

## **Instructional Design in Community-Based Digital Learning Ecosystems: A Developmental Research Case Study in Product Innovation**

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### **Abstract**

The increasing prevalence of virtual learning environments and digital ecosystems necessitates a broader approach to instructional design—one that extends beyond traditional learning processes and integrates recent advances in artificial intelligence (AI) and virtual reality (VR) technologies. This paper proposes a framework for instructional design that supports the development and implementation of innovative learning solutions within digital learning ecosystems. Using a developmental research methodology, we build upon an existing learning prototype designed for a community-based course on cross-border product innovation between China and Europe. Data collection includes literature review, stakeholder interviews, and focus group discussions to identify opportunities and challenges for improving the prototype. Insights from these activities inform collaborative design workshops with experts and stakeholders to co-develop features that leverage the affordances of digital learning ecosystems, particularly for enhancing personalisation, feedback, and learner engagement. The prototype is subsequently tested in an authentic learning environment using mixed methods including surveys, learning analytics, and observation. The resulting multi-level instructional design framework addresses key dimensions including curriculum design, project management, and technology integration. Findings highlight the importance of pedagogy-driven design, instructional strategies, and the synchronisation of learning activities within community-based digital ecosystems. The study provides practical guidance for instructional designers and practitioners seeking to implement technology-enhanced learning solutions in higher education contexts.

*Keywords:* instructional design, digital learning ecosystems, developmental research, product innovation

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## Introduction

Digital technologies have significantly reshaped higher education by transforming how teaching, learning, and assessment are organised. The growing adoption of online platforms, collaborative tools, and immersive technologies has accelerated the emergence of virtual learning environments and digital learning ecosystems. Digital technologies—including cloud computing, mobile devices, enterprise systems, social media, and collaborative platforms—are now widely integrated into learning environments and enable new forms of interaction and collaboration between students, educators, and industry partners. These developments require instructional designers to reconsider traditional approaches to course design and pedagogical practice. In parallel, advances in artificial intelligence (AI) and virtual reality (VR) provide new opportunities to personalise learning experiences, support immersive simulations, and facilitate complex collaborative learning scenarios. However, integrating these technologies into effective learning environments requires a structured instructional design approach that aligns pedagogical objectives, learning activities, and technological affordances.

The concept of digital learning ecosystems represents an evolution from traditional learning management systems (LMS). Within such ecosystems, learning increasingly occurs through community-based interactions, where students collaborate with peers, educators, and industry partners to solve real-world problems. Earlier systems were often closed platforms with limited flexibility and interoperability. In contrast, digital learning ecosystems emphasise open architectures, integration of multiple technologies, and dynamic interactions between stakeholders.

AI and VR technologies further extend the possibilities of digital learning ecosystems by enabling immersive learning experiences and personalised learning support. However, these technologies also introduce new design challenges, including the need for appropriate instructional strategies, cost considerations, and institutional readiness.

## Literature Review

Several recent studies highlight how digital tools increasingly influence teaching and learning processes in higher education, with long-lasting effects on educational delivery and student engagement. Scholars in technology-enhanced learning argue that higher education systems are undergoing a generational shift in which static LMS environments are gradually replaced by open and evolving ecosystems that integrate multiple services and platforms. They claim that these ecosystems should combine educational technologies, social networks, collaborative tools, and external knowledge sources to support a more flexible and learner-centred educational experience. Previous studies have evidenced that this approach is particularly relevant for interdisciplinary and innovation-oriented courses, where learning outcomes depend on collective knowledge creation and interaction among stakeholders.

## Research Objectives

Designing effective learning experiences within such ecosystems requires new instructional frameworks capable of coordinating multiple actors, technologies, and learning processes. Our research, therefore, proposes an instructional design framework for community-based digital learning ecosystems, based on the development and evaluation of a learning prototype designed for a course on cross-border product innovation between China and Europe.

## **Research Methodology**

To address this challenge, this study adopts a developmental research methodology, sometimes referred to as developmental action research. This approach involves the iterative design, implementation, and evaluation of a learning prototype in order to generate practical knowledge and refine theoretical frameworks. Developmental research is particularly suitable for investigating complex educational innovations because it allows researchers to experiment with prototypes, gather feedback from stakeholders, and continuously improve the learning design through iterative cycles of evaluation and refinement. The research process consists of several stages: (1) Literature review examining instructional design frameworks, digital learning ecosystems, and emerging AI- and VR-based learning technologies; (2) Stakeholder interviews involving educators, students, and industry participants to identify expectations and practical challenges. (3) Focus group discussions aimed at exploring opportunities for improving the learning prototype. (4) Collaborative design workshops, where experts and stakeholders co-develop features and activities that enhance learner engagement and personalisation. (5) Prototype testing within an authentic learning environment, using mixed research methods including surveys, learning analytics, and observational techniques. Through these steps, the study seeks to identify key design principles and develop a practical framework for instructional design within digital learning ecosystems.

## **Learning Prototype**

The experimental prototype examined in this study is a community-based learning environment focused on cross-border product innovation between China and Europe. The learning experience created in this environment brings together students, SMEs, and service providers to explore collaborative innovation processes. The learning design is structured around four main phases, each supporting the co-creation of knowledge among participants, while leveraging interactive tools that enable collaboration between SMEs and service providers involved in the development of cross-border trade. It is expected that such a learning solution facilitates value creation by enabling collaborative knowledge exchange between firms and external partners. In particular, co-creation activities in the learning design should encourage participatory engagement among stakeholders and support more informed decision-making during joint innovation projects. Digital technologies—including mobile applications, cloud computing, e-commerce platforms, and collaborative tools—play a critical role in supporting these interactions and enabling flexible learning processes.

## **Research Insights**

Based on insights from the prototype and the developmental research process, the study proposes a multi-level instructional design framework for digital learning ecosystems. The framework integrates three core dimensions.

### **Pedagogy-Driven Design**

Pedagogical principles remain central to the design of digital learning environments. Technology should support clearly defined instructional strategies rather than dictate the learning process. Effective design requires alignment between learning objectives, instructional activities, and assessment methods. Personalised learning pathways are particularly important within digital ecosystems. Adaptive technologies and AI tools can support personalised feedback, customised learning trajectories, and data-driven learning analytics.

## **Technological Interoperability**

Digital learning ecosystems rely on the integration of multiple technological components, including LMS platforms, collaborative tools, analytics systems, and immersive technologies. Interoperability between these systems is essential to ensure seamless user experiences and efficient data flows. Open architectures and modular infrastructures can facilitate integration and allow institutions to incorporate emerging technologies such as VR simulations and AI-based conversational agents. However, effective implementation therefore depends on balancing pedagogical innovation with technological feasibility and organisational capacity.

## **Community-Based Learning Management**

Community engagement is a defining feature of digital learning ecosystems. Instructional design should therefore include mechanisms to support collaboration among learners, educators, and external stakeholders. Community management functions—including discussion forums, collaborative projects, and knowledge-sharing platforms—enable continuous interaction and promote collective knowledge creation.

## **Conclusion**

This study proposes a practical instructional design framework for community-based digital learning ecosystems. Using a developmental research methodology, the research builds upon a prototype learning environment and systematically evaluates its design through stakeholder engagement and empirical testing. The resulting framework emphasises three key principles: pedagogy-driven design, technological interoperability, and community-based learning management. These elements collectively support the creation of innovative learning environments that integrate emerging technologies while maintaining strong pedagogical foundations.

The research findings suggest that instructional design for digital learning ecosystems requires a broader perspective than traditional course design. Instead of focusing solely on classroom activities, designers must consider the interaction between pedagogical strategies, technological infrastructure, and community dynamics.

By providing actionable guidance for instructional designers and educators, the study contributes to ongoing discussions on how digital ecosystems can transform higher education and enable more collaborative, personalised, and technology-enhanced learning experiences.

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