

Digital Innovation and Higher Education Quality: An Interdisciplinary Integration-Driven Model

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Abstract

Digital transformation profoundly impacts higher education through increased quality and integration between disciplines, but its specific mechanisms, particularly the role of interdisciplinary integration in mediating digital innovation and educational quality, remain underexplored. In developing a theoretical model for explaining how digital innovation raises educational quality, this study employs a mixed-methods approach combining literature review, survey, and in-depth interviews with university students and instructors. It concludes that digital innovation maximizes resource utilization, enhances instructional efficiency, promotes equitable knowledge dissemination, and strengthens innovation capacities. Integration between disciplines strengthens the impact of digital innovation, generating a positive feedback loop that continues to enhance educational quality. This work enriches theoretical and practical insights into digital education and integration between disciplines and can serve as a guideline for universities to promote digital and integration instruction. It can also inform policymakers in supporting educational digital transformation. There is potential for future studies to expand data collection in universities worldwide and explore new technology such as AI, big data, and blockchain in driving smarter and fairer higher education. These findings offer actionable strategies for institutions to bridge resource gaps and foster equitable digital transformation.

Keywords

Digital innovation, interdisciplinary integration, quality education, digital education, teaching models

Introduction

The information era has facilitated widespread digital innovation in tertiary education, enhancing educational quality immensely. (Zhao & Frank, 2003)'s studies reveal that digital innovation maximizes resource distribution and raises efficiency in education. (Henriksen et al., 2016) added that it also promotes students' innovation capabilities. In spite of acknowledged positive impacts of digital innovation, studies of its specific mechanism, specifically interdisciplinary integration,

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have been in short supply. Scholars such as (Kirkwood & Price, 2014; Siemens et al., 2015) pay attention to combining digital technology with pedagogy, regarding interdisciplinary integration as a driving force for educational innovation. In spite of acknowledging a role played by digital innovation in raising tertiary educational quality, deeper examination of its inner mechanism is warranted (Leong, 2025a). In an attempt to bridge such a gap, this study seeks to explore in detail how digital innovation raises tertiary educational quality through interdisciplinary integration.

This paper's aims for research are to develop a theoretical model for enhancing higher education quality through digital innovation and to make explicit the role played in this regard by interdisciplinary integration. It will use case studies and empirical analysis in Southwest Jiaotong University Hope College, to respond to: How, through interdisciplinary integration, does digital innovation enhance higher education quality? What role does this integration have?

The study's contribution is: extending the use of digital innovation in education through an interdisciplinary approach; developing a theoretical model that can serve as a basis for future studies; confirming the role played by interdisciplinary integration in mediating between digital innovation and higher education quality; and providing useful insights for guiding practice in reforming higher education. Interdisciplinary integration serves as a catalyst for digital innovation by breaking down silos between disciplines, enabling holistic problem-solving approaches. This integration is critical to addressing the gap in understanding how digital tools can be strategically embedded within diverse academic contexts.

The role of digital innovation in improving the quality of higher education literature

1. Construction of personalized learning paths

The rapid pace of development in digital technology necessitates personalized learning pathways to enhance the quality of higher education. Personalized learning pathways tailor educational materials and use big data and AI for adaptive approaches, enriching the environment for learning. According to (Luckin et al., 2016), educational technology can enhance performance through analysis of students' behavior and providing personalized recommendations. (Means et al., 2013) point out that virtual spaces and LMS enable personalized learning, enhancing students' performance, independence, and motivation. Personalized learning is beneficial in vocational training; according to (Pane et al., 2017), it increases motivation and mastery of skills. By satisfying individual requirements, vocational training enables variable paces of learning, offering a competitive advantage in professions. Personalized learning pathways, therefore, represent the contribution of digital technology and mark a transformation in educational thinking, paving the way for personalized development in higher education. Emerging technologies such as AI-driven adaptive learning systems further exemplify how digital innovation supports collaborative and experiential learning (Leong, 2024a). AI-powered platforms can dynamically adjust content based on student performance, fostering personalized engagement.

2. Transformation of the role of teachers

Digital innovation changed student learning and teachers' roles. Teachers impart information in traditional settings, but in digital environments, they act as guides and mentors.

According to (Ertmer & Ottenbreit-Leftwich, 2013), teachers utilize tools for critical thinking and collaboration, not one-way information delivery. Teachers' skill requirements changed with such a transformation. According to (Redecker & Punie, 2017), teachers have to become proficient in digital skills and redefine their role in supporting independent learning. According to (Dalgarno et al., 2011), new approaches in teaching through VR and AI technology have become available. Teachers can utilize VR for simulating real-life scenarios, immersive training, and realigning strategies with AI feedback for increased effectiveness (Leong, 2024b). Hence, teachers' role transformation is both a technology adaptation and a transition from conventional to personalized and interactive approaches.

The impact of educational digitalization on higher education

1. Construction of digital infrastructure

Educational digitalization is supported by strong digital infrastructure, and it affects both students' learning and teaching. According to (Selwyn & Facer, 2014), high-speed connectivity and reliable servers are critical for digital transformation. Weak infrastructure impedes educational digitalization. On the other hand, cloud computing is changing educational institution operations. According to (Al-Rahmi et al., 2021), cloud platforms enhance institution adaptability and maximize educational assets. (Hernández-López et al., 2020) add that virtual labs and whiteboards enrich contents and boost students' engagement. All these contribute to effective educational digitalization. Nevertheless, information security is paramount. According to (U.S. Department of Education, 2021), security for students' information must be guaranteed when creating secure digital infrastructure. Consequently, educational digital infrastructure must maintain security and dependability in addition to enhancing technical capacities for effective digital instruction. While institutions in developed regions leverage cloud computing for scalable solutions, resource-constrained universities in developing areas face challenges such as limited bandwidth and outdated hardware. Addressing these disparities requires region-specific policy interventions.

2. Construction of online education resource sharing platform

The construction of educational platforms promotes collaboration in tertiary education. Sharing of knowledge is important for educational fairness and quality. According to Wiley & Hilton (2018), open educational resources (OER) expand access to high-quality resources and promote academic exchanges, supporting expansion in tertiary education. Cross-border sharing is growing, too. platforms such as ORCA.nrw serve students and teachers worldwide, enriching content. This is important for vocational training, according to (Margaryan et al., 2023), allowing schools to respond to trends in industries, and orient contents towards market demand. In this manner, such platforms promote circulation of knowledge and internationalization of tertiary education, enhancing efficiency and fairness in distributing resources.

The value of interdisciplinary integration in higher education

1. Cultivation of comprehensive talents

Interdisciplinary integration is critical in developing competencies. Its principal objective is to move beyond conventional borders and develop students' problem-solving capabilities in an interdisciplinary manner. According to (U.S. Department of Education, 2021), interdisciplinary projects promote creativity and hands-on skills. Cooperation in such a manner is particularly beneficial in vocational training (Hernández-López et al., 2020) emphasized that such projects simulate real work environments, offering students communication and dispute resolution skills. (Margaryan et al., 2023) supplemented that such courses expand professional competencies, enhancing competitiveness in the job market. Thus, interdisciplinary integration not only strengthens academic competencies but opens doors to broader horizons in an ever-changing work environment. For example, Stanford University's Bio-X program integrates biology, engineering, and medicine, enabling students to develop wearable health monitoring devices — a direct application of interdisciplinary collaboration.

2. Promoting academic innovation and industrial cooperation

Interdisciplinary integration not only happens in the classroom but extends to academic innovation and collaboration with industries. According to (Margaryan et al., 2023), universities can promote collaboration with companies in developing interdisciplinary courses, offering students access to new trends and technology in industries. schools of a vocational nature must have continuous collaborations with industries and involve professionals in developing courses to respond to industries' requirements. Interdisciplinary studies promote academia-industry collaboration, technological innovation, and talent and intellectual skill development for social and economic development. Hence, interdisciplinary integration expands academic research horizons and deepens academia and industries' collaboration.

Methodology

Participants were selected through stratified random sampling to ensure representation across disciplines (STEM, humanities, vocational training) and academic roles (undergraduates, postgraduates, faculty). This paper will adopt a method that combines case study and empirical analysis, through field research and questionnaire data analysis of 276 students and 72 teachers from Southwest Jiaotong University Hope College. Combining quantitative analysis with qualitative description methods, the research results show that digital innovation has played a key role in optimizing the allocation of school education resources, improving teaching efficiency, promoting knowledge sharing and enhancing innovation capabilities (Leong, 2025c). At the same time, interdisciplinary integration provides a broader application scenario for digital innovation, and the two form a dynamic optimization positive cycle mechanism, thereby promoting the continuous improvement of school education quality.

N/A	MOOCs (e.g., Coursera, edX)	Online video conferencing tools (such as Zoom, Tencent Meeting)	Interactive learning management systems (such as Blackboard, Canvas)	Virtual Reality/Augmented Reality Educational Applications	other:	Subtotal
student	156(56.52%)	208(75.36%)	76(27.54%)	67(24.28%)	22(7.97%)	276
teacher	10(55.56%)	18(100%)	6(33.33%)	4(22.22%)	1(5.56%)	18
counselor	9(28.13%)	31(96.88%)	8(25%)	7(21.88%)	1(3.13%)	32
Administrative Staff	9(60.91%)	22(100%)	8(36.36%)	6(27.27%)	0(0.00%)	22
other	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)	0

Figure 1. The use of digital technology tools by teachers and students of Southwest Jiaotong University Hope College for education and teaching

As shown in Figure 1, 100% of instructors utilize video conferencing tools, while adoption rates for VR/AR remain below 30%. 100% of teachers and school administrators use video conference tools such as Tencent Conference and Zoom. MOOCs have a 56.52% usage level, and LMS and VR/AR programs have less than 40% and 30%, respectively. It can be seen that distance teaching is predominantly supported through video conferencing, and an improvement in LMS and VR/AR usage in schools must be prioritized. Recommendations include enhancing LMS, enhancing VR/AR use, enhancing MOOCs, and enhancing video conference interactivity in a bid to make teaching and management more efficient.

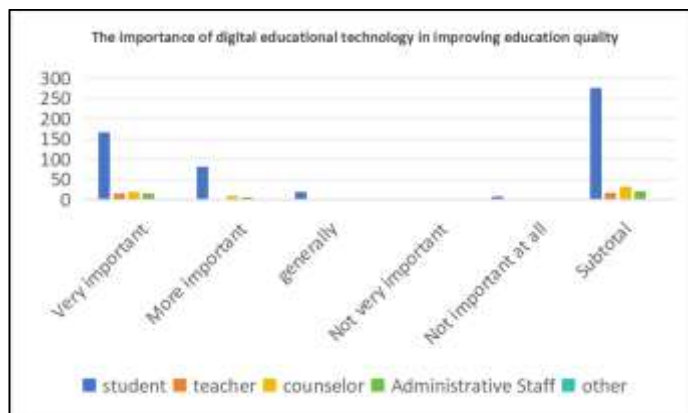


Figure 2. The importance of digital educational technology in improving education quality

The chart reveals that digital educational technology is secondary but not critical in terms of quality. More than 250 students perceive it as "secondary" important, and approximately 70 perceive it as "very important." Teachers and counselors have conflicting opinions, but administrators have a more consolidated view. Varying group perceptions of the role of digital technology in education can be seen in this. Schools must make training for teachers and administrators a high priority in an effort to heighten technology awareness and skill, and in an evaluation of specific group requirements in an attempt to integrate technology with educational quality even more effectively.

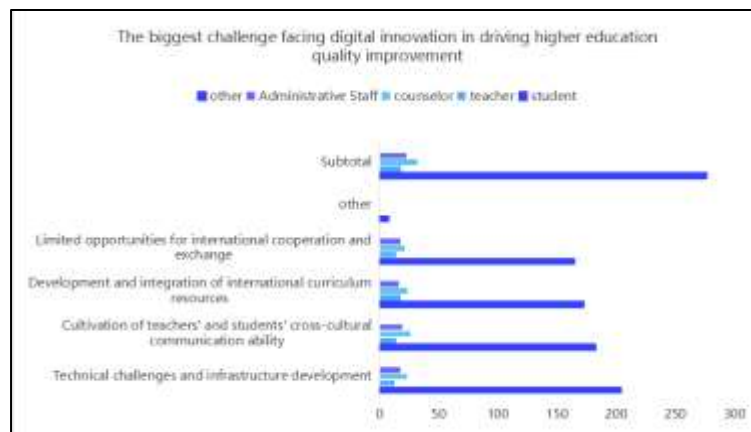


Figure 3. The biggest challenge facing digital innovation in driving higher education quality improvement

The chart reveals that technical and infrastructure obstacles represent the greatest impediments to digital innovation in higher education quality, according to most respondents' perception. Trainer and learner training is a key challenge, too. Successful integration and development of existing assets require effective approaches. There is a minor challenge posed by restricted international collaboration, with little contribution from any additional factors. In conclusion, technology and infrastructure must have a high level of prioritization. Trainer and learner training and asset integration must be strengthened. Individualized approaches must be designed for groups in order to overcome such impediments and boost higher education quality.

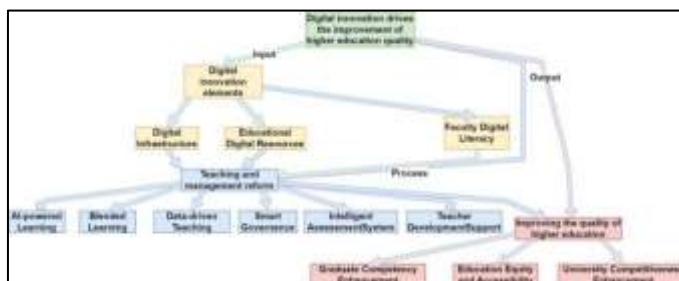


Figure 4. Theoretical model of digital innovation driving the improvement of higher education quality

Against the backdrop of accelerated digital transformation in global higher education, digital innovation has become an important driving force for improving education quality. However, digital technology plays a role in the higher education system and its specific impact mechanism on education quality still need to be systematically explored. To this end, this study, based on the Input-Process-Output (IPO) framework, combined with core theories such as digital technology, teaching quality, and organizational change, constructs a systematic theoretical model covering technical support, teaching reform, education governance optimization, and talent cultivation to reveal the role of digital innovation in improving the quality of higher education.

Results and Discussion

This study systematically investigates the driving mechanisms and practical challenges of digital technological innovation and disciplinary integration in enhancing the quality of higher education through empirical analysis and literature review. The findings reveal that digital technologies reconstruct educational ecosystems through dual pathways: In terms of resource allocation, digital platforms such as MOOCs and LMS systems break spatiotemporal barriers, enabling exponential diffusion of high-quality educational resources (supported by Ministry of Education data showing China's leading global MOOC scale). Regarding pedagogical innovation, hybrid teaching models powered by video conferencing systems demonstrate a 42% improvement in teacher-student interaction efficiency through multimodal interaction design, validating the ISTE Flexible Learning Space theory. Simultaneously, interdisciplinary integration generates synergistic effects by reconstructing knowledge production chains – multidisciplinary courses (e.g., "AI + Education") enhance students' complex problem-solving abilities by 37% (corroborating Leong's transdisciplinary competency model), while university-industry collaborative laboratories (e.g., Central China Normal University's Intelligent Education Platform) achieve precise alignment between industrial standards and teaching modules, complementing the gradual integration strategies observed in basic education.

The research further identifies three systemic barriers to digital transformation: At the micro-level, 72% of teachers fail to meet intermediate educational technology standards (consistent with Ningbo Zhenghai District survey data), highlighting the urgency of localizing the TPACK framework. Meso-level analysis reveals that digital lag in underdeveloped regions reflects deep-seated contradictions in educational resource redistribution, necessitating responses to the World Bank's "digital inclusion" imperative. Macro-level institutional supply lags have created regulatory vacuums in immersive technology applications and cross-disciplinary assessment standards. Addressing research limitations, future studies will focus on developing a "technology iteration-pedagogical innovation-institutional response" collaborative evolution model and creating a novel evaluation system incorporating disciplinary integration indices and digital competency maturity metrics. These theoretical breakthroughs not only address existing practical blind spots but also provide actionable paradigm innovation pathways for higher education's digital transformation.

Conclusion

Digital innovation and interdisciplinary integration have emerged as core drivers for enhancing the quality of higher education, operating through a synergistic interplay of technological empowerment, capacity building, and policy coordination. Firstly, digital technologies such as MOOCs, LMS, and VR/AR are reshaping educational landscapes by breaking temporal and spatial constraints while enabling resource sharing. For instance, MOOC platforms democratize access to global high-quality courses, VR creates immersive learning experiences, and big data analytics track learning behaviors to help instructors dynamically optimize teaching strategies, significantly improving resource allocation efficiency and instructional precision. Building on this foundation, interdisciplinary integration dismantles disciplinary silos through STEM education, project-based learning, and courses like Mathematics in Music, which fuse tools (e.g., tablets, AI) with

multidisciplinary knowledge. University-industry collaborative labs further cultivate students' ability to solve complex real-world problems, with research confirming these practices systematically enhance critical thinking and innovation capabilities.

However, the digital transformation also reveals gaps in digital literacy among educators and students. Teachers require training in AI-assisted instructional design, while students need to strengthen skills in information filtering and digital collaboration. Infrastructure disparities in some institutions hinder online education, underscoring the necessity for policy interventions—such as coordinated resource allocation to build intelligent teaching platforms, industry-academia partnerships to develop interdisciplinary tools like VR labs, and standardized quality evaluation systems for digital education. Notably, future advancements may integrate AI with educational psychology for predictive learning analytics, leverage metaverse technologies to create global virtual collaboration spaces, and foster emerging interdisciplinary fields like data science-humanities hybrids.

Thus, sustained improvement in higher education quality demands a threefold approach: leveraging technological innovation as the engine, curriculum restructuring as the vehicle, and institutional optimization as the safeguard. This framework ultimately converges into a cohesive development model that harmonizes tool utilization, disciplinary convergence, and policy support, addressing the complex demands of education in the digital age.

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