

Design, Implementation and Sustainability of Mobile Learning in Primary Education: A Longitudinal Case Study

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Abstract

The sustained integration of innovative digital technologies in school education remains a complex challenge, particularly in primary education, where pedagogical, organizational, and human factors strongly influence innovation processes. This study examines the design, implementation, and long-term sustainability of mobile learning as an educational innovation in a Greek experimental primary school. The research was conducted as a three-year longitudinal qualitative case study, adopting a human-centered and systemic perspective on educational change. Data were collected through vignettes, questionnaires, semi-structured interviews, focus groups, participant observation, reflective field notes, research diaries, instructional artefacts, and school documentation. The qualitative material was analyzed through reflexive thematic analysis supported by ATLAS.ti software and theoretically informed by the human-centered sustainability framework of Ng and Nicholas. The findings indicate that sustainable mobile learning integration did not emerge solely from technological availability, but through a gradual process of teacher professional learning, distributed leadership, collaborative school culture, and recognition of the pedagogical value of mobile technologies. While pedagogical, social, and organizational dimensions were strongly developed, economic and technological constraints remained ongoing challenges. The study contributes empirical evidence on how innovative technologies can become embedded in primary education and highlights the importance of human-centered design, contextual adaptation, and long-term support for achieving sustainable educational change.

Keywords: mobile learning, educational innovation, primary education, sustainability, teacher professional learning

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Introduction

The rapid evolution of digital technologies continues to reshape educational systems worldwide, creating increasing expectations for schools to adopt innovative pedagogical approaches that enhance teaching and learning. Among these innovations, mobile learning has attracted considerable attention because of its capacity to promote flexible, learner-centered, collaborative, and context-aware educational experiences (Crompton & Burke, 2023; Dorris et al., 2024). Mobile devices provide opportunities for personalized learning, immediate access to digital resources, authentic inquiry, and the development of students' digital competence, which has become a fundamental educational priority in the twenty-first century (OECD, 2024; UNESCO, 2023).

Despite these promising affordances, research consistently demonstrates that the educational value of mobile technologies depends less on the devices themselves than on the pedagogical and organizational conditions under which they are implemented (Dorris et al., 2024; Fullan, 2016). Numerous school initiatives achieve high levels of initial enthusiasm but gradually diminish once external funding, technical support, or project leadership is withdrawn. Consequently, the long-term sustainability of educational innovation has emerged as one of the most significant challenges in contemporary educational research (Prenger et al., 2022).

Within primary education, these challenges become even more evident. Teachers frequently encounter barriers related to professional confidence, pedagogical integration, infrastructure, curriculum alignment, and institutional support (Blackmore & Rønningsbakk, 2023; Crompton & Burke, 2023). Accordingly, successful mobile learning implementation requires more than technological infrastructure; it demands continuous professional learning, collaborative school cultures, supportive leadership, and organizational conditions that enable innovation to become embedded in everyday educational practice (Hargreaves & O'Connor, 2018; Harris et al., 2022).

Recent international literature increasingly adopts a human-centered perspective, recognizing that sustainable educational innovation is fundamentally shaped by teachers, school leaders, and learning communities rather than by technology itself (Ng & Nicholas, 2012; OECD, 2024). From this perspective, sustainability is viewed as a dynamic process through which educational innovations gradually become integrated into the culture, routines, and pedagogical practices of a school.

Responding to this research need, the present study investigates the design, implementation, and long-term sustainability of mobile learning within a Greek experimental primary school through a three-year longitudinal qualitative case study. Drawing on a human-centered sustainability framework, the research explores how leadership practices, school-based professional development, collaborative learning, and teachers' evolving pedagogical beliefs contributed to the sustained integration of mobile technologies into everyday teaching. By examining innovation as a gradual organizational and pedagogical process rather than a technological intervention, the study contributes empirical evidence to the growing international literature on sustainable educational innovation in primary education.

Literature Review

Mobile Learning in Primary Education

Mobile learning has evolved from a technology-driven concept into a pedagogical approach that promotes flexible, personalized, and context-aware learning experiences extending beyond traditional classroom settings. The widespread availability of tablets and other mobile devices has enabled primary schools to redesign teaching practices by supporting inquiry-based learning, collaboration, creativity, and differentiated instruction. Rather than functioning merely as digital substitutes for conventional resources, mobile technologies increasingly facilitate active student participation and authentic learning experiences (Blackmore & Rønningsbakk, 2023; Crompton & Burke, 2023).

Recent systematic reviews demonstrate that mobile learning can positively influence students' engagement, motivation, digital competence, and academic achievement when implementation is grounded in sound pedagogical principles rather than technological novelty (Crompton & Burke, 2023; Dorris et al., 2024). At the same time, researchers emphasize that successful mobile learning depends on teachers' pedagogical competence, instructional design, and the degree to which technology is meaningfully aligned with curriculum objectives (OECD, 2024; UNESCO, 2023).

Nevertheless, several studies indicate that many mobile learning initiatives remain confined to pilot projects or externally supported interventions and fail to become embedded in everyday educational practice (Prenger et al., 2022). Consequently, current research has shifted its focus from technology adoption toward understanding the conditions that support long-term sustainability within school organizations.

Educational Innovation and School-Based Change

School leadership represents one of the most influential factors affecting the implementation and sustainability of educational innovation. Rather than focusing exclusively on administrative management, contemporary leadership models emphasize collaboration, distributed decision-making, and the development of professional learning communities (Harris et al., 2022).

Distributed leadership enables teachers to assume active roles in instructional improvement, thereby strengthening ownership of innovation and promoting collective responsibility for school development. School leaders who encourage experimentation, provide pedagogical support, and cultivate collaborative cultures create organizational conditions that facilitate long-term educational change (Hargreaves & O'Connor, 2018; Harris et al., 2022).

Equally important is continuous professional development. Evidence from educational change research indicates that isolated workshops rarely produce sustained changes in classroom practice. Instead, professional learning is most effective when it is school-based, collaborative, practice-oriented, and directly connected to teachers' everyday instructional experiences (Darling-Hammond et al., 2017; OECD, 2024). Ongoing reflection, peer collaboration, coaching, and classroom experimentation contribute significantly to teachers' confidence in integrating digital technologies into pedagogical practice.

Sustainability of Mobile Learning

The concept of sustainability has become central to research on educational technology as attention shifts from initial implementation toward the long-term continuation of innovation (Prenger et al., 2022). Sustainable technology integration refers not merely to the continued use of digital devices but to the extent to which innovative pedagogical practices become embedded within everyday teaching, organizational routines, and school culture.

Among the theoretical models proposed in the literature, the framework developed by Ng and Nicholas (2012) remains particularly influential for understanding mobile learning sustainability. Their human-centered model conceptualizes sustainability as the interaction of pedagogical, social, technological, organizational, and economic dimensions, emphasizing that innovation is maintained primarily through human agency rather than technological infrastructure alone.

Recent international reports similarly argue that successful digital transformation depends on systemic educational change involving leadership, teacher capacity building, collaborative cultures, equity considerations, and continuous institutional support rather than on investments in technology alone (OECD, 2024, 2025; UNESCO, 2023). Sustainable innovation therefore emerges as a dynamic organizational process through which educational communities progressively integrate new pedagogical practices into their daily work.

Research Gap

Although recent studies have substantially advanced understanding of mobile learning in schools, several limitations remain. Most published research examines relatively short-term interventions, focuses primarily on student outcomes, or evaluates isolated technological initiatives. Longitudinal qualitative investigations exploring how mobile learning evolves within the everyday life of a school over multiple years remain comparatively limited, particularly in primary education.

Furthermore, few studies simultaneously examine leadership practices, teacher professional learning, organizational culture, and sustainability through a human-centered perspective. Addressing this gap, the present study investigates the design, implementation, and long-term sustainability of mobile learning through a three-year longitudinal qualitative case study conducted in a Greek experimental primary school. By examining innovation as an evolving organizational and pedagogical process, the study contributes empirical evidence regarding the conditions that support sustainable educational change in primary education.

Methodology

Research Design

This study adopted a qualitative longitudinal case study design to investigate the design, implementation, and sustainability of mobile learning as an educational innovation within a real-world primary school context. A qualitative approach was considered appropriate because the study sought to explore participants' experiences, meanings, interactions, and evolving perceptions rather than measure predefined variables (Merriam & Tisdell, 2016).

The research followed the same school community over three consecutive school years, from 2021 to 2024, enabling an in-depth examination of how mobile learning evolved from its initial implementation to its later institutionalization. This longitudinal perspective allowed sustainability to be understood as a dynamic and evolving process rather than a static outcome.

The study was theoretically informed by the human-centered sustainability framework proposed by Ng and Nicholas (2012), which conceptualizes sustainability as the interaction of pedagogical, social, technological, organizational, and economic dimensions. This framework provided the analytical lens for examining how leadership, teacher professional learning, and collaborative school culture contributed to the long-term integration of mobile learning.

Research Questions

The study was guided by the following research questions:

1. How do the attitudes of key members of the school community (principal, teachers, students) towards mobile learning evolve from the initiation of the innovation to its later stages?
2. How do leadership actions and teachers' instructional practices unfold during the integration of mobile devices into teaching and learning?
3. What is the contribution of a school-based professional development program to teachers' pedagogical use of mobile technologies?
4. How can the trajectory of mobile learning integration be interpreted through a human-centered sustainability framework?

These questions were designed to capture both the processual nature of innovation and the multiple levels at which change occurred, including individual beliefs, pedagogical practices, organizational routines, and sustainability conditions.

Research Context and Participants

The research was conducted in a Greek experimental primary school located in a regional area. The school was selected through purposeful sampling (Patton, 2015), as it had expressed a strong commitment to pedagogical innovation and was willing to participate in a long-term research project within the constraints of the public education system.

Participants represented multiple members of the school community, including the school principal, classroom teachers, specialist teachers, students, parents, and the school education coordinator. Although data were collected from the broader school community, a core group of classroom teachers actively participated in the design, implementation, and evaluation of mobile learning activities throughout the three-year period.

Participation was voluntary, and informed consent was obtained from adult participants and from parents or legal guardians of participating students. Ethical considerations concerning anonymity, confidentiality, and responsible handling of research data were observed throughout the study.

Phases of the Research Design

Data collection and analysis were organized into three interconnected phases corresponding to the gradual development of the innovation. The first phase documented baseline attitudes and school conditions before implementation through questionnaires, vignettes, and student focus groups. The second phase focused on active implementation and professional development through participant observation, reflective field notes, interviews, classroom observations, and instructional artefacts. The third phase monitored sustainability during the second and third school years, examining how teachers maintained, adapted, or transformed mobile learning practices under everyday school conditions with reduced external support.

The school-based professional development program constituted a central component of both the innovation and the research design. Rather than relying on isolated external seminars, professional learning was embedded within the daily life of the school through a continuous cycle of collaborative planning, classroom experimentation, reflection, feedback, and redesign. Teachers gradually progressed from introductory workshops to co-designing lessons, implementing mobile learning activities independently, sharing classroom experiences, and collectively reflecting on pedagogical practices.

Data Collection

Methodological triangulation was achieved through the use of multiple qualitative data sources collected throughout the three-year study. Data included vignettes, questionnaires, semi-structured interviews, focus group interviews, participant observation, reflective field notes, research diaries, classroom artefacts, instructional materials, and school documentation. The combination of multiple sources enabled a comprehensive understanding of the implementation process while strengthening the credibility of the findings (Lincoln & Guba, 1985).

Data Analysis

All qualitative data were analyzed using thematic analysis (Braun & Clarke, 2021). The coding process was supported by ATLAS.ti software, which facilitated the organization, coding, comparison, and retrieval of qualitative data across the different phases of the study. Coding was conducted inductively, allowing themes to emerge from the data, while remaining theoretically informed by the human-centered sustainability framework proposed by Ng and Nicholas (2012). Attention was given to patterns related to attitudes, pedagogical practices, leadership actions, collaboration, professional learning, and sustainability challenges. To ensure ethical integrity, all participants were anonymized through systematic coding.

Findings

The findings revealed that the implementation and long-term sustainability of mobile learning resulted from the dynamic interaction of leadership, teacher professional learning, collaborative school culture, and pedagogical adaptation. Rather than following a linear trajectory, the innovation evolved progressively through continuous reflection, experimentation, and organizational learning.

Evolution of Teachers' Attitudes and Pedagogical Practices

Teachers' attitudes towards mobile learning changed considerably during the three-year implementation. Initial uncertainty, mainly associated with limited pedagogical confidence and lack of experience, gradually gave way to increased self-efficacy and willingness to integrate mobile technologies into everyday teaching.

Participation in the school-based professional development programme enabled teachers to move beyond using mobile devices for simple information retrieval towards designing collaborative, inquiry-based, and student-centred learning activities. As their pedagogical confidence increased, teachers demonstrated greater flexibility in selecting digital tools that aligned with curriculum objectives rather than using technology as an end in itself. These findings suggest that sustained professional learning played a decisive role in transforming teachers' beliefs and instructional practices.

Leadership and Collaborative School Culture

School leadership emerged as a critical factor influencing the implementation process. Rather than adopting a directive approach, leadership promoted collaboration, trust, and distributed responsibility among teachers. Teachers were encouraged to experiment, exchange ideas, reflect on classroom experiences, and jointly solve implementation challenges.

This collaborative environment strengthened collective ownership of the innovation and contributed to the gradual integration of mobile learning into everyday school practice. Leadership therefore functioned primarily as an enabling mechanism that supported organizational learning and continuous improvement.

Student Learning Experiences

Students consistently reported positive experiences throughout the implementation process. Mobile learning increased engagement, participation, collaboration, and motivation while supporting differentiated instruction and active learning. Students demonstrated increasing autonomy when using mobile technologies to investigate authentic problems, collaborate with peers, and create digital artefacts. Nevertheless, classroom observations also indicated that meaningful learning depended on careful pedagogical planning and teacher guidance rather than on technology alone.

Sustainability of Mobile Learning

The longitudinal nature of the study demonstrated that sustainability extended beyond the continued use of mobile devices. Sustainable implementation was reflected in the gradual incorporation of mobile learning into teachers' everyday pedagogical practices and the broader organizational culture of the school.

Although economic limitations, ageing equipment, and technological infrastructure remained persistent challenges, the innovation continued because teachers had internalized its pedagogical value and the school leadership maintained a supportive professional environment. Overall, the findings indicate that sustainability was primarily driven by human and organizational factors rather than by technological resources alone.

Discussion

The findings of this longitudinal case study demonstrate that the sustainable integration of mobile learning is fundamentally a human and organizational process rather than a technological one. Consistent with previous research, the availability of mobile devices alone did not lead to meaningful pedagogical change. Instead, sustainable implementation emerged through the interaction of leadership, teacher professional learning, collaborative school culture, and continuous pedagogical reflection (Fullan, 2016; Harris et al., 2022).

One of the most significant findings concerns the evolving role of teachers throughout the innovation process. Initially, many teachers perceived mobile technologies as supplementary instructional tools. However, sustained participation in school-based professional development gradually transformed both their pedagogical beliefs and classroom practices. This finding supports evidence suggesting that continuous, practice-oriented professional learning is considerably more effective than isolated technology training sessions in promoting lasting instructional change (Darling-Hammond et al., 2017; OECD, 2024).

The study also highlights the importance of distributed leadership in supporting educational innovation. Rather than directing implementation through top-down decisions, school leadership created conditions that encouraged collaboration, experimentation, and collective responsibility. Such leadership practices strengthened teachers' professional agency and contributed to the gradual institutionalization of mobile learning within everyday school practice. These findings reinforce contemporary perspectives that view leadership as a relational process enabling organizational learning and school improvement (Hargreaves & O'Connor, 2018; Harris et al., 2022).

From the perspective of the human-centered sustainability framework proposed by Ng and Nicholas (2012), the findings indicate that sustainability should be understood as a dynamic process of organizational adaptation rather than simply the continued use of digital devices. Although economic limitations and technological infrastructure remained important constraints, they did not prevent the continuation of the innovation. Instead, sustainability was primarily supported by teachers' commitment, collaborative professional culture, and leadership practices that reinforced pedagogical innovation.

The longitudinal design of the study offers an additional contribution to the literature. Whereas many studies evaluate technology integration during short-term implementation projects, this research followed the same school community over three academic years. This extended perspective provides richer evidence regarding how educational innovations evolve, stabilize, and gradually become embedded within school culture. Consequently, the study contributes empirical evidence to the growing body of research examining sustainability as an ongoing organizational and pedagogical process rather than a temporary project outcome.

Overall, the findings suggest that successful mobile learning initiatives require schools to move beyond technology adoption towards building organizational capacity, strengthening professional learning, and cultivating collaborative cultures capable of sustaining innovation over time.

Implications for Practice

The findings suggest that school leaders should prioritize sustained professional learning, collaborative planning, and distributed leadership when implementing mobile learning initiatives. Investment in digital infrastructure should be accompanied by continuous pedagogical support, enabling teachers to integrate mobile technologies meaningfully into everyday classroom practice. Policymakers should therefore consider sustainability as an organizational process requiring long-term capacity building rather than short-term technological investment.

Conclusion

This study explored the design, implementation, and long-term sustainability of mobile learning within a Greek experimental primary school through a three-year longitudinal qualitative case study. The findings demonstrate that sustainable mobile learning is achieved not through technology alone but through the combined influence of leadership, teacher professional learning, collaborative school culture, and continuous pedagogical adaptation.

By adopting a human-centered perspective, the study contributes empirical evidence showing that sustainability is an evolving organizational process shaped by the everyday practices and relationships of school communities. The findings extend current research by illustrating how educational innovation becomes gradually embedded within school culture through continuous collaboration, reflective practice, and distributed leadership.

Although the study is limited to a single case, its longitudinal design provides rich insights into the conditions that support sustainable innovation in primary education. Future research could examine similar initiatives across different educational contexts or investigate how educational policy can further support long-term digital transformation in schools.

The study ultimately suggests that the future of mobile learning depends less on technological investment than on schools' capacity to cultivate collaborative professional cultures, strengthen leadership, and sustain continuous teacher learning.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Generative AI tools were used prior to submission solely to improve the clarity, language, readability, and academic organization of the manuscript. The author takes full responsibility for the content of the paper. No generative AI tools were used for data collection, data analysis, or interpretation of results.

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