BB Learn platform has the following major advantages.

Using the Blackboard Learn platform, one may construct their own course using a variety of frameworks, add and edit text documents of any type, embed mathematical equations in any location of text, upload and display their own and YouTube videos, and includes all current image formats and flash [2]. There are no constraints on how often this online educational technology can be used in courses. Using various applications such as video chat, classroom forums, document sharing, text chats, and blogs, it creates an environment where students may interact as a group. furthermore, Bb Learn integrated learning algorithms can be changed, allowing for the creation of a fully autonomous knowledge management system. Effective knowledge monitoring tools include libraries of individual and group exam items and course questions that Blackboard Learn has developed. Student assessment results can help adapt learning by providing statistics on

several assessments to evaluate learning needs. It's also possible to search for plagiarism in Blackboard Learn using an integrated tool. The password mechanism found in Blackboard Learn protects user information from being accessed.

Institutions should use online technologies in their classrooms so that students may develop the digital skills essential to be innovative and successful in the developing education system. Higher education must employ cutting-edge interactive teaching methods built on revolutionary digital technologies. Integrated, cloud-based education-specific information systems can positively influence the quality of education. In addition to this, using cloud computing methods will be important in realizing the lifelong learning principle [20]. Notwithstanding 4G, 5G, and 6G will have positive consequences on the expansion of cloud technology in the education industry. Since it relies on digital technologies, e-learning will not entirely replace conventional teaching techniques. Simultaneously, updated technologies, principles, and tools provide additional information, paradigms, and instructional methods to help the efficacy of education. There are numerous benefits to educators employing cloud services in their classroom methods, including increased computing strength, increased data storage, hybridization, and robust security and availability of cloud services.

Advanced computing capacity is provided when one uses a cloud-based e-learning infrastructure; the software stores a huge volume of data in multiple data centers [32]. Administrators use the cloud computing service to secure user data and do their best to provide unified data, assign resources, balance load, deploy software, and provide real-time, accurate monitoring. One benefit that many schools are currently providing is the option to take specific classes via a distant learning mode in order to save money on resources, space, and teaching staff [33]. According to research, virtualized e-learning has gained significant popularity since it is considered as an especially effective tool that universities in Saudi Arabia rely on to train students. The e-learning solution is using the cloud, and it doesn't really lead to innovation the popularity of cloud technology is linked to several benefits, particularly with regards to price and location optimization due to automated processes and transparent software. Students and teachers communicate in various geographic locations to make learning a vibrant and participatory experience, as group work is implemented to maximize the influence of teaching approaches [34].

Notwithstanding the emergence of cloud - based solutions at the university level in education, some believe they are mostly used as a database for storing papers, not as effective teaching aids [2, 21, 25]. Various studies show that although college staff members in various locations utilize LMS in varying degrees, most of them are unable to exploit the full power of the software. Academic,

commercial, and government interest in cloud computing has taken the computer science thing seriously. Digitalization economic technologies including Microsoft Azure, Software-Defined Networking, and edge computing have appeared alongside Internet of Things devices, enabling businesses to take use of digital infrastructure and strengthen the economic growth[35]. New research is required to reassess and improve adaptability, flexibility, privacy, and robustness, and it's due to the fact that these networks have both generated a need for such research.

#### 4. Conclusion

Teachers at higher educational institutions have become more interested in learning methods supported by cutting-edge technologies, whose main goal is to produce industry-ready digital era professionals. A lot of educators today prefer the cloud for storing their content and documents since it helps them save space on their devices, access their files anywhere, and be more environmentally friendly by using less energy and resources. A new, improved type of online education emerges when it incorporates innovative technology and training programs focused on cloud computing. This report will give you a theory-based look at the cloud architecture in the e-learning field, as well as the deployment models and their levels. To see how well LMSs can perform in a group distant learning scenario, during a pandemic. An experimental study employing the Blackboard Learn application (for creating online communities and virtual knowledge exchange) was conducted for interactive e-learning and putting together online course content. The investigation's goal was to engage 60 instructors to see how Blackboard's LMS fitted well in the classroom. During the inquiry, the main inherent benefits of Blackboard Learn in terms of the implementation of organizing and continuing to support the educational approach were highlighted. These included the ways to process educational content quickly, a simple system for organizing educational processes, efficient methods of assessing knowledge, and sound security and privacy system. In addition, the paper discussed the benefits of implementing cloud-based e-learning in universities. Based on the evidence, the study concludes that implementing cloud computing will yield positive effects on educational content and training: because cloud computing provides improved learning tools, educational concepts, and methodologies, students can now obtain the most recent learning content, models, and tools to more effectively educate and train themselves.

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## Reference

- [1] Dudin, M.N. and Y.S. Shishalova, Development of Effective Education and Training System in the Context of the Transition to International Accreditation. *European Journal of Contemporary Education*, 2019. 8(1): p. 118-127.
- [2] AlKhunzain, A. and R. Khan, The Use of M-Learning: A Perspective of Learners' Perceptions on M-Blackboard Learn. 2021.
- [3] Khan, R.M.I., et al., EFL Instructors' Perceptions on the Integration and Implementation of MALL in EFL Classes. *International Journal of Language Education and Applied Linguistics*, 2018: p. 39-50.
- [4] Ali, A., Cloud computing adoption at higher educational institutions in the KSA for Sustainable Development. *International Journal of Advanced Computer Science and Applications*, 2020. 11(3):413-419.
- [5] Ali, A., Manzoor, D., Alouraini, A., The implementation of Government Cloud for the Services under E-Governance in the KSA. *Science International Journal*, 2021. 3(3): 249-257.
- [6] Khan, R.M.I., et al., Learners' Perceptions on WhatsApp Integration as a Learning Tool to Develop EFL Spoken Vocabulary. *International Journal of Language Education*, 2021. 5(2): p. 1-14.
- [7] Khan, I., et al., Exploring The EFI Learners' Attitudes Towards the Integration of Active Reading Software in Learning Reading Comprehension at Tertiary Level. *MIER Journal of Educational Studies Trends & Practices*, 2020: p. 248-266.
- [8] Raza, S.A., et al., Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: an expansion of the UTAUT model. *Journal of Educational Computing Research*, 2021. 59(2): p. 183-208.
- [9] Manzoor, D., Ali, A., & Ahmad, A., Cloud and Web Technologies: Technical Improvements and Their Implications on E-Governance. *International Journal of Advanced Computer Science and Applications*, 2014.5(5): 196-201.
- [10] Baldassarre, M.T., et al., Cloud computing for education: A systematic mapping study. *IEEE transactions on education*, 2018. 61(3): p. 234-244.
- [11] Kale, M. and R. Mente, Impact of cloud computing on education system. *International Journal of Electronics, Electrical and Computational System IJEECS*, 2017. 6(11): p. 139-144.
- [12] Olaloye, F., et al., Cloud computing in education sector: An extensive review. *International Journal of Civil Engineering and Technology (IJCET)*, 2019. 10(3): p. 3158-3171.
- [13] Mwakisole, K., M. Kissaka, and J. Mtebe, Feasibility of cloud computing implementation for eLearning in secondary schools in Tanzania. *International Journal of Education and Development using ICT*, 2018. 14(1).
- [14] Mwakisole, K.F., M.M. Kissaka, and J.S. Mtebe, Cloud computing architecture for elearning systems in secondary schools in Tanzania. *The African Journal of Information Systems*, 2019. 11(4): p. 3.
- [15] Dahdouh, K., A. Dakak, and L. Oughdir, Integration of the cloud environment in e-learning systems. *Transactions on Machine Learning and Artificial Intelligence*, 2017. 5(4).
- [16] Suci, G., M. Anwar, and R. Mihalcioiu. Virtualized video and Cloud Computing for efficient elearning. in *The International Scientific Conference eLearning and Software for Education*. 2017. "Carol I" National Defence University.
- [17] Du, Z., et al. Method for sharing test data based on blackboard model. in *Journal of Physics: Conference Series*. 2021. IOP Publishing.
- [18] Alam, T., Cloud Computing and its role in the Information Technology. *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, 2021. 1: p. 108-115.
- [19] Mangla, N., Resource Scheduling on Basis of Cost-Effectiveness in Cloud Computing Environment, in *Mobile Radio Communications and 5G Networks*. 2021, Springer. p. 429-442.
- [20] Wu, W. and A. Plakhtii, E-Learning Based on Cloud Computing. *International Journal of Emerging Technologies in Learning*, 2021. 16(10).
- [21] GUPTA, S., E-Learning using Cloud Computing. 2021.
- [22] Mohammed, C.M. and S.R. Zebaree, Sufficient comparison among cloud computing services: IaaS, PaaS, and SaaS: A review. *International Journal of Science and Business*, 2021. 5(2): p. 17-30.
- [23] Wulf, F., et al. IaaS, PaaS, or SaaS? The Why of Cloud Computing Delivery Model Selection–Vignettes on the Post-Adoption of Cloud Computing. in *Proceedings of the 54th Hawaii International Conference on System Sciences*. 2021.
- [24] SRINIVASULU, P., B.R. Reddy, and A.S. Kumar, PaaS Platform Security Enhancement Using Fuzzy and Trust Based Signature. 2021.
- [25] Li, S., J. Huang, and B. Cheng, Resource Pricing and Demand Allocation for Revenue Maximization in IaaS Clouds: A Market-Oriented Approach. *IEEE Transactions on Network and Service Management*, 2021.
- [26] Van Eyk, E., et al., Serverless is more: From paas to present cloud computing. *IEEE Internet Computing*, 2018. 22(5): p. 8-17.
- [27] Yasrab, R., Platform-as-a-Service (PaaS): The Next Hype of Cloud Computing. *arXiv preprint arXiv:1804.10811*, 2018.
- [28] Saraswat, M. and R. Tripathi. Cloud Computing: Analysis of Top 5 CSPs in SaaS, PaaS and IaaS Platforms. in *2020 9th International Conference System Modeling and Advancement in Research Trends (SMART)*. 2020. IEEE.
- [29] Palos-Sanchez, P.R., F.J. Arenas-Marquez, and M. Aguayo-Camacho, Cloud computing (SaaS) adoption as a strategic technology: Results of an empirical study. *Mobile Information Systems*, 2017. 2017.
- [30] Nazir, R., et al., Cloud Computing Applications: A Review. *EAI Endorsed Transactions on Cloud Systems*, 2020. 6(17).
- [31] Khafaga, A.F., The perception of blackboard collaborate-based instruction by EFL majors/teachers amid COVID-19: A case study of Saudi universities. *Journal of Language and Linguistic Studies*, 2021. 17(2): p. 1160-1173.

- [32] Sivaraj, V., A. Kangaammal, and A.S. Kashyap. Enhancing Fault Tolerance using Load Allocation Technique during Virtualization in Cloud Computing. in 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS). 2021. IEEE.
  - [33] Bello, S.A., et al., Cloud computing in construction industry: Use cases, benefits and challenges. *Automation in Construction*, 2020: p. 103441.
  - [34] Albakri, A. and A. Abdulkhaleq, An Interactive System Evaluation of Blackboard System Applications: A Case Study of Higher Education, in *Fostering Communication and Learning with Underutilized Technologies in Higher Education*. 2021, IGI Global. p. 123-136.
  - [35] Rafique, W., et al., Complementing IoT services through software defined networking and edge computing: A comprehensive survey. *IEEE Communications Surveys & Tutorials*, 2020. 22(3): p. 1761-1804.
  - [36] Zou, H., et al., Towards occupant activity driven smart buildings via WiFi-enabled IoT devices and deep learning. *Energy and Buildings*, 2018. 177: p. 12-22.
  - [37] Nayar, K.B. and V. Kumar, Cost benefit analysis of cloud computing in education. *International Journal of Business Information Systems*, 2018. 27(2): p. 205-221.
- Shahbaz, M. and R.M.I. Khan, Use of mobile immersion in foreign language teaching to enhance target language vocabulary learning. *MIER Journal of Educational Studies Trends & Practices*, 2017: p. 66-82.



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