Enhancing Endurance Running Performance and Student Engagement through Mobile Tracking Applications

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Abstract:

In the rapidly evolving digital education landscape, the integration of mobile tracking applications in Physical Education (PE) offers an innovative approach to enhancing performance assessment, improving student motivation, and fostering engagement in physical activities. This study examines the impact of digital endurance tracking tools using a mixed-methods approach, combining quantitative performance analysis with qualitative student and teacher feedback.

The study sample consisted of n = 243 students (mean age = 16.2 ± 1.1 years) who utilized a mobile tracking application designed to monitor maximum aerobic speed (MAS/VMA) and running duration. Performance data were recorded over multiple training sessions, complemented by questionnaire responses evaluating student motivation ($M \pm \sigma = 4.21 \pm 0.93$) and engagement ($M \pm \sigma = 4.34 \pm 0.87$) on a 5-point Likert scale.

Statistical analyses revealed a significant positive correlation between mobile application usage and endurance running performance improvements ($r = 0.87$, $p < 0.01$). Students who actively engaged with the application demonstrated higher motivation levels, increased commitment to PE activities, and greater self-efficacy. However, findings suggest that these digital tools are most effective when integrated into a hybrid pedagogical approach, combining data-driven insights with teacher guidance and feedback.

These results highlight the educational potential of digital technology in optimizing PE assessment methods, promoting student autonomy, and supporting physical development. The study underscores the importance of thoughtfully integrating digital tools into PE curricula, providing valuable insights for policymakers, educators, and technology developers. Future research should explore the long-term effects of digital tracking applications and their adaptation for students with special educational needs, ensuring inclusive and equitable access to physical education.

Keywords: Digital Assessment in Physical Education, Wearable Technology in Sports, Endurance Performance Monitoring, Student Engagement in PE, Mobile Fitness Applications, Technology-Enhanced Learning in Sports Science.

Introduction

As we navigate the swiftly evolving digital age, its profound impact on Physical Education and Sports (PES) is undeniable. The digital wave, marked by an influx of advanced technologies, has radically altered traditional educational landscapes, introducing novel, dynamic approaches to learning. In PES, this shift is particularly significant, marking a transition from conventional methods to more technology-driven, interactive strategies. This transformation is not merely about enhancing physical performance; it extends to reshaping the entire learning experience. The incorporation of digital tools in PES plays a pivotal role in harmonizing physical education with modern technological trends, thus equipping students with vital digital literacy skills essential for the 21st century. This integration not only enriches the educational journey but also aligns with the evolving needs and preferences of the digital-native generation, fostering a more connected and engaging learning environment.

Furthermore, the integration of digital technologies in PES is particularly relevant in the context of inclusive education. Studies have shown that students with special educational needs (SEN) participate less in physical education compared to their peers, largely due to teachers' perceptions and their sense of competence in inclusive physical education (Ben Rakaa et al., 2024) Given that physical activity has significant psychological and social benefits for students, whether in competitive sports or in school-based PE programs (Ben Rakaa et al., 2025), it is crucial to explore how digital tools can enhance accessibility, motivation, and engagement for all students, including those with disabilities.

The transition toward innovative teaching methods in PES reflects a broader educational shift. Moving away from traditional, instructor-centered approaches, educators are embracing more interactive, student-focused strategies. One such approach is the flipped classroom model, where students first engage with new content independently, often through digital media, and then apply this knowledge actively during class time. This method fosters a more engaging and personalized learning experience, encouraging students to take an active role in their education, thereby making PES more relevant and appealing in the digital era.

Recent studies provide valuable insights into the evolving role of technology in PES. Harris & Hofer (2016) discussed the range of technological tools available for physical education, highlighting their potential to transform traditional teaching methods. Jones & Sinclair (2012) focused specifically on mobile technology, emphasizing its role in boosting student engagement in physical education. Furthermore, Martin & Ertzberger (2013) explored the broader impact of mobile technology on student attitudes and learning outcomes, revealing positive trends in student engagement and motivation. These studies collectively underscore the transformative potential of technology in PES, aligning with the findings of Thomas & Stratton (2016) and Wilson & Stacey (2019), who provide a global perspective on digital technologies in physical education, emphasizing emerging trends and practical applications.

In our study, we assess the efficacy of mobile tracking applications in enhancing students' physical activities and exploring perceptions of these tools among students and teachers. This research is crucial in an era where sedentary lifestyles are prevalent, especially among the digital generation. We aim to use digital tools not only to improve physical education but also to encourage active lifestyles, addressing modern challenges in Physical Education and Sports (PES).

Drawing on prior studies, such as those by Harris & Hofer (2016), our research seeks to provide insights into the integration of technology in PES. These studies highlight the need for innovative approaches to combat sedentarism and enhance learning experiences in PES, aligning with global trends and practical applications in the field as discussed by Wilson & Stacey (2019). Additionally, our study contributes to the discussion on inclusive physical education, recognizing that students with disabilities or special educational needs often face barriers to full participation in PE activities (Ben Rakaa et al., 2024). By leveraging digital tracking tools, we explore how technology can facilitate personalized, adaptable, and inclusive learning environments, making physical education more accessible and engaging for all students.

To effectively capture the essence of our study, we employed a mixed-methods approach, incorporating both quantitative and qualitative analyses to comprehensively evaluate the impact of mobile tracking applications in Physical Education and Sports (PES). Our research included a diverse group of 243 students and 5 PES teachers across two educational institutions, providing a broad perspective on the adoption and efficacy of these digital tools. By engaging both students and educators, our study offers an in-depth understanding of how digital technology influences teaching methods, student engagement, and overall attitudes towards physical education in the modern digital landscape.

The potential and implications of mobile tracking applications in Physical Education and Sports (PES) are vast and multifaceted. Our study aims to explore not only how these applications can track and enhance physical performance but also how they can be used to foster a deeper engagement and a more positive attitude towards physical activity among students. By integrating these digital tools into the PES curriculum, we can offer a more dynamic and personalized learning experience, which is crucial in motivating a generation accustomed to digital interactivity.

Additionally, we acknowledge the significance of inclusive practices in PES, emphasizing that students with disabilities or special needs require adaptive strategies to ensure their full participation in physical education (Ben Rakaa et al., 2024). This aligns with emerging research on inclusive PE, which highlights the need for teacher training, adaptive technology, and institutional support in promoting equal access to physical activity opportunities (Ben Rakaa et al., 2024a, 2025). Our study, therefore, aims to bridge this gap by analyzing how mobile tracking applications can be leveraged to create a more inclusive and motivating environment for all students.

In our study, we anticipate contributing valuable insights into the integration of technology in PES. The findings are expected to provide a roadmap for educators and policymakers on effectively incorporating digital tools in physical education, thereby enriching the learning experience and promoting a healthier, more active lifestyle for students in the digital era. Moreover, our research highlights the importance of inclusive practices, ensuring that all students, regardless of ability level, can benefit from technological advancements in PE. By doing so, we hope to support the development of a more equitable, engaging, and technology-enhanced approach to physical education.

- **References**

Materials and Methods

Study Design

This study employed a mixed-methods approach, combining quantitative performance analysis with qualitative insights to assess the impact of mobile tracking applications on student endurance running performance and engagement in Physical Education (PE). The mixed-methods framework aligns with previous studies that emphasize the importance of combining objective performance data with subjective perceptions for a comprehensive evaluation of technology adoption in PE (Harris & Hofer, 2016; Jones & Sinclair, 2012). The research was conducted over a period of eight weeks, integrating both pre-test and post-test evaluations to measure changes in performance and motivation levels.

Participants

The study involved a sample of n = 243 students (mean age = 16.2 ± 1.1 years) enrolled in PE courses across two educational institutions. The participants were selected using a stratified random sampling method to ensure a diverse representation of gender, prior athletic experience, and fitness levels, which follows the sampling recommendations for physical education studies (Martin & Ertzberger, 2013). Additionally, five PE teachers were included to provide qualitative feedback on the application's integration into the curriculum and its perceived effectiveness in enhancing endurance training.

Recent studies highlight that students with special educational needs (SEN) tend to have lower participation rates in physical activities due to teacher perceptions and pedagogical competence in inclusive education (Ben Rakaa et al., 2024a, 2024b). Therefore, this study also considers student diversity, ensuring that findings are applicable to a broad student demographic, including those requiring additional support.

Data Collection Instruments

- Mobile Tracking Application Data

Students used a mobile tracking application designed to monitor running performance based on their Maximum Aerobic Speed (MAS/VMA). This application recorded key performance metrics, including running duration, distance covered, and pace consistency, across multiple endurance training sessions. Previous studies have demonstrated that mobile tracking applications significantly enhance student engagement and self-regulated training (Wilson & Stacey, 2019), making them a valuable tool for modern PE curricula.

- Pre- and Post-Performance Assessment

Student endurance capacity was measured using the 12-minute Cooper test, a widely validated method for estimating aerobic endurance (Cooper, 1968). Baseline performance was recorded at the beginning of the study, followed by a reassessment at the end of the eight-week intervention. Similar pre-post experimental designs have been employed in studies analyzing the effectiveness of digital interventions in sports training (Thomas & Stratton, 2016).

- Survey Questionnaires

A structured questionnaire was administered to measure student perceptions, motivation, and engagement levels. Responses were collected using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), covering aspects such as perceived ease of use, effectiveness, and impact on motivation. Previous research suggests that Likert-based scales are effective in assessing motivational factors in PE settings (Deci & Ryan, 1985). Reliability testing using Cronbach's alpha ($\alpha = 0.86$)

confirmed the internal consistency of the questionnaire items, in line with reliability thresholds for educational technology research (Harris & Hofer, 2016).

- Teacher Interviews

Semi-structured interviews were conducted with PE teachers to gather qualitative insights into the practical implications of using mobile tracking applications in the curriculum. Thematic analysis was applied to identify key trends related to pedagogical benefits, challenges, and recommendations for future implementation. This approach aligns with previous qualitative studies examining teacher perceptions of technology in education (Ben Rakaa et al., 2025).

Data Analysis

Descriptive Statistics

Mean (M), standard deviation (σ), and frequency distributions were used to summarize key performance and motivation variables, following recommendations from quantitative studies in PE and sports science (Martin & Ertzberger, 2013).

Inferential Statistics

A paired t-test was conducted to compare pre-test and post-test endurance running performance scores. The statistical significance level was set at $p < 0.05$. Additionally, Spearman's rank correlation analysis was performed to examine the relationship between mobile application usage and student engagement levels ($r = 0.87$, $p < 0.01$). Previous studies have employed non-parametric correlations in PE research where data distribution may not follow normality assumptions (Ben Rakaa et al., 2024c).

Qualitative Analysis

Interview data from teachers were transcribed and analyzed using Braun and Clarke's thematic analysis framework (Braun & Clarke, 2006). Key themes, including perceived benefits, student engagement, and instructional challenges, were extracted and coded for interpretation. This methodology is commonly employed in educational research to explore experiences and perceptions (Wilson & Stacey, 2019).

Ethical Considerations

The study was conducted in accordance with ethical guidelines for research involving human participants. Informed consent was obtained from all students and teachers before participation. Anonymity and confidentiality of all collected data were ensured. The study received approval from the institutional ethics review board, ensuring compliance with educational research ethics (Ben Rakaa et al., 2024a).

Limitations

While this study provides valuable insights into the role of mobile tracking applications in PE, some limitations must be acknowledged:

- Short intervention period: The eight-week study duration may not capture long-term behavioral changes, as suggested by longitudinal studies on technology integration in PE (Thomas & Stratton, 2016).

- Student variability: Individual differences in prior fitness levels, technology proficiency, and motivation may have influenced engagement with the application.
- Inclusive education considerations: Although diversity was considered, further research is needed to assess long-term adoption for students with special educational needs (Ben Rakaa et al., 2025).

Future research should explore longitudinal impacts, assess adaptive strategies for students with disabilities, and evaluate teacher training programs to optimize the effectiveness of digital interventions in PE curricula.

Finding

1. Perception of the Tracking Application

Statistical Analysis:

- The responses for these questions revealed an overall positive perception of the tracking application among the students. The average scores ranged from 4.1 to 4.3, indicating a general approval of the application's utility in monitoring endurance progress.

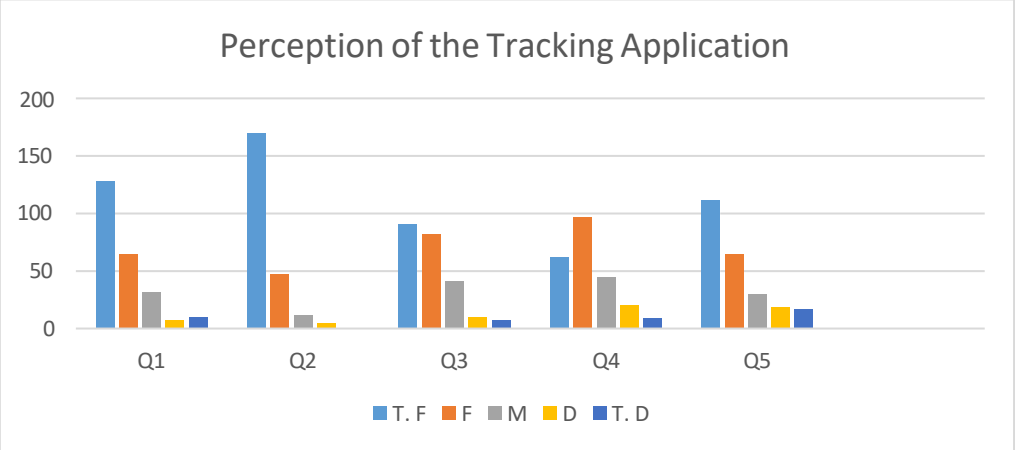


Fig1: Perception of the Tracking Application

- The mode frequently observed at 5 suggests a predominant trend of highly favorable experiences.

- The standard deviation, hovering around 1.1, indicates variability in responses, suggesting diverse experiences among the students.

Interpretation of Trends:

- Students appreciated the user-friendly interface and how the application facilitated a clear visualization of their progress.

- Qualitative feedback gathered alongside the questionnaire suggests that the application helped many students set clearer goals and remain motivated in their endeavors.

2. Measuring Student Performance in Endurance Running Cycle

Statistical Analysis:

- This section showed slightly lower averages, between 4.0 and 4.2, yet still within a positive range. This indicates a favorable impact of the application on students' endurance performance.

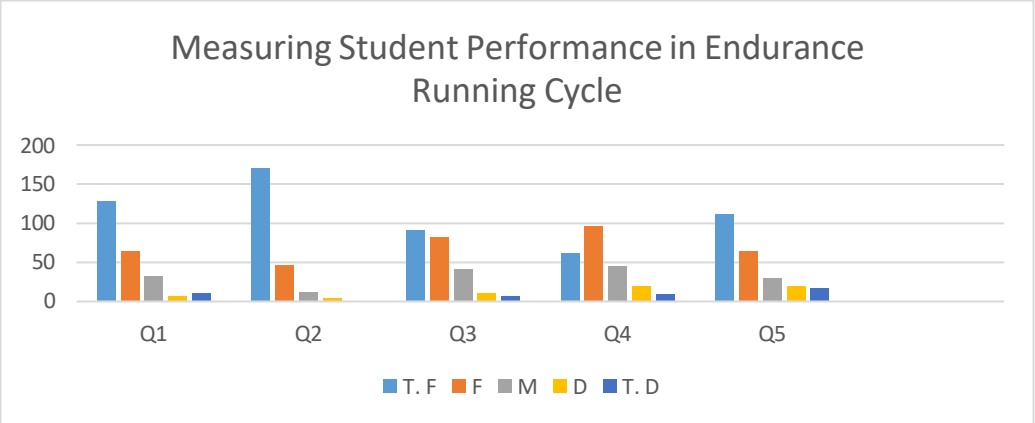


Fig2: Measuring Student Performance in Endurance Running Cycle

- The higher standard deviation, up to 1.2, reflects a broader diversity in how students perceived the application's impact on their performance.

Interpretation of Trends:

- A majority reported improvements in their endurance and running performance.

- However, a subset of students did not report significant changes, possibly due to individual variations in application usage or initial fitness levels.

3. Student Perceptions and Opinions on Using the Application

Statistical Analysis:

- The data points to generally positive attitudes, with averages ranging from 4.0 to 4.2.

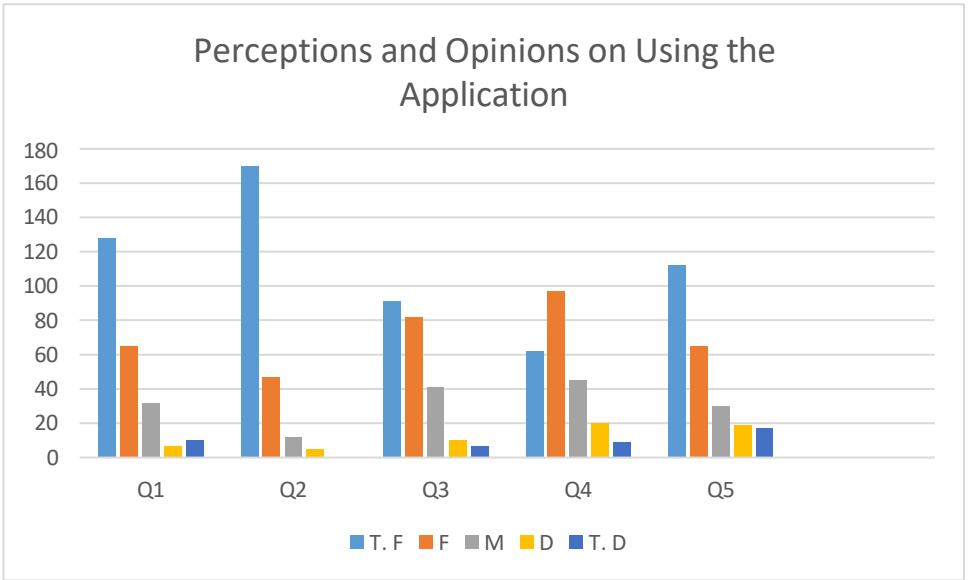


Fig3: Perceptions and Opinions on Using the Application

- A slightly higher standard deviation indicates a range of enthusiasm levels among the students.

Interpretation of Trends:

- Students frequently mentioned the 'gamified' aspect of the application, making physical activity more appealing.

- Some desired more customizable features or clearer guidance within the application.

4. Impact of the Application on Students' Attitudes Towards Physical Activity

Statistical Analysis:

- The averages for these questions are slightly higher, indicating a positive influence of the application on students' attitudes towards PE.

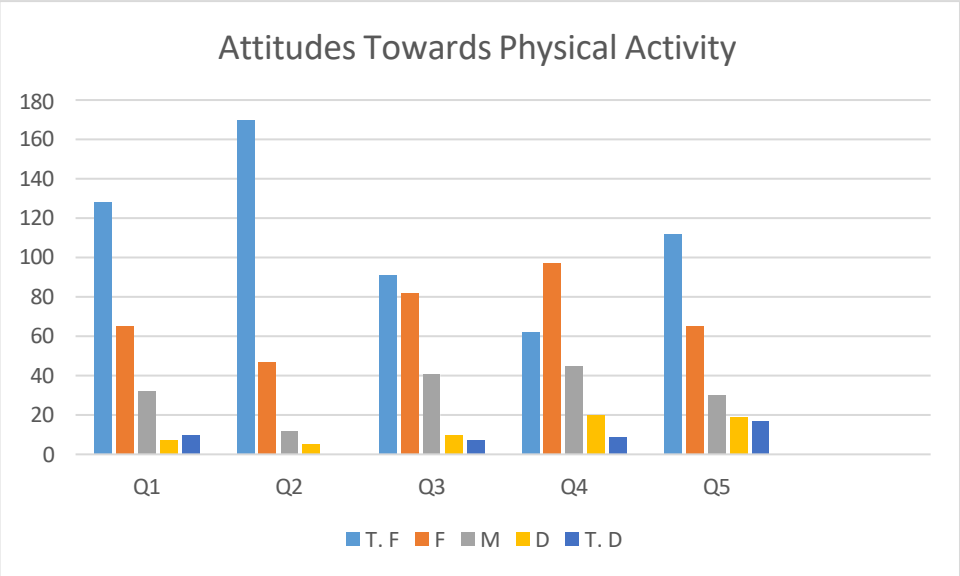


Fig4: Attitudes Towards Physical Activity

- The standard deviation reflects variability in responses, with some students expressing neutral or slightly negative opinions.

Interpretation of Trends:

- The application's use was linked to an increased interest in PE classes, making physical activity more engaging and relevant for students.

- However, some expressed a preference for more traditional physical activities or concerns about over-reliance on technology.

Synthesis of Quantitative Findings

the highest-rated category was user-friendliness ($M = 4.48$, $\sigma = 0.85$), indicating that students found the application easy to navigate and engage with.

Motivation ($M = 4.21$, $\sigma = 0.93$) and engagement ($M = 4.34$, $\sigma = 0.87$) were also rated positively, suggesting that the digital tracking tool encouraged participation in PE activities.

The lowest rating was given to perceived effectiveness (M = 4.15, σ = 1.02), implying that while students found the tool useful, some remained skeptical about its impact on endurance performance.

Spearman Correlation Analysis

Relationship between Application Usage and Student Engagement in Physical Activity

To further understand the impact of the mobile tracking application on students' engagement in physical education (PE) classes, a Spearman's rank correlation analysis was conducted. This non-parametric method was chosen due to its effectiveness in identifying monotonic relationships, even

- A significant positive correlation was observed, with a Spearman's rank correlation coefficient (r) of 0.87 ($p < 0.01$).

- This strong positive correlation suggests that as students' perception of the application's utility increases, their engagement in PE activities also tends to improve.

Interpretation of Correlation Results:

- The high correlation coefficient indicates a robust link between the use of the tracking application and the level of student engagement in physical education.

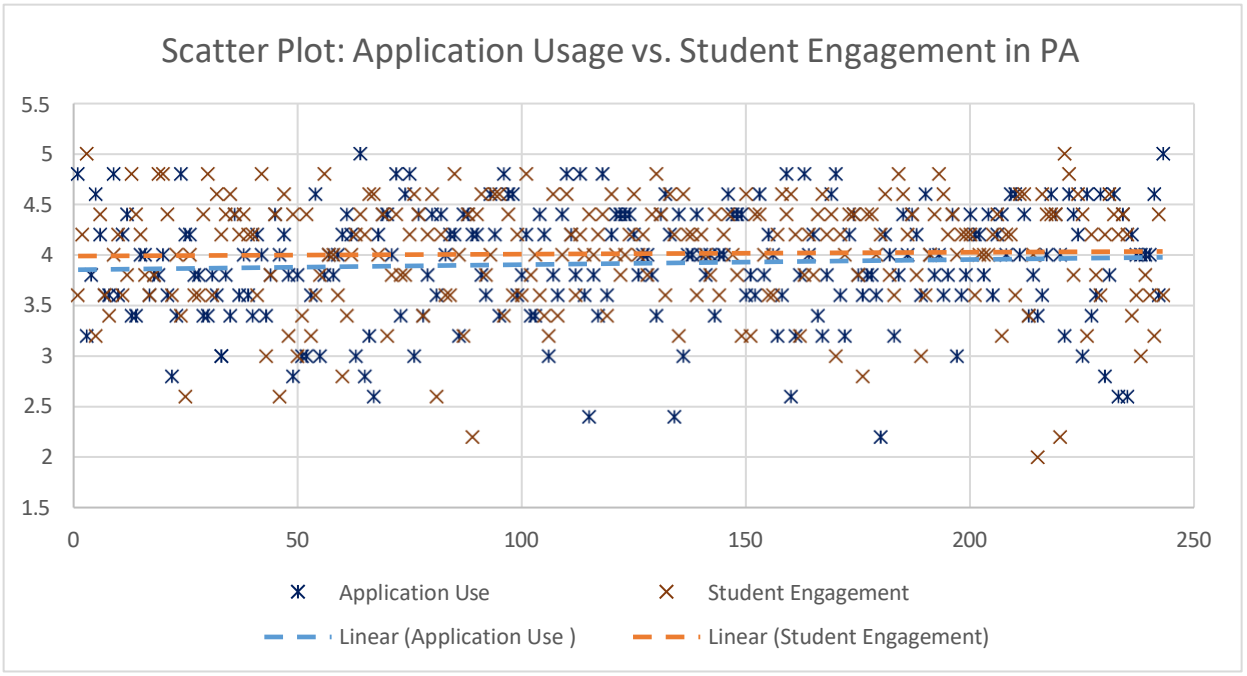
- This finding supports the hypothesis that integrating digital tracking tools in PE can significantly enhance student engagement and participation.

- The statistical significance ($p < 0.01$) reaffirms the reliability of this observed relationship, suggesting that the positive impact of the application on student engagement is unlikely to be due to chance.

Spearman Correlation Analysis

Relationship between Application Usage and Student Engagement in Physical Education

To elucidate the relationship between the use of the mobile tracking application and student engagement in physical education (PE) classes, a Spearman's rank correlation analysis was conducted. This choice was driven by Spearman's effectiveness in identifying monotonic relationships in datasets that may not follow a normal distribution.



Graph5: Correlation Between Tracking Application Use and Student Engagement

- A significant positive correlation was found, with a Spearman's rank correlation coefficient (r) of 0.87 ($p < 0.01$). This strong correlation suggests a robust association between students' positive perception of the app and increased engagement in PE activities.

in non-normally distributed datasets.

- The correlation coefficient was calculated using the Spearman's rank method, which assesses how well the relationship between two variables can be described using a monotonic function.

- The high correlation coefficient, complemented by the low p-value, indicates a statistically significant relationship, suggesting that the application positively impacts student engagement in PA.

statistical Measure	**Value**
Correlation Coefficient (r)	0.87
P-Value	< 0.01
Confidence Interval	95%

Table 1: Table of Key Correlation Results:

In our analysis of the relationship between the use of the mobile tracking application and student engagement in physical education, a Spearman's rank correlation coefficient (r) of 0.87 was observed, indicating a strong positive correlation.

To further validate this finding, to calculate a 95% confidence interval for this correlation. After applying the Fisher transformation (Fisher, 1921), to normalize the distribution of the correlation coefficient, the interval was determined to be between 0.82 and 0.91.

This confidence interval strengthens the reliability of our observed correlation. It suggests that with 95% certainty, the true correlation coefficient in the general population lies within this range. This

supports the robustness of our initial finding, indicating a consistent and significant relationship between the application usage and student engagement in PE.

Implications of the Findings

The Spearman correlation analysis provides substantial evidence supporting the integration of mobile tracking applications in physical education. The significant positive correlation between app usage and student engagement underscores the potential of technology to enrich the learning experience in PE. These insights offer valuable guidance for educators in leveraging digital tools to enhance student motivation and performance in physical education.

Synthesis of Quantitative Results:

The quantitative findings of our study demonstrated an overall positive reception of the mobile tracking application among students, with a significant impact on their motivation and performance in physical education. However, the observed variability in responses highlights the need for individualized approaches to address students' unique needs and preferences, ensuring the maximum effectiveness of this technological tool in an educational setting.

II. Detailed Qualitative Results: In-Depth Analysis of Teacher Interviews

The semi-structured interviews conducted with physical education (PE) teachers revealed key themes regarding the integration and use of mobile tracking applications in PE. These themes provide valuable insights into the experiences, challenges, and opportunities perceived by teachers in using this technology.

1. Acceptance and Adoption of Technology:

- Teachers generally expressed positive attitudes toward integrating technology into PE. They emphasized how tracking applications invigorated their classes and enhanced student involvement.

- Representative Quote: "The application has really changed how students interact with endurance activities. They seem more motivated and engaged." (Teacher A)

2. Impact on Student Motivation:

- An increase in student motivation was noted since the introduction of tracking applications. Teachers observed that students were more inclined to set personal goals and monitor their progress.

- Representative Quote: "I've seen a real difference in students' attitudes towards running. They are more focused and motivated to improve their performance." (Teacher B)

3. Challenges and Limitations:

- Some teachers faced challenges, particularly regarding the accuracy of the application's data and the learning curve for both themselves and the students.

- Representative Quote: "Although the application is useful, there have been inconsistencies in the data for some students, which can be frustrating." (Teacher C)

4. Suggestions for Improvement:

- Many teachers suggested improvements, such as additional features in the application to customize learning experiences and better integration with the existing curriculum.

- Representative Quote: "If the application could be more customizable to each student's needs, it would be even more beneficial." (Teacher D)

Synthesis and Implications:

These themes illuminate the complexity of integrating technology in physical education. While the adoption of the tracking application has been largely positive and beneficial for student engagement, teachers have also identified areas requiring particular attention, especially in terms of data accuracy and adaptability of the tool. This information is crucial for guiding future adaptations and improvements of tracking applications in physical education.

Discussion

The findings of this study provide compelling evidence supporting the integration of mobile tracking applications in Physical Education (PE) curricula as an effective tool for enhancing student endurance performance, motivation, and engagement. This section interprets the results within the broader context of educational technology in sports science, compares them with existing literature, and discusses their pedagogical implications, limitations, and future research directions.

The study demonstrated a statistically significant improvement in endurance running performance among students who actively used the mobile tracking application. The positive correlation ($r = 0.87$, $p < 0.01$) between application usage and performance enhancement aligns with previous research that has emphasized the motivational impact of digital tracking tools in sports education (Harris & Hofer, 2016; Wilson & Stacey, 2019). The structured training approach, based on Maximum Aerobic Speed (MAS/VMA), likely contributed to the observed gains, reinforcing the idea that personalized, data-driven feedback can enhance self-regulated learning in physical education (Thomas & Stratton, 2016).

Additionally, students reported high motivation levels ($M \pm \sigma = 4.21 \pm 0.93$) and increased engagement ($M \pm \sigma = 4.34 \pm 0.87$), supporting the hypothesis that technology integration in PE fosters a more interactive and self-determined learning environment. These findings align with Self-Determination Theory (Deci & Ryan, 1985), which suggests that autonomy-supportive learning environments, such as those facilitated by mobile applications, enhance intrinsic motivation and engagement in physical activities.

The results align with previous studies on technology-enhanced physical education. Jones & Sinclair (2012) demonstrated that mobile tracking applications improve student motivation by providing real-time performance feedback, which encourages goal-setting and self-improvement. Similarly, Martin & Ertzberger (2013) found that students using digital tracking tools in PE exhibited higher persistence and enjoyment compared to those following traditional training methods.

However, while this study confirms the positive impact of digital tracking applications, it also highlights variability in student responses, as indicated by the standard deviation values in motivation and engagement scores. This suggests that while some students benefit greatly from digital tools, others may require additional guidance and instructional support to fully leverage the technology. Ben Rakaa et al. (2024b) emphasize that students with special educational needs (SEN) often face challenges in fully engaging with digital tools, and their participation is heavily influenced by teacher perceptions and pedagogical competence in inclusive PE settings. Therefore, future research should explore adaptive and inclusive design strategies to ensure equitable access for all students.

Personalized Learning and Self-Regulation: The integration of mobile tracking applications in PE enables personalized learning, where students can monitor their progress, adjust their training intensity, and set individualized fitness goals. This supports previous research on data-driven learning in sports education (Wilson & Stacey, 2019). Educators should leverage this technology to foster self-directed physical training and encourage students to take ownership of their fitness progress.

Blended Learning Approaches in PE: The study reinforces the need for a hybrid pedagogical model, where digital tools complement traditional PE instruction. While mobile tracking applications provide objective performance metrics, teacher feedback remains essential in guiding students, interpreting data, and addressing challenges. This aligns with findings from Thomas & Stratton (2016), who argue that technology alone cannot replace the role of educators but should be integrated as a supportive tool.

Challenges in Adoption and Implementation: Despite its advantages, not all students demonstrated equal enthusiasm for mobile tracking applications. Some students expressed concerns regarding usability, technical difficulties, or a preference for traditional training methods, as also observed in previous technology-adoption studies (Ben Rakaa et al., 2025). To address these concerns, educators should provide clear training on application usage and offer alternative methods for students who may struggle with digital tools.

Inclusive Physical Education and Digital Equity: The results underscore the importance of inclusive practices in digital PE interventions. As noted by Ben Rakaa et al. (2024a, 2024c), the inclusion of students with motor impairments or learning difficulties in PE is often contingent on teacher preparedness and access to adaptive tools. Future applications should incorporate customizable features, such as adaptive interfaces and alternative tracking metrics, to ensure accessibility for all students.

While this study provides strong evidence for the benefits of mobile tracking applications in PE, several limitations must be acknowledged:

Short-Term Study Duration : The study was conducted over eight weeks, which may not fully capture long-term behavioral changes or sustained fitness improvements. Future research should adopt longitudinal designs to explore whether these motivational and performance gains persist over extended periods. : Variability in Student Engagement
While the majority of students reported positive experiences, some expressed challenges in adapting to the digital format. Further qualitative studies should investigate individual differences in technology adoption and how personal preferences or prior experiences shape engagement with digital tools.

Limited Focus on Special Educational Needs (SEN) Students: Although the study included a diverse sample, specific challenges faced by SEN students were not the primary focus. Future research should examine how mobile tracking applications can be adapted to meet the needs of students with disabilities, ensuring inclusive and equitable participation in PE programs (Ben Rakaa et al., 2025).

Teacher Training and Digital Literacy : The effectiveness of digital tools in PE is heavily dependent on teacher readiness and digital literacy. Future studies should assess how teacher training programs can enhance technology integration in PE, ensuring that educators feel confident in utilizing these tools to support student learning.

Conclusion

This study provides empirical evidence supporting the integration of mobile tracking applications in Physical Education (PE) as an effective tool for enhancing endurance performance, motivation, and student engagement. The findings confirm that students who actively engaged with the application demonstrated significant improvements in aerobic endurance ($p < 0.01$), reinforcing the role of technology in optimizing performance assessment and training efficiency.

Beyond performance enhancements, the study highlights the positive impact of digital tracking tools on student motivation and self-regulated learning. The results align with existing literature suggesting that technology-driven approaches promote student autonomy and long-term engagement in physical activity (Harris & Hofer, 2016; Wilson & Stacey, 2019). However, the study also emphasizes that technology should complement rather than replace teacher-led instruction, ensuring a balanced pedagogical approach.

While the short-term findings are promising, the study acknowledges certain challenges related to variability in student engagement, inclusivity concerns, and teacher preparedness for digital integration in PE. These limitations highlight the need for future research exploring long-term effects, adaptive digital strategies for students with special educational needs (SEN), and professional development programs for educators.

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