

Digital Transformation and Management Innovation in Vocational Education: Evidence from AI-Enabled Project-Based Learning

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Abstract

Digital transformation has become a defining trend in global education systems, particularly in vocational education where alignment with rapidly evolving industry technologies is essential. In China, national digitalization strategies have accelerated the integration of artificial intelligence (AI) into teaching and governance practices, raising new challenges for institutional management systems. However, how AI-driven pedagogical innovation reshapes educational management processes remains insufficiently examined. This study investigates the mechanisms and pathways of digital transformation and educational management innovation in Chinese vocational education. Focusing on the integration of Artificial Intelligence (AI) with Project-Based Learning (PBL), the research adopts a qualitative single-case study design, examining the “AI+” PBL reform implemented in the E-commerce program at Hunan Vocational College of Electronic Science and Technology (DK College). Data were collected through semi-structured interviews, classroom observations, and multi-source document analysis involving administrators, faculty members, students, and industry partners. The findings indicate that AI-enabled PBL has catalyzed adaptive transformation across four key managerial domains: (1) curriculum management shifted from rigid scheduling to flexible project-cycle organization; (2) faculty management evolved toward cross-disciplinary project mentor teams; (3) resource support integrated institutional AI platforms with authentic enterprise data environments; and (4) assessment practices expanded to include multi-dimensional evaluation of learning processes, project outcomes, and digital literacy. The study further reveals that digital transformation in vocational education management is a dynamic and iterative process shaped by continuous interaction among technological logic, pedagogical logic, and organizational logic. Based on the case analysis, an integrated analytical framework Technology Integration–Management Transformation–Organizational Adaptation is proposed. This research contributes empirical insights into localized management innovation and offers practical implications for vocational institutions and policymakers advancing educational digitalization, particularly with regard to institutionalizing management innovation.

Keywords: Digital transformation; Educational management innovation; Artificial intelligence; Vocational education; Project-based learning

Introduction

Digital transformation has become a central driver of organizational change across global education systems, reshaping governance models (Kim, Y. S., & Park, J. H, 2022; Korea Ministry of Education, 2022), organizational structures, and management practices in education. In China, the national “Education Digitalization Strategy Action” explicitly emphasizes the role of digital technologies in modernizing education governance and

management. Against this backdrop, vocational education faces intensified pressure to respond to industrial digitalization, particularly in technology-intensive fields such as e-commerce, artificial intelligence, and data-driven services.

Artificial intelligence (AI), as a key enabling technology, is increasingly embedded in educational administration, instructional delivery, and learning assessment (Dikkatwar et al., 2025; Yadav, 2026; Yarra & Ghassemi, 2025). Simultaneously, Project-Based Learning (PBL) has gained prominence as a pedagogical model aligned with vocational education's emphasis on practice, collaboration, and problem-solving. The integration of AI with PBL ("AI + PBL") presents a promising pathway for aligning vocational education with real-world industry demands while fostering students' advanced digital competencies, particularly in problem-solving, data-informed decision-making, and applied digital skills (Ministry of Education of the People's Republic of China, 2021; National Institute of Education Sciences, 2023).

However, translating such pedagogical innovation into sustainable institutional practice remains challenging. Many vocational colleges continue to operate under management systems characterized by rigid scheduling, discipline-based organizational structures, and standardized evaluation mechanisms, which often constrain pedagogical innovation in digitally enhanced learning environments (Wang, Y et al, 2023; Zhu, Z. T., & Hu, J, 2021). These inherited arrangements often conflict with the flexibility, interdisciplinarity, and process orientation required by AI-enabled PBL, resulting in a persistent gap between policy aspirations and practical implementation (Knox, J, 2022).

Existing research on digital transformation in education has largely focused on technological applications or learning outcomes, with relatively limited attention to the management mechanisms that mediate between technology adoption and pedagogical change (Alkhaja et al., 2025; Veseli et al., 2025; Wesonga & van der Westhuizen, 2026). Studies addressing AI in education tend to emphasize instructional tools and ethical issues, while research on project-based learning (PBL) primarily concentrates on curriculum design and student performance (Al Eisaei et al., 2025; Fütterer et al., 2025; Wickramasinghe & Appiah, 2026). Consequently, there is a lack of empirically grounded analysis examining how AI-driven pedagogical innovation reshapes teaching management processes at the institutional level, particularly within the context of vocational education.

To address this gap, this study examines how AI-enabled project-based learning reshapes teaching management processes in vocational education institutions. It analyzes the managerial adaptations that emerge to support the implementation of AI+ project-based learning and the tensions revealed in this process. It further explores how these adaptations contribute to the broader digital transformation of vocational education management.

This study makes three primary contributions. First, it shifts analytical focus from instructional technology to education management, highlighting how AI-enabled pedagogy acts as a catalyst for organizational and managerial transformation. Second, it provides an in-depth, context-sensitive case analysis of vocational education in China, enriching the literature with localized empirical evidence. Third, it proposes an integrated analytical framework that connects technology integration, management transformation, and organizational adaptation, offering a transferable lens for examining similar initiatives in other vocational institutions.

Digital transformation is increasingly understood as a systemic process involving organizational structures, governance models, and institutional culture, rather than mere technological adoption (Wang, Y et al, 2023; Williamson, B., & Eynon, R, 2021). In education, this shift entails a move from experience-based and hierarchical management toward data-informed, service-oriented, and collaborative governance models.

Recent studies emphasize that successful transformation depends on aligning technological affordances with institutional capacities and management logic.

Research on AI in education highlights its transformative potential in learning analytics, personalized support, and data-informed governance, while also emphasizing challenges related to data governance, ethical risks, and institutional readiness (Holmes, W et al, 2022). Separately, PBL has been shown to enhance problem-solving ability, collaboration, and applied learning outcomes in vocational and technical education contexts (National Institute of Education Sciences, 2023). However, its effectiveness depends heavily on supportive management structures, including flexible scheduling, interdisciplinary collaboration, and diversified assessment systems. The intersection of AI and PBL therefore introduces complex managerial demands that remain insufficiently examined in existing literature.

Within vocational education, digital transformation is complicated by strong industry linkages and practice-oriented curricula. Existing studies point to persistent tensions between innovative teaching models and standardized management systems. However, empirical research examining how vocational institutions adapt their management practices to accommodate AI-enhanced PBL is scarce, underscoring the need for case-based investigation.

In summary, existing studies have yet to provide an integrated explanation of how AI-enabled pedagogical innovation reshapes teaching management processes in vocational education. To address this gap, the present study constructs an integrated analytical framework that connects technology integration, management transformation, and organizational adaptation to guide the subsequent case analysis (see Fig. 1).

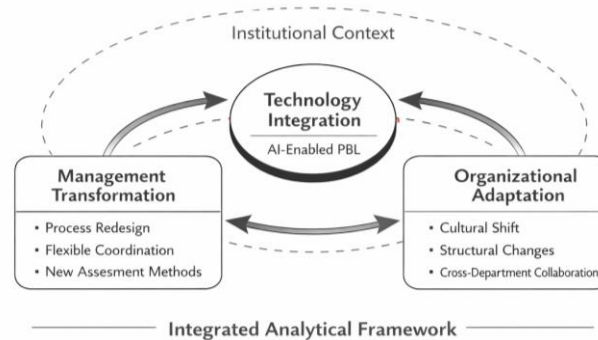


Fig 1. Integrated Analytical Framework of AI-Enabled Digital Transformation in Vocational Education Management

Methodology

This study adopts a qualitative single-case study design to explore the management transformation associated with AI-enabled project-based learning. The case selected is the E-commerce program at DK College, a public higher vocational institution actively engaged in digital teaching reform. Data were collected through three primary methods: semi-structured interviews with administrators, faculty members, students, and industry partners; participant and non-participant observations of key instructional activities; and document analysis of institutional policies, instructional materials, and digital platform records. An overview of the data sources and participants is provided in Table I.

Table 1. Data Sources and Participants

Data Source	Participants/Materials	Analytical Purpose
Semi-structured interviews	Administrators, faculty members, students, industry partners	Examine managerial practices, role perceptions, and governance challenges
Observations	Project meetings, classroom activities, final project presentations	Capture implementation processes and interaction patterns
Document analysis	Institutional policies, syllabi, project artifacts, digital platform records	Provide contextual evidence and support triangulation

Data analysis followed a thematic analysis approach, enabling the identification of recurrent patterns and managerial mechanisms across data sources. Methodological triangulation and member checking were employed to enhance credibility. As illustrated in Fig. 2, the study followed a phased qualitative case study process integrating data collection, thematic analysis, and triangulation.

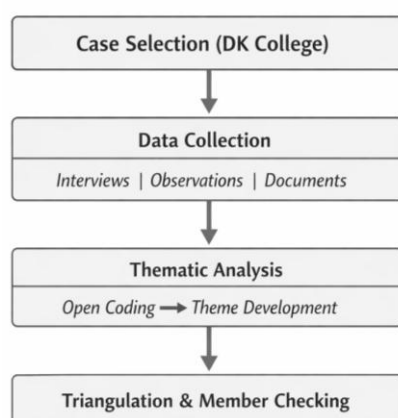


Fig 2. Research Design and Data Collection Analysis Process

Results and Discussion

Reconfiguration of Teaching Management Processes: From Rigid Control to Data-Informed Flexibility

The findings indicate that the integration of AI with project-based learning (PBL) triggered a significant reconfiguration of teaching management processes, particularly in terms of process datafication and scheduling

flexibility. AI-related tools transformed previously implicit learning activities into traceable and analyzable data, including students' code submission records, collaborative document histories, and platform usage logs. These digital traces enabled administrators and mentoring teams to monitor project progress and identify learning bottlenecks in real time, marking a shift from experience-based to evidence-informed management.

To accommodate the uncertainty inherent in project-based work, DK College piloted flexible scheduling arrangements, such as project-dedicated time blocks. However, these practices exposed tensions between flexible instructional needs and rigid institutional systems, including timetable software, classroom allocation rules, and workload calculation mechanisms. As one administrator noted, enabling flexibility for projects required "reprogramming the management system itself" (Interview M-02). This finding highlights the challenge of introducing flexibility into legacy management structures.

Teacher Role Transformation and Cross-Disciplinary Mentoring Teams

The study reveals a substantial transformation in teachers' roles, shifting from discipline-bound knowledge transmitters to hybrid roles combining project architect, technical coordinator, and learning coach. This transformation was institutionalized through the formation of cross-disciplinary project mentoring teams, typically composed of e-commerce faculty, AI or computer science instructors, and industry mentors.

These teams collaborated in project design, technical troubleshooting, and assessment, thereby reducing disciplinary silos and fostering knowledge integration. Nevertheless, two challenges emerged. First, existing evaluation and incentive systems struggled to recognize cross-disciplinary mentoring workloads. Second, gaps in teachers' AI-related pedagogical competencies generated "knowledge anxiety," particularly regarding how to translate technical tools into effective teaching and assessment strategies. These issues constrained the sustainability of collaborative teaching practices.

Emerging Student Competencies and the Assessment Dilemma of Digital Literacy

AI-enabled PBL significantly enhanced students' ability to address complex, authentic problems. Beyond traditional e-commerce skills, two emergent competencies were identified: AI-augmented skills, referring to students' capacity to extend their abilities through AI tools, and human-AI collaboration literacy, reflecting their understanding of AI's capabilities and limitations in task allocation.

However, assessing these process-oriented competencies posed a major management challenge. Conventional examinations and final reports were insufficient to capture students' decision-making logic, ethical considerations, and iterative learning processes. Although DK College experimented with project portfolios and oral defenses, evaluation remained difficult. An industry mentor remarked that while final products were assessable, students' cognitive growth in "taming AI tools" was hard to quantify (Interview E-01). This finding underscores the lag of existing assessment systems in effectively capturing process-oriented digital literacy and higher-order competencies in the intelligent era (Lee, J. Y., & Choi, M. H, 2021; Williamson, B., & Eynon, R, 2021).

From Departmental Silos to Emerging Collaborative Governance

To support AI-enabled PBL, DK College initiated cross-departmental coordination among academic affairs, IT services, academic units, and industry cooperation offices. These arrangements facilitated the alignment of technological infrastructure, enterprise resources, and flexible teaching organization. Despite

these advances, collaboration largely depended on informal communication and individual leadership rather than standardized, platform-based governance mechanisms. As a result, cross-departmental coordination remained project-driven and fragile, highlighting the difficulty of institutionalizing collaborative governance during early stages of digital transformation.

A Dynamic Model of Digital Transformation in Vocational Education Management

Synthesizing the findings, this study proposes a preliminary dynamic model of digital transformation in vocational education management. The model conceptualizes transformation as an iterative process involving four stages: technological triggering, conflict and adjustment, adaptive change, and feedback-driven evolution. In the DK College case, the institution appears to be transitioning from conflict-driven adjustment toward deeper adaptive change, with partial institutionalization still underway. The proposed stages and their iterative relationships are illustrated in Fig. 3.

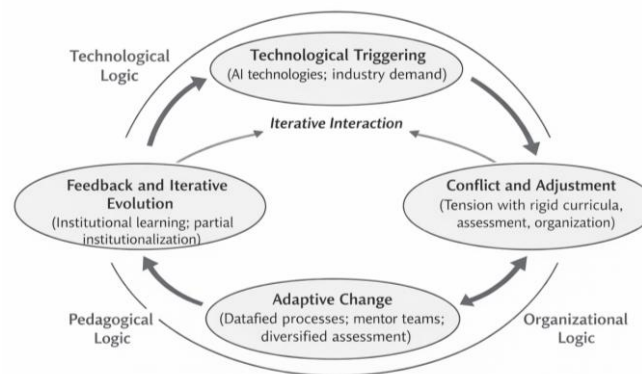


Fig 3. Dynamic Model of Digital Transformation in Vocational Education Management

This study examined the management transformation associated with AI-enabled project-based learning in a Chinese vocational education context. The findings demonstrate that AI+ PBL functions as a catalyst for institutional-level change, reshaping teaching management across curriculum organization, faculty collaboration, resource integration, and assessment design. Rather than a linear modernization process, digital transformation emerged as a dynamic and iterative adaptation driven by tensions between technological affordances and established organizational routines.

Conclusion

This study demonstrates that the integration of Artificial Intelligence (AI) with Project-Based Learning (PBL) serves as a catalyst for comprehensive management innovation in vocational education. Rather than functioning solely as an instructional enhancement, AI-enabled PBL drives institutional transformation by reshaping curriculum organization, faculty collaboration, resource management, assessment practices, and governance mechanisms. The findings suggest that successful digital transformation depends not only on adopting advanced technologies but also on redesigning managerial structures and organizational processes to accommodate flexible, interdisciplinary, and data-informed educational practices.

The proposed dynamic model technological triggering, conflict and adjustment, adaptive change, and feedback-driven evolution highlights the complex interplay among technological, pedagogical, and organizational logics. The case illustrates that sustainable digital transformation requires not only

technological integration but also managerial redesign and organizational restructuring. Despite its contributions, this study has several limitations. First, as a single-case study, the findings are context-specific and may not be fully generalizable to other vocational institutions with different governance structures or resource conditions. Second, the research primarily focuses on management transformation within one academic program, which may not capture broader institutional variations. Third, the long-term sustainability and scalability of AI-enabled PBL reforms require further longitudinal investigation.

Future research should adopt comparative and multi-case designs to examine whether similar transformation patterns occur across diverse institutional contexts. Quantitative studies could also explore the relationship between management innovation and student learning outcomes at scale. Additionally, further inquiry is needed into governance mechanisms that balance innovation flexibility with ethical and regulatory safeguards in AI-integrated vocational education systems.

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