



Formulating a Model for Leveraging Emerging Technologies in School Physical Education to Optimize Student Learning

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Abstract

The purpose of this study was to formulate a model for leveraging emerging technologies in school physical education to optimize student learning. This study employed a qualitative approach based on Strauss and Corbin's grounded theory methodology. Data were collected through semi-structured interviews using purposive sampling and snowball sampling techniques until theoretical saturation was achieved. Open, axial, and selective coding were utilized to extract the main categories. The credibility of the findings was assessed using Lincoln and Guba's criteria. The coding process yielded 166 open codes, categorized into 32 subcategories and five main categories: causal conditions (enhancing student motivation, advancements in educational technology, educational policy-making, access to affordable digital tools); contextual conditions (school structure and curriculum, digital readiness of students and teachers, school financial and infrastructural resources, culture of active learning in society); intervening conditions (budget constraints, resistance to change and technical issues, tool reliability, access disparities); strategies (planning technology integration into classrooms, continuous teacher training, collaboration with the technology industry, ongoing evaluation of effectiveness); and outcomes (increased motivation and active learning, improved motor and cognitive skills, achievement of educational equity, promotion of sustainable health habits). These were integrated

into a final model. This research provides a comprehensive framework for utilizing emerging technologies in physical education. The findings can contribute to fostering healthier lifestyles for future generations in a technology-driven world. Additionally, it offers practical guidance for policymakers and teachers to align physical education with the needs of Generation Z and technological advancements.

Introduction

Emerging technologies including artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and wearable devices are transforming educational systems worldwide. Physical education (PE), as a critical component of holistic student development, stands to benefit substantially from these innovations (Dhar & Kumar, 2025; Malinauskas & Malinauskiene, 2021). The World Health Organization has identified physical inactivity as a primary risk factor for chronic diseases among youth (Sharma et al., 2018; Zimakova et al., 2024). Traditional PE approaches increasingly fail to motivate Generation Z students, who have grown up in digitally

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saturated environments (Gholami, 2026). The COVID-19 pandemic exposed PE delivery vulnerabilities while demonstrating technology's potential to create intelligent, data-driven learning experiences (Naghizadeh Baghi et al., 2024; Centeio et al., 2026; Xu, 2025). Research demonstrates that AI-powered technologies can increase student participation by up to 30% (Martín-Rodríguez & Madrigal-Cerezo, 2025), with deep learning achieving 85% accuracy in fitness prediction and 88.3% in movement detection (Tan et al., 2025; Ji et al., 2025). Gamification promotes motivation and STEAM integration (Fu, 2025). However, significant gaps persist: most studies focus on technical applications rather than culturally-adapted, comprehensive models for diverse contexts, particularly developing countries (Wang & Wang, 2024; Khodaverdei, 2025). Ethical considerations regarding data privacy, costs, and sustainability remain underexplored (Rahmani, 2025). This study aimed to formulate a comprehensive model for leveraging emerging technologies in school PE to optimize student learning outcomes.

Methods and Material

This qualitative study employed Strauss and Corbin's (1990) systematic grounded theory approach, selected due to the absence of existing models explaining the phenomenon. Data were collected through semi-structured interviews with 16 managers and experts from Iran's Ministry of Education specializing in PE, curriculum planning, and educational technology, all possessing at least five years of experience and familiarity with emerging technologies. Purposive and snowball sampling were used until theoretical saturation. Methodological and data triangulation incorporated interviews, educational clips, and relevant literature. Interview questions explored causal factors, contextual conditions, barriers, strategies, and consequences of technology integration in PE. The analytical process comprised three stages: open coding (extracting initial concepts), axial coding (organizing subcategories), and selective coding (synthesizing main categories within the Strauss and Corbin paradigm model). Lincoln and Guba's (1985) criteria ensured research quality. Credibility was established through member checking; transferability through comprehensive process description; dependability through inter-coder reliability (82% agreement, exceeding the 60% threshold); and confirmability through external expert review and exhaustive procedural documentation.

Results and Discussion

The systematic coding process yielded 166 open codes, organized into 32 subcategories and five main categories aligned with the Strauss and Corbin (1990) paradigm model. Demographic analysis revealed that 75% of participants held doctoral degrees. Causal Conditions included four categories: enhancing student motivation (through AI personalization, VR, AR, and gamification); advancements in educational technology (AI analytics and wearable devices); educational policy-making (STEAM integration and data-driven assessment); and access to affordable digital tools. Contextual Conditions comprised: school structure and curriculum; digital readiness of students and teachers; financial and infrastructural resources; and culture of active learning in society. Intervening Conditions included four barriers: budget constraints, resistance to change, technical issues, and access disparities. Strategies included: integrating technology into classrooms, continuous teacher training, industry collaboration, and ongoing evaluation. Consequences comprised four positive outcomes: increased motivation and active learning, improved motor and cognitive skills, educational equity, and sustainable health habits.

The findings confirm previous research while making distinctive contributions. The identification of student motivation as a causal condition corroborates Martín-Rodríguez and Madrigal-Cerezo (2025) and Xu (2025). The explicit inclusion of educational policy-making

represents a novel contribution, as prior studies focused mainly on technical aspects (Hrytsenko et al., 2024; Tan et al., 2025). The emphasis on affordable digital tools extends Khodaverdei's (2025) work on reducing technology costs for educational equity. This study offers three theoretical contributions: formulating an integrated culturally-adapted model for developing countries (Wang & Wang, 2025); emphasizing long-term evaluation for sustained outcomes (Li, 2025; Ji, 2025); and addressing ethical concerns including data privacy and digital equity (Khodaverdei, 2025; Rahmani, 2025). Limitations include implementation costs and organizational resistance. Future research should pursue longitudinal studies, cross-cultural comparisons, and ethical investigations.

Conclusion

This study formulated a comprehensive model for leveraging emerging technologies in school physical education, comprising five interconnected categories: causal conditions, contextual conditions, intervening conditions, strategies, and consequences. The findings confirm the transformative potential of AI, VR, AR, and wearable technologies (Martín-Rodríguez & Madrigal-Cerezo, 2025; Xu, 2025), while emphasizing culturally-adapted implementation and sustainability often overlooked in prior research (Khodaverdei, 2025; Rahmani, 2025). Theoretically, this research contributes an integrated model bridging technological potential with practical, sustainable implementation. Practically, it offers guidance for policymakers to allocate budgets, administrators to implement teacher training, school leaders to partner with industry, and teachers to use gamification and AI personalization. In conclusion, this framework can transform physical education into intelligent, personalized learning experiences that motivate Generation Z students, develop sustainable health habits, and foster active lifestyles.

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Keywords: educational technologies, emerging technologies, student motivation, physical education, student learning.