SYSTEMATIC LITERATURE REVIEW: ENHANCING STUDENTS' DIGITAL LITERACY AND DIGITAL COMPETENCY THROUGH TECHNOLOGICAL INNOVATIONS IN HIGHER EDUCATION

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Abstract

This article explores the enhancement of students' digital literacy and competencies through technological innovation in higher education. Digital transformation has reshaped the way teaching and learning occur, particularly with the implementation of artificial intelligence, virtual reality, and digital learning platforms. This literature review spans research from 2019 to 2023, highlighting the impact of the COVID-19 pandemic, the role of technology in distance learning, and the challenges of integrating technology into educational institutions. The research findings indicate that technological innovation in higher education has the potential to improve students' digital literacy and competencies, although infrastructure challenges and institutional readiness remain significant barriers.

Keywords: *Technological innovation, digital literacy, digital transformation, digital competence, higher education*

Introduction

In recent decades, digital technology has played a central role in revolutionizing various sectors, including higher education. Digital transformation in higher education has become one of the main themes in discussions on developing students' skills and competencies in the 21st century. A study by van Laar et al. (2020) identified factors influencing 21st-century digital skills, including the effective use of technology, understanding digital data, and the ability to collaborate through digital platforms. The development of digital technology has significantly changed the landscape of higher education. Along with advancements in technologies such as artificial intelligence (AI), virtual reality (VR), and internet-based technologies, digital transformation has driven changes in the way teaching and learning are conducted in universities (Alexander, 2019; Burbules et al., 2020). The EDUCAUSE Horizon Report indicates that these technologies not only offer new ways of teaching but also create opportunities for students to develop the digital competencies needed in the modern era (Alexander et al., 2019).

Technological innovations in education not only encompass new digital tools but also focus on enhancing students' digital literacy, defined as the ability to search, evaluate, and effectively utilize digital information (Amhag et al., 2019; Chen et al., 2020). Digital literacy, which includes information literacy, media literacy, and computer literacy, is a crucial skill for addressing 21st-century challenges (Tejedor et al., 2020). As the demand for these skills grows, many higher education institutions are introducing more technology-integrated teaching methods (Kraus et al., 2021). The COVID-19 pandemic accelerated the adoption of technology in distance learning, emphasizing the need for higher digital skills among students and educators (Deroncele-Acosta et al., 2023). However, the adoption of these technologies still faces challenges, including infrastructure readiness and uneven technological competencies across educational institutions (Abad-Segura et al., 2020; Yu et al., 2021). Technological innovations in higher education not only impact teaching methods but also change how students engage with learning materials, enable personalized learning, and enhance engagement through digital platforms (Oke & Fernandes, 2020).

Overall, the challenges of digital transformation in higher education are highly complex and require collaboration among various stakeholders, including educational institutions, governments, and the private sector. Therefore, it is crucial to understand how digital literacy and competencies can be enhanced through the appropriate implementation of technological innovations, ultimately fostering more inclusive and high-quality

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education in the future. This literature review aims to explore various studies conducted from 2019 to 2023 on the impact of technological innovation on improving students' digital literacy and competencies. The focus is on how digital technology can enhance students' learning experiences while also highlighting potential barriers to digital transformation in higher education.

Literature Review
Digital Transformation in Higher Education

Digital transformation is understood as the use of new digital technologies, such as social media, mobile devices, analytics, or embedded devices, to enable significant improvements in business, such as enhancing customer experience, streamlining operations, or creating new business models (Horlacher et al., 2016; Singh & Hess, 2017). Meanwhile, Schallmo et al. (2017) define digital transformation as the formation of a network of actors, such as companies and customers, across all segments of the value chain and the application of new technologies. Vial (2019) explains that digital transformation involves fundamental changes in an organization's operational processes, including higher education. The use of digital technology not only improves efficiency but also transforms teaching methods. Nadkarni & Prügl (2021) emphasize the need for a structured approach to the transformation process, given the management challenges arising from such changes. This study finds that adapting digital transformation in higher education requires structural and organizational cultural changes.

Digital Literacy and Digital Competence

Digital literacy is described as the integration of computer literacy, information literacy, and media literacy (Paynton, 2012) and has emerged alongside the development of the internet, requiring knowledge on how to access, search, and critically analyze information (Liu et al., 2020). Meanwhile, digital competence is a key driver of recent educational policies and consists mainly of four elements: (a) technical and practical skills in using technology; (b) the ability to use and apply digital technology in work, study, and daily activities; (c) the ability to critically understand and evaluate digital technology, its limitations, and challenges; and (d) the motivation to participate and engage in digital culture (Ilomäki et al., 2016).

Artificial Intelligence (AI) and Virtual Reality (VR)

AI refers to the ability of machines to mimic human intelligent behavior, particularly cognitive functions associated with the human mind, including problem-solving and learning (Carbonell, Michalski, & Mitchell, 1983). VR can be defined as an implementation where individuals find themselves in a virtually created environment using various tools and interact with that environment (Carrozzino & Bergamasco, 2010).

Research Methodology

This study employs a qualitative-descriptive research type with a literature review approach to identify trends and challenges in digital transformation in higher education. The literature review is conducted by collecting articles from various sources, including Scopus-indexed international journals and working papers published by international organizations (UNESCO) that align with the research objectives. Content analysis is then conducted to identify trends and challenges in digital transformation in higher education. This study covers articles published between 2019 and 2023, focusing on various methodological approaches used in related studies, including case studies, surveys, and literature reviews.

Research Findings and Discussion

Based on the article search using the Publish or Perish (PoP) application with the keywords "Technological Innovation," "Digital Literacy," "Digital Transformation," "Digital Competence," and "Higher Education" in the last five years (2019-2023), a total of 13 selected articles were identified as follows:

Table 1. Selected Articles According to Research Objectives

Year	Article Title	Authors	Key Findings
2019	Managing for competency with innovation change in higher education	Jackson, N.C.	Challenges in change management due to digital transformation.
2019	Artificial Intelligence in	Pedro, F., Subosa, M.,	AI has great potential to support

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Year	Article Title	Authors	Key Findings
	Education: Challenges and Opportunities for Sustainable Development	Rivas, A, & Valverde, P.	SDGs by improving access and quality of education.
2019	Systematic review of research on artificial intelligence applications in higher education	Zawacki-Richter, O., Marín, V.I., Bond, M., & Gouverneur, F.	Artificial intelligence aids personalized learning, but there is little educator involvement in AI research.
2020	From digital literacy to digital competence: the teacher digital competency framework	Falloon, G	A digital competency framework model for teachers that can be adapted to enhance students' digital competence.
2020	Digital Transformation in Higher Education Institutions: A Systematic Literature Review	Benavides, L.M.C, Arias, J.A.T., , Serna, M.D.A., Bedoya, J.W., & Burgos, D	Provides a research map of digital transformation in higher education, focusing on institutional challenges.
2020	Trends in Educational Research about e-Learning: A Systematic Literature Review	Valverde-Berrocoso, J., Garrido-Arroyo, M.D.C., Burgos-Videla, C., & Morales-Cevallos, M.B	Significant increase in online learning adoption, but infrastructure and digital literacy challenges remain high.
2020	Impact of Covid-19 Pandemic on Higher Education and Research	Rashid, S., & Yadav, S.S	COVID-19 accelerated digital transformation in higher education but exacerbated the digital divide.
2020	Impacts of the COVID-19 Pandemic on Life of Higher Education Students: A Global Perspective	Aristovnik, A., Kerži˘, D , Ravšelj , D., Tomaževi˘, N., & Umek, L.	Limited computer skills and perceptions of increased workload hinder educators from recognizing performance improvements in the new teaching environment.
2020	A systematic review of immersive virtual reality applications for higher education	Radianti, J., Majchrzak, T.A., Fromm, J., & Wohlgenannt, I	VR enhances student engagement and motivation through immersive learning simulations.
2021	Digital competence in higher education research: A systematic literature review	Zhao, Y, Llorente, M.P, & Gomez, M.C.S	Digital competence is key to successful learning in the digital era, yet many institutions still lack adequate infrastructure.
2021	Digital transformation: a review, synthesis and opportunities for future research	Nadkarni, S., & Prügl, P	Identifies two main dimensions of digital transformation, namely technology and actors, and provides a cross-disciplinary perspective that enriches discussions on how organizations can adapt in the digital age.
2022	Digital literacy in the university setting: A literature review of empirical studies between 2010 and 2021	Gutiérrez-Ángel, N., Sánchez-García, J-N., Mercader-Rubio, I., García-Martín, J., &	Digital literacy in higher education varies widely and requires a more holistic approach in the curriculum.

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Year	Article Title	Authors	Key Findings
		Brito-Costa, S	
2022	Transformation and digital literacy: Systematic literature mapping	Farias-Gaytan, Aguaded, I., & Ramirez-Montoya, M	Identifies research gaps in digital literacy and digital transformation across various educational contexts.

Source: Processed in Research: 2024

Based on the literature review, digital transformation in higher education involves comprehensive changes in teaching methods and learning processes. Jackson (2019) emphasized the importance of managing competencies in innovative changes, particularly concerning the adoption of new technologies. In this context, Pedro et al. (2019) noted that the implementation of artificial intelligence (AI) in education can support the achievement of Sustainable Development Goals (SDGs) by improving access to quality education. However, infrastructure and faculty training remain major obstacles.

Research by Zawacki-Richter et al. (2019) also identified that AI has great potential in enhancing personalized learning, but educator involvement in AI application development remains minimal. Radianti et al. (2020) added that VR applications can increase student motivation by providing a more immersive learning experience, especially in disciplines that require complex visualizations. Valverde-Berrocoso et al. (2020) stated that there has been a significant increase in online learning adoption, but infrastructure and digital literacy challenges remain high. This study shows that although many institutions have transitioned to online learning models, not all students have adequate access to participate effectively in classes, further highlighting the digital divide.

Regarding digital literacy, a study by Falloon (2020) highlighted the importance of a digital competency framework for educators, which can be applied to students to enhance their digital skills. Benavides et al. (2020), in their review, indicated that despite increased adoption of digital technology, many institutions still face institutional challenges regarding infrastructure support and policies to facilitate digital transformation. The COVID-19 pandemic accelerated this transformation globally, as outlined by Rashid & Yadav (2020). Although technology enabled remote learning during the pandemic, and students were highly satisfied with the support provided by their instructors and universities, limited computer skills and the perception of increased workload hindered them from recognizing performance improvements in the new teaching environment (Aristovnik et al., 2020). Zhao et al. (2021) and Gutiérrez-Angel et al. (2022) emphasized that digital literacy and competency are now fundamental skills that students must master in this digital era. However, the biggest challenge remains providing adequate infrastructure and institutional readiness to adopt these technologies.

Gaytan et al. (2022) conducted a literature mapping that identified research gaps in digital literacy and digital transformation across various educational contexts. These findings indicate that although there is extensive research on digital literacy, there is still a lack of practical implementation and integration of technology into the curriculum. Therefore, further research is needed to bridge the gap between theory and practice in developing digital literacy in higher education. Through digital transformation, higher education institutions face significant challenges, both in terms of infrastructure readiness and human preparedness (Nadkarni & Prügl, 2021). The rapid adoption of technology is often not accompanied by adequate training for faculty and students, as shown in studies by Falloon (2020) and Zhao et al. (2021). Additionally, the digital divide highlighted by Rashid & Yadav (2020) serves as an important reminder that digital transformation must be accompanied by efforts to ensure equal access for all students, especially in developing countries. On the other hand, studies such as those by Radianti et al. (2020) and Zawacki-Richter et al. (2019) demonstrate the significant potential of technologies like AI and VR in creating more engaging and personalized learning environments. However, the role of educators in utilizing these technologies still requires greater attention, given that most technological applications today are developed without sufficient input from those at the forefront of teaching.

Conclusion

Technological innovations in higher education have great potential to enhance students' digital literacy and competencies. However, significant challenges must be addressed, particularly concerning technological infrastructure, faculty readiness, and equitable access for all students. The COVID-19 pandemic has accelerated digital transformation but also exposed weaknesses in institutional preparedness for rapid adaptation. Therefore, digital transformation in higher education requires a holistic approach that includes improving digital literacy, developing digital competency skills, and providing better support for adopting new technologies.

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In a continuously evolving digital era, enhancing digital literacy and competency among students in higher education is becoming increasingly essential. Digital transformation driven by technological advancements presents both opportunities and challenges for educational institutions. Literature review findings indicate that technological innovations not only change teaching and learning methods but also influence how students interact with information, collaborate, and develop the skills needed to compete in the global job market. Finally, to prepare students for future challenges, educational institutions must proactively integrate technological innovations into their curricula. Through a holistic approach that includes instructor training, infrastructure development, and the provision of adequate resources, higher education can create an environment that supports the development of students' digital literacy and competencies. This ensures that students are not only ready to meet workforce demands but also become change agents capable of making positive contributions to an increasingly complex society.

REFERENCES

1. Abad-Segura, E., González-Zamar, M., Juan C. Infante-Moro, J. C., & García, G. R. (2020). Sustainable management of digital transformation in higher education: Global research trends. Sustainability, 12(5), 2107. https://doi.org/10.3390/su12052107

2. Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., McCormack, M., Pomerantz, J., Seilhamer, R., & Weber, N. (2019). EDUCAUSE Horizon Report 2019 Higher Education Edition.

3. Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher educators' use of digital tools and needs for digital competence in higher education. Journal of Digital Learning in Teacher Education, 35(3), 169-178. https://doi.org/10.1080/21532974.2019.1646169

4. Aristovnik, A., Keržiˇ, D , Ravšelj , D., Tomaževiˇ, N., & Umek, L. (2020). Impacts of the COVID-19 pandemic on life of higher education students: A global perspective. Sustainability, 12(20), 8438. https://doi.org/10.3390/su12208438

5. Benavides, L.M.C, Arias, J.A.T., , Serna, M.D.A., Bedoya, J.W., & Burgos, D. (2020). Digital Transformation in Higher Education Institutions: A Systematic Literature Review. Sensors, 20(11), 3291. https://doi.org/10.3390/s20113291

6. Burbules, N. C., Fan, G., & Repp, P. (2020). Five trends of education and technology in a sustainable future. Geography and Sustainability, 1(3), 191-195. https://doi.org/10.1016/j.geosus.2020.05.001

7. Carbonell, J. G., Michalski, R. S., & Mitchell, T. M. (1983). An Overview of Machine Learning. Machine Learning An Artificial Intelligence Approach, Vol I. https://doi.org/10.1016/B978-0-08-051054-5.50005-4

8. Carrozzino, M. & Bergamasco, M. (2010.) Beyond virtual museums: Experiencing immersive virtual reality in real museums. Journal of Cultural Heritage, 11(4): 452-458. https://doi.org/10.1016/j.culher.2010.04.001

9. Chen, L. , Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. IEEE Access, 8, 137772-137783. https://doi.org/10.1109/ACCESS.2020.2988510

10. Deroncele-Acosta, A., Palacios-Núñez, M. L., & Toribio-López, A. (2023). Digital transformation and technological innovation on higher education post-COVID-19. Sustainability, 15(3), 2466. https://doi.org/10.3390/su15032466

11. Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency framework. Education Tech Research Dev, 68(5), 2449-2472. https://doi.org/10.1007/s11423-020-09767-4

12. Farias-Gaytan, Aguaded, I., & Ramirez-Montoya, M. (2022). Transformation and digital literacy: Systematic literature mapping. Education and Information Technologies, 27(3), 1417-1437. https://doi.org/10.1007/s10639-021-10624-x

13. Gutiérrez-Ángel, N., Sánchez-García, J-N., Mercader-Rubio, I., García-Martín, J., & Brito-Costa, S. (2022). Digital literacy in the university setting: A literature review of empirical studies between 2010 and 2021. Frontiers in Psychology. 13:896800. https://doi.org/10.3389/fpsyg.2022.896800

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14. Horlacher, A., Klarner, P., Hess, T., 2016. Crossing boundaries: organization design parameters surrounding CDOs and their digital transformation activities. In: Americas Conference of Information Systems, San Diego, CA

15. Jackson, N. C. (2019). Managing for competency with innovation change in higher education: Examining the pitfalls and pivots of digital transformation. Business Horizons, Elsevier, 62(6), 761-772. https://doi.org/10.1016/j.bushor.2019.08.002

16. Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. Educ Inf Technol 21, 655–679. https://doi.org/10.1007/s10639-014-9346-4

17. Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. Computers & Education, 148, 103778. https://doi.org/10.1016/j.compedu.2019.103778

18. Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N & Roig-Tierno, N (2021). Digital transformation: An overview of the current state of the art of research. SAGE Open, 11(1), https://doi.org/10.1177/21582440211047576

19. Oke, A., & Fernades, F. A.P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th Industrial Revolution (4IR). Journal of Open Innovation: Technology, Market, and Complexity, 6(2), 31. https://doi.org/10.3390/joitmc6020031

20. Liu, Z. J., Tretyakova, N., Fedorov, V., & Kharakhordina, M. (2020). Digital literacy and digital didactics as the basis for new learning models' development. International Journal of Emerging Technologies in Learning, 15(14), 4–18. https://doi.org/10.3991/ijet.v15i14.14669

21. Nadkarni, S., & Prügl, P. (2021). Digital transformation: A review, synthesis and opportunities for future research. Management Review Quarterly, 71, 233–341 https://doi.org/10.1007/s11301-020-00185-7

22. Paynton, S. (2012). Developing digital literacies: Briefing paper. JISC. Retrieved from http://www. jisc. ac. uk/publications/briefingpapers/2012/developing-digitalliteracies. aspx . (Accessed October 2024).

23. Pedro, F., Subosa, M., Rivas, A, & Valverde, P. (2019). Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development. Working Papers on Education Policy. UNESCO

24. Rashid, S., & Yadav, S. S. (2020). Impact of COVID-19 pandemic on higher education and research. Indian Journal of Human Development, 14(1), 1-4. https://doi.org/10.1177/0973703020946700

25. Schallmo, D., Williams, C. A., & Boardman, L. (2017). Digital transformation of business models-best practice, enablers, and roadmap. International Journal of Innovation Management, 21(8), 1–17. https://doi.org/10.1142/S136391961740014X

26. Singh, A., & Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. MIS Quart. Exec. 16 (1), 1–17

27. Tejedor, S., Cervi, L., Pérez-Escoda, A., & Jumbo, F. T. (2020). Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador. Publications, 8(4), 48. https://doi.org/10.3390/publications8040048

28. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. Journal of Strategic and International Studies, 12(2), 72-81. http://dx.doi.org/10.1016/j.jsis.2019.01.003

29. Valverde-Berrocoso, J., Garrido-Arroyo, M. D. C., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). Trends in educaional research about e-learning: A systematic literature review (2009–2018). Educational Technology Research and Development, 68(5), 2247-2265. https://doi.org/10.1007/s11423-020-09769-2

30. van Laar, E. , van Deursen, A. J. A.M., , Jan A. G. M. van Dijk, J. A. G. M,, & de Haan, J. (2020). Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review. SAGE Open, 10(1), 1-14. https://doi.org/10.1177/2158244019900176

31. Yu, Z., Llorente, A. M. P., & Gomez, M. C. S. (2021). Digital competence in higher education research: A systematic literature review. Computers & Education, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212

32. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0

33. Zhao, Y, Llorente, M.P, & Gomez, M.C.S. (2021). Digital competence in higher education research: A systematic literature review. Computers & Education, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212