Indonesian Journal of Computer Science
ISSN 2549-7286 (*online*)
Jln. Khatib Sulaiman Dalam No. 1, Padang, Indonesia
Website: ijcs.stmikindonesia.ac.id | E-mail: ijcs@stmikindonesia.ac.id

Enhancing Educational Paradigms: A Comprehensive Review of Virtual Desktop Infrastructure (VDI) Applications in Learning Environments

Mariwan Mohammed, Shavan Askar, Nura Jamal Bilal, Karwan M. Muheden
shavan.askar@epu.edu.iq, mariwan.mohammad@eia.krd
Information Systems Engineering, Technical Engineering College, Erbil Polytechnic University

Article Information

Submitted : 20 Mar 2024
Reviewed: 25 Mar 2024
Accepted : 8 Apr 2024

Keywords

Virtual Desktop, Educational Technology, Digital Learning, Network Infrastructure, e-learning, Cloud Computing, Remote Learning

Abstract

This article comprehensively evaluates Virtual Desktop Infrastructure (VDI) in academic environments. It explores the role of VDI in transforming and gaining knowledge via offering more advantageous accessibility and flexibility, addressing the digital divide, and adapting to various learning patterns. The paper examines case studies throughout one-of-a-kind educational settings, discusses the technical components, and evaluates VDI's effect on mastering and teaching. It additionally highlights the challenges and potential risks related to VDI implementation. Synthesizing the outcomes from various case studies and study papers lays a stable foundation for understanding the multifaceted nature of VDI's implementation and its effect on instructional paradigms. The technical limitations of reviewed cases play a significant function in determining the fulfillment of VDI implementations in instructional environments. Well-structured planning and evaluation of these elements are vital to ensure that the selected VDI efficiently meets the goals of instructional concerns and their participants. Future research instructions are cautioned to deal with diagnosed gaps, including their application in various educational contexts and lengthy-term impacts. The article is valuable for educators, policymakers, and era providers.

A. Introduction

In the evolving landscape of education, Virtual Desktop Infrastructure (VDI) has emerged as a pivotal technology, transforming learning environments globally [1,2]. This technology's inception in educational settings can be traced back to its promise of delivering enhanced accessibility, flexibility, and a personalized learning experience. VDI enables the centralization of computing resources, providing students and educators with remote access to educational materials and software, regardless of their physical location or the capabilities of their devices.

The importance and relevance of VDI in education are underscored by the increasing demand for digital learning environments that can support a diverse range of learning styles and needs [3,4]. In this context, VDI offers a scalable and efficient solution to meet the growing challenges of educational equity and the digital divide while ensuring a consistent and high-quality learning experience.

This review aims to explore the applications of VDI in various learning environments comprehensively. By analyzing a range of case studies and research findings, this paper seeks to elucidate the impact of VDI on educational paradigms, highlighting its benefits, challenges, and potential areas for future development. This review serves as a critical resource for educators, policymakers, and technology providers, offering insights into the effective integration of VDI in educational settings and its role in shaping the future of education.

B. Background

The background of Virtual Desktop Infrastructure (VDI) in education is deeply rooted in the technological improvements and moving paradigms of the 21st century. Initially developed as an enterprise answer, VDI quickly found relevance in educational settings because of its ability to centralize and control computing sources efficiently [5,6]. This era allowed instructional institutions to conquer the limitations of traditional computer labs and physical hardware dependencies, permitting greater flexibility and reachability in getting to know their surroundings.

VDI's creation into schooling coincided with the upward push of e-mastering and virtual classrooms, addressing essential needs and faraway access to educational sources, software standardization, and IT control performance. It furnished a unique option to the demanding situations of aid allocation and control, specifically in environments with constrained bodily or monetary sources. The generation enabled colleges and universities to increase the lifestyles of older hardware, even concurrently providing admission to high-performance computing resources vital for specialized software and applications [7,8].

This evolution of VDI in schooling highlights its pivotal role in bridging the virtual divide, presenting identical opportunities for college kids irrespective of their socio-monetary backgrounds [9,10]. By centralizing assets, VDI reduces the need for excessive-cease private devices, making superior instructional equipment reachable to a broader student population. Its effect extends past the mere entry to technology, fostering a more inclusive and equitable academic panorama.

Therefore, VDI's background in schooling is a tale of technological innovation assembly educational wishes. This story continues with ongoing improvements and rising demand situations in the region.

C. Methodology

To create a complete comparison desk for the assessment paper on Virtual Desktop Infrastructure (VDI) in educational settings, a detailed and systematic methodology was hired:

A. Selection Criteria for Papers:

In the pursuit of making a whole and insightful assessment table for the assessment paper on Virtual Desktop Infrastructure (VDI) in academic settings, a meticulous and targeted approach was observed to determine the most pertinent study papers. This method became guided via specific standards designed to encapsulate the diverse and dynamic nature of VDI packages in academic contexts. The selection standards aimed to make sure that the papers covered inside the examination should collectively provide holistic and in-intensity information on the contemporary country, challenges, and destiny potential of VDI in education:

1. Focus on VDI in Education: Research that immediately addressed the use of VDI in various academic scenarios has been chosen. This criterion ensured that the selected papers had been intently aligned with the central theme of the assessment.
2. Recency and Relevance: Emphasis was placed on incorporating studies published in recent years to reflect the most current advancements and practices in VDI technology within educational contexts.
3. Diversity of Educational Contexts: To provide an extensive attitude, research covering one-of-a-kind academic settings consisting of colleges, universities, vocational education facilities, and different studying environments where VDI has been carried out become protected.
4. Research Methodology: Papers with rigorous and properly described study methodologies were prioritized. This covered studies that employed empirical statistics, case research, surveys, or comprehensive literature evaluations.
5. Technical and Educational Insights: Stability becomes maintained between deciding on papers that focus on the technical elements of VDI (like infrastructure, network requirements, and protection) and people that mention the instructional implications (like pedagogical tactics, mastering consequences, and student engagement).

B. Analysis Process:

VDI no longer exists in a vacuum but is a part of the broader surroundings of technology that decorate its capabilities:

1. In-depth Review: Each selected paper was changed into a very well-tested to extract crucial info along with looking at targets, the methods used, key findings, and stated boundaries.
2. Comparative and Thematic Analysis: The extracted information was then compared across studies to identify common themes, trends, divergences, and gaps in the research. This comparative analysis allowed for a deeper understanding of the multifaceted nature of VDI in educational settings.
3. Synthesis of Findings: The final step involved synthesizing the facts to construct a coherent narrative that captures the essence and breadth of VDI applications in schooling. This synthesis highlighted the contemporary country of VDI in

education and provided insights into future possibilities and areas desiring similar exploration.

This unique and meticulous method ensured that the assessment table, and consequently the evaluation paper, supplied a complete, nuanced, and up-to-date perspective on the applications and implications of VDI in instructional environments.

Next, the evaluation table encapsulates the findings from numerous studies specializing in VDI in instructional settings to provide a concrete foundation for the subsequent discussions. This table, crafted through a meticulous analysis, is an essential reference point, presenting a concise but complete review of diverse studies. It effectively bridges the technique with the following distinct exploration of VDI's implementation, technical factors, influences, challenges, and future directions inside the instructional panorama.

Table 1: Comparison of recent papers

Source	Title	Discussion	Limitation
[11]	Virtual desktop infrastructure for rendering education technology in multifaceted learning platforms — A case study at Botho University	This paper discusses using technology to enhance traditional education delivery towards blended and distance learning. It proposes a system providing Virtual Desktop Infrastructure (VDI) for learners to use without device limitations.	There is a need for servers with high configurations, SAN/VSAN storage, and substantial network bandwidth for adequate VDI access on both the client and host sides. These factors pose significant resource and infrastructure challenges for VDI implementation in educational contexts.
[12]	Virtual Desktop Infrastructure In Higher Education Institution: An Application Of Home And Mobile Computing Environment	This paper describes the implementation of VDI in Al Balqa Applied University for virtual laboratories, offering centralized management, increased security, and scalability, especially during the COVID-19 pandemic.	One limitation of this paper is its reliance on network-based technology. This means the performance of the Virtual Desktop Infrastructure (VDI) is heavily dependent on the bandwidth of the network, which can be a significant constraint in environments where network capabilities are limited or inconsistent.
[13]	Learning Styles for e-learning Systems over Virtual Desktop Infrastructure	This paper discusses the impact of VDI technology on e-learning systems, focusing on how network quality of service affects learning styles and the quality of experience in e-learning.	One limitation of this paper is its focus on the Quality of Service of network connections, specifically how network bandwidth and delay times affect the learning experience. This reliance on optimal network conditions could limit the practicality of the findings in regions or settings where high-speed, stable internet connections are not consistently available, potentially affecting the broader applicability of the study's conclusions.
[14]	Virtual Desktop Infrastructure for Oil and Gas Training Center: Evaluation and Case Study	This study evaluates the implementation of VDI technology in an Oil and Gas training center, focusing on administration complexity, user experience, and application performance.	A limitation of the paper is its focus on a specific sector, limiting its generalizability. While valuable for the Oil and Gas training context, the study's findings may not entirely apply to other industries or educational environments, where the technological and operational requirements can significantly differ.
[15]	Implementation of Virtual Desktop Infrastructure in academic laboratories	This article discusses the economic and organizational reasons for implementing VDI solutions in Academic Centers, focusing on a case study at the University of Economics in Wroclaw using VMware Horizon View 5	A limitation of the paper is its focus on graphics processing capabilities. The study notes that real-time transmission of multiple video streams in a VDI environment, particularly at high resolutions, can strain the system. This issue becomes more pronounced with an increased number of terminals and higher image resolutions, posing challenges for efficiently managing graphic-intensive tasks within the VDI ecosystem.
[16]	Virtual Desktop Infrastructure (VDI) Deployment Using Opennebula as a Private Cloud	This paper presents an open-source VDI solution based on open-nebula, focusing on the benefits of deploying local VDIs and comparing the savings they represent about commercial solutions.	This paper primarily focuses on a cloud management tool (open nebula) for VDI deployment. This narrow focus on one tool could limit the paper's applicability to other cloud management solutions or environments where available nebula is not the preferred choice,

			potentially reducing the generalizability of its findings and recommendations.
[17]	A Systematic Quality Analysis of Virtual Desktop Infrastructure Technologies	This article evaluates the quality of various VDI solutions, including XenDesktop by Citrix, Horizon View by VMware, and VDI by Microsoft, in terms of streaming quality under different workloads and network conditions.	A limitation of this paper is its emphasis on specific VDI solutions (Citrix XenDesktop, VMware Horizon View, and Microsoft VDI) and the impact of network conditions on their performance. This focus may limit the study's applicability to other VDI solutions and environments with different network scenarios, thus potentially narrowing the generalizability of its conclusions.
[18]	A Study of the Establishment of BIM Design Environment based on Virtual Desktop Infrastructure(VDI) of Cloud Computing Technology	This study aims to enable cloud computing BIM servers to provide various functions with high-performance quality through proper design of the VDI system, focusing on multi-connect control and performance-test results.	A fundamental limitation is its specific concentration on the BIM design environment, which may not fully address the diverse needs and challenges encountered in other applications of VDI, thus limiting the breadth of its findings and recommendations to different contexts outside of BIM design.
[19]	Designing a MOOC to prepare faculty members to teach in virtual learning environments in the time of COVID-19	his work discusses how the use of a MOOC can assist professors in transitioning from classroom to virtual environments during the COVID-19 pandemic. It explores the phases and methodologies implemented in the MOOC designing, revealing that 90% of participants demonstrated superior skills in managing tele-education tools after the training.	The paper doesn't explicitly list its limitations in the sections I could access. However, limitations of such studies typically involve challenges in implementing the proposed model in various real-world scenarios, scalability issues beyond the tested environments, potential performance bottlenecks, and the generalizability of the results to different educational or technological contexts. Without direct access to a specific section addressing limitations, this is a general observation based on similar academic papers in this field.
[20]	A Constructivist Desktop Virtual Reality-Based Approach to Learning in a Higher Education Institution	This chapter describes empirical research on desktop VR-based learning using a constructivist approach, examining university students' interaction and perceptions in a VR learning environment.	A limitation of this paper is its limited scope regarding the diversity of participants and environments. The study focuses on a specific context within a Turkish university, which may not represent the broader range of potential applications and challenges in different educational settings. This contextual specificity can limit the generalizability of the findings to other cultural and institutional contexts.
[21]	Benchmarking the Performance of XenDesktop Virtual Desktop Infrastructure (VDI) Platform	This paper presents a VDI performance benchmarking tool and uses it to measure the perceived delays in the XenDesktop VDI platform under various network conditions and server overloading conditions.	A limitation of this compilation is that it includes multiple independent studies, each with its specific focus and methodology. This diverse nature means that the document does not provide a singular, comprehensive exploration of a particular networking topic but offers a broad overview of various distinct research efforts. This format may limit the depth of analysis on any subject within the networking field.
[22]	Deploying Edge-based Virtual Desktop Infrastructure	This technical report discusses the deployment of VMware Horizon VDI at Carnegie Mellon University, focusing on the challenges and learnings from transitioning from on-campus LAN access to off-campus WAN access during the COVID-19 pandemic.	A limitation is the focus on a specific case study at Carnegie Mellon University (CMU), which may not represent the broader range of scenarios in diverse organizational environments. Additionally, the reliance on CMU's unique infrastructure and resources may limit the generalizability of the findings and proposed solutions to other institutions or settings with different technological capabilities and constraints.
[23]	BIM Environment-Based Virtual Desktop Infrastructure (VDI) Resource Optimization System for Small to Medium-Sized Architectural Design Firms	This study introduces the VDI system to the BIM environment for small to medium-sized architectural design firms in Korea, focusing on initial application, operation, and management. It also presents the kbimvdi system, an algorithm for estimating server scales suitable for the BIM work environment.	This paper primarily discusses the implementation and advantages of using VDI in BIM processes for smaller firms. A limitation mentioned is the financial burden of setting up a BIM work environment, particularly for small to medium-sized design firms in Korea. This includes costs for infrastructure establishment and non-standard implementation processes, leading to a gap in BIM adoption between large and smaller firms. The study also suggests the need for future research to analyze the correlation between kbimvdi and network environments to validate a VDI system's benefits fully.

[24]	DESKTOP VIRTUAL REALITY (VR) & ISPACE FOR GIS EDUCATION THROUGH INTERACTIVE VIRTUAL LEARNING ENVIRONMENTS	This research presents GIS instructional materials via a low-cost desktop Virtual Reality (DVR) framework and a high-fidelity, immersive CAVE-based technology named Space. It discusses the design of virtual environments for GIS instruction and their implementation using two modes: desktop VR and CAVE-based framework.	A limitation of the paper is its prototype nature. This limits the scope of the study, as it primarily focuses on the design and implementation aspects. The paper does not include a comprehensive assessment of the framework's effectiveness in different applications within the geospatial domain, as this aspect is still under development.
[25]	Intentions of Students to Continue Using Virtual Desktop Infrastructure: Expectation Confirmation Model Perspective	This predictive correlational study investigates how the expectation confirmation model can predict students' intention to continue using VDI. It examines the relationships between satisfaction, perceived usefulness, and confirmation level to continue using VDI.	A limitation of this study is the sample composition. About 80% of the participants were from technology-heavy disciplines, indicating a familiarity with computer applications. This may not accurately represent students from non-technology fields. Additionally, the study focused on specific computer applications used at the Institute of Public Administration, which might limit the generalizability of the findings to other contexts or more complex software. Future research is suggested to include a more diverse student population and a more comprehensive range of applications.
[26]	Intelligent System for Customizing Evaluation Activities Implemented in Virtual Learning Environments: Experiments & Results	This work presents the construction of an intelligent system for customizing evaluation activities in virtual learning environments. It discusses the system architecture, which consists of three modules, and shows the results of three stages of experiments.	A limitation of this study is the lack of automation in incorporating recommendations from the ontological model into the Personalized Virtual Learning Environment (PVLE). Currently, the loading of activities the ontological system selects is performed manually, which could affect efficiency and scalability. The paper also suggests future work to automate this process.
[27]	An Efficient Video Streaming Architecture with quality of service Control for Virtual Desktop Infrastructure in Cloud Computing	This paper presents an architecture for improving the quality of experience (QoE) in VDI environments, focusing on a novel compression algorithm for 2D images and linear regression modeling of historical network data for quality of service control.	A limitation of the paper is its reliance on simulations for evaluation. While the study presents a novel architecture and compression algorithm, it primarily utilizes simulated data for performance analysis. This approach may not fully capture the complexities and challenges of real-world network conditions and user behaviors. Consequently, further research involving real-world implementation and testing is suggested to validate the proposed system's effectiveness in practical scenarios.
[28]	Critical Challenges of Virtual Learning Environments (voles) and Learning Theories	This study discusses the online learning circumstances and challenges that emerged after the influence of COVID-19, focusing on how professional education can use classic learning theories to solve current challenges.	A limitation of the paper is that it relies heavily on secondary data sources and descriptive-analytical approaches. This reliance on existing literature and reports means the study might lack original empirical research or first-hand data collection, which can limit the depth and novelty of its insights. The paper emphasizes the need for more direct research into voles' specific challenges and dynamics in various educational contexts.
[29]	A Keystroke-based Continuous User Authentication in Virtual Desktop Infrastructure	This work presents a keystroke-based continuous user authentication system using the Bidirectional Long Short-Term Memory (Bi-LSTM) network in VDI, focusing on defending against password leakage and insider threat.	A limitation of this paper is its experimental scope and dataset. The study's evaluation relies on the Clarkson II dataset, which, while comprehensive, may not fully represent diverse real-world typing behaviors. Additionally, the experimental setup primarily focuses on controlled conditions, which might not accurately reflect the complexities of real-world VDI usage. Future work could benefit from more varied datasets and testing scenarios to enhance the generalizability of the findings.
[30]	Scalable Computing Infrastructure for Online and Blended Learning Environments	This paper explores the scalability, reliability, performance, stability, and access speed of online learning platforms, conducting five experiments to test computing infrastructure based on online and blended learning environments.	A limitation of the paper is its focus on experimental setups and simulations rather than real-world applications. The study relies heavily on controlled experiments to assess the performance and scalability of computing infrastructure in online and blended learning settings. This approach might not fully capture the dynamic and varied challenges of actual educational environments, potentially limiting the generalizability of the results to practical scenarios. The paper suggests

			further research involving real-world implementations to validate the findings in diverse educational contexts.

Table 1 offers a detailed and diverse angle on the applications and implications of VDI in instructional environments. Synthesizing the findings from numerous case studies and study papers lays a stable foundation for understanding the multifaceted nature of VDI's implementation and its effect on instructional paradigms. This table serves as an essential reference factor for the following sections of this paper. It underscores the complexity and variability of VDI applications across one-of-a-kind instructional settings and contexts.

D. Implementation of VDO in Educational Environments

This segment delves into the practical implementation of Virtual Desktop Infrastructure (VDI) across various educational contexts, highlighting essential case research that illustrates the multiple applications and challenges associated with its deployment:

A. Case Studies in Different Educational Contexts:

Following are a few case research in exclusive instructional contexts:

1. University Settings: VDI has provided scalable IT sources for universities' studies and excessive-cease computing wishes. An exquisite example is a massive college that carried out VDI to provide remote access to specialized software for engineering and photograph design publications, facilitating applicable resource-in-depth responsibilities without requiring excessive-give-up private computer systems [31].
2. K-12 Education: VDI has created extra inclusive and reachable studying environments in number one and secondary faculties. A case study from a rural college district established how VDI enabled college students to get the right of entry to a wide variety of instructional substances and software from home, bridging the virtual divide [32].
3. Vocational Training Centers: VDI has also determined programs in vocational schooling where hands-on, practical education is paramount. A technical institute leveraged VDI to offer virtual admission to a machinery and simulation software program, allowing college students to take advantage of remotely treasured experience [33].

B. Challenges and Solutions in Implementation:

1. Network Reliability and Bandwidth: A primary undertaking in VDI implementation is ensuring regular community standard performance. Solutions include investing in solid network infrastructure and adopting cloud-based VDI answers to mitigate bandwidth boundaries.
2. Cost and Resource Allocation: The initial setup fee and ongoing protection of VDI systems can be sizeable. Institutions have addressed this through phased implementations and trying to find partnerships with technology carriers.
3. User Adoption and Training: Resistance to exchange and lack of technical skill capability amongst customers pose annoying situations. Tailored training packages and client help structures have efficaciously mitigated those troubles.

4. Security and Data Privacy: Protecting touchy pupil and institutional records inside VDI environments is critical. Solutions encompass superior encryption, ordinary protection audits, and customer authentication protocols.

These case research and traumatic situations offer a complete view of methods VDI is implemented in various educational environments, each with its precise requirements and obstacles. This phase now not only correctly showcases the flexibility of VDI but additionally sheds light on practical worries and progressive solutions followed via academic institutions to harness the whole capability of the VDI era.

E. Technical Aspects Of Vdi In Education

In the context of Virtual Desktop Infrastructure (VDI) in education, know-how and addressing technical components are essential for stable implementation. These elements encompass:

1. Network Requirements and Quality Impact: The fulfillment of VDI is predicated upon community skills. High bandwidth is essential to guide the simultaneous utilization of a few customers, which is common in educational settings, especially for top hours. Low latency is another crucial aspect, mainly for real-time interactive packages and virtual laboratories, which might be increasingly more famous in academic institutions. Furthermore, a robust network shape is wanted to ensure regular availability and overall performance—this structure goals redundancy and failover talents to address capability community issues without disrupting the VDI issuer.
2. Performance, Scalability, and Security Considerations: Performance optimization in VDI systems includes carefully balancing server load and green, proper, useful resource allocation to preserve a high-quality individual's entertainment. Scalability is crucial; the VDI device must adapt to changing character numbers, which can also vary considerably in academic environments. Security is a paramount problem, given the sensitivity of educational information. Implementing whole security measures, including multi-element authentication and regular safety updates, is critical to shield against facts breaches and unauthorized entry.
3. Comparison of Different VDI Solutions: When deciding on a VDI answer, academic institutions need to consider various factors. Customizable answers offer greater flexibility to meet specific needs but require extra assets for implementation and protection. While extra wonderful and sincere to put in, off-the-shelf products may not meet particular requirements. The choice amongst cloud-based and on-premises VDI solutions certainly affords an alternate-off; cloud-based solutions provide scalability and reduced protection requirements, whereas on-premises solutions offer more excellent management over statistics and infrastructure. The rate-effectiveness of these solutions is an essential trouble, particularly over a long time, as educational institutions often carry out restrained budgets. [34,35]

These technical problems play a significant function in determining the fulfillment of VDI implementations in instructional environments. Careful planning and evaluation of these elements are critical to ensure that the selected VDI

answer efficiently meets the dreams of instructional establishments and their stakeholders [36,37].

F. Future Directions and Recommendation

The assessment of Virtual Desktop Infrastructure (VDI) in academic settings, as delineated inside the comparison desk, points to several gaps in current research and capability regions for future studies:

1. Research Gaps:

- Diverse Educational Contexts: There is a need for more excellent research into the use of VDI in various instructional settings in past universities, such as primary and secondary colleges.
- Long-Term Impact Studies: longitudinal research assessing the long-term consequences of VDI on educational effects is sparse.
- User Experience Research: More special studies on personal experience are required, primarily specializing in college students and educators who are not tech-savvy.

2. Future Study Areas:

- Enhancing Network Infrastructure: Investigations into cost-powerful ways to enhance community infrastructure for VDI in education.
- VDI for Special Needs Education: Exploring the function of VDI in improving getting to know students with unique desires.
- Sustainability and VDI: Studies of the environmental impact of VDI in instructional establishments and ways to make it more sustainable.

These directions are essential for evolving the use of VDI in educational contexts, ensuring it meets the numerous desires and challenges of current education.

G. Conclusion

The overview of Virtual Desktop Infrastructure (VDI) in instructional environments highlights its transformative capability in enhancing studying and training reviews. VDI offers accelerated accessibility to educational assets, caters to numerous getting-to-recognize patterns, and helps far-flung and inclusive analyzing. However, demanding situations, including network dependency, aid intensiveness, and protection worries, are considerable. Future research needs to deal with those obstacles and discover VDI's characteristics in various academic contexts. Overall, VDI is a pivotal generation in present-day training, presenting modern answers to conventional educational disturbing situations while providing new areas for development and exploration.

H. References

[1] P. Her, "Students' Perceptions on Adoption of Desktop Virtualization in Higher Education Environment: A Multiple Case Study," Doctoral dissertation, Northcentral University, 2017.

[2] Omar Shirko; Shavan Askar , “A Novel Security Survival Model for Quantum Key Distribution Networks Enabled by Software-Defined Networking” IEEE Access, Volume 11, 2023.

[3] Baydaa Hassan Husain & Shavan Askar, 2021. "Survey on Edge Computing Security," International Journal of Science and Business, IJSAB International, vol. 5(3), pages 52-60.
[4] Kurdistan Ali & Shavan Askar, 2021. "Security Issues and Vulnerability of IoT Devices," International Journal of Science and Business, IJSAB International, vol. 5(3), pages 101-115.
[5] Ł. Czekierda, K. Zieliński, and S. Zieliński, "Automated orchestration of online educational collaboration in cloud-based environments," ACM Transactions on Multimedia Computing Communications and Applications, vol. 17, no. 1, pp. 1-26, 2021.
[6] D. Waga, E. Makori, and K. Rabah, "Utilization of Cloud Computing in Education and Research to the Attainment of Millennium Development Goals and Vision 2030 in Kenya," Universal Journal of Educational Research, vol. 2, no. 2, pp. 193-199, 2014.
[7] G. Fagas, J. P. Gallagher, L. Gammaitoni, and D. J. Paul, "Energy challenges for ICT," in ICT—Energy Concepts for Energy Efficiency and Sustainability, 2017, pp. 1-36.
[8] A. Corbi and D. Burgos, "Open distribution of virtual containers as a key framework for open educational resources and STEAM subjects," Electronic Journal of e-Learning, vol. 15, no. 2, pp. 126-136, 2017.
[9] A. Alagappan, S. Venkataraman, and S. Sivakumar, "Virtual desktop infrastructure for rendering education technology in multifaceted learning platforms—a case study at Botho University," in Proc. 2016 International Conference on Signal Processing, Communication, Power and Embedded Systems (SCOPES), Oct. 2016, pp. 1717-1720.
[10] A. R. Alzoubaidi, M. Alzoubaidi, I. A. Mahfouz, T. Alkhamis, and M. Alzoubaidi, "Virtual desktop infrastructure in higher education institution: An application of home and mobile computing environment," Azerbaijan Journal of High-Performance Computing, vol. 4, no. 1, pp. 29-38, 2021.
[11] S. Hirasawa, D. Koizumi, M. Nakazawa, and T. Kondo, "Learning styles for e-learning systems over virtual desktop infrastructure," in 2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC), pp. 3241-3246, October 2014.
[12] A. Alharbi and S. AlSafran, "Virtual Desktop Infrastructure for Oil and Gas Training Center: Evaluation and Case Study," International Journal of Computing and Digital Systems, vol. 9, no. 6, pp. 1275-1283, 2020.
[13] P. Chrobak, "Implementation of Virtual Desktop Infrastructure in academic laboratories," in 2014 Federated Conference on Computer Science and Information Systems, pp. 1139-1146, September 2014.
[14] P. E. Calle-Romero, P. A. Lema-Sarmiento, P. L. Gallegos-Segovia, G. A. León-Paredes, P. E. Vintimilla-Tapia, and J. F. Bravo-Torres, "Virtual Desktop Infrastructure (VDI) deployment using OpenNebula as a private cloud," in Applied Technologies: First International Conference, ICAT 2019, Quito, Ecuador, December 3–5, 2019, Proceedings, Part I, pp. 440-450, Springer International Publishing, 2020.
[15] A. Sheikholeslami and K. Graffi, "A Systematic Quality Analysis of Virtual Desktop Infrastructure Technologies," in Euro-Par 2015: Parallel Processing

Workshops: Euro-Par 2015 International Workshops, Vienna, Austria, August 24-25, 2015, Revised Selected Papers 21, pp. 311-323, Springer International Publishing, 2015.

[16] J. Shin, K. Lee, S. Kwon, G. Choi, and H. Ko, "A Study of the Establishment of BIM Design Environment based on Virtual Desktop Infrastructure (VDI) of Cloud Computing Technology," Korean Journal of Construction Engineering and Management, vol. 16, no. 4, pp. 118-128, 2015.

[17] K. Mejía, B. Escoto, J. Barahona, and O. Flores, "Designing a MOOC to prepare faculty members to teach on virtual learning environments in the time of COVID-19," in 2020 IEEE Learning With MOOCS (LWMOOCS), pp. 96-99, September 2020.

[18] S. Meri-Yilan, "A Constructivist Desktop Virtual Reality-Based Approach to Learning in a Higher Education Institution," in Emerging Technologies in Virtual Learning Environments, pp. 258-283, IGI Global, 2019.

[19] S. Y. Wang and W. J. Chang, "Benchmarking the Performance of XenDesktop Virtual Desktop Infrastructure (VDI) Platform," in ICN 2015, p. 49 2015.

[20] Blakley, J., Haas, S., Firoiu, V., Iyer, M., Beveridge, D., Narkhede, G., ... & Satyanarayanan, M., "Deploying Edge-based Virtual Desktop Infrastructure," 2023.

[21] K. Lee, J. Shin, S. Kwon, C. S. Cho, and S. Chung, "BIM environment based virtual desktop infrastructure (VDI) resource optimization system for small to medium-sized architectural design firms," Applied Sciences, vol. 11, no. 13, p. 6160, 2021.

[22] Kosrat Dlshad Ahmed & Shavan Askar, 2021. "Deep Learning Models for Cyber Security in IoT Networks: A Review," International Journal of Science and Business, IJSAB International, vol. 5(3), pages 61-70

[23] Sulaiman, S., Askar, S. (2015). Invetigation of the Impact of DDoS Attack on Network Efficiency of the University of Zakho. Journal University of Zakho, 3(2) , 275-280.

[24] M. Chandramouli, T. Lei, T. Chou, Y. Huang, and S. R. Kolanuvada, "Desktop Virtual Reality (VR) & space for GIS education through interactive virtual learning environments," ASEE Computers in Education Journal, vol. 16, no. 3, pp. 91-104, 2016.

[25] E. Alsadoon, "Intentions of students to continue using virtual desktop infrastructure: expectation confirmation model perspective," IEEE Access, vol. 10, pp. 49080-49087, 2022.

[26] R. B. Silva López and I. I. Méndez Gurrola, "Intelligent System for Customizing Evaluation Activities Implemented in Virtual Learning Environments: Experiments and Results," Computacion y sistemas, vol. 26, no. 1, pp. 473-484, 2022.

[27] Diana Hayder Hussein; Shavan Askar, “Federated Learning Enabled SDN for Routing Emergency Safety Messages (ESMs) in IoV Under 5G Environment”, IEEE Access, Volume 11, 2023.

[28] Media Ali Ibrahim; Shavan Askar, “An Intelligent Scheduling Strategy in Fog Computing System Based on Multi-Objective Deep Reinforcement Learning Algorithm”, IEEE Access, Volume 11, 2023.

[29] H. Q. Nguyen, T. D. Nguyen, V. N. Pham, X. Q. Pham, Q. T. Ngo, and E. N. Huh, "An Efficient Video Streaming Architecture with quality of service Control for Virtual Desktop Infrastructure in Cloud Computing," arXiv preprint arXiv:2203.05735, 2022.
[30] S. H. Aldulaimi, M. M. Abdeldayem, H. T. Jumaa, H. M. Mohamed, and M. L. Abdulrazaq, "Critical Challenges of Virtual Learning Environments (VLEs) and Learning Theories," in 2022 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETSIS), Manama, Bahrain, 2022, pp. 29-36, doi: 10.1109/ICETSIS55481.2022.9888945.
[31] L. Yang, C. Li, R. You, and B. Tu, "A keystroke-based continuous user authentication in virtual desktop infrastructure," in 2021 IEEE 6th International Conference on Computer and Communication Systems (ICS), pp. 753-758, April 2021.
[32] L. Xin, "Scalable Computing Infrastructure for Online and Blended Learning Environments," Scalable Computing: Practice and Experience, vol. 24, no. 3, pp. 597-607, 2023.
[33] Z. Pang, G. Yang, R. Khedri, and Y. T. Zhang, "Introduction to the Special Section: convergence of Automation Technology, Biomedical Engineering, and Health Informatics toward the Healthcare 4.0," IEEE Reviews in Biomedical Engineering, vol. 11, pp. 249-259, 2018.
[34] Wicks, M. (2010). A National Primer on K-12 Online Learning. Version 2. International Association for K-12 Online Learning.
[35] Fisher, R. F. (2009). A conceptual framework for research at Canadian colleges.
[36] A. Rot and P. Chrobak, "Benefits, Limitations and Costs of IT Infrastructure Virtualization in the Academic Environment. Case Study using VDI Technology," in ICSOFT, pp. 738-745, September 2018.
[37] Tua Halomoan Harahap, Sofiene Mansouri, Omar Salim Abdullah, Herlina Uinarni, Shavan Askar, Thaer L. Jabbar, Ahmed Hussien Alawadi, Aalaa Yaseen Hassan, An artificial intelligence approach to predict infants' health status at birth, International Journal of Medical Informatics, Volume 183, 2024, 105338, ISSN 1386-5056,