Mobile-First Blended Learning for Pharmacology Education Reform:
An Empirical Study

Lili Wang
http://orcid.org/0009-0003-0675-345X
Bozhou University, China

Yuzhu Ge
Bozhou University, China

Xiuquan Xu
Bozhou University, China
Received: December 4th, 2025 | **Accepted:** April 22nd, 2026

ABSTRACT

This study developed and preliminarily evaluated a mobile-first blended pharmacology model with virtual simulation, PWA micro-lectures, and real-time interaction. A 16-week quasi-experiment on 100 second-year pharmacy students allocated 40%/35%/25% instructional time to pre-class mobile micro-learning, in-class simulation, and post-class online activities. Versus traditional teaching, key outcomes improved significantly: knowledge accuracy (65.0%±7.2 to 82.0%±5.8, $p<0.001$, Cohen's $d=2.61$), assignment (50.0%±12.3 to 85.0%±6.9), and simulation completion (60.0%±12.0 to 90.0%±5.5; all $p<0.001$). Mobile analytics showed 65% micro-lecture access via smartphones (20:00–22:00), with 23% reporting small-screen fatigue in simulations. Device-sensitive design (mobile for micro-learning, tablets for detailed simulation) optimized usability. Preliminary findings suggest integrated mobile tools correlate with better pharmacology learning engagement and outcomes, offering a replicable blueprint for device-flexible teaching in resource-constrained settings.

KEYWORDS

Blended Learning, Pharmacology Education, Teaching Reform, Virtual Simulation, Device-Sensitive Design

INTRODUCTION

Pharmacology instruction in medical education faces persistent challenges in conveying complex, abstract concepts such as pharmacokinetic processes and drug-receptor interactions through traditional teacher-centered lecturing (Daneshmand & Ziai, 2023; Fasinu & Wilborn, 2024). Engels (2018) similarly observed that pharmacology education requires innovative approaches to address these inherent complexities. This pedagogical gap highlights the need for innovative teaching models. Such models must move beyond passive knowledge transfer to foster active, flexible learning experiences (Lucey & Johnston, 2020). Meanwhile, the rapid spread of mobile technologies has accelerated a shift toward mobile-first blended learning (Crompton & Burke, 2018). Huynh (2017) noted that this trend is fundamentally reshaping how medical education is delivered. However, most existing models prioritize content delivery over the strategic fusion of asynchronous mobile interaction and

DOI: 10.4018/IJMBL.408838

synchronous engagement. This shortfall is particularly pronounced for laboratory-intensive disciplines like pharmacology, which demand both visual demonstration and repeated skill practice (Seybert et al., 2019; Zhao et al., 2024).

Critically, current research exhibits three significant limitations. First, most studies focus on applications of a single tool, such as micro-video flipped classrooms (Wu et al., 2022) or data-driven blended models (Zhao et al., 2024). Few have explored how multiple mobile-accessible technologies can be combined to form a cohesive learning ecosystem. Hu et al. (2023) demonstrated that even within pharmacy-specific blended implementations, content integration remains fragmented. Second, theoretical grounding is often superficial. Although constructivist and multimedia learning principles are often invoked, few investigations operationalize these theories to guide device-sensitive design—in which micro-learning leverages smartphone portability while virtual simulation benefits from tablet screen real estate (Crompton & Burke, 2018; Fasinu & Wilborn, 2024). Third, as Lall et al. (2019) demonstrated through a qualitative systematic review, the implementation factors for mobile learning in medical education remain poorly understood, with institutional support, educator readiness, and learner digital literacy acting as critical yet under-researched moderators. Wilbur (2016) further illustrated that an evaluation of online platforms in continuing education of pharmacists reveals persistent gaps in institutional readiness. These gaps are exacerbated by a lack of mobile learning analytics that capture when, where, and how students engage with cross-platform resources, thus limiting our understanding of mobile-blended learning dynamics in authentic educational settings.

To address these gaps, this study developed and preliminarily evaluated a mobile-first blended learning model integrating three synergistic components: (1) mobile-optimized micro-lectures delivered via a Progressive Web App (PWA) with offline caching, designed on the basis of cognitive load theory principles (Crompton & Burke, 2018); (2) real-time interactive feedback tools (Kahoot!, Rain Classroom) accessible across devices, grounded in social constructivist paradigms (Graham et al., 2013); and (3) cross-platform virtual simulation (SimPharmaco v2.1) adaptable for smartphone preview and tablet-based deep interaction, addressing the experiential learning needs of pharmacology education (Means et al., 2013). We conducted a 16-week quasi-experimental study with 100 second-year pharmacy students, systematically assessing learning outcomes while collecting device-specific usage data to inform device-sensitive design principles (Liu et al., 2016).

This research contributes to the mobile-blended learning literature by (a) providing empirical evidence on the feasibility of integrating virtual simulation with mobile micro-learning in pharmacology; (b) revealing usage patterns that challenge the one-size-fits-all mobile learning assumption; and (c) offering a replicable blueprint for resource-constrained institutions seeking scalable, device-flexible education innovation. Recognizing the inherent limitations of a single-group pre–post design, we framed this study as exploratory. Its primary aim is to generate hypotheses for future randomized controlled trials, rather than establish definitive causality (Means et al., 2013).

LITERATURE REVIEW

Theoretical Foundations: Contradictions in Mobile-Blended Learning Design

Cognitive Load Theory supports the use of mobile micro-learning. Delivering content in chunks via smartphones can reduce extraneous cognitive load (Crompton & Burke, 2018). However, this advantage diminishes when students visualize complex pharmacological mechanisms. On small screens, the intrinsic cognitive load increases, forcing learners to mentally piece together fragmented visual information. Wu et al. (2022) demonstrated that micro-video flipped classrooms improved pharmacology knowledge retention, yet their study exclusively used laptops, sidestepping the screen-size constraint that defines authentic mobile learning contexts. This methodological gap reveals a theoretical blind spot: Most mobile learning studies conflate "portability" with "mobile-optimization," failing to design device-sensitive interfaces that adapt content complexity to screen real estate. Our model addresses this issue by implementing adaptive bitrate streaming and

Related Content

Students' Perception of the Integration of Mobile Devices as Learning Tools in Pre-Primary and Primary Teacher Training Degrees
Blanca García Riazaand Ana Iglesias Rodríguez (2020). *Mobile Devices in Education: Breakthroughs in Research and Practice (pp. 374-391).*
www.irma-international.org/chapter/students-perception-of-the-integration-of-mobile-devices-as-learning-tools-in-pre-primary-and-primary-teacher-training-degrees/242621

The Effect of Self-Regulated Learning in Online Professional Training
Qiwei Men, Belinda Gimbertand Dean Cristol (2023). *International Journal of Mobile and Blended Learning (pp. 1-17).*
www.irma-international.org/article/the-effect-of-self-regulated-learning-in-online-professional-training/318225

Engaging Preservice Teachers in Professional Development about iPads
Katheryn E. Shannonand Theresa A. Cullen (2016). *International Journal of Mobile and Blended Learning (pp. 35-43).*
www.irma-international.org/article/engaging-preservice-teachers-in-professional-development-about-ipads/152273

Mobile Learning as a Tool for Indigenous Language Revitalization and Sustainability in Canada: Framing the Challenge
Marguerite Kooleand Kevin wâsakâyâsiw Lewis (2018). *International Journal of Mobile and Blended Learning (pp. 1-12).*
www.irma-international.org/article/mobile-learning-as-a-tool-for-indigenous-language-revitalization-and-sustainability-in-canada/210083

Online Materials for Teaching Japanese
Kai Masumi (2010). *Cases on Online and Blended Learning Technologies in Higher Education: Concepts and Practices (pp. 227-248).*
www.irma-international.org/chapter/online-materials-teaching-japanese/38018