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The Evolving Role of Cloud Computing in Education: A Comprehensive Review

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Abstract: In recent years, cloud computing has emerged as a transformative force within the field of education. Cloud computing offers numerous advantages such as cost-effectiveness, scalability, and accessibility, positioning it as a pivotal technology in the 21st-century education landscape.Cloud-based Learning Management Systems (LMS) have streamlined administrative tasks and enriched the learning experience by enabling seamless remote access to educational resources. national and international journals and conferences, the review aims to examine the key factors that establish cloud computing as an indispensable tool in educational organizations. It also underscores the challenges associated with its implementation.As the education sector continues to evolve, cloud computing is expected to assume an even more significant role. Emerging technologies and innovations promise to revolutionize teaching and learning further. However, educational institutions must prioritize addressing data security and privacy issues to fully capitalize on the benefits of cloud computing, ensuring its secure and effective integration into the educational framework.

Keywords: Cloud computing, Education, Education System.

I. INTRODUCTION

A. Cloud Computing Concept

Cloud computing is a transformative force that delivers on-demand services via the Internet, offering cost-effective, accessible, and flexible solutions in today's technology-driven world. This computing paradigm connects thousands of terminals and servers to remote data centers, forming a robust computing system.

Users access data centers via various terminals, including computers and mobile phones, tailored to their specific requirements.

These models enable organizations and individuals to leverage cloud computing's scalability and flexibility, transforming how computing resources are utilized and managed across different sectors, including education, business, and beyond. These service models collectively enhance the accessibility, flexibility, and efficiency of educational solutions, ensuring that both educators and students can leverage advanced technological resources without being hindered by the limitations of their local hardware.





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Figure 1.1: Service Models in Cloud Computing

B. Cloud Computing and Education

The need for bulk data storage and on-demand service delivery in educational settings necessitates the use of cloud computing infrastructure. The future of educational technology infrastructure lies in utilizing cloud computing applications to meet the dynamic demands of the information age. Cloud integration streamlines resource management, effectively addressing data processing challenges and the information explosion. It adapts to the ever-evolving IT landscape and the Software as a Service (SaaS) trend, enhancing resource utilization and cost-efficiency. Moreover, cloud computing supports green energy initiatives, centralizes management, and bolsters security.

Initiatives like Google's collaboration with Chinese universities, such as Tsinghua University, to advance cloud computing education, highlight the growing importance of this technology in the educational sector. Seizing this opportunity is crucial for the evolution of educational information technology services. The role of cloud computing in educational organizations significantly impacts the efficiency of computing power as well as overall productivity.

Google offers a cloud service known as Google Drive, which includes document creation tools like Google Docs and cloud storage services such as Gmail, Google Translate, Google Maps, and Google Talk. Google Drive allows users to save files both in the cloud and on their local hard drives, providing access from anywhere, even while on the move. Any modifications made to a file, whether on the web, computer, or mobile device, automatically synchronize across all devices with Google Drive installed. With features like Google Docs, Sheets, and Slides, Google Drive enables seamless creation, viewing, and collaborative editing of files without the need for duplicating or sharing documents.

In summary, the adoption of cloud computing in education not only enhances resource management and cost-efficiency but also promotes sustainability and security. The integration of cloud services like Google Drive demonstrates the practical benefits of cloud computing, facilitating efficient and collaborative workflows in educational environments.

II. REVIEW THE ROLE OF CLOUD COMPUTING

The following table provides a concise summary of key studies that delve into the realm of cloud computing's impact on education. There are about 20 articles from various sources, those are included in this review about role of cloud computing in education. These studies offer valuable insights into how cloud technology is transforming the educational landscape, from enhancing accessibility to improving cost-efficiency.

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Table 1: Summary of Key Studies on Cloud Computing in Education

Study Title	Description	Study Outcomes	Impact on Education	Limitation
Adoption of Cloud Computing in Education System: A Survey [1].	This study explores the application of computing inside the cloud in the system, particularly in India. It discusses the potential benefits, challenges, and guidelines for implementing distributed computing in the cloud at educational institutions. The focus is on enhancing the quality of education through technological advancements and efficient resource management.	The study identifies potential benefits, including cost- effectiveness and accessibility, along with challenges such as security concerns and the need for improved service quality. It emphasizes the importance of integrating cloud computing into education to enhance quality and efficiency.	The study concludes that distributed computing system has a significant impact on education by offering cost- effective solutions and improving accessibility. Integrating cloud technology into education can enhance quality and efficiency, benefiting both institutions and students.	Privacy, security, network performance and integration of cloud services with the existing systems are major concerns.
The Application of Cloud Computing in Information [2].	The study focusses on the use of distributed cloud computing in teaching methods. It underscores the role of cloud computing in adapting to evolving IT trends and improving educational information sharing. The paper highlights cost- efficiency and improved access in learning while addressing resource distribution and sharing challenges.	This study underscores the potential benefits of computing using cloud in the education system, emphasizing cost savings, improved resource sharing, and enhanced accessibility to educational tools. It highlights the capacity of cloud computing to address resource distribution and sharing challenges while modernizing educational information.	The impact of computing at cloud on education is transformative. It revolutionizes resource access, collaboration, and cost-efficiency in the educational sector. Cloud-based platforms enhance resource sharing, reducing disparities, and offer scalable, cost-effective solutions, fostering a more inclusive and technologically advanced learning environment	Challenges include data privacy and security, dependency on internet connectivity, and potential inequalities in access to technology. Additionally, there may be resistance to change among educators, and data ownership and control issues need to be addressed
The Role of Cloud Technologies	It highlights the flexibility and accessibility they offer,	The significance of cloud technologies in education,	The adoption of cloud technologies in education	The study does notspecifylimitationabout

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in the Digitalization of Education [3].	enabling enhanced communication and reducing costs. Google's cloud services are identified as a valuable tool to promote independent and creative learning, fostering a new information culture in alignment with evolving educational standards.	emphasizing their capacity to enhance student engagement and knowledge acquisition. By integrating cloud services, students gain greater mobility and access to educational resources, fostering independence and creativity. This technological approach aligns with the evolving educational standards and encourages a modern information culture among both educators and learners.	revolutionizes the learning process by enhancing accessibility, promoting mobility, and offering a dynamic platform for student engagement. It accommodates diverse learning styles and enables efficient collaboration, ultimately improving educational quality while fostering an information-rich culture in schools.	could computing adaption in education.
Cloud Computing Issues and Benefits Modern Education [4].	This research paper examines the fusion of computing use of cloud and e-learning in the education sector. It underscores the advantages, like cost savings and improved performance, as well as the challenges, such as security and compliance issues. The paper advocates for proactive security measures and the development of appropriate standards to navigate these concerns effectively.	The study highlights the potential benefits of integrating cloud computing with e- learning in modern education. It emphasizes lower costs, improved performance, instant software updates, and enhanced compatibility. The research underscores the advantages for both students and teachers and proposes proactive measures to address security and compliance issues, ensuring a promising future for cloud- based e-learning.	The effect of computing onto cloud for education is profound. It enables more accessible and flexible e-learning opportunities, reduces costs for educational institutions, and enhances collaboration among students and teachers. However, it also poses challenges in terms of data security and privacy that need to be carefully addressed to ensure its successful integration into education.	The study discusses several limitations and challenges associated with cloud-based e- learning, including concerns related to security, privacy, reliability, legal issues, and long- term viability.



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The Necessity Of Using Cloud Computing In Educational System [5].	The paper emphasizes the importance of online education in technical science and engineering and discusses the advantages of utilizing cloud computing for online learning. It highlights cost	The study underscores the benefits of implementing cloud- based educational systems, such as cost reduction, scalability, and enhanced security. It discusses how cloud computing	Theimpactofimplementingcloudcomputingineducationissignificant.Itenablesgreateraccesstoeducationalresourcesresourcesandservices,making	Limitations of cloud-based education include the need for robust computation power for lab-based education, potential cost concerns, and privacy issues. These factors can
	reduction, scalability, and enhanced security while mentioning the need to address certain challenges in implementing cloud- based educational systems.	can bridge the gap between on-campus and distance education, especially in technical science and engineering fields.	learning more flexible and accessible. It also supports innovative teaching methods and collaborations among students and institutions, promoting global education advancements.	pose challenges for universities and organizations adopting cloud- based learning systems.
Cloud Computing and Education: A state-of-the-art survey [6].	This study conducted a systematic review of cloud computing in education, identifying its advantages and specific benefits, such as innovative learning scenarios and flexible resource provisioning. It also examined potential risks, including privacy and security concerns. The study highlights research challenges, including infrastructure design and scalability, and emphasizes the need for more in-depth research in this field to fully harness the potential of cloud technology for education.	The study identified numerous advantages of using cloud computing in education, such as cost savings, innovative learning scenarios, and support for resource- intensive applications. It also revealed risks, including privacy and performance concerns. The research emphasized the need for further exploration in infrastructure design, scalability, and interoperability.	The adoption of cloud computing in education has transformed the learning landscape. It has enabled cost-effective, innovative teaching methods and resource-intensive applications. However, concerns like privacy and performance issues need attention. Further research and infrastructure development are essential to harness its full potential.	The limitation includes privacy and security concerns related to sensitive student data, potential vendor lock-in, performance issues in resource- intensive scenarios, and the need for more standardized licensing models.
Cloud	The study explores	The study highlights	The adoption of	

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Computing in	cloud computing	the potential benefits	cloud computing in	The limitations in
Education in	adoption in developing	of cloud computing	education,	adopting cloud
Developing	countries, with a focus	in developing	especially in	computing in
Countries [7].	on Saudi Arabian	countries' education	developing countries	developing
	universities. Cloud	systems, emphasizing	like Saudi Arabia,	countries, such as
	computing offers cost	cost reduction,	can have a	Saudi Arabia,
	reduction and enhanced	resource	transformative	include high costs,
	flexibility. It can	accessibility, and	impact. It can	limited local
	benefit education by	standardized content	reduce IT costs,	infrastructure, a lack
	providing standardized	delivery. It also	improve resource	of cloud expertise,
	content delivery,	identifies barriers like	accessibility,	security concerns,
	improving	cost, infrastructure,	enhance content	reliability issues,
	collaboration, and	and security concerns	delivery, and	and cultural/legal
	easing IT infrastructure	that need to be	facilitate	barriers. These
	management. However,	addressed for	collaborative	challenges need to
	challenges include cost	successful cloud	learning. However,	be addressed for
	barriers, lack of local	adoption in	challenges related to	successful adoption
	infrastructure, and	education.	cost, infrastructure,	in education.
	security concerns.		and security must be	
			overcome to fully	
			realize these	
			benefits.	
Cloud	This study assesses the	The study vielded	According to the	The study has
Computing and	influence of cloud	significant positive	study, the impact of	several limitations.
its Impact on	computing on distance	correlations between	cloud computing on	including a focus on
Online	education across	cloud computing and	education is	a specific context
Education [8].	various cloud	distance education	substantial. It	and sample, which
	computing dimensions.	across various	enhances the quality	may limit the
	It examines	dimensions.	of distance	generalizability of
	correlations and effects	Theoretical analysis	education by	the findings to other
	using statistical	suggests that cloud	offering greater	educational settings.
	analysis and finds that	physical devices,	flexibility,	Additionally, the
	cloud physical devices,	cloud database	collaborative	study relies on self-
	cloud database	activities, and cloud	opportunities, and	reported data, which
	activities, and cloud	operating systems	cost-efficiency.	could introduce
	operating systems and	and applications can	Cloud physical	response bias. It also
	applications	enhance the quality	devices, cloud	does not delve into
	significantly impact	of distance education	database activities,	the potential
	distance education. The	by providing	and cloud operating	challenges and risks
	study offers	flexibility,	systems and	associated with
	recommendations for	collaborative	applications play	implementing cloud
	improving cloud	capabilities, and cost-	vital roles in	computing in
	computing integration	efficiency. These	improving the	education, such as
	in education.	findings have	educational	data security and
		practical implications	experience. These	privacy concerns.
		for optimizing cloud-	findings emphasize	



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		based educational platforms.	the importance of integrating cloud technology into educational institutions for more effective and efficient learning.	
Cloud Computing in Education: Potentials and Challenges for Bangladesh [9].	The study describes the application of cloud computing in the education sector of Bangladesh, highlighting its potential benefits such as cost-effectiveness, improved accessibility, and collaboration. It also mentions challenges, including security concerns and limited portability between cloud providers. The paper emphasizes the transformative potential of cloud technology for education in Bangladesh.	The study demonstrates that implementing cloud computing in Bangladesh's education sector can provide cost- effective, accessible, and collaborative learning solutions. Successful case studies, such as online result publication and cloud-based classrooms, have shown that cloud technology can significantly improve education and reduce the digital divide, benefiting both students and institutions.	The real impact of cloud computing on education in Bangladesh, as highlighted in this study, is a transformative shift towards cost-effective, accessible, and collaborative learning. Cloud technology reduces infrastructure costs, improves resource accessibility, and promotes collaboration among students and teachers. It streamlines administrative tasks, prepares students for a technology-driven future, and lowers licensing costs, ultimately enhancing the overall quality of education in the country.	The limitations are potential security vulnerabilities, reduced operational control, and challenges related to portability between cloud providers. Additionally, the study recognizes that the lack of established industry standards in the cloud computing sector can hinder the seamless transition between cloud providers, potentially creating obstacles for educational institutions and organizations in Bangladesh.
Role of Cloud Computing in Education [10].	The study explores the role of cloud computing in education, emphasizing its potential to reduce costs, increase accessibility, and personalize learning. The cloud helps	cloud computing in education can enhance accessibility, reduce costs, and offer personalized learning. It addresses challenges in the Indian education system, such as	Cloud computing enables personalized learning, cost reduction, and 24/7 accessibility, addressing the limitations of traditional infrastructure. It	One limitation is the concern over data security when hosting critical educational data in the cloud. Another limitation is the reliance on third- party cloud

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	overcome infrastructure challenges in Indian education, allowing for centralized systems. However, security and data protection are key concerns, while the benefits include cost savings and resource accessibility.	infrastructure limitations. Concerns include data security. The study underscores the potential for significant cost savings and improved resource availability in education.	allows educational institutions to focus on improving teaching quality while saving on infrastructure costs, making education more efficient and environmentally friendly.	providers, which may lead to dependency on a single provider and increase the risk of unsolicited advertising. It's important to address these issues to fully leverage CC's benefits in education.
Role of Cloud Computing in Education [11].	This paper explores the transformative role of cloud computing in education. It discusses how cloud technology can enhance educational services, cut costs, and benefit areas like distance learning. It highlights the growing demand for cloud computing in India and its potential to bridge the digital divide in the education sector.	Cloud computing in education emphasizes its potential to enhance resource accessibility, reduce costs, and improve teaching and research activities. It discusses practical applications and advantages, citing real-world examples. The study underscores the need for educational institutions, particularly in India, to adopt cloud computing to meet evolving demands.	This study explains the significant impact of cloud computing on education. It discusses how cloud computing can make education more accessible, cost- effective, and efficient. It emphasizes that cloud computing can enable educational institutions to focus on teaching and research while reducing the burden of IT management, thereby improving the overall quality of education. This impact is particularly crucial in addressing challenges in India's educational system.	The study does not cover any limitation explicitly but security and privacy should be kept in view for implementing cloud computing environment in education.
Impact of Cloud Computing on Education System [12].	The study explores the impact of cloud computing on the education sector. Cloud technology offers scalable, cost-effective.	The study underscores the transformative impact of cloud computing on the education sector. Cloud	According to the study, cloud computing has a significant impact on education by revolutionizing the	The study does not explicitly mention limitations of cloud computing in the education sector. It primarily focuses on

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	and user-friendly solutions for delivering education. It enables personalized learning, easy access to resources, and efficient data sharing. The study highlights the advantages of cloud- based education, including lower costs and improved accessibility.	technology facilitates personalized learning, cost- effective infrastructure, and ubiquitous access to educational resources. It enhances data security, minimizes maintenance, and reduces environmental footprint. Overall, it enhances the quality and efficiency of education services through advanced technology.	sector. It provides personalized learning opportunities, cost- effective infrastructure, and widespread access to educational resources. Cloud technology enhances data security, reduces maintenance costs, and promotes an eco-friendlier approach.	the benefits and positive impacts of cloud computing. Therefore, it may not provide a comprehensive view of potential challenges or drawbacks associated with implementing cloud technology in education.
Role and Service of Cloud Computing for Higher Education System [13].	This study highlights how cloud computing can revolutionize higher education by overcoming the limitations of traditional systems. It emphasizes the cost- effectiveness, accessibility, and resource richness of cloud services. Additionally, it explores the role of commercial cloud vendors in enhancing learning and research. The novelty lies in offering a comprehensive perspective on the benefits of cloud computing in higher education.	The study discusses the benefits and advantages of implementing cloud computing in higher education, such as cost-effectiveness, accessibility, and improved resource availability, but it does not present specific findings, statistics, or data related to the study's implementation or its impact on educational institutions.	Cloud computing has a profoundly positive impact on education. It reduces costs, improves resource accessibility, enhances collaboration, and offers administrative efficiency. It addresses limitations of traditional education systems by providing anytime, anywhere access to resources and fostering a collaborative learning environment.	The study emphasizes that the limitations of traditional education systems, such as uniform teaching methods and resource constraints, can be mitigated by adopting cloud computing. Cloud computing overcomes these limitations by providing cost- effective, accessible resources and collaborative tools. The study does not focus on limitations but rather the benefits of using cloud computing in education.
Cloud computing for	The paper discusses the emergence and	The study underscores the	According to the study, cloud	This study highlights

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education: A	adoption of cloud	growing adoption of	computing has a	limitations of cloud
new dawn?	computing, particularly	cloud computing in	significant impact	computing (CC),
[14].	in small to medium	various sectors,	on education. It	including control
	enterprises (SMEs) and	particularly among	offers educational	issues, vendor lock-
	educational institutions.	small to medium	institutions cost-	in, performance and
	It highlights cost	enterprises and	effective solutions	reliability concerns,
	savings, efficiency, and	educational	for upgrading their	security and privacy
	green advantages. A	institutions, driven by	software and IT	risks, data
	case study of the	cost savings and	infrastructure. It	ownership disputes,
	University of	efficiency gains. The	enables greater	and potential
	Westminster's use of	case study of the	flexibility, improved	environmental
	Google Apps for	University of	collaboration, and	impacts,
	Education is presented.	Westminster	efficient access to	underscoring the
	The paper	demonstrates how	educational	need for careful
	acknowledges concerns	cloud computing can	resources. By	evaluation before
	regarding security and	provide cost-effective	reducing IT costs	CC adoption.
	reliability but notes that	solutions while	and providing	
	cloud computing is	improving user	access to cloud-	
	gaining popularity due	experiences and	based services,	
	to its cost-effectiveness	reducing	cloud computing	
	and potential to	environmental	empowers	
	transform various	impact.	educational	
	industries.		institutions,	
			particularly in	
			underdeveloped	
			regions, to enhance	
			the quality and	
			accessibility of	
			education. The study	
			showcases various	
			universities and	
			schools that have	
			adopted cloud	
			computing to	
			improve their	
			services and adapt to	
			changing	
			educational needs.	

III. CONCLUSION

A review of 16 research articles from national and international journals reveals significant findings regarding the impact of cloud computing in educational institutions. The analysis demonstrates a strong consensus on the benefits of cloud computing in education. Key advantages highlighted in the studies include "Cost-Effectiveness" and "Resource Sharing," with approval ratings as high as 90% and 80%, respectively. Additionally, "Accessibility," "Innovation &

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Collaboration," and "Reduction of IT Costs" received positive feedback, illustrating the transformative potential of cloud technology in educational settings.

However, the review also identifies several challenges. "Security and Privacy Concerns" and "Reliability and Performance Issues" emerge as primary obstacles, with concern levels reaching approximately 60% and 50%, respectively. As education evolves, addressing these challenges becomes crucial for fully harnessing the benefits of cloud computing.

In conclusion, the review provides a comprehensive overview of the conveniences and challenges associated with implementing cloud computing in educational scenarios, emphasizing the need for robust solutions to ensure secure, reliable, and efficient cloud-based educational environments.

A. Importance of Cloud Computing:

- 1. **Cost-Effectiveness**: All 16 articles highlighted that cloud computing offers cost-effective solutions in education.
- 2. Accessibility: Accessibility was emphasized in all 16 articles as a significant advantage of cloud computing in education.
- 3. **Resource Sharing**: 15 out of 16 articles pointed out that cloud computing enhances resource sharing in education, making educational materials more readily available.
- 4. **Innovation and Collaboration**: 13 out of 16 articles mentioned that cloud computing promotes innovation, collaboration, and student engagement.
- 5. **Reduction of IT Costs**: 11 out of 16 articles noted that cloud computing reduces IT infrastructure and maintenance costs for educational institutions.



Figure 3.1: Review outcomes of importance of cloud computing

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B. Challenges

- 1. **Security and Privacy Concerns**: 15 out of 16 articles identified security and privacy as major challenges when implementing cloud computing in education.
- 2. **Reliability and Performance Issues**: 10 out of 16 articles highlighted concerns about reliability and performance, particularly regarding internet connectivity.
- 3. **Data Ownership and Control**: 8 out of 16 articles mentioned issues related to data ownership and control when using cloud services.
- 4. **Dependence on Internet Connectivity**: 9 out of 16 articles mentioned that dependence on internet connectivity was a challenge.
- 5. **Integration with Existing Systems:** 8 out of 16 articles emphasized the difficulty of integrating cloud services with existing educational systems.
- 6. **Standardization and Licensing**: 6 out of 16 articles discussed the need for standardization in cloud computing for education, including licensing models.
- 7. **Cultural/Legal Barriers**: 4 out of 16 articles recognized cultural and legal barriers in adopting cloud computing, particularly in developing countries.



Figure 3.2: Review outcomes of challenges to cloud computing

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