ПРОФЕСІЙНА ОСВІТА

Challenges and Benefits of Cloud Solutions in Education

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Abstract. This review explores the benefits of cloud solutions in education, focusing on the top companies to watch and their functionalities. It begins by discussing the increasing role of technology in education and the significance of cloud solutions in transforming educational practices. The review categorizes cloud solutions based on their functionalities and evaluates prominent cloud solution providers in the education sector. Real-world examples of educational institutions successfully implementing cloud solutions are included, highlighting the challenges faced and the benefits realized. The article examines the key benefits of adopting cloud solutions in education, focusing on scalability, accessibility, cost-effectiveness, and flexibility. These features improve both the operational efficiency of institutions and the learning experience. Scalability allows schools to adjust IT resources to changing needs without significant investment in infrastructure. Accessibility enables students and faculty to access resources from anywhere with an internet connection, supporting hybrid and remote learning. Cost-effectiveness reduces the need for costly hardware, while flexibility supports a range of learning environments. Additionally, the article explores how cloud solutions foster collaboration through tools like shared documents and virtual meeting spaces, enhancing group work and critical skills such as teamwork and communication. However, the article also highlights potential challenges, including data security, privacy concerns, the digital divide, and the need for reliable internet. It stresses the importance of secure platforms and suggests strategies such as encryption, educator training, and equitable access to technology to address these

challenges. By addressing these concerns, institutions can effectively integrate cloud solutions while minimizing risks.

The review concludes with recommendations for educational institutions considering the adoption of cloud solutions and cites academic papers, articles, and case studies to support the information presented.

Keywords: *cloud solutions, educational technology, cloud-based platforms*.

Виклики та переваги хмарних рішень в освіті

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Анотація. Ця стаття досліджує переваги хмарних рішень в освіті, зосереджуючись на найкращих компаніях, на які варто звернути увагу, та їхніх функціях. Він починається з обговорення зростаючої ролі технологій в освіті та значення хмарних рішень у трансформації освітньої практики. Огляд класифікує хмарні рішення на основі їх функціональних можливостей і оцінює відомих постачальників хмарних рішень у секторі освіти. Включено реальні приклади освітніх установ, які успішно впроваджують хмарні рішення, висвітлюючи проблеми, з якими зіткнулися, і отримані переваги. У статті розглядаються ключові переваги впровадження хмарних рішень в освіті, зосереджуючись на масштабованості, доступності, економічній ефективності та гнучкості. Ці функції покращують як ефективність роботи установ, так і досвід навчання. Масштабованість дозволяє школам адаптувати IT-ресурси до мінливих потреб без значних інвестицій в інфраструктуру. Доступність дозволяє студентам і викладачам отримувати доступ до ресурсів з будь-якого місця, де є підключення до Інтернету, підтримуючи гібридне та дистанційне навчання. Економічна ефективність зменшує потребу у дорогому апаратному забезпеченні, а гнучкість підтримує низку навчальних середовищ. Крім того, у статті досліджується, як хмарні рішення сприяють співпраці за допомогою

таких інструментів, як спільні документи та віртуальні простори для зустрічей, покращуючи групову роботу та важливі навички, такі як командна робота та спілкування. Однак у статті також висвітлюються потенційні проблеми, включаючи безпеку даних, проблеми конфіденційності, цифровий розрив і потребу в надійному Інтернеті. У ньому підкреслюється важливість безпечних платформ і пропонуються такі стратегії, як шифрування, навчання викладачів і справедливий доступ до технологій для вирішення цих проблем. Вирішуючи ці проблеми, установи можуть ефективно інтегрувати хмарні рішення, мінімізуючи ризики.

Огляд завершується рекомендаціями для навчальних закладів, які розглядають можливість впровадження хмарних рішень, а також цитується наукові роботи, статті та тематичні дослідження на підтримку представленої інформації.

Ключові слова: *хмарні рішення, освітні технології, хмарні платформи.*

Problem statement. The increasing role of technology in education has led to the widespread adoption of cloud solutions, which have significantly transformed educational practices. The article will provide a brief overview of the increasing role of technology in education, citing sources such as Vakaliuk (2019), who analyzed the current stage of educational studies of cloud-based learning systems, emphasizing the importance of designing a cloud-based system for supporting the education of bachelors of computer science [1]. The article then introduces the significance of cloud solutions in transforming educational practices, citing sources such as Mansuri et al. (2014), who discussed the benefits of cloud computing for educational institutions and online marketing, highlighting the cost-effectiveness, ease-of-use, and accessibility of cloud solutions in the educational sector [2, 3]. The review presents **the purpose** of the review: to analyze various cloud solution providers and their benefits in an educational context, citing sources such as Popel and Shyshkina (2019), who investigated the relationship between the notions of the cloud-based learning system and the cloud-

based learning environment, revealing that researchers pay most attention to the design of a cloud-based learning environment [4, 5].

Analysis of recent research and publications. The search results include several academic papers and articles that provide insights into the benefits of cloud computing in education. For instance, the practical use of cloud services for the organization of future specialists' professional training has been explored, demonstrating the economic and educational benefits of utilizing cloud solutions in higher education [6, 7]. These sources provide valuable information on the impact and benefits of cloud solutions in education. The review cites these sources to support the information presented and provide a comprehensive analysis of cloud solutions in education.

The evolution of cloud technology in education has been a subject of significant study. Mansuri, Verma, and Laxkar (2014) discussed the benefits of cloud computing for educational institutions and online marketing, highlighting the cost-effectiveness, ease-of-use, and accessibility of cloud solutions in the educational sector [8, 9]. Vakaliuk (2019) analyzed the current stage of educational studies of cloud-based learning systems, emphasizing the importance of designing a cloud-based system for supporting the education of bachelors of computer science [10, 11]. These studies provide valuable insights into the potential strategic benefits and challenges of cloud computing in higher education, as well as the main principles and potentials of cloud computing as applied to the world of education [12, 13].

The challenges faced by traditional educational systems in adopting cloud solutions have been a topic of interest. Kasian (2016) provided a practical guide for the implementation of cloud computing in higher education, discussing the promises and challenges of cloud computing in this context. This study presents the main principles and potentials of the cloud, as applied to the world of education, and discusses potential strategic benefits and challenges of cloud computing in higher education [13].

Among the key challenges highlighted are the resistance to change from traditional systems, the need for significant initial investments in training and

infrastructure, and concerns over data sovereignty and compliance with local regulations. Additionally, the study emphasizes the importance of addressing the digital divide, ensuring equitable access to technology for all students, and developing robust cybersecurity measures to protect sensitive educational data. These challenges underscore the necessity for a well-planned transition strategy that includes stakeholder engagement, continuous professional development for educators, and the establishment of clear policies to govern the use of cloud technologies in educational settings.

Given these complexities, this research aims to provide a comprehensive framework for overcoming these barriers by identifying best practices, innovative solutions, and actionable recommendations tailored to the unique needs of educational institutions. By doing so, it seeks to bridge the gap between the potential of cloud technologies and their practical implementation, ensuring that the benefits of scalability, accessibility, and cost-effectiveness are fully realized while minimizing risks and addressing ethical, technical, and organizational concerns.

The relevance of the study lies in the fact that cloud technologies are becoming a key tool for transforming education, but their potential is limited by technical, organizational, and ethical barriers. This topic is important for the scientific community because it complements existing knowledge about the implementation of cloud solutions, and for practitioners – because it offers concrete steps to overcome challenges and maximize the benefits of these technologies, namely:

1. Analysis of modern cloud solutions – identifying their functional capabilities and advantages for education.

2. Identification of key challenges – such as data security, the digital divide, ethical aspects of AI use, and integration with traditional systems.

3. Development of recommendations – proposing practical steps for the effective implementation of cloud technologies in the educational process.

The objectives of the study are based on the analysis of current scientific works, real-world examples of cloud solution implementation in education, and the needs of

educational institutions. They are objective because they consider both the advantages and challenges associated with the use of cloud technologies and aim to ensure a scientifically grounded approach to their integration.

Thus, the task of the study is to propose a comprehensive approach to the implementation of cloud technologies in education, which would ensure their effective integration, minimize risks, and maximize benefits for all participants in the educational process. This will not only improve the quality of education but also ensure the sustainable development of educational institutions in the digital age.

Presentation of the main research material. The potential of cloud solutions to address these challenges and enhance educational processes has been a focus of research. Kasian (2016) provided a practical guide for the implementation of cloud computing in higher education, discussing the promises and challenges of cloud computing in this context [13]. Mansuri, Verma, and Laxkar (2014) discussed the benefits of cloud computing for educational institutions and online marketing, highlighting the cost-effectiveness, ease-of-use, and accessibility of cloud solutions in the educational sector (figure 1) [8]. These studies provide valuable insights into the potential strategic benefits and challenges of cloud computing in higher education, as well as the main principles and potentials of cloud computing as applied to the world of education (figure 2 [8]).
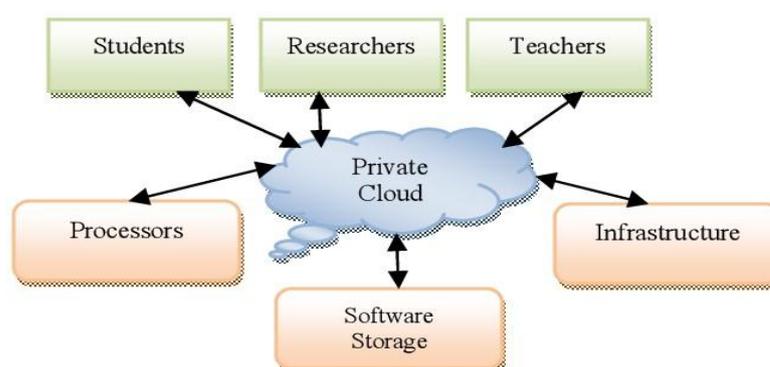

Figure 1. Existing Private Cloud for Education

These studies provide valuable insights into the potential strategic benefits and challenges of cloud computing in higher education, as well as the main principles and

potentials of cloud computing as applied to the world of education. They offer a comprehensive analysis of the impact and benefits of cloud solutions in education, providing valuable information on the evolution of cloud technology in education, the challenges faced by traditional educational systems, and how cloud solutions address these challenges and enhance educational processes.

Categorizing cloud solutions based on their functionalities is a critical aspect of understanding their relevance to education. The search results provide valuable insights into the benefits of cloud computing for educational institutions and online marketing [14]. Additionally, the role of cloud computing in management and education has been highlighted, emphasizing the need to tailor cloud computing service architecture to the specific requirements of educational institutions. Furthermore, the promises and challenges of cloud computing in higher education have been extensively discussed, providing a practical guide for the implementation of cloud computing in this context. The impact of cloud computing in education, teaching, and research has also been the subject of a scientific review, emphasizing the usefulness of cloud computing in accessing applications anytime and anywhere. A state-of-the-art survey on the use and research of cloud computing in education has been conducted, providing a comprehensive analysis of the current state of the art in this field [15]. These sources offer a wealth of information that can be used to categorize cloud solutions based on their functionalities and provide brief descriptions of each type and their relevance to education.

The search results provide valuable insights into the benefits of cloud computing for educational institutions and online marketing [16]. Additionally, the role of cloud computing in management and education has been highlighted, emphasizing the need to tailor cloud computing service architecture to the specific requirements of educational institutions. Furthermore, the promises and challenges of cloud computing in higher education have been extensively discussed, providing a practical guide for the implementation of cloud computing in this context [17]. The impact of cloud computing in education, teaching, and research has also been the subject of a scientific

review, emphasizing the usefulness of cloud computing in accessing applications anytime and anywhere. These sources offer a wealth of information that can be used to conduct an in-depth analysis of prominent cloud solution providers in the education sector and evaluate each provider based on features and functionalities, user-friendliness, integration capabilities with existing educational systems, security measures, and customization options for educational institutions (figure 3 [18]).
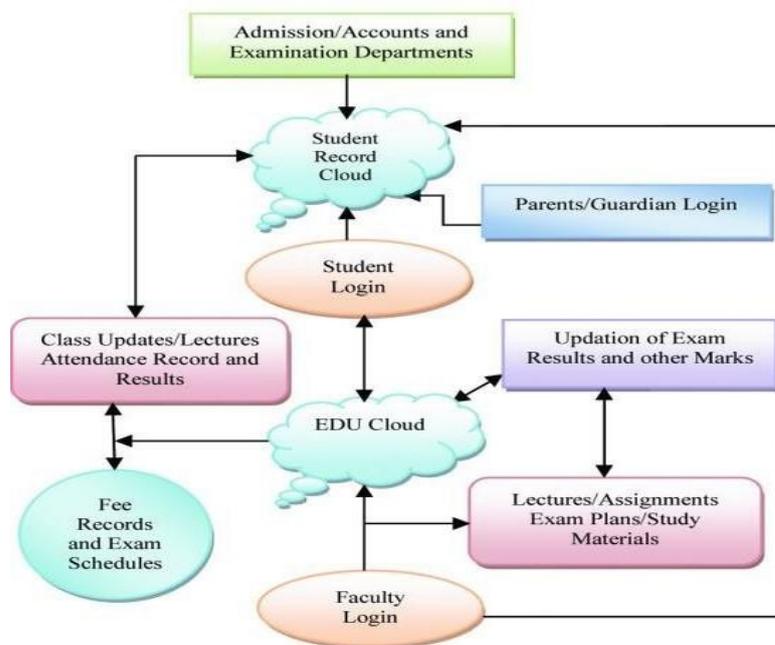

Figure 2. Education System Model Using Cloud Computing

The evaluation of each cloud solution provider in the education sector can be based on the following criteria:

- Features and functionalities: This involves assessing the specific capabilities and offerings of each provider, such as storage, collaboration tools, learning management systems, and other relevant features for educational institutions.

- User-friendliness: This criterion focuses on the ease of use and accessibility of the cloud solutions for students, educators, and administrative personnel within educational institutions.

- Integration capabilities with existing educational systems: It is important to evaluate how well each provider's solutions can integrate with the current IT infrastructure and systems in place at educational institutions.

- Security measures: This involves assessing the robustness of the security measures implemented by each provider to safeguard the data and privacy of educational institutions and their users.

- Customization options for educational institutions: This criterion involves evaluating the extent to which cloud solutions can be tailored to meet the specific needs and requirements of educational institutions.
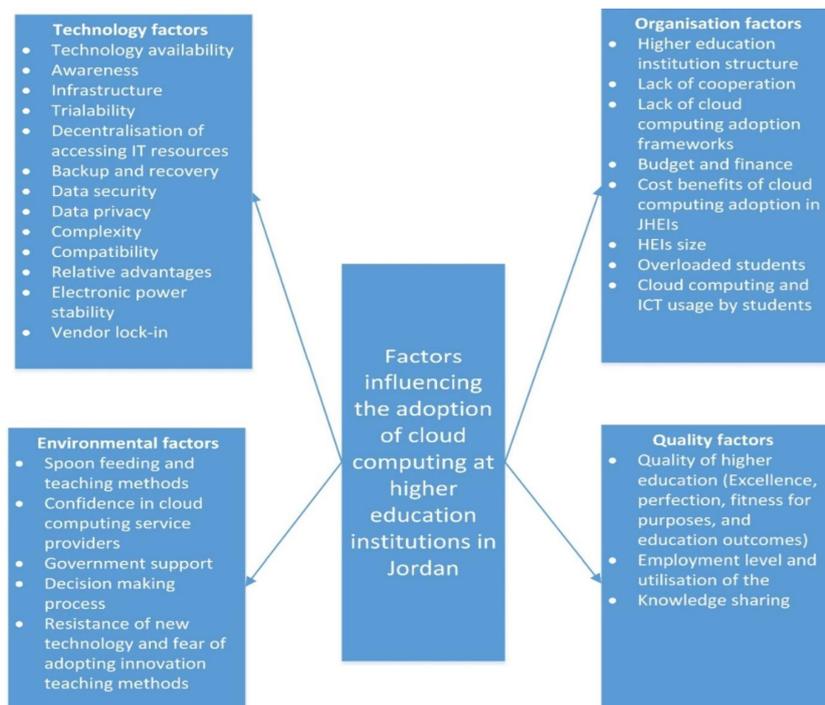

Figure 3. TOEQ classification criteria. modified using the TOE frameworks

The provided search results offer valuable insights into the benefits and impact of cloud computing in educational institutions, as well as the effective use of cloud computing in the education sector. These sources can be used to inform the evaluation of prominent cloud solution providers in the education sector based on the specified criteria.

Benefits, Challenges and Considerations. Cloud solutions have become increasingly popular in educational institutions, offering numerous benefits and innovative approaches to teaching and learning. This section provides real-world examples of educational institutions successfully implementing cloud solutions, discusses the challenges faced, and highlights the benefits realized (figure 4 [19]).

Figure 4. Features of a learning management system

One notable example is the University of California, Berkeley, which has implemented a cloud-based learning management system (LMS) called Canvas. This LMS allows students and faculty to access course materials, submit assignments, and participate in discussions from anywhere with an internet connection. The university has reported significant improvements in student engagement and faculty satisfaction since implementing the cloud-based LMS (figure 5 [20]).
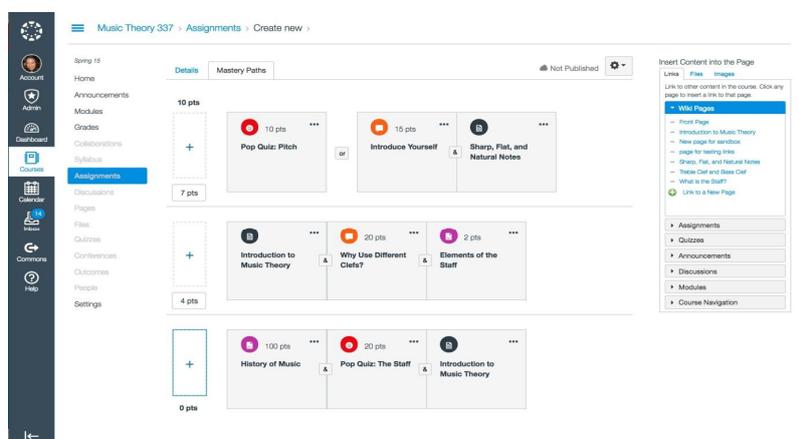

Figure 5. Opigno LMS

Another example is the University of Central Florida, which has adopted a cloud-based platform called Blackboard. This platform provides a range of tools and resources for students and faculty, including online courses, discussion boards, and multimedia content. The university has reported increased student success and retention rates since implementing the cloud-based platform.

Implementing cloud solutions in educational institutions can present several challenges, such as ensuring data security, addressing network connectivity issues, and managing the transition from traditional on-premises systems. However, the benefits of cloud solutions in education are numerous. These benefits include:

- Cloud solutions can reduce the costs associated with maintaining on-premises IT infrastructure, such as hardware, software, and maintenance.

- Cloud solutions can easily scale to accommodate the needs of a growing student population or expanding course offerings.

- Cloud solutions allow students and faculty to access course materials and resources from anywhere with an internet connection, promoting flexibility and convenience.

- Cloud solutions facilitate collaboration among students and faculty, enabling real-time communication and collaboration on projects and assignments.

Cloud solutions have also led to innovative uses and unique approaches in education. For example, the University of California, San Diego has implemented a cloud-based platform called Coursera, which offers massive open online courses (MOOCs) (figure 6 [21]) to students worldwide. This platform allows students to access high-quality educational content from top universities and institutions, regardless of their location or financial resources.

Figure 6. Massive Open Online Courses

Another innovative use of cloud solutions in education is the implementation of gamification in online courses. Gamification involves incorporating game-like

elements, such as points, badges, and leaderboards, into educational content to increase student engagement and motivation. This approach has been shown to be effective in improving student learning outcomes and retention rates.

Cloud solutions have become an integral part of modern education, offering numerous benefits and innovative approaches to teaching and learning. Realworld examples of successful implementation, such as the University of California, Berkeley, and the University of Central Florida, demonstrate the potential of cloud solutions in enhancing student engagement, faculty satisfaction, and overall educational outcomes. Despite the challenges faced, the benefits of cloud solutions in education far outweigh the costs, making them a valuable investment for educational institutions.

Cloud technology has become an essential tool for educators, allowing them to access and store data more effectively. As an emerging trend in education technology, cloud computing offers strong authentication facilities to ensure data security and facilitates easy collaborations among students and teachers [8, 22]. This section discusses emerging trends in cloud technology for education and explores potential future developments and innovations. Some of the emerging trends in cloud technology for education include [23, 24]:

- Cloud-based platforms enable students to access course materials and resources from anywhere with an internet connection, promoting flexibility and convenience.

- Artificial intelligence (AI) can be used to personalize learning experiences, provide real-time feedback, and identify areas where students may need additional support.

- Cloud-based AR and VR technologies can be used to create immersive learning experiences, allowing students to explore virtual environments and interact with digital content in new ways.

- Incorporating game-like elements, such as points, badges, and leaderboards, into educational content can increase student engagement and motivation.

- Wearable devices, such as smartwatches and fitness trackers, can be integrated with cloud-based platforms to monitor student progress and provide personalized feedback.

- Cloud-based platforms can automate the assessment process, providing realtime feedback and allowing educators to track student progress more effectively.

- Cloud-based platforms can use data analytics to adapt to individual student needs, providing personalized learning experiences and improving learning outcomes.

As cloud technology continues to evolve, we can expect to see several future developments and innovations in education. These include: Advanced Analytics: Cloud-based platforms can integrate with data analytics tools to gain insights into student preferences and learning patterns, allowing for the deployment of customized eLearning solutions.

Internet of Things (IoT) (figure 7 [9]): Cloud-based platforms can be integrated with IoT devices to create smart classrooms and learning environments, enhancing the overall educational experience.

Automated Scaling of Applications: Cloud-based platforms can automatically scale to accommodate the needs of a growing student population or expanding course offerings, ensuring seamless learning experiences.

Cross-Cultural Cooperation: Cloud-based platforms can facilitate cross-cultural cooperation and collaboration among students and educators from different parts of the world.

Cloud technology is transforming the education sector by offering numerous benefits and innovative approaches to teaching and learning. Emerging trends, such as mobile learning, AI-powered learning environments, and gamification, are already being adopted by educational institutions worldwide. As cloud technology continues to evolve, we can expect to see even more advanced developments and innovations in the future, further enhancing the educational experience for students and educators alike.

Figure 7. IoT In The Education Industry: Embracing The New Way Of Learning

Conclusions. This review has explored the transformative impact of cloud solutions on education, highlighting their benefits, challenges, and emerging trends. Key findings from the review include:

- Benefits of cloud solutions: Cloud solutions offer numerous benefits in education, such as cost savings, increased accessibility, and improved collaboration among students and teachers.

- Challenges: Implementing cloud solutions in education can present challenges, such as ensuring data security, addressing network connectivity issues, and managing the transition from traditional on-premises systems.

- Emerging trends: Cloud technology is transforming education through mobile learning, AI-powered learning environments, gamification, and other innovative approaches.

- Future developments: As cloud technology continues to evolve, we can expect to see advanced analytics, IoT integration, automated scaling of applications, and cross-cultural cooperation in education.

- Based on these findings, we recommend the following for educational institutions considering the adoption of cloud solutions:

- Assess your needs: Determine your institution's specific needs and goals before selecting a cloud solution. Consider factors such as data security, accessibility, and collaboration requirements.

- Choose a reliable provider: Select a cloud solution provider with a proven track record in the education sector. Ensure they offer the necessary features and support to meet your institution's needs.

- Plan for transition: Develop a comprehensive plan for transitioning from traditional on-premises systems to cloud solutions. This should include training for staff and students, as well as strategies for addressing potential challenges.

- Monitor and adapt: Regularly monitor the effectiveness of your cloud solution and be prepared to adapt as new trends and innovations emerge in the field.

Collaborate with peers: Engage with other educational institutions that have successfully implemented cloud solutions to learn from their experiences and best practices.

Cloud solutions have the potential to revolutionize education by offering numerous benefits and innovative approaches to teaching and learning. By carefully considering your institution's needs and goals, selecting a reliable provider, and planning for a smooth transition, you can harness the transformative power of cloud technology to enhance the educational experience for students and teachers alike.

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