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Exploring Student Perceptions of Smart Wearable Devices in Middle-Distance Running

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Abstract

This study investigates middle school students' perceptions of smart wearable devices integrated into an 800m running teaching module, involving a total of 120 students across experimental, reference, and control groups. Through semi-structured interviews, the study examined how wearable technology influenced students' engagement, motivation, self-regulation, and awareness of performance. Students in the experimental group, who received real-time feedback on heart rate, pace, and lap time, reported enhanced motivation, strategic pacing, and increased confidence, while students in other groups expressed curiosity and interest, reflecting the broader appeal of technology-enhanced instruction. The integration of gamification elements further encouraged goal-setting and participation. Findings suggest that smart wearable devices can significantly enrich physical education by promoting self-directed learning and measurable progress. The study recommends embedding wearable-assisted modules into PE curricula to foster fitness literacy and student-centered instruction.

Keywords: Smart Wearable Devices, Physical Education, Student Perceptions, Motivation and Engagement, Technology-Enhanced Learning

Introduction

The integration of digital technology into physical education (PE) has gained considerable attention in recent years, offering new avenues to enhance student learning, motivation, and performance. Among these technological innovations, smart wearable devices—such as heart rate monitors, fitness bands, and GPS-enabled watches—have shown promising potential in delivering real-time feedback, tracking progress, and promoting self-regulated learning (Almusawi et al., 2021; Gao et al., 2014). These tools are particularly relevant in endurance-based training, such as middle-distance running, where pacing, cardiovascular load, and technique are critical. Despite the growing use of wearables in fitness and professional athletics, their integration into school-based PE, particularly in middle school settings, remains limited and underexplored (Chen, 2022).

The rising prevalence of sedentary behavior among adolescents has prompted global concern regarding youth health and physical literacy (WHO, 2020; Aubert et al., 2018). Middle school students, particularly girls, often demonstrate lower levels of physical activity engagement due to a lack of personalized instruction, limited feedback mechanisms, and reduced motivation in traditional PE classes (Haegele et al., 2021; Lunde et al., 2023). As

digital technologies become increasingly accessible in education, integrating smart wearable devices into PE not only responds to students' tech-driven lifestyles but also addresses long-standing pedagogical gaps (Liu et al., 2020; Chen et al., 2025). This area of research is thus crucial to understanding how technology can make PE more inclusive, student-centered, and effective in promoting lifelong fitness habits (Lolowang et al., 2025; Martín-Rodríguez & Madrigal-Cerezo, 2025). Moreover, middle-distance running, such as the 800m event, requires both technical instruction and self-regulation skills that many students struggle to develop without real-time guidance (Cardinale & Varley, 2017; Sperlich et al., 2020). Exploring this topic responds to an urgent educational need by investigating how wearable technology can support more tailored, responsive training experiences.

In China, the conventional approach to PE emphasizes generalized fitness development rather than sport-specific or event-specific skill acquisition. In the case of middle-distance events like the 800m run, instruction often lacks structure and personalization. Female students are typically required to complete the 800m as part of both the National Student Physical Fitness and Health Test and the Secondary School Entrance Examination**,** making it a critical measure of physical competence (Li et al., 2024; Zhang & Min, 2020). However, traditional instruction relies heavily on standardized routines, such as timed laps and verbal feedback, with little attention given to individual pacing strategies or technical refinement (Rane et al., 2023). This can result in significant disparities in student performance and engagement, especially among students with varying physical capabilities and fitness levels.

Recent studies highlight the limitations of this one-size-fits-all approach in PE. Generic instructions fail to accommodate students' differing needs, and the absence of personalized data prevents meaningful self-monitoring and goal-setting (Weeldenburg et al., 2020; Xu et al., 2021). Research has further shown that adolescent girls, in particular, are more susceptible to disengagement from physical activities when they feel inadequately supported or lack ownership over their learning experience (Bessa et al., 2021). These concerns underscore the need for a more tailored, data-informed instructional model—one that leverages wearable technologies to enhance real-time feedback and personalize the learning experience for students during the 800m training.

Wearable smart devices offer a viable solution by enabling instructors and students to track heart rate, pace, distance, and stride frequency during practice sessions (Zulkifli & Danis, 2022; Toner et al., 2023). This data can inform targeted coaching interventions and foster deeper student reflection on performance. Moreover, such integration supports the principles of gamification and active engagement by allowing students to visualize their progress and compete against personal benchmarks (Lee & Lee, 2021). In doing so, wearable technology not only promotes physical development but also cultivates intrinsic motivation, especially in students who may otherwise feel excluded from traditional athletic instruction.

Given these advantages, this study aims to explore how smart wearable devices can be integrated into a structured 800m running teaching module for middle school students, with a specific focus on female students. Through a comparative analysis of student perceptions from three distinct training contexts—traditional instruction, module-based instruction with wearable integration, and school athletic team training—this study seeks to

provide pedagogical insights into the value of wearable technologies in PE. By analyzing these perceptions, the research contributes to the evolving discourse on technology-enhanced physical education and offers practical recommendations for educators seeking to modernize and personalize PE instruction in China and beyond.

The significance of this study lies in its potential to inform physical education practices that are both pedagogically sound and technologically enriched. By centering students' voices, the research highlights how smart wearable devices can enhance self-monitoring, goal-setting, and motivation—factors that are often overlooked in conventional PE instruction. The insights gained from this study benefit multiple stakeholders: PE teachers gain practical strategies for integrating technology into instruction; curriculum designers receive evidence for designing data-informed modules; and school administrators can better assess the value of investing in wearable technologies for broader PE reform. Ultimately, this study contributes to the broader discourse on equitable and personalized learning, advocating for a shift from one-size-fits-all physical education to more engaging and effective models that support diverse learner needs.

Literature Review

The current landscape of physical education (PE) in Chinese middle schools reveals a blend of tradition and reform, shaped by national policies emphasizing holistic student development (Yu et al., 2018). While PE is recognized as a vital element of student growth, traditional curricula often focus on basic fitness routines and standardized assessments that fail to accommodate the diverse needs and learning styles of students (Fan & Cao, 2017). Kirk (2019) and Lynch (2019) argue that such a one-size-fits-all approach overlooks individualized learning experiences, which are essential for cultivating meaningful student engagement in PE. This standardized model, though systematic, can hinder long-term motivation and enthusiasm for physical activity among students.

Significant challenges persist within the current PE framework in Chinese middle schools. Cheng et al. (2024) highlight the inadequacy of school infrastructure and limited access to training equipment as major obstacles in implementing dynamic and personalized PE programs. Wu et al. (2019) further emphasize disparities in instructional clarity and communication, which often arise from vague lesson objectives and inconsistent teaching methods. These structural and pedagogical limitations necessitate innovative solutions—chiefly, the integration of educational technologies—to elevate the quality and inclusivity of PE instruction.

Scholars have long emphasized that PE contributes not only to physical fitness but also to cognitive and social development. Bidzan-Bluma and Lipowska (2018) identified strong correlations between physical activity and enhanced executive functions, including attention and memory. Furthermore, Adambaevna (2023), Conkle (2019), and Evans and Sims (2022) underscore the role of PE in nurturing life skills such as collaboration, discipline, and resilience. As such, a well-rounded PE program must transcend physical training alone and address the broader developmental needs of students, reinforcing the value of pedagogical models that integrate physiological, psychological, and social domains.

Middle-distance running, particularly the 800m event, requires a nuanced training approach that balances aerobic endurance, speed, and strength (Hlaselo, 2020). Physiologically, students must develop cardiovascular capacity and lower-body strength to enhance performance and reduce injury risk (Karp, 2024; Mesfen & Melkamu, 2024). Equally important are psychological factors such as motivation, confidence, and mental resilience. Hess (2024) found that young runners who engage in goal-setting and mental imagery training exhibit improved performance and attitude towards running. These findings affirm the need for coaching strategies that address both physical and mental preparation.

Instructional design frameworks like the ADDIE Model offer a systematic approach to structuring PE programs. Comprising five phases—Analysis, Design, Development, Implementation, and Evaluation—the ADDIE Model provides educators with a step-by-step guide to designing learner-centered and outcome-driven curricula (Adeoye et al., 2024). In PE contexts, this model facilitates the alignment of fitness goals, pedagogical methods, and assessment tools. For instance, Novenda and Widiawati (2025) demonstrated how ADDIE-based curricula significantly improved students' engagement and understanding in health-related fitness programs. This structured methodology supports the integration of digital tools, such as wearable technology, into PE instruction.

Wearable smart devices have emerged as transformative tools in physical education, offering real-time data on student performance and facilitating personalized feedback. These devices—equipped with sensors that monitor heart rate, movement, and distance—can enhance student motivation and accountability by visualizing progress (Almusawi et al., 2021; Zulkifli & Danis, 2022). Research by Díaz et al. (2019) and Fu et al. (2021) confirmed the effectiveness of wearables in promoting individualized learning in PE, while McCallum et al. (2018) and Strain et al. (2020) emphasized their superiority over traditional assessment methods in capturing accurate activity data. Nevertheless, successful implementation requires addressing barriers such as cost, teacher training, and data privacy concerns (Seneviratne et al., 2017; Xie et al., 2018). Despite these challenges, the pedagogical implications of wearable technologies suggest a shift toward more adaptive, engaging, and data-informed PE practices.

Methodology

This study adopted a qualitative research approach to explore middle school students' perceptions of smart wearable devices integrated into an 800m running teaching module. The purpose of semi-structured interview was to gain an in-depth understanding of how students experienced and responded to the use of wearable technology in their PE training. The interviews provided a platform for students to share their thoughts, emotions, and reflections regarding engagement, motivation, challenges, and perceived benefits associated with the intervention.

A total of 120 female students aged 13 to 15 years old from Fenghuangcheng Experimental School participated in the study, distributed equally among the control, experimental, and reference groups (n = 40 per group). Purposive sampling was employed to ensure a diverse yet relevant sample that met the study's objectives. Selection criteria included age, prior experience in physical education, and varied fitness levels. Students from all three groups were invited to participate in focus group discussions, enabling a comparative

exploration of their experiences under different instructional conditions. Fenghuangcheng Experimental School was selected for its openness to educational innovation and existing infrastructure that supported the implementation of smart wearable devices in classroom instruction.

The semi-structured focus group interviews were guided by a flexible protocol that allowed for both consistency and depth. Interview questions covered a range of themes, including students' engagement and motivation, effectiveness of the teaching module, perceived improvements in fitness and running skills, and experiences with wearable technology. Each focus group consisted of six to eight students from the same training group, ensuring that the discussions remained contextually grounded.

Thematic analysis was employed to systematically analyze the qualitative data gathered from the focus group interviews. Following Braun and Clarke's (2006) six-phase framework, the researcher familiarized herself with the transcripts, generated initial codes, searched for patterns, and reviewed and refined them iteratively to ensure analytic rigor. Coding was conducted manually to allow for close engagement with the data and a nuanced interpretation of students' responses. This process enabled the identification of meaningful patterns and distinctions across the different training groups. By focusing on students' subjective experiences, the analysis provided insights into how the integration of smart wearable technology and the structure of the teaching module shaped their attitudes, learning experiences, and engagement with physical education.

Findings

This section presents the findings of the study based on semi-structured interviews conducted with 30 students across the experimental, reference, and control groups. Thematic analysis revealed four prominent themes: (1) Motivation and Engagement, (2) Ease of Use and Adaptability, (3) Perceived Effectiveness, and (4) Comparison of Perceptions Across Groups.

Motivation and Engagement

The theme of motivation and engagement emerged prominently among students in the experimental group, who experienced a significant boost in enthusiasm due to the smart wearable devices. The real-time feedback helped them set personal targets and track their progress. Students felt empowered by being able to monitor their pace and heart rate, which translated into increased focus and sustained effort. S2 stated, "I used to feel like I was running blind. Now that I can see my heart rate and pace, I know when to push and when to slow down. It's like having a coach on my wrist." This level of autonomy encouraged more active participation.

Another motivator was the gamification effect. Students enjoyed challenging themselves and competing with peers using the metrics displayed on their devices. As S7 noted, "It's like a game where you keep trying to beat your high score." The sense of competition further increased their investment in the activity, with many reporting improved concentration and resilience during training.

In contrast, the reference group, though engaged by the structured training module, lacked the immediate feedback loop and reported difficulty maintaining focus. S15 reflected,

"It felt like I was running without a clear goal." Meanwhile, the control group exhibited the lowest motivation. Without structured guidance or data, they often questioned their own progress. S21 mentioned, "We just ran without knowing how we were doing."

Interestingly, students in the reference and control groups expressed curiosity and even envy towards the wearable devices. S28 from the control group admitted, "I think I would have tried harder if I had that kind of feedback." This suggests the devices had not only direct effects on users but also indirect motivational influence on others.

Ease of Use and Adaptability

The second emerging theme was the adaptability and ease of use of the wearable devices. While students initially faced a learning curve in understanding performance data, they quickly adjusted with guidance from their coach. S5 explained, "At first, I didn't know what all the numbers meant, but after the coach explained it, it made sense."

Comfort and wearability were also emphasized. Most students described the devices as lightweight and unobtrusive, with S10 noting, "After a few sessions, I didn't even notice I was wearing it." A few reported minor discomfort, particularly during intense sessions, but these did not outweigh the benefits.

Some students encountered technical issues such as connection problems and sensor failures. S3 shared, "Sometimes the watch would lose connection, and it would stop recording halfway." These incidents caused some frustration, yet most students developed workarounds and continued to engage actively with the devices.

The complexity of the data was another concern. While some students valued the depth of information, others felt overwhelmed. S6 admitted, "Sometimes there were too many numbers. I just wanted to know if I was doing better or not." This reflects the need for customizable or simplified displays to accommodate different user preferences.

Students in other groups expressed interest in trying the devices themselves. S22 from the control group said, "I think I would have improved more if I had something like that to guide me." These observations underscore the appeal and potential accessibility of wearable technology in broader educational settings.

Perceived Effectiveness

The third theme was the perceived effectiveness of the wearable devices in improving students' running performance. Many students in the experimental group highlighted how they developed better pacing strategies by monitoring real-time metrics. S1 reported, "Now I know exactly how fast I'm going, so I can adjust my pace."

Students also noted improved endurance and stamina. S9 explained, "Now, I can check my heart rate and slow down before it gets too high. It's helping me last longer." This insight allowed for more intelligent energy distribution throughout the 800m run.

Improved technique was another commonly cited benefit. The ability to view biomechanical data helped students refine their form. S8 shared, "The coach showed me my

stride data and helped me adjust my foot placement. I didn't even know I was running inefficiently before."

Psychologically, students felt more in control and motivated by seeing measurable progress. S12 remarked, "You can't argue with the data—it shows you're getting better." This sense of ownership and accomplishment contributed to a deeper engagement with training.

Reference group students, though trained with the same structure, lacked real-time insights and often had to rely on guesswork. S13 said, "Without the data, you're kind of running blind." Meanwhile, control group students faced greater difficulty interpreting their physical effort and progress.

Comparison of Perceptions Across Groups

The final theme compares the experiences of students across the three groups. The experimental group consistently reported higher satisfaction and improvements due to the integration of technology. S3 stated, "Now, I know if my heart rate is too high, I can slow down and recover."

The reference group appreciated the structured training but noted challenges in tracking performance. S20 commented, "It was still trial and error." This lack of precision hindered their ability to self-regulate effectively.

Control group students experienced the greatest limitations. S23 summarized their experience: "There was no plan, no feedback—just 'run as fast as you can.'" Many struggled with pacing and motivation, and several expressed a desire for more structured or tech-supported guidance.

Interestingly, the control and reference group students' observations reinforced the value of the devices. S30, from the experimental group, concluded, "When you know how you're doing, it's easier to improve." This statement encapsulates the collective insight gained from comparing across all three groups.

In conclusion, the findings indicate that smart wearable devices significantly enhance student motivation, engagement, pacing strategies, and overall performance when integrated into a structured teaching module. The emerging themes of motivation and engagement, ease of use and adaptability, perceived effectiveness, and intergroup comparison collectively demonstrate the potential of technology-driven instruction to enrich physical education outcomes for middle school students.

Discussion

The integration of smart wearable devices into the 800m running teaching module substantially influenced students' perceptions of training effectiveness, motivation, and self-regulation. Students in the experimental group, who had access to wearable feedback, demonstrated increased engagement and more strategic performance behaviors compared to students in the reference and control groups. Their experiences provide strong evidence supporting the role of wearable technology in enhancing physical education outcomes at the middle school level, aligning with the findings of Havard and Podsiad (2020) and Gao et al.

(2014), who emphasized the role of technology in fostering motivation and autonomous learning in PE.

A notable theme that emerged from the findings was the heightened motivation and engagement facilitated by real-time data. Students valued access to heart rate, pace, and lap time feedback, which allowed them to better understand and adjust their physical efforts. This self-monitoring fostered a sense of ownership over their learning, consistent with research by Havard and Podsiad (2020), who found that wearable technology increased student motivation by making fitness progress tangible and personalized. The feedback acted as both an internal and external motivator, encouraging students to stay focused and improve their performance.

The incorporation of a gamification element further reinforced engagement. Students viewed their training as a challenge against previous records or as a healthy competition with peers. This is supported by Van Hooren et al. (2024) and Sotos-Martinez et al. (2023), who observed that wearable technology enhanced student satisfaction by promoting goal-setting and comparative self-assessment. Gamified experiences, particularly when supported by visual feedback, increase enjoyment and voluntary participation in PE among adolescents.

In contrast, students in the reference group, who followed the structured module without wearables, initially reported motivation due to the novelty and organization of the training. However, the absence of performance metrics led to waning interest over time. This aligns with the findings of Cents-Boonstra et al. (2021), who emphasized the necessity of feedback mechanisms to maintain student engagement, even in pedagogically sound programs. The control group, relying solely on traditional instruction, exhibited the least motivation and clarity, confirming the assertions of Casey et al. (2017) regarding the limitations of conventional PE in fostering sustained student participation.

From a usability standpoint, most experimental group students found the devices accessible and user-friendly after initial guidance. This reflects findings by Sousa et al. (2023), who emphasized the role of teacher support in helping students develop digital literacy with wearable technology. While some students initially struggled with interpreting multiple data metrics, the majority adapted and incorporated the devices into their training routines. Mayer's (2014) cognitive theory of multimedia learning supports the observation that too much simultaneous data can overwhelm learners, highlighting the need for streamlined displays. Mencarini et al. (2019) similarly advocated for customizable and simplified interfaces in wearable sports technology.

Students perceived the devices as highly effective for improving their pacing, endurance, and running technique. The ability to make real-time adjustments based on feedback helped them manage their energy more effectively and build confidence through visual proof of progress. These observations echo the work of Chen et al. (2023) and Marttinen et al. (2019), who reported that wearable feedback enhances both performance and psychological well-being in young athletes. Biomechanical data also played a valuable role; students who received feedback on stride and cadence showed improved form and reduced fatigue, as reported by Van Hooren et al. (2024). Additionally, students in the reference and control groups expressed curiosity and a desire to access similar tools,

reflecting Kinney et al.'s (2019) findings on the motivational spillover effect of observing peer engagement with educational technology. Overall, the comparative analysis supports the conclusion that real-time feedback, enabled through wearable devices, significantly enhances middle school students' engagement, learning, and athletic development in physical education.

Conclusion and Educational Implications

This study affirms that integrating smart wearable devices into a structured 800m running teaching module can significantly enhance students' motivation, engagement, and self-regulation. Students in the experimental group reported that real-time feedback transformed their training into a goal-oriented, gamified experience that fostered ownership over personal progress. Even students in the reference and control groups—who lacked direct access to the devices—expressed curiosity and a desire to engage with the technology, indicating the broad motivational influence of wearables in physical education settings.

Theoretically, the study supports self-determination theory and feedback-driven learning models by demonstrating how real-time data can empower learners with autonomy and insight into their own performance. These findings contribute to ongoing efforts to integrate educational technology into physical education, a field often perceived as less adaptable to digital innovation. By embedding physiological and biomechanical data into instructional design, educators can offer a more cognitive, personalized, and reflective approach to physical training, bridging the gap between sport science and pedagogy.

Pedagogically, the structured 800m module showcased the benefits of combining clear objectives, real-time feedback, and individualized instruction. Teachers were able to shift from generalized evaluations to targeted, data-informed coaching, while students gained tools to self-monitor and refine their performance. This approach provides a replicable framework for enhancing middle-distance running instruction and offers insight into broader PE curriculum reform—advocating for technology-enhanced modules that promote fitness literacy and student-centered learning outcomes.

From a policy and practical perspective, the implementation of wearable-supported modules calls for strategic investment in infrastructure, teacher training, and privacy policies. While financial and logistical barriers may exist, especially in rural schools, solutions such as shared device models or technology partnerships can help bridge the gap. The study underscores that smart wearable integration is not merely a luxury but a forward-thinking strategy for promoting equitable, personalized learning that nurtures both physical and character development in adolescents.

Future research should investigate the long-term impact and scalability of wearable technology in school-based PE. Studies could explore whether the benefits demonstrated in short-term interventions—such as improved pacing, endurance, and motivation—are sustained over time and across different age groups. Additionally, adapting wearable-supported modules to other sports and diverse school contexts would offer deeper insight into the adaptability and inclusivity of this approach. Exploring student diversity, teacher readiness, and cost-effectiveness will be essential to developing inclusive, future-proof PE programs that blend physical training with digital fluency and lifelong wellness education.

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