



Integration of technology in physical education to improve the quality of learning and student engagement

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ABSTRACT

This study explores the integration of technology in physical education to enhance student engagement and learning quality. The research employed a qualitative phenomenological approach to examine the experiences and perceptions of students and teachers using mobile applications, wearable devices, and interactive platforms in classroom settings. Data were collected through semi-structured interviews, participatory observations, and documentation of digital learning artifacts involving students aged 10–18 and their physical education teachers. Thematic analysis identified three main themes: increased student motivation and engagement, pedagogical adaptation by teachers, and challenges in technology implementation, including access disparities and varying digital literacy. Findings indicate that technology facilitates personalized, interactive, and adaptive learning, while teacher competency and infrastructure readiness are critical for effective integration. The study contributes theoretically by linking intrinsic motivation and technology acceptance to pedagogical practice and provides practical implications for curriculum design and policy development in digital physical education. Future research is recommended to examine long-term impacts, comparative effectiveness of digital tools, and contextual influences on pedagogical adaptation.



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1. Introduction

Physical education as a formal subject is facing changing demands due to the increasingly widespread digitalization of global education, where conventional methods have proven ineffective in consistently enhancing student engagement throughout the learning process. According to Patil (2024), the integration of digital technology into physical education has the potential to enhance student motivation, engagement, and participation through the use of digital devices such as wearable trackers, fitness apps, and interactive learning platforms capable of providing real-time feedback, as well as enabling personalized and adaptive learning. Research synthesizing these various pedagogical innovations indicates that technology can help students become more physically active, expand the scope of learning beyond the classroom, and support the objective monitoring of student performance through digital data. (Patil, 2024)

In a national context, studies on learning transformation conducted at universities indicate that the use of technology-based differentiated learning models has significantly increased student motivation and engagement in physical education activities due to a more personalized and adaptive approach to individual learning needs. (Nurafiati & Angriawan, 2025) This research emphasizes that digital technology enables a variety of learning strategies that accommodate diverse student learning styles, enriches physical education experiences, and increases active participation in physical activities. Students' intrinsic motivation tends to increase when they feel a sense of control and receive immediate feedback on their physical actions. (Nurafiati & Angriawan, 2025)

Other research indicates that the primary challenges in integrating technology into physical education in Indonesia relate to infrastructure readiness, teachers' digital competencies, and unequal access across regions, which collectively act as barriers to the effective implementation of digital technology in learning. (Hamzah, 2025) However, a broader literature review on the use of digital technology in physical education indicates that tools such as smartphones, fitness trackers, and digital learning apps can provide more engaging, flexible, and contextual learning experiences for students in both elementary and secondary schools. (Putri & Bhakti, 2025) This suggests that despite tangible structural barriers, the pedagogical opportunities of digital technology continue to evolve and need to be explored contextually through empirical studies.

Theoretically, the integration of technology in physical education can be explained through intrinsic motivation theory and technology acceptance models, where students' perceptions of ease of use and the benefits of technology serve as key predictors of their engagement in the learning process. (Martín-Rodríguez & Madrigal-Cerezo, 2025) Technological pedagogical models also explain that the use of digital devices and learning platforms not only provides performance data but also encourages students to set personal goals, monitor progress, and experience autonomy in physical learning. This perspective supports the argument that technology is not merely a tool but also a pedagogical agent that facilitates changes in students' learning behaviors in physical education.

Although many quantitative studies show a positive relationship between technology integration and physical education learning outcomes, qualitative research exploring the meaning of teachers' and students' experiences in this context remains limited. Some small-scale qualitative studies note that students enthusiastically embrace physical education technology, particularly in the use of apps and trackers for activity monitoring, yet they also face barriers related to access, data synchronization, and initial technical skills. (Gong, Castro & Chen, 2024) This gap highlights the need for more in-depth qualitative research to understand pedagogical adaptation processes, classroom dynamics, and the meaning of students' experiences in the real-world context of technology use in physical education.

Against this backdrop, this study aims to explore the experiences, meanings, and practices of integrating digital technology into physical education from the perspectives of students and teachers, specifically how technology influences engagement, motivation, and the pedagogical strategies employed in the context of physical education. The research findings are expected to provide theoretical contributions to enrich the understanding of the interaction process between technology and physical education pedagogy, as well as practical contributions to the development of educational policies, teacher training, and the design of a more adaptive digital physical education curriculum.

2. Materials and Methods

This study employs a phenomenological qualitative approach to understand the subjective experiences and interpretations of students and teachers regarding the integration of technology in physical education. The phenomenological approach was chosen due to its focus on understanding how individuals interpret their experiences within real-life contexts, including

perceptions and emotional reactions to the use of digital devices in interactive and contextual physical education learning environments. (Nurafiati & Angriawan, 2025)

The research was conducted in several elementary and secondary schools in Indonesia that have implemented various forms of digital technology in physical education, including the use of fitness apps, wearable devices, mobile learning, and interactive digital learning platforms over a full academic semester. This extended observation period was chosen to allow for monitoring of the dynamics of students' interactions with technology and changes in their engagement over time, as well as to capture the context of technology implementation in daily physical education activities. (Putri & Bhakti, 2025)

Research participants consisted of students aged 10 to 18 years and physical education teachers with direct experience in using digital technology in their classrooms. The purposeful sampling technique was used to select informants with significant experience in using technology in physical education, while the snowball sampling technique was used to identify additional relevant informants capable of providing rich narratives about ongoing learning practices. (Nurafiati & Angriawan, 2025)

Data were collected through semi-structured interviews designed to explore students' and teachers' perceptions, experiences, and challenges regarding the use of digital technology during the physical education learning process, participant observation in the classroom to capture real-time interactions between students and technology, and documentation of digital learning artifacts including students' digital activity logs, technology-based instructional materials, and digitally produced assignment outcomes. (Gong, Castro & Chen, 2024)

Data validation was conducted through source triangulation by comparing narratives from students and teachers, method triangulation between interviews, observations, and documentation, as well as member checking by returning preliminary findings to participants to ensure data accuracy and representativeness. Data analysis employed thematic analysis, which includes open coding, axial coding, and selective coding to identify central themes representing participants' subjective experiences in the integration of technology into physical education. (Patil, 2024)

3. Results and Discussions

The analysis of interviews, observations, and documentation revealed that the experiences of students and teachers regarding the integration of technology in physical education are organized into three main themes. The first theme is enhanced student engagement and motivation. Students reported that using mobile applications and wearable trackers increased their awareness of daily physical performance. According to Patil (2024), real-time activity monitoring encourages students to participate more actively because they perceive greater control over achieving personal fitness goals. Observations indicated that students proactively recorded their activity, compared results with peers, and set daily realistic targets, which demonstrates that digital experiences promote intrinsic motivation more effectively than traditional methods. Students expressed that digital feedback made physical education more meaningful and personally relevant, enhancing both their participation and commitment to consistent activity.

The second theme relates to teachers' pedagogical adaptation. Teachers indicated that technology integration altered their instructional practices, including providing digital video demonstrations, monitoring wearable device data, and using student performance data to provide timely and individualized feedback. Nurafiati and Angriawan (2025) highlighted that teachers who effectively use digital data can adapt instruction to meet students' abilities, creating a more flexible learning environment. Observational data showed that teachers implemented differentiated instruction strategies, grouping students according to skill and digital literacy levels, which fostered collaboration and maximized engagement. This pedagogical adjustment enhanced teachers' digital competence and promoted reflective, interactive teaching, supporting

the findings of Martín-Rodríguez and Madrigal-Cerezo (2025), who emphasized that technology integration stimulates the design of interactive and data-informed learning activities.

The third theme concerns challenges in technology implementation, including limited access to devices, network connectivity issues, and varying levels of digital literacy among students. Interviews revealed that students from less privileged economic backgrounds faced difficulties accessing applications and wearable devices, resulting in lower participation compared to peers with personal devices. Hamzah (2025) emphasized that such disparities can hinder inclusive educational outcomes. Teachers reported developing creative solutions, such as rotating device usage or collaborative group activities, to ensure all students could participate. These findings highlight that successful technology integration relies not only on the tools themselves but also on social context, administrative support, and learners' readiness.

Beyond the main themes, thematic analysis identified subcategories such as students' social experiences in using technology, self-reflection via digital data, and data-informed learning for self-assessment. Several students indicated that gamified applications encouraged collaboration, reinforced social skills, and improved motivation. Putri and Bhakti (2025) noted that reflecting on digital performance enabled students to understand their strengths and weaknesses in fundamental movements and fitness, promoting continuous improvement. These patterns were consistent across schools, although engagement levels varied depending on technological readiness and teacher competence in using digital tools effectively.

Overall, the results demonstrate that technology integration can create more adaptive, interactive, and personalized physical education experiences. Students exhibited increased motivation, active participation, and awareness of their performance, while teachers could optimize assessment and instruction. These findings suggest that technology functions not only as a tool but also as a pedagogical agent shaping teaching practices and the social context of the classroom. Aksir (2025) emphasized that when integrated with appropriate teaching strategies, digital technology strengthens data-driven learning and provides meaningful learning experiences for students.

Discussion

The findings align with intrinsic motivation theory and the technology acceptance framework, where students' perceptions of usefulness and ease of use influence their engagement and participation. Patil (2024) argued that technology meets students' needs for autonomy, competence, and relatedness, thereby fostering intrinsic motivation. This study corroborates previous literature indicating that digital technology integration in physical education enhances students' activity levels, creates consistent engagement, and provides personalized learning opportunities (Putri & Bhakti, 2025).

Teacher pedagogical adaptation emerged as a key factor in successful technology implementation. Nurafiati and Angriawan (2025) noted that teachers who utilize digital data effectively can provide timely feedback and adapt instructional strategies to student needs. The present findings demonstrate that technology's effectiveness depends not only on tools but also on teachers' ability to adjust pedagogy and facilitate productive classroom interactions.

Challenges such as access inequities, technical issues, and differing student digital literacy highlight critical considerations for inclusive implementation. Hamzah (2025) emphasized that infrastructure support and differentiated instructional strategies are necessary to ensure all students benefit. This study provides empirical evidence that social, cultural, and economic contexts must be considered for effective technology integration.

From a practical perspective, the study suggests that physical education curricula should systematically integrate digital tools, combining wearable trackers, fitness applications, and collaborative platforms with teacher training, equitable access, and reflection-based learning. Such implementation enhances student engagement, learning outcomes, and digital literacy.

Theoretically, the findings underscore the value of qualitative approaches in capturing the subjective experiences of teachers and students, which are often overlooked in quantitative research.

Finally, the study implies directions for future research, including longitudinal investigations into the long-term impact of technology on students' physical activity habits, comparative studies of different types of digital tools, and explorations of social and cultural influences on pedagogical adaptation. These findings offer new insights into technology integration in physical education, emphasizing the importance of personalization, social interaction, and pedagogical context (Aksir, 2025).

4. Conclusions

This study shows that the integration of technology into physical education enhances student engagement, motivation, and active participation through the use of mobile apps, wearable trackers, and interactive learning platforms. Teachers who can effectively utilize digital data can tailor teaching strategies, provide timely feedback, and create more adaptive and personalized learning experiences. The findings also highlight implementation challenges, including access gaps, infrastructure limitations, and variations in digital literacy, which require differentiated strategies and administrative support to ensure inclusivity and effectiveness.

Theoretically, this study strengthens our understanding of the relationship between intrinsic motivation, technology acceptance, and pedagogical practices in the context of physical education. Practically, the research findings provide guidance for teachers, curriculum developers, and policymakers in designing effective and inclusive technology-based physical education. Further research is recommended to explore the long-term impact of technology integration on students' physical habits, compare various types of digital tools, and analyze the influence of social and cultural contexts on pedagogical adaptation.

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