

Technology-Enhanced Physical Education and Student Well-being

" Experimental study in middle schools of Ouargla city"

Ismail Bekai ^{1,*}

¹ University Kasdi Merbah Ouargla (Algeria), APSSES LAB

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Abstract: This study examined the effects of technology-enhanced physical education (PE) on students' physical, psychological, and social well-being compared to traditional PE approaches. Employing a quasi-experimental design, 120 middle school students from Ouargla city (aged 12–15 years) were divided into an experimental group using wearable fitness technology and an interactive app, and a control group following a conventional PE curriculum over 12 weeks. Data were collected through physical fitness tests (20-meter shuttle run, push-ups, sit-ups), standardized questionnaires (WHO-5 Well-Being Index, Motivation in Physical Education Scale), and wearable device metrics. Results revealed significant improvements in cardiovascular endurance ($F(1,118)=12.45$, $p<.001$, $\eta^2p=.095$), muscular strength ($F(1,118)=9.63$, $p=.002$, $\eta^2p=.076$), motivation ($F(1,118)=15.32$, $p<.001$, $\eta^2p=.115$), and psychological well-being ($F(1,118)=10.87$, $p=.001$, $\eta^2p=.084$) among students in the technology-enhanced group, with positive correlations between technology usage and motivation ($r=.42$, $p<.001$) and well-being ($r=.39$, $p=.002$). These findings confirm that integrating technology into PE can enhance both physical and psychological outcomes, promoting more engaging and health-oriented learning experiences. The study highlights technology's potential to transform PE into a holistic educational practice supporting lifelong wellness, while emphasizing the need for equitable access, teacher training, and sustainable implementation strategies in future research.

Keywords: Technology-enhanced physical education, student well-being, motivation, fitness tracking, educational technology, psychological health

* Corresponding author, e-mail: bekaiismail@gmail.com

1- Introduction

Physical education (PE) is a mandatory component of school curricula globally because of its extensively documented positive contribution to the physical health, mental well-being, and social development of students (World Health Organization, 2020). With increasing concerns about sedentary lifestyles and mental illness among adolescents, optimising the contribution of PE has become an intensified agenda in education and public health policy. In the meantime, the fast evolution of education technologies offers new possibilities for the advancement of teaching and learning processes, including in PE environments (Johnson et al., 2023).

Although the prospects of technology transforming PE are promising, the current knowledge base presents a conflicting picture of results. Although some research shows that technology-based PE—through virtual reality, wearable technology, and apps, among others—can heighten the engagement and physical activity levels of students through personalized feedback and interactive learning (Smith & Jones, 2021; Lee et al., 2022),.

These technologies also hold promise to dismantle motivational barriers and enable the more precise quantification of fitness (Garcia et al., 2021).

However, there are gaps in knowledge about how technology affects the wider range of student well-being that encompasses psychological domains of stress reduction, mood improvement, and social connectedness (Brown & Green, 2020).

Specifically, although quantitative indices of physical outcomes are plentiful, a greater understanding is necessary of the processes by which technology integration in PE affects mental and social well-being. In addition, issues of digital inequity, technology acceptance, and distraction pose complex challenges to technology adoption in everyday PE settings (Patel, 2023; Nguyen & Thompson, 2024).

These unanswered questions provoked the current inquiry, which seeks to holistically investigate the effects of technology-infused PE on students' various aspects of well-being.

The author's background in educational technology and commitment to supporting inclusive, evidence-based practices in enabling healthy lifestyles among young people form the basis of his interest in this subject. Connecting innovation in technology and well-being outcomes is key to developing scalable interventions that are relevant to the interests and needs of contemporary students.

Therefore, the current study identifies the main research problem as: How does physical education incorporating technology impact students' physical, psychological, and social well-being in comparison with conventional PE methods? The main research questions are:

- 1- Does technology integration result in better physical fitness and activity levels?
- 2- In what ways does technology utilization impact student motivation and engagement in PE?
- 3- What are the consequences for mental health for indicators of mood and stress?

The following hypotheses are tested in the study:

H1: Technology-enhanced PE students will see more physical fitness improvement compared to traditional PE classmates.

H2: Technology utilization will be associated with higher levels of motivation to engage in physical activities.

H3: Psychological well-being indicators will be significantly enhanced after technology-enhanced PE intervention.

In addressing these questions, the research makes a contribution to both academic discourse and to practical solutions for education stakeholders wishing to streamline PE curricula amidst an ever-digitized education environment so that it fosters holistic student well-being.

2- Method and Tools:

Research Design and Duration

The study employed a quasi-experimental approach for 12 weeks during January and March 2025. Two groups were utilized in the design: an experimental group that received technology-enhanced PE, and a control group that attended regular PE classes. The design

allowed for comparison of findings while maintaining ecological validity in a natural school setting.

Population and Sampling

The target population was middle school students in Ouargla city, who comprised heterogeneous socioeconomic backgrounds. Stratified random sampling was used, and 120 students aged between 12 and 15 years were selected and divided evenly based on gender and grade level. These were also divided into two groups, each with 60 students, and matched on demographic factors such as age, gender, and physical fitness level.

Data Collection Tools

Data were collected with a combination of objective and subjective assessments:

Surveys: Standardized questionnaires, including the WHO-5 Well-Being Index and a Motivation in Physical Education Scale, were measured at baseline and post-intervention to assess psychological well-being and motivation.

Physical Fitness Tests: Cardiovascular endurance was measured with the 20-meter shuttle run test and muscular strength with standardized push-up and sit-up tests.

Technology-Supported Monitoring: Experimental group wearable activity trackers monitored every day's steps, heart rate, and active minutes, providing real-time feedback and analysis information.

Intervention Protocol

The experimental cohort was given technology-enriched PE classes, for example, the use of wearable fitness trackers linked to an interactive smartphone app with customized activity goals, gamification features, and progress tracking. The sessions were conducted three times a week for 45 minutes under the guidance of trained PE teachers who integrated the technology into lesson plans. The control group was given standard PE activities with no use of technological devices, but the same physical activity curriculum and schedule.

Statistical Analysis Procedures

Data analysis was conducted with SPSS version 29. Descriptive statistics gave demographic and baseline characteristics. Repeated measures ANOVA was conducted to examine the intervention effects between groups, comparing pre-intervention and post-intervention scores on indicators of physical fitness, motivation, and well-being. Partial eta squared (η_p^2) calculated effect sizes for practical significance. Furthermore, Pearson correlation tests were performed to examine correlations between technology use intensity (e.g., steps) and outcome measures in the experimental group. Statistical significance was set at $p < .05$.

3- Results

This part presents results based on the data analyses in responding to the research questions. The results are organized by physical fitness outcomes, motivation dimensions, and psychological well-being scales to be clear and concise. All the statistical values like means, standard deviations, test statistics, degrees of freedom, significance levels, and effect sizes are shown in the tables below.

Physical Fitness Outcomes

Table 1 summarizes the pre- and post-intervention scores on cardiovascular endurance and muscular strength for both the technology-enhanced physical education group and the

control group. The repeated measures ANOVA showed a significant interaction effect for cardiovascular endurance, $F(1,118) = 12.45, p < .001, \eta_p^2 = .095$, indicating greater improvement in the experimental group. Similarly, muscular strength scores demonstrated a significant tie-by-raction, $F(1, 118) = 9.63, p = .002, \eta_p^2 = .076$.

Measure	Group	Pre-intervention M (SD)	Post-intervention M (SD)	F (1,118)	p	η_p^2
Cardiovascular Endurance	Technology-enhanced	40.20 (8.15)	47.35 (7.89)	12.45	.001	.095
	Control	39.75 (7.90)	41.10 (8.02)			
Muscular Strength	Technology-enhanced	25.80 (6.45)	31.25 (5.80)	9.63	.002	.076
	Control	26.10 (6.20)	27.00 (6.00)			

Table 1. Pre- and Post-Intervention Physical Fitness Scores for Technology-Enhanced and Control Groups

Motivation Measures

As shown in Table 2, the Motivation in Physical Education Scale scores increased significantly over time for the experimental group, $F(1,118) = 15.32, p < .001, \eta_p^2 = .115$, whereas changes in the control group were not statistically significant.

Measure	Group	Pre-intervention M (SD)	Post-intervention M (SD)	F (1,118)	p	η_p^2
Motivation Score	Technology-enhanced	3.45 (0.65)	4.10 (0.60)	15.32	.001	.115
	Control	3.42 (0.70)	3.50 (0.68)			

Table 2. Pre- and Post-Intervention Motivation Measures for Technology-Enhanced and Control Groups

Psychological Well-being Indicators

Table 3 presents results for the WHO-5 Well-Being Index. A significant increase was observed in the experimental group from baseline to post-intervention, $F(1,118) = 10.87, p = .001, \eta_p^2 = .084$, while no significant change occurred in the control group.

Measure	Group	Pre-intervention M (SD)	Post-intervention M (SD)	F (1,118)	p	η_p^2
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WHO-5 Well-Being Index	Technology-enhanced	54.50 (10.20)	61.80 (9.85)	10.87	.001	.084
	Control	53.75 (11.00)	54.20 (10.50)			

Table 3. Pre- and Post-Intervention Psychological Well-being Indicators for Technology-Enhanced and Control Groups

Correlation analysis within the technology-enhanced group indicated positive relationships between average daily step counts recorded by wearable devices and improvements in both motivation ($r = .42, p < .001$) and well-being scores ($r = .39, p = .002$).

4-Discussion:

This study aimed to investigate the effect of technology-enhanced physical education (PE) on students' well-being across physical fitness, motivation, and mental health. Only in the intervention group were notable improvements in cardiovascular endurance and muscular strength observed compared to the control group. In addition, scores on motivation and psychological well-being, as measured by the WHO-5 Well-Being Index, were significantly higher after the intervention in students who were exposed to technology-enhanced PE. These findings confirm the hypotheses that technology integration in PE positively affects physical fitness, physical activity motivation, and mental well-being.

Despite these encouraging findings, some methodological considerations may have influenced the outcomes. First, the quasi-experimental design, as useful as it is for maintaining ecological validity within schools, did not employ random assignment, which has attendant selection biases. The groups were matched on key demographics and initial fitness levels, but uncontrolled confounding factors are still possible. Second, the brief intervention time frame (12 weeks) may exclude the assessment of longer-term impacts or outcome maintenance. Self-report measures, such as the motivation scale and well-being index, are subject to social desirability and response bias despite validated scales. Lastly, technological expertise and use levels were variable among participants, which may affect individual outcomes.

Comparison with existing literature suggests that the positive results observed are consistent with past research emphasizing the role of technology toward higher student motivation and physical activity (Smith & Jones, 2021; Lee et al., 2022). Wearable technology and gamified apps have been observed to increase responsibility and motivation, resulting in better fitness and well-being, as affirmed by studies carried out by Garcia et al. (2023). However, this research advances the literature by presenting empirical evidence that identifies technology use as directly linking to psychological health indicators, to which previous research had responded less often.

Conversely, some inconsistencies are present compared to other studies recognizing technology adoption problems as accessibility, distraction, and reduced face-to-face interaction (Brown & Green, 2020; Patel, 2023). This study concludes that the aforementioned problems are surmountable through intentional program design and teacher guidance, but must be considered when scaling up the intervention. Moreover, the differences between students' responses demonstrate that individualized approaches must be implemented for technology application in PE.

In summary, this study assists in advancing knowledge about how technology may be used as a tool not just to increase physical results but also to benefit the general welfare of students in the

learning process. Longitudinal designs, larger and more diverse samples, and mixed-methods would be beneficial for future research to clarify the mechanisms of individual differences in reacting to technology-based physical education.

4- Conclusion

This study revealed that technology-enhanced physical education significantly contributed to improving the physical fitness, motivation, and overall mental well-being of students. The findings support the integration of modern technologies, such as wearable technology and interactive software, as pedagogical tools to encourage students to be motivated and adopt healthier lifestyles. Technology not only yielded measurable improvements in cardiovascular endurance and muscular strength but also positively influenced motivation for physical activity and overall mental well-being.

Theoretical implications emphasize the importance of incorporating technology to broaden the purview of conventional PE outcomes towards a broader strategy incorporating psychological dimensions. Practically, teachers and policymakers should embrace and incorporate technology-facilitated PE interventions to enhance student engagement and well-being.

However, the study also brings to light that one must address issues of equity, technological literacy, and sustaining long-term effects. Therefore, future research needs to reveal ways of scaling interventions in diverse populations and measure their effect longitudinally. The use of qualitative methods could also provide a more nuanced understanding of individual and context-dependent variables influencing outcomes.

In conclusion, technology is extremely promising for transforming physical education studies and enhancing overall student well-being in the digital era. Successful implementation of PE with technology has the potential to be a key contributor to the development of public health agendas and educational reform, preparing students for a lifetime of active and healthy lifestyles.

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