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Navigating Technological and Economic Barriers in Virtual Teaching: Perspectives of University Educators

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Abstract

The rapid shift towards virtual teaching in higher education has converted the teaching practices drastically while at the same time there were significant challenges which were faced by educators. The present study investigates the nature and magnitude of these barriers from the viewpoints of university teachers who are involved in Virtual Teaching. The main objective of the present study is to identify key technological constraints like digital tool mastery, rapid tech evolution, technical failure, cyber security and privacy and digital accessibility alongside economic barriers including the Heavy Cost of Devices and Infrastructure, Internet Connectivity Expenses, Institutional Financial Constraint, Training and Skill Development Costs, Maintenance and Technical Support Costs etc.

The researcher in the present study revied the literature pertaining to technological and economic barriers in virtual teaching in Higher Education. Through extensive literature review research has also identified the domains for each of the technological and economic barriers. For each of the domain of both the challenges or barriers the researcher has identified various items which will be helpful to quantify these challenges. The study highlights that these barriers not only affect teaching efficiency but also impact educators' motivation and overall teaching quality. The paper highlights the need for smart institutional investment, strategic policy, capacity building initiatives to support educators in overcoming these challenges. It also emphasizes the importance of inclusive digital policies to bridge the gap between technological advancement and accessibility. The findings contribute to the growing body of literature on virtual learning environments and offer practical implications for enhancing the sustainability and effectiveness of virtual teaching in higher education.

Keywords: Virtual Teaching, Technological Barriers, Economic Barriers, Higher Education, University Educators, Digital Divide

1. Introduction

1.1.Background of Virtual Teaching in Higher Education: The rapid transformation in Higher Education is visible due to integration of virtual teaching methodologies. The landscape shift from traditional method which was around face-to-face instruction, higher educational institutions have significantly adopted digital platforms to enhance teaching and learning processes. This transition was further accelerated by the global disturbances during COVID-19 pandemic. With the advent of virtual

teaching, there was continuity in education though it was flexible, accessible and there were opportunities for innovative pedagogical practices. However, this shift has also exposed underlying challenges that affect both educators and learners, particularly in resource-constrained contexts.

1.2.Emergency of Digital Learning Environments: Virtual Learning Environments (VLE) has evolved as a thorough ecosystem that integrates Learning Management Systems (LMS), interactive applications, digital content repositories, video conferencing tools. Through these applications and tools teaching can be done through synchronous and asynchronous earning, it helps collaboration and there is greater level of student engagement which was not visible during traditional classroom boundaries. There are advancements in technology such as mobile learning, artificial intelligence, cloud computing, etc. Despite these advancements, disparities in access to technology and digital competence continue to influence the effectiveness of these environments, especially in developing countries.

1.3.Importance of Studying Barriers: Though Virtual Teaching provides many advantages, there are always technological and economic barriers which can hinder its effectiveness. To know about these barriers is very crucial for knowing the gaps in implementation and ensuring equitable access to quality education. Without addressing these challenges, the benefits of virtual teaching may remain unevenly distributed, thereby widening the digital divide in higher education.

1.4.Rationale of the Study: The present study focuses on the need to identify the dual challenges of technological and economic barriers from the perspective of university educators. The present study has given focus to the educators who are central to the teaching-learning process. The study also focuses on comprehensive understanding of the obstacles faced in virtual teaching and to contribute to the development of informed strategies for improvement.

1.5.Structure of the paper: The paper is systematically organized so as to have proper analysis of the topic. Starting with the introduction, the review of literature focussing on existing studies related to economic barriers and technological barriers in virtual teaching. The methodology section focussed about the research design. Later on the results and discussions were presented by the researcher, where findings are mentioned with supporting studies and there was interpretation for the same. The paper concludes with key findings, recommendations, limitations, and suggestions for future research.

2. Review of Literature:

2.1 Technological Barriers in Virtual Teaching

Berge and Mrozowski (1999) did a review and content analysis to find different barrier which are related with online teaching and also identified the number of barriers used in different research papers. Consistent results were found in which majority of the review papers reflected barrier of educational technology. Biswas and Nandi (2020) had studied the involvement of technology in teaching and focus to find the barriers faced by teachers and overawed all the obstacles by providing the approaches to enhance the virtual learning environment. Torres-Madroñero et.al (2020) had an analysis of the meaning of ICT-mediated assessment and types of assessment. They highlighted the modern pedagogical simulations and their implementations. Mortazavi et.al (2021) did qualitative study during pandemic when there was vast transformation in the field of education in view of students perspective. They had conclusion that among students it has adverse impact in consideration of quality content and infrastructure. Pacheco-Castillo and Vega-Estrella (2025) had concluded that teachers faced some difficulties in dealing equipment digital courses that requires earlier preparation to equip with digital technologies.

2.1.1. Digital Tool Master: Saleh and Al (2022) they found in their study that virtual education has directly related with virtual learning resources and eduational self-efficacy which has a positive impact on the growth of virtual education system and also it has a positive impact on learners academic progression. Torres Martín et.al (2021) did the research to discover the opinion that students have about the teaching methodology implemented in the digital learning environment. The results of this study found that the students were have unsatisfactory expression about virtual learning process.Yu (2022) his study determined that learners have experienced countless changes encouraged by information technology also the digital skills and social regulation can advance virtual learning environment. This study has been done through a rapid assessment review based on the protocol of Peferred reporting items for systematic review and meta-analysis (PRISMA). Gomez (2014) had describes and analyses the dynamic of the use of digital learning environment. The research conducted through questionnaire with 32 items was respond by 174 educators. Also conducted the interviews with coordinators consider for the final interpretation. This study suggested that the virtual learning environment skills are extremely important for the the learner as well as educator to develop virtual learning and distance education system. Roy (2012) In line with research literature, this paper suggests that virtual leadership needs to be a mix of relationship-building and technical skills, as well as the ability to effectively manage team frustrations. Core competencies include knowledge and relationship building; people can achieve a better understanding of each other and be productive and friendly, as well as demonstrate emotional intelligence; create a supportive team with good communication ability and lead by example in virtual activities where people should feel safe and productive, and where collaboration benefits everyone. And that is the basis for why we must continue to enhance both our interpersonal and technical abilities in digital work so we can effectively lead in digital environments. García-Martínez (2020) ICT applications, and how well they have been used in a formal context, are key components in the discussion of the PLE analysis. This study examined the tools employed by students to access information and develop content as well as how they share/interact with it within higher education. In terms of the research methods, we took a quantitative approach: it was an ex post facto transactional approach and we used a questionnaire, the stratified probabilistic study (n = 1187) of university students taking different courses in the country's National University in Costa Rica in the sample that we collected. The methodology to analyze the use of tools (e.g. data mining on data mining platforms, social media-based interaction between the students on PLEs) is a strong aspect of our study of the use of data. Students used more resources related to information processing, sharing, and interacting more and less with their content creation. We did find that tools could be used differently based on sex, previous technology knowledge, and academic performance but we would appreciate the adoption of open, flexible methods of learning, which are already in today's digital world to support PLE and not only in lifelong learning but also beyond the classroom.

2.1.2. Rapid Tech Evolution: Gopalan (2016) The rapid development of educational technology is altering how education is taught and assessed and promoting approaches that are more student-centered with different forms of learning. But it is uncertain if we can be sure this transition is working, especially when so much work is not done to assess how well these technologies are in testing when the evidence for them is strong. This paper presents the challenges and opportunities of technology-driven change so fast in education.Ravichandran et.al (2024) The state of education is essential in the planning of its future. The current digital learning environment is more

mainstream in which e-learning is prevalent in the education world, helped by the COVID-19 outbreak and subsequent increase in access and investment to digital learners. Moodle, Blackboard, and Canvas are among the best learning management technologies to take your class and monitor student progression in digital education. Virtual classrooms can be used with Zoom and Google Meet which are a source of learning that has improved access and efficiency for all. Li (2023) This research looks at historical learning technology from the Printing Revolution up to online learning today. That research has explored, historically, how the printing press democratizes education and paved the way to public education as it introduced the world to the 20th century via television and computers for access to digital education, which has further democratized learning and allowed for much closer education at home and in schools. Norton et.al (2013). In their book The online evolution, they had concluded that online technology has been called a disruptive force that could change the face and the mode of education for general study when compared with traditional universities and higher education institutions. But higher education institutions are still viable due to their larger responsibilities and they are based in the context of having student experiences, professional relationships, practical experience, and brand standing. But while online and non-school systems such as learning on the internet lead the way—and are available to all people—they do not replace on-campus education. Technology can transform the role and structure of a culture that learns but the future of education is likely to be more like digital innovations and institutional strengths that we are used to.

2.1.3. Technical Failures : Ghasemi and Kadkhoda (2023) After the COVID-19 pandemic, virtual education replaced teaching in the classroom. Virtual education was beneficial for many, but also made it difficult for primary school students to do well and was associated with academic decline. This study aimed to explore primary school teachers' experiences regarding the reasons for the failure of students in virtual learning. This research has a qualitative, phenomenological approach. Data were collected through in-depth interviews with 11 primary school teachers selected using purposive sampling and analyzed using Colizzi's method with MAXQDA 11 software. The findings revealed six important factors contributing to academic failure: technical and infrastructural issues, teacher-related challenges, student and family-related problems, psychological pressures, improper evaluation methods, and decreased student motivation. The study concludes that multiple factors impact academic failure in virtual education, many of which can be handled by teachers. So teachers need to be better in teaching, classroom management, assessment, and communication with students and parents. Pugh, P. (2019) Inconsistent project management approaches in building virtual learning environments (VLEs) may cause issues such as unmet budgets, timelines, and system requirements due to poor communication and unclear user needs. This qualitative study investigated the communication between instructional designers and project managers with 18 participants in the U.S. The findings also showed two elements to be critical: effective meetings/training and clear definition of needs. The research shows that involving all the stakeholders in the process and at every stage of the project leads to better communication and outcomes and makes a case for the need for a consistent project management process where there is a clear role defined for each of the parties. Jacobson et.al (2011) This paper explores the use of collaborative virtual worlds and productive failure in learning to enhance learning outcomes. A design research approach is adopted by multidisciplinary teams such as pedagogical experts, technical developers, graphics designers, and learning researchers, and this

paper asks how virtual environments can be designed for learning to be hard, difficult, and to learn from failure so that we know what is going on, problem-solving skills and collaboration are developed, and we can learn from failure more than anything else. We found that learning from different backgrounds in the virtual world needs to be combined to create effective, engaging and pedagogically sound virtual learning experiences. Borja II et al. (2024) Virtual learning environments (VLEs) are in discussion in higher education around the world and there is little research on their effects on student satisfaction. VLEs increase student engagement and academic performance by means of interaction and communication. With recent advancements in technology, virtual learning models such as social media, mobile devices and the internet are becoming an integral part of learning and students and teachers can share their knowledge with one another.

At the same time, family background influences students' attention, access to resources, and participation in online learning. To make VLEs effective, institutions should provide quality and quick learning materials with no technical hurdles. Frequent technical problems and slow system performance can deter students from using virtual classes and hinder learning goals, especially in the case of a pandemic.

2.1.4. Cybersecurity and Privacy: Tazi et.al (2021) In 2020, remote learning was rapidly growing as it was an educational mode for all and safe learning worldwide. On the one hand, but with the rise in ICT and its use, the cybersecurity and privacy implications like phishing, cyberbullying and unauthorized webcam access were also high, as well as the risks of cyberbullying and unauthorized webcam access. The research conducted by 520 participants in our study, based on a survey of 520 parents, teachers, and caregivers, was conducted to get a sense of what parents, teachers and caregivers had to say about their issues of security and privacy and to suggest to the community that better protection and security awareness is needed in an online learning environment for safety and security in the learning environment. Tazi et.al (2023). The COVID-19 pandemic made the transition from in-person to online education much more focused on ICT and put students at greater risk for cybersecurity. 983 parents, educators, and caregivers were surveyed and found very little technical support and little communication from schools about cyber safety. More than 31 percent said they had not been provided with such guidance. The results also highlight the differences in information on online safety among stakeholders and the need for better training, awareness, and stronger action taken to ensure secure and privacy-focused online education.

2.1.5. Digital Accessibility: Rice and Oritz (2020). Accessibility is still a major issue for students with disabilities in online learning, especially in virtual schools. There is confusion about accessibility and who is responsible for ensuring it is accessible and some of that confusion is mistaken for personalization or engagement. In this study, we surveyed 111 teachers in 6 virtual schools under corrective action and found that instructional materials were "somewhat" accessible with different responses.These results show that policies and accessibility are in need of better understanding and better support so as to ensure all students are learning and better outcomes for all. Prado et.al (2023) verified the gaps concerned with digital accessibility in education by doing systematic review of articles for the variables, education, educational, teaching, digital accessibility, etc.

2.2 Economic Barriers in Virtual Teaching

Boté-Vericad (2021) discussed in their paper about the perceived barriers during distance teaching during COVID-19 crises in higher education. Careemdeen (2023) found the major disparity among the students

was based on the income of the parents and their educational levels and so they highlighted in their research about the need of high level of support meant for virtual environment support for student learning

2.2.1. Heavy Cost of Devices and Infrastructure refers to the cost incurred on the devices like laptops, tablets, stable internet, tablets, etc which are of the use of teachers and students. Machusky and Herbert-Berger (2022) did a review study related with challenges and emerging trends of online learning infrastructure of US K-12 School in which he highlighted the internet bandwidth issues which affects the ability of the students to participate from remote locations also. The researchers has also suggested Fiber, 5G, Smart City and satellite internet which will help to improve digital infrastructure. They also suggested that there is a dire need for training the teachers, parents and staff for online learning. Miseviciene et. al. (2012) introduced the virtualization technologies which were implemented at the University and have highlighted their benefits and functions. Chavan (2024) explored various tangible and intangible aspects and got the clarity in dilemma of Classroom Training Vs. Virtual Training: Which is more Cost-Effective?

2.2.2. Internet Connectivity Expenses refers to the expenses which are required for Continuous online classes like high-speed data plans, increasing monthly costs, especially in regions with expensive or unreliable internet. O'Leary and Ramsden (2002) in their study mentioned that accessibility is greatly influenced by the speed of the user's Internet Connection. Lee et.al. (2001) did the analytical study as how students' used to prepare themselves for Virtual Learning Environment in Higher Education and the importance of internet connectivity was also discussed in the paper. Dutton et. al. (2004) discussed in their paper about various constraints which teachers and students face on e-learning in higher education where they pointed out that internet connectivity is one of such major challenge. Twigg (2005) in his paper discussed various means through which learning can be improved can cost can be reduced. Harper et. al. (2004) investigated various ways through which distance learning, virtual classrooms and teaching pedagogy in Virtual Learning Environment can be enhanced.

2.2.3. Institutional Financial Constraints: Universities face challenges in investing in Learning Management Systems (LMS), software licenses, and digital platforms. Dutton et. al. (2004) discussed various constraints on e-learning in higher education. Ndibalema (2022) recommended that thoughtful investment is required so that digital culture can be promote. Also, the researcher suggested that various ways for digital inclusion for marginalized groups in developing countries. AL-ENAZI (2016) found that there are seven areas where support are highly desired which includes Institutional Support Practices (ten items), Technical Support (six items), Pedagogical Support (six items), Technical Training (six items), Pedagogical Training (six items), Flexibility of Training Programmes (five items) and Institutional Incentives (five items). The results from the studies of Kurbakova et. al. (2020) are helpful for regulators, educators and IT Experts for giving a light to develop strategies and tactics for effective online education.

2.2.4. Training and Skill Development Costs refers to those expenses in which Institutions must spend on training teachers for digital pedagogy and technical skills. Chavan (2024) did a comparative study on costs of classroom training v/s virtual training. The investigation encompasses diverse facets of cost, including infrastructure expenses, training material outlays, and ancillary costs such as travel and accommodation. O'Leary and Ramsden (2002) discussed in detail about the training and skill development costs associated with Virtual Learning Environments. Odrekhivskyy et. al. (2019) researched that the modeling, implementation and use of information technologies in education changes not only individual actions, but also human activity in general, affecting all mental processes, as there is indirect activity with new sign systems and means that requires additional psychological efforts from students, and from teachers - the use of new methods and methods of training; the interconnected and interconnected

combination in the process of learning real and virtual is analyzed, which will allow to ensure the efficiency of modern teaching technologies that provide for the proactive character of personal development.

2.2.5. Maintenance and Technical Support Costs includes Ongoing expenses for IT support, platform maintenance, and troubleshooting add financial pressure. Fazlollahtabar and Yousefpoor (2008) aimed to evaluate different maintenance strategies (such as corrective maintenance, time-based preventive maintenance, condition-based maintenance, and predictive maintenance) for different equipment used in a virtual learning environment. Lee et. al. (2001) aimed to identify factors that address the requirements of learners to enable appropriate use of ICT in their learning. Nawaz and Khan (2012) found various technical issues for e-learning in higher education, also they pointed out that if constructive measures are taken, these issues can turn into opportunities. Papathanasiou et. al. (2012) aimed for a smooth acceptance of the new e-Maintenance system, by providing easily accessible and context-depended support for maintenance personnel.

2.3 Previous Studies on Virtual Teaching Challenges

According to Lloyd et. al. (2012) there were faculty-perceived barriers during Virtual Learning Environment and their resistance to use of technology. Berge and Mrozowski (1999) studied the barriers at elementary level, secondary level and teacher education level during online teaching. There is a need to set up a strategy targeting the stakeholders to address the barriers through a comprehensive approach which will combine policy level interventions, pedagogical and institutional challenges. (Glazkova et. al., 2025). There is a need to investigate inclusive and personalized learning for accommodating and consolidating geographical and social barriers so that inequalities can be reduced as far as students' access to education is concerned i.e. learners should not be denied of any technical and digital divide so that the potential of students did not get limited and the concept of 'Global village' is adopted. (Gunawardena and Dhanapala, 2023). Khobragade et. al. (2021) discussed the barriers like technical problems, internet connectivity, communication and low motivation. Their research also suggested measures like well training lecturers, highly motivated and smaller size class which may help in breaking the barriers. Assareh and Bidikht (2011) categorized the barriers into four categories like learners, teachers, curriculum, the school where under each category there are sub-division of barriers like financial problems of students, motivation, lack of adequate knowledge about e-teaching environment, curriculum ambiguity, evaluation, organizational and structural factors, etc.

3.0 Objectives of the study:

1. To examine technological barriers in virtual teaching
2. To identify economic barriers faced by university educators.
3. To analyze the dimensions and their respective items to identify the barriers

4.0. Discussions

4.1. Identification of Technological barriers

4.1.1. Digital tool mastery: This has been seen that mastery in digital tools is very much required to use learning platforms, e-resources and virtual labs and library to enhance student learning and quality virtual teaching. With the changing scenario of education becoming more comprehensive,

one needs to shift from traditional classroom teaching to the virtual mode which requires digital tool mastery.

4.1.2. Rapid Tech Evolution: For growth and opportunity, digital tool mastery needs to adapt quickly to the changes in the virtual teaching environment. Rapid changes in educational technology may disrupt the teaching plans without the virtual skills. It needs to constantly adapt to frequent advancements in educational technology.

4.1.3. Technical Failures : There are many inadequacies in virtual mode of teaching such as software glitches, internet issues, system errors, others many technical failure. Technical failure causes anxiety and stress during online teaching. Many times teachers lose valuable classes due to internet failure therefore classes often postponed or activities get affected. The Technical failures cause stress during online classes and backup plans for possible technical failures. Troubleshoot common software problems. lose valuable class time due to internet failures.

4.1.4. Cybersecurity and Privacy Protecting student data, course materials, and digital interactions from unauthorized access or misuse

4.1.5. Digital Accessibility Ensuring all students, including those with disabilities or limited resources, can access and use digital learning materials.

4.2. Identification of Economic Barriers

4.2.1. Heavy Cost of Devices and Infrastructure: To check heavy cost of devices and infrastructure researcher has constructed the questionnaire and there are items pertaining to this domain. Examples of the items are like The high cost of devices (laptrops/tablets) limits the participation in virtual learning, finding it difficult to afford the required digital devices for online education, lack of access to updated technological devices affects the quality of learning, expenses related to setting up a proper digital learning environment are too high, The cost of reliable internet infrastructure (e.g., broadband, Wi-Fi setup) is burdensome, Frequent upgrades of devices/software create additional financial strain, Institutions do not adequately support students in accessing necessary digital tools and High infrastructure costs discourage effective use of virtual learning platforms.

4.2.2. Internet Connectivity Expenses: The cost of high-speed internet is difficult for me to afford regularly, Increasing monthly data charges create financial pressure for attending online classes, facing difficulty in accessing uninterrupted internet due to financial limitations, Expensive internet plans reduce my participation in live virtual sessions, Poor internet affordability affects my ability to submit assignments on time, compromise on internet quality due to budget constraints. Internet expenses are a major barrier in continuing online education.

4.2.3. Institutional Financial Constraints: Lack of sufficient funds in the institution to provide effective virtual learning platforms, Limited institutional budget affects the quality of digital learning resources, The institution does not provide adequate access to licensed educational software, Financial constraints hinder the development of effective Learning Management Systems (LMS), Students are required to bear additional costs due to lack of institutional support, Digital inclusion initiatives are insufficient due to financial limitations of institutions, Institutions do not invest enough in improving online learning infrastructure.

4.2.4. Training and Skill development costs during Virtual Learning Environment includes the expenses to acquire digital skills required for online learning. Many Institutions do not provide adequate free training for using virtual learning tools. Teachers require additional financial investment to upgrade their

digital teaching skills. To check this domain more items like training programs for virtual learning are often costly and inaccessible, Lack of affordable training opportunities affects my effectiveness in online learning, Financial constraints prevent participation in skill development programs or Costs related to learning new technologies create additional burden.

4.2.5. Maintenance and Technical Support Costs plays an important role for the efficient and smooth running of Virtual Classes. It can be understood by the following items the cost of maintaining digital devices is financially challenging, technical issues increase expenses due to repair and maintenance needs, Institutions do not provide adequate technical support for online learning, incurring additional costs for troubleshooting and technical assistance, regular software updates and maintenance add to financial burden or lack of affordable technical support affects continuity of online learning and Maintenance costs of digital platforms create financial strain for institutions.

5.0. Findings of the Study:

The discussion of data revealed several significant findings regarding technological and economic barriers in virtual learning.

- Technological barriers are prevalent in Higher Education Institutions as under various studies university educators have reported the issues related with lack of access to digital tools, unstable internet connectivity and insufficient technical support.
- Economic burden on Educators as they often incur expenses purchasing devices, upgradation of internet plans, etc.
- Technological and Economical challenges affect negatively the teaching efficiency, classroom engagement and content delivery.
- There is a need for training and support for teachers as number of teachers have reported the need for training programs for virtual learning.

6.0. Suggestions/Recommendations:

Continuous Professional Development should be emphasized by educators so that digital literacy and pedagogical skills are developed. Inclusive policies should be put in place for equitable access to digital education resources for all learners and public-private partnerships should be implemented to strengthen digital infrastructure in higher education and dedicated funding should be put in place for the development, enhancement and maintenance of robust virtual learning environments.

7.0 Conclusion:

Virtual teaching has been considered an important aspect of higher education, yet is still hampered by technological and economic barriers to the education system. These obstacles impact the quality of the teaching and create stress in the teachers and affect their performance as well as their well-being. And the results also indicate that the educators, the institution and the policymakers need to work together to overcome the obstacles. We can create a more inclusive, effective virtual teaching environment by investing in infrastructure, raising digital skills and getting financial support.

8.0. Limitations of the study:

The main focus in this study is on educators and is not part of students or administrators' perspectives.

9.0. Scope of future research:

The future research needs to be carried out on comparative studies of countries, institutions and disciplines to better understand technological and economic barriers, longitudinal studies should also be made to monitor how these barriers evolve with the technological progress and interventions that are effective in overcoming them and the need for such barriers in the study of them. In addition, using more advanced statistical methods like Structural Equation Modeling (SEM) can provide a picture of barriers and teaching and the impact on educators' mental health and job satisfaction can also be explored, we are also looking at the relationship between barriers and teaching outcomes, and how the barriers affect educators' mental health and job satisfaction in this context.

References

1. AL-ENAZI, G. H. A. N. E. M. (2016). *Institutional support for academic staff to adopt Virtual Learning Environments (VLEs) in Saudi Arabian universities* (Doctoral dissertation, Durham University).
2. Aliyu, H., & Talib, C. A. (2023). A systematic review of 21st-century chemistry laboratory experiments and classroom instructions facilitated/aided with digital technologies and e-resources. *International Journal of Current Educational Studies*, *2*(1), 18-36.
3. Assareh, A., & Bidokht, M. H. (2011). Barriers to e-teaching and e-learning. *Procedia Computer Science*, *3*, 791-795.
4. Berge, Z. L., & Mrozowski, S. E. (1999). Barriers to online teaching in elementary, secondary, and teacher education. *Canadian Journal of Learning and Technology*.
5. Biswas, R. A., & Nandi, S. (2020). Teaching in virtual classroom: Challenges and opportunities. *International Journal of Engineering Applied Sciences and Technology*, *5*(1), 334-337.
6. Borja II, G. K. S., Ferrer, L., Julianes, B., & Magnampo, P. (2024) Fulfillments and Failures of Virtual Learning Environment (VLE): A Systematic Review.
7. Boté-Vericad, J. J. (2021). Perceived barriers for distance teaching in higher education during the COVID-19 crisis:"I never did a video before". *Education for Information*, *37*(3), 377-397.
8. Careemdeen, J. D. (2023). The impact of socio-economic factors in the virtual learning environment on student learning. *Int J Acad Res Bus Soc Sci*, *13*(12), 802-814.
9. Carnahan, C. D. (2010, January). Virtual learning & real students: exploring success and failure of K-12 cyber education. In *The Proceedings of the Laurel Highlands Communications Conference* (pp. 185-193). Indiana University of Pennsylvania, Department of Communications Media.
10. Chavan, S. S. (2024). Comparative Study Of Classroom Training Vs. Virtual Training: Which Is More Cost-Effective. *Journal of Advanced Zoology*, *45*.
11. Dutton, W. H., HOPE CHEONG, P. A. U. L. I. N. E., & Park, A. (2004). An ecology of constraints on e-learning in higher education: The case of a virtual learning environment. *Prometheus*, *22*(2), 131-149.

12. Fazlollahtabar, H., & Yousefpoor, N. (2008). Selection of optimum maintenance strategies in a virtual learning environment based on analytic hierarchy process. In *Proceedings of the 3rd International Conference on Virtual Learning, Constanta, October 31-November* (Vol. 2, pp. 143-152).
13. García-Martínez, J. A., Rosa-Napal, F. C., Romero-Tabeayo, I., López-Calvo, S., & Fuentes-Abeledo, E. J. (2020). Digital tools and personal learning environments: An analysis in higher education. *Sustainability*, *12*(19), 8180.
14. Ghasemi, S. A., & Kadkhoda, M. (2023). Analyzing the lived experiences of primary school teachers about the causes of students' academic failure in virtual education during the covid-19 pandemic. *Journal of New Approaches in Educational Sciences (JNAES) Original Article*, *5*(1).
15. Glazkova, I., Falko, N., Khomenko, O., Khatuntseva, S., Rula, N., Shulzhenko, A., & Tatarin, V. (2025). Barriers in online education for displaced universities: Insights from faculty and students. *Problems and Perspectives in Management*, *23*(2), 136.
16. Gomez, M. V. (2014). Use and Mastery of Virtual Learning Environment in Brazilian Open University.
17. Gopalan, C. (2016). The impact of rapid change in educational technology on teaching in higher education. *HAPS Educator*, *20*(4), 85-90.
18. Gunawardena, M., & Dhanapala, K. V. (2023). Barriers to removing barriers of online learning. *Communications of the Association for Information Systems*, *52*(1), 17.
19. Harper, K. C., Chen, K., & Yen, D. C. (2004). Distance learning, virtual classrooms, and teaching pedagogy in the Internet environment. *Technology in Society*, *26*(4), 585-598.
20. Jacobson, M., Taylor, C., Hu, C., Newstead, A., Wong, W. Y., Richards, D., ... & Kapur, M. (2011). Collaborative virtual worlds and productive failure: design research with multidisciplinary pedagogical, technical and graphics, and learning research teams.
21. Khobragade, S. Y., Soe, H. H. K., Khobragade, Y. S., & bin Abas, A. L. (2021). Virtual learning during the COVID-19 pandemic: What are the barriers and how to overcome them?. *Journal of Education and Health Promotion*, *10*(1), 360.
22. Kurbakova, S., Volkova, Z., & Kurbakov, A. (2020, July). Virtual learning and educational environment: New opportunities and challenges under the COVID-19 pandemic. In *2020 The 4th International Conference on Education and Multimedia Technology* (pp. 167-171).
23. Lee, J., Hong, N. L., & Ling, N. L. (2001). An analysis of students' preparation for the virtual learning environment. *The internet and higher education*, *4*(3-4), 231-242.
24. Li, S. (2023). The historical evolution of educational technology: from the printing press to online education. *OOO" Zhurnal" Voprosy Istorii*.
25. Lloyd, S. A., Byrne, M. M., & McCoy, T. S. (2012). Faculty-perceived barriers of online education. *Journal of online learning and teaching*, *8*(1).
26. Machusky, J. A., & Herbert-Berger, K. G. (2022). Understanding online learning infrastructure in US K-12 schools: A review of challenges and emerging trends. *International Journal of Educational Research*, *114*, 101993.
27. Miseviciene, R., Ambraziene, D., Tuminauskas, R., & Pazereckas, N. (2012). Educational infrastructure using virtualization technologies: Experience at kaunas university of technology. *Informatics in Education*, *11*(2), 227-240.
28. Moore, R. L., & Fodrey, B. P. (2017). Distance education and technology infrastructure: Strategies and opportunities. In *Leading and managing e-learning: What the e-learning leader needs to know* (pp. 87-100). Cham: Springer International Publishing.

29. Mortazavi, F., Salehabadi, R., Sharifzadeh, M., & Ghardashi, F. (2021). Students' perspectives on the virtual teaching challenges in the COVID-19 pandemic: A qualitative study. *Journal of education and health promotion*, *10*(1), 59.
30. Nawaz, A., & Khan, M. Z. (2012). Issues of technical support for e-learning systems in higher education institutions. *International Journal of Modern Education and Computer Science*, *4*(2), 38.
31. Ndibalema, P. (2022). Constraints of transition to online distance learning in Higher Education Institutions during COVID-19 in developing countries: A systematic review. *E-learning and Digital Media*, *19*(6), 595-618.
32. Norton, A., Sonnemann, J., & McGannon, C. (2013). *The online evolution: When technology meets tradition in higher education* (Vol. 48). Melbourne, Australia: Grattan Institute.
33. O'Leary, R., & Ramsden, A. (2002). Virtual learning environments. *Learning and Teaching Support Network Generic Centre/ALT Guides, LTSN. Retrieved July*, *12*, 2005.
34. Odrekhivskyy, M., Pasichnyk, V., Rzheuskyi, A., Andrunyk, V., Nazaruk, M., Kunanets, O., & Tabachyshyn, D. (2019). Problems of the Intelligent Virtual Learning Environment Development. *MoMLeT*, *2019*, 359-369.
35. Pacheco-Castillo, J., & Vega-Estrella, R. (2025). Challenges faced by teachers when integrating technology in the teaching of virtual courses in a higher education institution. *Journal of Education and Development*, *9*(2), 47.
36. Papathanasiou, N., Emmanouilidis, C., Pistofidis, P., & Karampatzakis, D. (2012, May). E-learning and context aware e-support software for maintenance. In *Journal of Physics: Conference Series* (Vol. 364, No. 1, p. 012110).
37. Prado, B. D. B., Gobbo Junior, J. A., & Bezerra, B. S. (2023). Emerging themes for digital accessibility in education. *Sustainability*, *15*(14), 11392.
38. Pugh, P. (2019). *Communication Quality Failures: Misunderstanding Virtual Learning Environment User Requirements* (Doctoral dissertation, Capella University).
39. Ravichandran, K., Virgin, B. A., Edwin, M. R., Morris, V. S., & Milton, B. J. (2024). Moving towards a Blended Tomorrow: The Evolution of EdTech in Education. *Library of Progress-Library Science, Information Technology & Computer*, *44*(3).
40. Rice, M., & Oritz, K. (2020). Perceptions of accessibility in online course materials: A survey of teachers from six virtual schools. *Journal of Online Learning Research*, *6*(3), 245-264.
41. Roy, S. (2012). Digital mastery: The skills needed for effective virtual leadership. *International Journal of e-Collaboration*, *8*(3), 56-66.
42. Saleh, S., & AlAli, R. (2022). Digital learning tools (institutional-open) and their relationship to educational self-effectiveness and achievement in online learning environments. *Przestrzeń Społeczna (Social Space)*, *22*(3), 226-256.
43. Tazi, F., Shrestha, S., & Das, S. (2023). Cybersecurity, safety, & privacy concerns of student support structure for information and communication technologies in online education. *Proceedings of the ACM on Human-Computer Interaction*, *7*(CSCW2), 1-40.
44. Tazi, F., Shrestha, S., Norton, D., Walsh, K., & Das, S. (2021, November). Parents, educators, & caregivers cybersecurity & privacy concerns for remote learning during COVID-19. In *Chi greece 2021: 1st international conference of the acm greek sigchi chapter* (pp. 1-5).
45. Torres Martín, C., Acal, C., El Homrani, M., & Mingorance Estrada, Á. C. (2021). Impact on the virtual learning environment due to COVID-19. *Sustainability*, *13*(2), 582.

46. Torres-Madroñero, E. M., Torres-Madroñero, M. C., & Ruiz Botero, L. D. (2020). Challenges and possibilities of ICT-mediated assessment in virtual teaching and learning processes. *Future Internet*, *12*(12), 232.
47. Twigg, C. A. (2005). Improving learning and reducing costs for online learning. In *Encyclopedia of distance learning* (pp. 1054-1060). IGI Global Scientific Publishing.
48. Yu, Z. (2022). Sustaining student roles, digital literacy, learning achievements, and motivation in online learning environments during the COVID-19 pandemic. *Sustainability*, *14*(8), 4388.