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Toward a Smart Campus: A Qualitative Study of the Digital Learning Ecosystem Model in Indonesian Higher Education

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Abstract: This study aims to describe the implementation of innovative campuses in Indonesia based on a digital learning ecosystem model, while also analyzing how universities leverage technology to foster institutional innovation and support the development of a Smart Campus framework. This research employed a descriptive qualitative approach by conducting interviews with lecturers and students from several universities in Indonesia, including Makassar State University, Pontianak State Polytechnic, IPB University, Gadjah Mada University, Budi Luhur University, and Multimedia Nusantara University. Data were collected through semi-structured in-depth interviews using an interview protocol that focused on technology utilization, system integration, digital literacy, and organizational readiness. The data were analyzed using thematic analysis to identify recurring patterns in the implementation of Smart Campus initiatives. The findings reveal that the implementation of Smart Campus in Indonesian universities remains partial and fragmented due to limited system integration, unequal technological infrastructure, and varying levels of digital readiness among academic staff. These findings indicate that developing a sustainable Digital Learning Ecosystem requires not only the provision of technological infrastructure but also strong institutional alignment, continuous digital literacy development, and the design of integrated digital platforms.

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Introduction

Indonesia's higher education institutions are accelerating digital transformation, yet Smart Campus implementation still lags due to persistent structural barriers (Hartati et al., 2023; Hidayat & Sensuse, 2022). The most frequently reported barriers include unequal ICT infrastructure and network quality across institutions, limited interoperability between academic administrative systems, insufficient digital readiness among academic staff, and inconsistent institutional governance and planning that prevents technology adoption from scaling beyond isolated applications (Nieminen, 2024). As a result, many universities implement digitalization in a fragmented manner, so the intended gains in efficiency, service quality, and learning experience remain uneven and difficult to sustain (Essien et al., 2026).

In the broader higher-education literature, digital transformation is commonly framed not merely as technology procurement but as an ecosystemic shift that requires governance, data integration, user readiness, and continuous support (Das, 2024). Studies on technology integration emphasize that digital tools can enhance access, personalization, and learning

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analytics, but only when institutional processes and human capacity develop in parallel. Similarly, smart campus scholarship highlights that campuses function as "miniature smart cities," where multiple subsystems must interact and exchange data to produce value for stakeholders. Therefore, the central issue is not the absence of technology, but the absence of an integrated Digital Learning Ecosystem that aligns infrastructure, services, data flows, and stakeholder capabilities into one coherent system

Higher education institutions consist of many components that can be used as business processes to be considered miniature smart cities. Sospedra said that campuses perfectly represent urban areas, even though they have differences in dimensions and structures (H. Bayu, 2016). The innovative campus concept is a campus environment that utilizes technology to facilitate the primary requirements of its users, motivate them to confront emergent problems, and encourage them to develop superior abilities. This environment is composed of interactions between various complex systems. Although Indonesia does not yet have a standard for the Smart Campus model, numerous studies have developed innovative campus models, including the Pagliaro Smart Campus model. Pagliaro categorizes smart campuses into the following categories: economy, environment, energy, mobility, and people and living (Pagliaro, 2016). Pagliaro's (2016) model remains conceptually relevant because it frames the Smart Campus as an integrated socio-technical system; however, its application in Indonesia requires adaptation to address uneven infrastructure, fragmented digital platforms, and disparities in institutional readiness. In the 2024/2025 context, Smart Campus development must move beyond technological deployment toward an interoperable Digital Learning Ecosystem supported by governance alignment and sustained digital capability building.

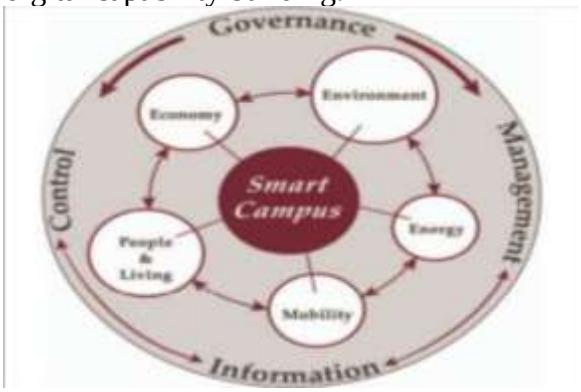

Figure 1. Smart Campus Model

Education is a critical factor in enhancing the quality of human resources as we confront the challenges of the era of Society 5.0. To answer the challenges of the social era, educational institutions must change their paradigms, including educators paying attention to the function of learning resources and letting teachers focus on inspiring students. Education 5.0 is a breakthrough from society 5.0 by integrating humans and technology to take advantage of opportunities through creative and innovative ways (Arjunaita, 2020). From the education perspective, the 5.0 era of society, viewed from an ontological perspective, emphasizes character education, morals, and exemplary behavior. A person's knowledge can be easily assessed using technology, but a person's soft and hard skills cannot be replaced by technology.

Technology integration in higher education is becoming more widely acknowledged as critical for enhancing student experience, learning, and instruction. The significance of technology in higher education is attributed to various factors (Chan, 2023; Paudel, 2020). Technology facilitates the acquisition of an immense quantity of information and resources.

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Students and faculty can effortlessly access many scholarly articles, research papers, e-books, and educational materials from any location and at any time, thanks to the internet and digital libraries (Bond & Bedenlier, 2019; Santos et al., 2019). Technology should expand educational opportunities and access. Online and distance learning programs enable individuals who may not have access to traditional higher education settings to pursue their education remotely (Attard & Holmes, 2022; Iglesias-Pradas et al., 2021).

Technology is essential for facilitating academic research and inter-university collaboration (Hartati et al., 2020; Jagannathan et al., 2019). Scholarly articles and publications are accessible to researchers through online research platforms, including Scopus and Google Scholar. Collaboration tools, including virtual meeting platforms and shared document repositories, allow researchers to collaborate with their colleagues globally by utilizing technology to facilitate effective communication and information dissemination, thereby facilitating interdisciplinary research (Barker et al., 2019; Dam et al., 2019). Students, faculty, and staff are provided with the most recent information on academic programs, events, announcements, and campus news through official university websites, social media platforms, and mobile applications. This guarantees that the university community is kept informed and connected, as it facilitates efficient and expeditious communication. The support of technology is essential for the development of an innovative campus in Indonesia.

The formulation of the problem in this study is how the implementation of an innovative campus in Indonesia is based on a digital learning ecosystem model. This study aims to analyze the efforts of universities in Indonesia to utilize technology to create an innovative campus. This study is expected to picture developing an innovative campus model in Indonesia. This research focuses on developing a Digital Learning Ecosystem Model, providing a more comprehensive and holistic view than previous studies that tend to be sporadic and focused on specific areas. This model will be designed to adapt to the specific context of higher education in Indonesia, considering local challenges and needs and the potential for collaboration between various stakeholders within the campus and with external partners. This research can also explore how this ecosystem supports more interactive, adaptive, and inclusive learning and how this model can be widely applied in various higher education institutions in Indonesia. This approach will not only contribute to improving the quality of learning in smart campuses but also has the potential to be a reference for developing higher education policies that are more responsive to the digital era in Indonesia. Hartati et al. (2020) examined the challenges and efforts of implementing technology to create an innovative campus in Pekanbaru, while Amos & Papalangi (2023) explored the factors influencing student satisfaction with innovative campus services in Makassar. Although both studies provide valuable insights into their respective local contexts, this latest study seeks to integrate these findings nationally. Furthermore, this study continues prior research on smart campuses, which are higher education institutions that employ advanced technology and data-driven solutions to establish a sustainable, connected, and intelligent environment for the campus community (Hidayat & Sensuse, 2022). Consequently, existing studies tend to explain parts of the problem (technology, management, or satisfaction) separately, leaving a gap in understanding how the Digital Learning Ecosystem should be structured as an integrated model that is empirically derived from multi-case evidence across Indonesian higher education. Thus, this research will help build a stronger foundation for equitable and effective adoption of educational technology across Indonesia, supporting digital transformation in the higher education sector in a more structured and sustainable manner.

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Research Method

This study employs a qualitative multi-case study design as the primary methodological framework. The choice of a multi-case approach is grounded in the objective of the research, which is to examine Smart Campus implementation as an institutional phenomenon across several higher education contexts in Indonesia. This study focuses on analyzing Smart Campus implementation as a bounded system within specific universities and comparing patterns across institutions. By examining multiple cases, this study seeks to identify recurring themes and cross-case similarities that contribute to the development of a contextual Digital Learning Ecosystem model.

The research was conducted in six higher education institutions in Indonesia: Makassar State University (UNM), Pontianak State Polytechnic (PNP), IPB University, Gadjah Mada University (UGM), Budi Luhur University, and Multimedia Nusantara University (UMN). These institutions were selected using purposive sampling based on clear academic considerations rather than accessibility alone. The selection criteria included: (1) the formal implementation of Smart Campus or digital campus initiatives such as Learning Management Systems (LMS), integrated academic platforms, or digital administrative systems; (2) institutional variation in type, including public universities, private universities, and polytechnics; (3) differences in technological infrastructure maturity, ranging from emerging to relatively advanced digital ecosystems; and (4) geographical representation to reflect contextual diversity in Indonesia's higher education landscape. A total of twelve participants were involved in the study, consisting of lecturers and institutional stakeholders such as IT administrators and academic managers. Participants were selected based on their direct involvement in or experience with Smart Campus systems for at least one year, ensuring that they could provide informed and reflective insights into institutional digital transformation practices.

Data were collected through semi-structured in-depth interviews guided by an interview protocol developed by Smart Campus and Digital Learning Ecosystem literature. The interview guide explored four major domains: technology utilization and digital infrastructure, system interoperability and platform integration, digital literacy and user readiness, and institutional governance and change management. Each interview lasted approximately 45 to 60 minutes and was conducted between May and July 2024.

The data were analyzed using Thematic Analysis following Braun and Clarke's six-phase framework. The analysis began with familiarization through repeated reading of the transcripts, followed by the generation of initial open codes. These codes were then organized into broader categories and refined into overarching themes through iterative comparison across cases. Cross-case analysis was conducted to identify patterns of similarity and divergence among institutions. Through this process, three dominant themes emerged: technological interoperability challenges, generational digital acceptance gaps, and institutional readiness and governance alignment. These themes formed the analytical foundation for constructing the proposed Digital Learning Ecosystem model.

Source triangulation was conducted by collecting data from multiple participant groups, including lecturers, students, and institutional administrators. Member checking was performed by sharing interview summaries with selected participants to confirm interpretative accuracy. In addition, peer debriefing with fellow researchers was conducted to minimize subjective bias and strengthen analytical credibility. These procedures collectively reinforce the credibility, dependability, and confirmability of the study.

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Results and Discussion

Implications of Smart Campus in Various Indonesian Campuses

The implementation of Smart Campus in Indonesia has shown significant development in various universities. Learning management systems (LMS) and digital integration in campus administration are the main foundations of smart campuses in Indonesia. This shows that implementing Smart Campus in Indonesia leads to increased operational efficiency of campus and provides a better and more structured learning experience for students. The technological infrastructure in these universities also varies. Almost all major universities have adequate wifi networks to support academic activities, but the quality and ease of access vary. Some universities, such as IPB and UMN, have sophisticated infrastructure, such as digital whiteboards and buildings designed for energy efficiency. On the other hand, PNP has sophisticated equipment in its laboratories, such as lathes from Germany, which are used in vocational education. However, the built technology has its specific function, which often results in difficulty managing data and ensuring interoperability between existing systems.

To clarify these patterns, Table 1 presents a comparative overview of core infrastructure and digital systems across four representative campuses (IPB, UMN, UNM, and PNP).

Table 1. Cross-Case Comparison of Digital Infrastructure, Platform Integration, and Smart Campus Features in Indonesian Universities

Institution	Network & Connectivity	Core Systems & Platforms	Smart-Campus Features
IPB (Bogor)	Fiber backbone; robust campus Wi-Fi	Fully integrated LMS, Academic and Finance ERP; unified login	Smart ID cards (campus access), automated library systems, IoT-enabled labs
UMN (Jakarta)	High-speed campus network; campus-wide Wi-Fi	Cloud-based LMS and Student Info System with single sign-on	IoT sensors in classrooms, biometric access, AI-based analytics tools
UNM (Makassar)	Standard campus network (medium speed)	Separate LMS and academic records; partial data integration	Limited smart features (pilot e-attendance, basic security cameras)
PNP (Pontianak)	Standard institutional network; connectivity varies across departments	LMS adoption limited to specific study programs; minimal integration between academic and administrative systems	Advanced vocational laboratories with industry-grade machinery; technology concentrated in program-specific applications rather than campus-wide ecosystem

Smart Campus Implementation Challenges

One of the biggest challenges in implementing an innovative campus is digital literacy. Some lecturers, especially senior lecturers, have difficulty adapting to new technologies, affecting the effectiveness of technology in the learning and administration process. This inability hinders the maximum application of technology and slows down the digitalization process on campus. Some senior lecturers are often more comfortable with

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traditional teaching and administration methods, so transitioning to digital technology takes longer and requires additional support.

> *"At the beginning, the age of the doctoral students was diverse, so even though they were officials, they were still confused about using the application. So, it was back to the guidebook and the IT team. The same goes for the lecturers, if the lecturers were older, they didn't want to use the application, so they wanted to do it conventionally face-to-face." (Respondent 1)*

Based on research conducted and interviews with several related parties, technology adoption and implementation in higher education still face several significant obstacles that need to be overcome with the right strategy. At the technology adoption stage, campuses must increase awareness and understanding of all stakeholders regarding the benefits of digital technology. Many parties are still hesitant or even reluctant to switch to a digital system due to a lack of understanding of the potential benefits offered. Therefore, it is necessary to make a serious effort to increase awareness and understanding of the importance of digital technology in supporting the education process.

A dominant theme was the generational divide in digital readiness among faculty. Many senior lecturers expressed low confidence and motivation to use new platforms, while younger faculty and students readily adopted them. By linking these accounts to technology-acceptance theory, we find clear TAM/UTAUT explanations. According to TAM, technology use is driven by perceived usefulness (PU) and perceived ease-of-use (PEOU). Our senior participants typically reported lower PEOU. This echoes prior findings that Indonesian educators with limited digital literacy tend to view e-learning tools as less useful and harder to use. UTAUT's performance expectancy and effort expectancy similarly apply, senior staff had low performance expectancy (they doubted positive outcomes from using the technology) and high effort expectancy (they anticipated difficulty), both of which predict resistance (Feriady et al., 2020).

In TAM terms, the lack of training (a facilitating condition) means lecturers' PEOU stays low, so even if management mandates a new system, adoption stalls. Indeed, similar research in Indonesia shows that academic communities can be slow in responding to blended learning innovations, hindering implementation. In short, resistance among senior lecturers can be traced to TAM-style barriers, amplified by institutional shortcomings in support and change management.

In addition, digital literacy and training for staff and lecturers are important in implementing an innovative campus. Overall, digital literacy on Indonesian campuses still varies and faces various challenges. Differences in technological readiness, human resource capabilities, and infrastructure support are the main factors affecting digital literacy. With continuous efforts to provide training, adequate IT support, and policies that support technology adoption, universities in Indonesia can improve digital literacy and create a more efficient and innovative learning environment.

Higher education is significantly influenced by technology. The digital transformation has impacted administrative processes, learning, research methods, and communication channels within higher education institutions (Geng et al., 2019; Santos et al., 2019). The imperative necessity of integrating technology into higher education to enhance the overall student experience, learning, and instruction is becoming more widely acknowledged. Technology facilitates interactive and compelling learning experiences. Multimedia presentations, simulations, virtual reality, and gamification are among the digital tools that offer opportunities for active learning, problem-solving, and skill building (Blau et al., 2020; Mohamed Hashim et al., 2022).

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Education 5.0 explicitly aims for human-centered, technology-enhanced learning, fostering not just technical skills but also creativity, critical thinking, and ethical awareness. In this light, our evidence points to a significant gap between ideals and reality. The identified generational divide means that the human side of Education 5.0 is currently achieving human–technology synergy unevenly: while students and junior staff benefit from new tools, senior lecturers (who are also educators of those students) are not fully engaged. This undermines the inclusive, collaborative learning processes that Education 5.0 envisions. Moreover, the fragmentation of services counteracts Education 5.0's goal of personalized and continuous learning. If data and learning experiences are locked in silos, it is hard to support adaptive learning pathways or institutional analytics for improvement. Thus, our findings reveal that simply deploying technology is insufficient; the underlying ecosystem must be cultivated (Hamedani et al., 2024).

In terms of policy, these insights reinforce that achieving a Smart Campus in Indonesia requires integrated strategies. Universities and policymakers should emphasize interoperability standards (e.g. APIs for system integration), invest in comprehensive digital literacy programs (especially for long-tenured faculty), and reform governance models to break down silos. This aligns with the shift toward Society 5.0: higher education institutions must not just add technology, but adapt organizational culture to leverage it for inclusive, future-ready education. By addressing these systemic challenges as highlighted in our conceptual model, Indonesian campuses can better fulfill the promise of Education 5.0 and sustainably improve educational outcomes (Feriady et al., 2020).

In Indonesia, prior research on smart campuses has focused on higher education institutions that utilize advanced technologies and data-driven solutions to establish a sustainable, connected, and intelligent environment for the campus community (Hidayat & Sensuse, 2022b). This entails integrating various technology systems and infrastructure to improve overall campus management, promote Sustainability, enhance the learning experience, and optimize operations. The successful implementation of an innovative campus in Indonesian higher education institutions is contingent upon resolving numerous challenges. It is imperative to comprehend these obstacles to identify prospective obstacles and develop practical solutions. A substantial obstacle is the requirement for a sufficient infrastructure to facilitate the implementation of advanced technologies. This encompasses reliable hardware and software systems, scalable data storage, robust network connectivity, and sufficient bandwidth. The implementation and functionality of innovative campus initiatives can be impeded by inadequate infrastructure (Gaidelys et al., 2022; Mitrofanova et al., 2019). Another challenge outlined in this study is how to improve the understanding of how higher education institutions in Indonesia can create an innovative campus focusing on technology and digital literacy.

Another challenge that higher education institutions face is financial difficulties due to changing enrolment patterns, declining public funding, and increasing costs. Institutions are investigating alternative revenue streams and collaborating with industry and community organizations to implement cost-saving strategies that will guarantee Sustainability and affordability. Research and innovation are still indispensable in addressing societal challenges and advancing knowledge, as evidenced by modern alternative solutions (Abuhmaid, 2011; Ko & Liu, 2021).

Future Smart Campus Design in Indonesia

Increasing digital literacy is the main hope for all campuses in optimizing the implementation of smart campuses. It is hoped that lecturers and students will receive more intensive training and socialization in innovative campus technology. This training is not only

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limited to the use of applications but also includes an in-depth understanding of the benefits and potential of the technology in improving the quality of education and administration. Comprehensive training should include practical modules that allow lecturers and students to try out the technology they use daily. Campuses are also expected to provide additional resources, such as online tutorials, consultation sessions with technology experts, and easily accessible technical support. Thus, the academic community can be more prepared and confident in utilizing existing technology.

With increased digital literacy and better system integration, it is hoped that implementing an innovative campus can run more effectively and efficiently. This will improve the quality of education and administration and create a more modern learning environment that is responsive to technological developments. These expectations must be realized through a firm commitment from the university, including investment in technology infrastructure, human resource training, and collaboration with leading technology providers. Thus, smart campuses can catalyze positive change in Indonesia's higher education.

Synthesizing these themes, we propose a conceptual Digital Learning Ecosystem model for Indonesian campuses. In this framework the core is Interoperable Infrastructure, such as all learning (LMS), administrative (ERP), and service (library, e-office) platforms must connect via standardized data flows. Surrounding this core are Governance Structures and Human Capacity: institutions must establish clear policies (e.g., integration of roadmaps, data standards) and invest in stakeholder training. Our thematic synthesis suggests three interlocking pillars: (1) Integrated Technology (network, IoT, platforms), (2) People & Processes (training, leadership, support), and (3) Organizational Alignment (shared vision, coordination mechanisms). These pillars feed into each other: better digital literacy improves platform uptake, which in turn motivates further system integration. In practice, such a model would mean, say, that a student’s online learning activity is seamlessly reflected in administrative records and analytics dashboards without manual intervention. Faculty readiness programs (e.g., peer mentoring, workshops) would accompany any new system rollout. Informed by participant suggestions, our model stresses iterative alignment: each campus component (e.g., an LMS, an e-library) should be introduced along with measures to integrate it with existing systems and to gauge user skill gaps. This model transforms qualitative patterns into an actionable framework that departments and policymakers can reference when planning Smart Campus initiatives.

Conclusion

This study demonstrates that Smart Campus development in Indonesia is not primarily constrained by the absence of digital technology, but by the absence of systemic integration, organizational alignment, and human-technology synchronization. Across the six institutions examined, Smart Campus implementation remains heterogeneous and fragmented, revealing three dominant structural gaps: limited interoperability among digital systems, uneven digital readiness across generational cohorts, and insufficient governance alignment to scale innovation beyond isolated applications. These findings refine existing Smart Campus frameworks by showing that in developing-country contexts, digital transformation evolves along differentiated institutional trajectories rather than through uniform technological progression.

Theoretically, this study extends Smart Campus and Education 5.0 discourse by introducing a contextual Digital Learning Ecosystem model grounded in empirical multi-case evidence. While Pagliaro’s Smart Campus model conceptualizes campuses as integrated socio-technical systems, our findings suggest that in emerging higher education systems,

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integration cannot be assumed as a starting condition but must be institutionally constructed through coordinated infrastructure development, digital capability building, and governance reform. Furthermore, the identified generational digital gap challenges the aspirational premise of Education 5.0, which emphasizes seamless human–technology synergy. In practice, this synergy remains uneven when institutional change management and capacity-building mechanisms lag technological deployment. Thus, the study contributes a developing-country perspective to Smart Campus theory by foregrounding interoperability and institutional readiness as foundational, rather than secondary, dimensions of digital transformation.

Recommendation

Based on these findings, strategic follow-up actions are required at multiple governance levels. For university leaders, Smart Campus development should move beyond technology procurement toward ecosystem integration. Institutional roadmaps must prioritize system interoperability standards, unified data architecture, and structured digital capability development programs for faculty and staff. Leadership commitment to change management is critical to reduce resistance and align institutional culture with digital transformation goals. For policymakers, the study highlights the need for national-level Smart Campus interoperability guidelines and digital governance standards. Rather than allowing institutions to develop fragmented systems independently, a coordinated regulatory framework, such as standardized APIs, integrated student data platforms, and national digital competency benchmarks for academic staff would significantly reduce duplication and inefficiency. Targeted funding mechanisms should also prioritize infrastructure equity across regions to minimize digital disparities between metropolitan and peripheral institutions. For future researchers, longitudinal and mixed-method investigations are recommended to measure the impact of Digital Learning Ecosystem maturity on institutional performance, student engagement, and educational equity. Comparative cross-national studies within Southeast Asia or other developing regions may further test the transferability of the proposed model. Additionally, quantitative validation of the ecosystem framework through structural modeling (e.g., SEM) could strengthen its theoretical generalizability.

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References

Abuhmaid, A. (2011). ICT training courses for teacher professional development in Jordan. *Turkish Online Journal of Educational Technology*, *10*(4). https://doi.org/https://eric.ed.gov/?id=EJ946628

Amos, V., & Papalangi, N. (2023). Identify Smart Campus' Features and Factors Which Affect Student Satisfaction in Using Its Services. *Riwayat: Educational Journal of History and Humanities*, *6*(3), 763–775.

Arjunaita. (2020). Pendidikan di era revolusi industri 5.0. *Prosiding Seminar Nasional Pendidikan Program Pascasarjana Universitas PGRI Palembang*, 179–196.

Attard, C., & Holmes, K. (2022). An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms. *Mathematics Education Research Journal*, *34*(4), 719– 740. https://doi.org/https://doi.org/10.1007/s13394-

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020-00359-2

Barker, M., Olabarriaga, S. D., Wilkins-Diehr, N., Gesing, S., Katz, D. S., Shahand, S., Henwood, S., Glatard, T., Jeffery, K., Corrie, B., Treloar, A., Glaves, H., Wyborn, L., Hong, N. P. C., & Costa, A. (2019). The global impact of science gateways, virtual research environments, and virtual laboratories. *Future Generation Computer Systems*, *95*, 240–248. https://doi.org/https://doi.org/10.1016/j.future.2018.12.026

Besnoy, K. D., Dantzler, J. A., & Siders, J. A. (2012). Creating a digital ecosystem for the gifted education classroom. *Journal of Advanced Academics*, *23*(4), 305–325. https://doi.org/10.1177/1932202X12461005

Blau, I., Shamir-Inbal, T., & Avdiel, O. (2020). How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students? *Internet and Higher Education*, *45*(May 2019), 100722. https://doi.org/https://doi.org/10.1016/j.iheduc.2019.100722

Bond, M., & Bedenlier, S. (2019). Facilitar la participación de los estudiantes a través de la tecnología educativa: hacia un marco conceptual. *Journal of Interactive Media n Education*, *2019*(1), 1–14.

Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, *20*(1), 38. https://doi.org/https://doi.org/10.1186/s41239-023-00408-3

Chatterjee, I., & Chakraborty, P. (2021). Use of Information Communication Technology by Medical Educators Amid COVID-19 Pandemic and Beyond. *Journal of Educational Technology Systems*, *49*(3), 310–324. https://doi.org/https://doi.org/10.1177/0047239520966996

Cordiaz, M. (2017). Penerapan Smart campus sebagai Pendukung Kegiatan Pendidikan dalam Tri Dharma Perguruan Tinggi. *Jurnal Informatika Universitas Pamulang*, *2*(2), 77–80. https://doi.org/10.32493/informatika.v2i2.1508

Cox, J. (2021). The higher education environment driving academic library strategy: A political, economic, social and technological (PEST) analysis. *The Journal of Academic Librarianship*, *47*(1), 102219. https://doi.org/https://doi.org/10.1016/j.acalib.2020.102219

Dam, M., Ottenhof, K., Van Boxtel, C., & Janssen, F. (2019). Understanding cellular respiration through simulation using lego as a concrete dynamic model. *Education Sciences*, *9*(2), 72. https://doi.org/https://doi.org/10.3390/educsci9020072

Das, D. K. (2024). Exploring the Symbiotic Relationship between Digital Transformation, Infrastructure, Service Delivery, and Governance for Smart Sustainable Cities. *Smart Cities*, *7*(2), 806–835. https://doi.org/10.3390/smartcities7020034

David, O. (2018). *Environnement numérique*. Espaces Temps.Net. https://www.espacestemps.net/en/articles/environnement-numerique/

Essien, A., Ekhaese, E., & Babalola, D. (2026). Sustainable development strategies for smart sustainable campus operations: global trends, challenges and opportunities. *Frontiers in Sustainable Cities*, *8*. https://doi.org/10.3389/frsc.2026.1747438

Feriady, M., Nurkhin, A., Mahmud, N., Setiani, R., & Astuti, D. P. (2020). Influence of organizational suport and digital literacy on lecturer acceptance of e-learning in indonesia: A modification of the technology acceptance model. *International Journal of Scientific and Technology Research*, *9*(1), 2229–2233.

Gaidelys, V., Čiutienė, R., Cibulskas, G., Miliauskas, S., Jukštaitė, J., & Dumčiuvienė, D. (2022). Assessing the Socio-Economic Consequences of Distance Learning during the COVID-19 Pandemic. *Education Sciences*, *12*(10), 1–22.

https://doi.org/https://doi.org/10.3390/educsci12100685

Geng, S., Law, K. M. Y., & Niu, B. (2019). Investigating Self-Directed Learning and Technology Readiness in Blending Learning Environment. *International Journal of Educational Technology in Higher Education*, *16*(1), 1–22. https://doi.org/https://doi.org/10.1186/s41239-019

Gupta, S. (2022). A Standards-First Approach for Digital Ecosystem Interoperability in Education. *MagicBox*.

H. Bayu, S. (2016). Analisis Pengukuran Tingkat Kesiapan Implementasi E-Learning (E-Learning Readiness) Studi Kasus: UPN 'Veteran' Jakarta. *Seminar Nasional Teknologi Informasi Dan Multimedia*.

Hartati, S., Sumarto, Nurdin, D., & Suryana, A. (2023). Taking Up the Challenges Faced by Higher Education Institutions in Technology to Create Smart Campus. *Journal of Education Research and Evaluation*, *7*(4), 671–683. https://doi.org/10.23887/jere.v7i4.66851

Hartati, S., Syamsuadi, A., Elvitaria, L., Abdurrab, U., & Cobit, F. (2020). Tranformasi Manajemen Universitas menggunakan Framework. *Ganaya: Jurnal Ilmu Sosial Dan Humaniora*, *3*(1), 163–174.

Hidayat, D. S., & Sensuse, D. I. (2022). Knowledge Management Model for Smart Campus in Indonesia. *Data*, *7*(1), 7. https://doi.org/10.3390/data7010007

Holland, C., Westwood, C., & Hanif, N. (2020). Underestimating the Relationship Between Academic Advising and Attainment: A Case Study in Practice. *Frontiers in Education*, *5*(September), 1–11. https://doi.org/https://doi.org/10.3389/feduc.2020.00145

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *199*. https://doi.org/https://doi.org/10.1016/j.chb.2021.106713

Jagannathan, S., Ra, S., & Maclean, R. (2019). Dominant recent trends impacting on jobs and labor markets - An Overview. *International Journal of Training Research*, *17*(sup1), 1–11. https://doi.org/https://doi.org/10.1080/14480220.2019.1641292

Kamruzzaman, M. M., Alanazi, S., Alruwaili, M., Alshammari, N., Elaiwat, S., Abu-Zanona, M., Innab, N., Mohammad Elzaghmouri, B., & Ahmed Alanazi, B. (2023). AI- and IoT-Assisted Sustainable Education Systems during Pandemics, such as COVID-19, for Smart Cities. *Sustainability*, *15*(10), 8354. https://doi.org/https://doi.org/10.3390/su15108354

Ko, W. W., & Liu, G. (2021). The Transformation from Traditional Nonprofit Organizations to Social Enterprises: An Institutional Entrepreneurship Perspective. *Journal of Business Ethics*, *171*(1), 15–32. https://doi.org/https://doi.org/10.1007/s10551-020-04446-z

Lubis, A. H. (2018). *ICT Usage Amongst Lecturers and Its Impact Towards Learning Process Quality* (Vol. 34, Issue 1).

Mitrofanova, Y. S., Sherstobitova, A. A., & Filippova, O. A. (2019). Modeling the Assessment of Definition of a Smart University Infrastructure Development Level. *Smart Innovation, Systems and Technologies*, *144*, 573–582. https://doi.org/https://doi.org/10.1007/978-981-13-8260-4_50

Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, *27*(3), 3171–3195. https://doi.org/https://doi.org/10.1007/s10639-021-10739-1

Vol. 12, No. 1 : March 2026
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Nieminen, J. H. (2022). Assessment for Inclusion: rethinking inclusive assessment in higher education. *Teaching in Higher Education*, 1–19. https://doi.org/https://doi.org/10.1080/13562517.2021.2021395

Nieminen, J. H. (2024). Assessment for Inclusion: rethinking inclusive assessment in higher education. *Teaching in Higher Education*, *29*(4), 841–859. https://doi.org/10.1080/13562517.2021.2021395

O'Leary, E. S., Shapiro, C., Toma, S., Sayson, H. W., Levis-Fitzgerald, M., Johnson, T., & Sork, V. L. (2020). Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *International Journal of STEM Education*, *7*(1). https://doi.org/https://doi.org/10.1186/s40594-020- 00230-7

Pagliaro, F. (2016). A roadmap toward the development of Spienza Smart Campus. *IEEE*.

Paudel, P. (2020). Online Education: Benefits, Challenges and Strategies During and After COVID-19 in Higher Education. *International Journal on Studies in Education*, *3*(2), 70–85. https://doi.org/https://doi.org/10.46328/ijonse.32

Peek, L., Tobin, J., Adams, R. M., Wu, H., & Mathews, M. C. (2020). A Framework for Convergence Research in the Hazards and Disaster Field: The Natural Hazards Engineering Research Infrastructure CONVERGE Facility. *Frontiers in Built Environment*, *6*(July), 1–19. https://doi.org/https://doi.org/10.3389/fbuil.2020.00110

Santos, H., Batista, J., & Marques, R. P. (2019). Digital transformation in higher education: the use of communication technologies by students. *Procedia Computer Science*, *164*, 123–130. https://doi.org/https://doi.org/10.1016/j.procs.2019.12.163

Shahidi Hamedani, S., Aslam, S., Mundher Oraibi, B. A., Wah, Y. B., & Shahidi Hamedani, S. (2024). Transitioning towards Tomorrow's Workforce: Education 5.0 in the Landscape of Society 5.0: A Systematic Literature Review. *Education Sciences*, *14*(10), 1041. https://doi.org/10.3390/educsci14101041