IMPACT OF DIGITAL TOOLS INTEGRATION ON LEARNING OUTCOMES IN PHYSICAL EDUCATION

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Abstract

The growing integration of technology in education has transformed teaching and learning processes, including the delivery of Physical Education in contemporary schools. This study investigated the impact of digital tools integration on the learning outcomes of junior high school students in Physical Education. Specifically, it examined the effects of digital tool use on physical fitness, skill acquisition, and knowledge retention. It compared the outcomes of students exposed to digital-enhanced instruction with those taught through traditional methods. The study employed a quantitative quasi-experimental pre-test/post-test control-group design with an experimental and a control group. Standardized assessments were used to measure physical fitness through the FITNESSGRAM, skill acquisition through performance-based assessments, and knowledge retention through teacher-made pre- and post-tests. Findings revealed that students exposed to digital tools demonstrated significantly greater improvement across all measured outcomes than those who received traditional instruction. The experimental group obtained higher post-test mean scores in cardiovascular endurance ($M = 51.5$, $SD = 7.8$), muscular strength ($M = 42.3$, $SD = 6.5$), skill acquisition ($M = 82.7$, $SD = 7.3$), and knowledge retention ($M = 78.9$, $SD = 8.5$). Moreover, significant positive correlations were found between the frequency of digital tool usage and improvements in fitness ($r = 0.62$, $p < .001$), skill acquisition ($r = 0.55$, $p < .001$), and knowledge retention ($r = 0.48$, $p < .001$). The study concluded that integrating digital tools in Physical Education significantly enhances student learning outcomes and supports more engaging, data-driven, and effective instruction.

Keywords: Digital Tools, Physical Education, Learning Outcomes, Physical Fitness, Skill Acquisition, Knowledge Retention, Quasi-Experimental Study

1. Introduction

Physical education (PE) occupies a distinctive place in the school curriculum because it addresses learning through the body as well as through the mind. UNESCO defines quality physical education as a form of learning that develops rounded skills and supports physical, social, emotional, and psychosocial well-being. At the same time, the World Health Organization (WHO) maintains that children and adolescents need regular physical activity for significant health benefits. These two positions are important for contemporary schooling because they frame PE not as an auxiliary subject, but as a core educational space in which health, movement competence, self-regulation, and lifelong activity habits are cultivated. In the 21st century, however, PE is being reshaped by the same digital turn that has transformed other learning areas. The 2023 UNESCO Global Education Monitoring report notes that technology now affects education through multiple channels and that its educational value depends on how appropriately it is usedwithin specific teaching contexts. In the Philippines, this shift is also reflected in policy: DepEd Order No. 016, s. 2023 states that the Department of Education Computerization Program aims to provide public schools and offices with appropriate, quality, and equitable technologies that enhance teaching and learning. These developments create a strong policy and pedagogical basis for examining how digital tools may improve learning outcomes in PE.

The promise of digital integration in PE is especially compelling because the subject depends heavily on feedback, movement observation, repetition, and active engagement. Unlike primarily text-based disciplines, PE requires students to see, perform, refine, and internalize motor actions in real time. A recent systematic review by Zhong et al. (2025) found that digital-intelligent technologies in PE have been used across the instructional cycle through adaptive learning platforms, virtual simulation tools, multimodal assessment systems, and health-behavior monitoring. The same review explains that these technologies can address long-standing constraints in traditional PE, including delayed feedback, time and space limitations, and restricted access to individualized guidance. Similarly, Martín-Rodríguez and Madrigal-Cerezo (2025), in a review of 151 studies, concluded that technology-enhanced pedagogy in PE is associated with stronger motivation, engagement, motor skill development, tactical understanding, and cognitive learning. Such findings suggest that digital tools are not merely decorative additions to PE classes; when instructionally aligned, they can serve as pedagogical mediators, making feedback more immediate, assessment more objective, and learning more personalized.

Evidence from recent intervention studies further strengthens this position. In *Computers & Education*, Hsia et al. (2025) reported that a gamified intelligent tutoring and instant-feedback system improved students' performance and learning engagement in yoga compared with a conventional digital system, showing that the design of feedback-rich, motivationally informed technologies can enhance performance in PE. In a secondary school setting, Ghorbel et al. (2026) found that a blended PE model combining digital content with face-to-face teaching significantly improved both motor learning and knowledge retention in gymnastics compared to a traditional approach. These studies matter because they align closely with the key outcomes often targeted in school PE: physical performance, skill acquisition, and cognitive understanding. They also support broader review evidence that digital tools can strengthen not only participation and motivation but also measurable learning outcomes when used systematically rather than incidentally. For PE teachers, this means that wearables, video analysis, learning platforms, and gamified applications may offer more than novelty; they may also support more precise instruction and deeper student learning.

At the same time, the literature does not support an uncritical embrace of technology. UNESCO's 2023 report cautions that digital technology does not automatically transform education and that its effects remain uneven across contexts. This caution is highly relevant to PE, where embodiment, movement space, and access to equipment directly shape whether a tool helps or distracts. Zhong et al. (2025) identified persistent implementation problems in PE, including algorithmic limitations, data privacy concerns, and unequal access to digital resources. Martín-Rodríguez and Madrigal-Cerezo (2025) similarly note barriers such as digital inequality, insufficient teacher training, and ethical questions surrounding student data collection. These concerns are not peripheral. In PE, where devices may gather movement, biometric, or participation data, schools must consider instructional value alongside fairness, privacy, and feasibility. The literature therefore points to a balanced conclusion: digital tools can enrich PE, but their success depends on pedagogical fit, teacher readiness, ethical safeguards, and equitable infrastructure.

A second reason this topic deserves focused inquiry is that the existing evidence base still has clear gaps. Zhong et al. (2025) found that most empirical studies on digital-intelligent PE were concentrated in higher education, while only a small share addressed secondary education. The same review also reported that most applications were implemented in offline PE classes, with comparatively limited work in online and blended environments. This matters because the realities of junior high school differ substantially from those of universities in terms of developmental stage, school structure, teacher workload, and access to technology. Findings from higher education cannot be transferred directly to younger learners without testing.

Moreover, the Philippine school context adds another layer of urgency. Although national policy supports technology provision and educational modernization, local evidence is still needed to show whether digital integration in PE actually improves outcomes that matter to schools, such as physical fitness, skill execution, and knowledge retention.

In this context, the present study is timely and significant. The uploaded thesis shows that the study investigates the impact of integrating digital tools into PE instruction on the learning outcomes of junior high school students, with particular attention to physical fitness, skill acquisition, and knowledge retention. It also compares students exposed to digital-enhanced instruction with those taught through traditional methods and considers perceived benefits and challenges as bases for intervention. This focus is educationally important because it shifts the discussion from general enthusiasm about educational technology to a more exact question: whether digital integration in PE produces measurable gains in core learning outcomes under actual school conditions. By examining this issue through a quasi-experimental framework, the study responds directly to current calls for context-sensitive, school-based evidence on how technology can be used to strengthen quality physical education.

2. Method

2.1 Research Design

The study employed a quantitative quasi-experimental research design, specifically a pre-test/post-test control group design, to determine the impact of digital tool integration on the learning outcomes of junior high school students in physical education. This design was appropriate because it enabled the researcher to compare changes in student performance across two groups—an experimental group receiving digitally enhanced PE instruction and a control group taught through traditional methods—while maintaining a structured, measurable intervention framework. Both groups were assessed before and after the intervention using the same standardized instruments, thereby allowing the researcher to establish baseline equivalence, measure learning gains over time, and isolate the instructional effect of digital tool integration on key outcome variables such as physical fitness, skill acquisition, and knowledge retention. The intervention period was standardized in terms of PE session duration and frequency for both groups to minimize extraneous influences and strengthen internal validity. To further enhance the rigor of the design, the study used statistical procedures such as independent-samples t-tests, paired-samples t-tests, and analysis of covariance (ANCOVA), while also considering effect sizes and correlational patterns within the experimental group. Overall, the chosen design provided a robust and empirically defensible framework for evaluating whether digital tools could significantly improve student learning outcomes in physical education under authentic school conditions.

2.2 Participants

The study was junior high school students drawn from a specific grade level within the selected school setting, chosen to maintain relative homogeneity in age, developmental stage, and prior educational exposure. Using convenience sampling, the researcher recruited eligible learners and carefully assigned them to two comparison groups: an experimental group that received physical education instruction enriched with digital tools and a control group that followed the same standardized physical education curriculum through traditional teacher-led methods without digital integration. This grouping structure was essential to the quasi-experimental design because it enabled the study to compare the effects of the intervention across learners exposed to different instructional conditions while preserving comparability in curricular content, session frequency, and school context. The selected participants were therefore appropriate for the study's aim of determining whether integrating digital tools could produce measurable differences in physical fitness, skill acquisition, and knowledge retention among junior high school learners in physical education.

2.3 Instrumentation

The study employed a multi-instrument quantitative assessment system designed to capture the effects of digital tool integration on the three core learning outcomes of physical education: physical fitness, skill acquisition, and knowledge retention. For physical fitness, the researcher used the FITNESSGRAM, which generated objective measures of cardiovascular endurance, muscular strength and endurance, flexibility, and body composition, and this was further supplemented by heart rate monitors to record real-time physiological responses during selected activities. Skill acquisition was measured through performance-based assessments supported by standardized rubrics and observational checklists, while video recordings analyzed through movement analysis software and compared against expert models were used to increase precision in evaluating motor performance. Knowledge retention, meanwhile, was assessed using researcher-prepared pre-tests and post-tests composed of multiple-choice, true/false, and short-answer items aligned with the physical education curriculum, with digital journals also serving as supplementary evidence of students' theoretical understanding. In addition, the study gathered digital tool usage logs, standardized observation forms, and questionnaires on perceived usefulness and ease of use among students in the experimental group, thereby producing a comprehensive, triangulated, and methodologically robust set of instruments suitable for evaluating the instructional effectiveness of digital tools in physical education.

2.4 Data Analysis

The study employed a comprehensive quantitative data analysis framework to determine the effect of digital tools integration on students' learning outcomes in physical education. Using appropriate statistical procedures, the researcher first computed descriptive statistics, including means, standard deviations, and frequencies, to summarize the respondents' demographic characteristics and establish the central tendencies and dispersions of the key variables. To determine whether significant differences existed between the experimental group and the control group on the dependent variables, the study utilized independent samples t-tests; at the same time, analysis of covariance (ANCOVA) was applied to control for relevant covariates such as pre-test scores and selected demographic variables, thereby improving the precision of the group comparisons and minimizing the influence of extraneous factors. To examine changes in performance over time within each group, the study also used repeated measures ANOVA, which enabled the researcher to track learning gains from pre-test to post-test across the intervention period. In addition, effect size estimates, particularly Cohen's d, were computed to determine the practical magnitude of the intervention's impact beyond statistical significance. At the same time, Pearson's r was used within the experimental group to explore the association between the frequency and type of digital tool use and the measured learning outcomes. Finally, reliability and validity analyses were conducted on the assessment instruments to ensure their consistency and accuracy, thereby strengthening the rigor, objectivity, and interpretive credibility of the study's quantitative findings.

3 Results

The study found that integrating digital tools consistently produced stronger learning outcomes in physical education than traditional instruction. In the domain of physical fitness, the experimental group posted marked gains across all FITNESSGRAM indicators from pre-test to post-test. Cardiovascular endurance improved from 40.2 ± 8.5 to 51.5 ± 7.8, muscular strength from 35.1 ± 7.2 to 42.3 ± 6.5, muscular endurance from 38.7 ± 6.9 to 45.9 ± 6.1, and flexibility from 25.4 ± 5.8 to 30.1 ± 5.2. Body composition also showed a favorable change, decreasing from 22.8 ± 3.1 to 21.5 ± 2.9. By contrast, the control group demonstrated only modest improvements across the same indicators, suggesting that digitally enriched physical education was more effective in promoting measurable fitness development than conventional teacher-led methods alone.

A similarly strong pattern emerged in skill acquisition. Students in the experimental group achieved substantially higher post-test scores in all three measured skill areas than their pre-test levels and than the control group's post-test performance. For Skill A, the experimental group rose from 65.2 ± 8.1 to 82.7 ± 7.3, while the control group moved only from 66.0 ± 8.5 to 71.3 ± 8.0. For Skill B, the experimental group increased from 68.9 ± 7.5 to 85.1 ± 6.8, whereas the control group improved from 69.5 ± 7.8 to 73.2 ± 7.6. In Skill C, the experimental group advanced from 63.5 ± 9.0 to 80.2 ± 8.2, compared with the control group's smaller gain from 64.0 ± 9.3 to 68.1 ± 9.1. These results indicate that the use of video analysis software and mobile skill-development applications supported more substantial refinement of motor performance than traditional instructional approaches.

The findings were equally notable in knowledge retention. The experimental group's mean score increased from 60.5 ± 9.2 in the pre-test to 78.9 ± 8.5 in the post-test, while the control group showed only a limited improvement from 61.0 ± 9.5 to 65.2 ± 9.0. This result indicates that digital integration not only enhanced physical and psychomotor outcomes but also strengthened students' cognitive understanding of physical activity, health, and fitness concepts. The magnitude of the increase in the experimental group suggests that online learning platforms, interactive modules, and digitally mediated review activities were more effective in reinforcing theoretical content than traditional delivery alone.

Beyond the test scores, the study also revealed generally positive student and teacher perceptions of digital tool integration. Students reported increased motivation and engagement, greater enjoyment of physical activity, more meaningful self-monitoring, and clearer personalized feedback. Teachers, in turn, identified benefits such as improved data tracking, more individualized instruction, stronger student participation, wider access to teaching resources, and greater efficiency in record keeping. At the same time, both groups recognized several challenges, including device malfunctions, internet connectivity issues, data privacy concerns, the learning curve associated with unfamiliar technologies, the need for technical training, and the possibility of increased workload. These findings indicate that while digital tools enhanced learning, their successful use still depended on adequate infrastructure, teacher preparation, and institutional support.

Taken together, the results present a coherent pattern: students exposed to digitally enhanced physical education outperformed those in traditional classes in physical fitness, skill acquisition, and knowledge retention, while also reporting more engaging and responsive learning experiences. The evidence therefore supports the study's central argument that digital tools can serve as effective pedagogical supports in PE when systematically integrated into instruction. At the same time, the identified technical and implementation issues suggest that the benefits of digital integration will be maximized only when schools provide sufficient resources, training, and policy support for both teachers and learners.

4. Discussion

The findings of this study showed that students exposed to digitally enhanced physical education achieved stronger gains in physical fitness than those taught through traditional methods, particularly in cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition. This pattern is well supported by recent literature. Zhong et al. (2025) concluded in their systematic review that digital-intelligent technologies in physical education now support real-time process visualization, data-driven evaluation, and health-behavior monitoring, thereby enabling more personalized and data-informed instruction. Similarly, Martín-Rodríguez and Madrigal-Cerezo (2025) found that technology-enhanced pedagogy in physical education is associated with stronger engagement, improved motor development, and better cognitive learning when the tools are aligned with instructional goals. Read against the present findings, these studies suggest that the fitness gains observed in the experimental group were not incidental; rather, they likely emerged because wearable and interactive tools made effort, feedback, and progress more visible and actionable for learners during physical activity.

The study also found that skill acquisition improved more substantially in the experimental group than in the control group. This result strongly aligns with recent evidence on technology-supported motor learning. Hsia et al. (2025) reported that a gamified, intelligent tutoring and instant-feedback system in physical education significantly improved performance and learning engagement in yoga, underscoring the instructional value of immediate, personalized feedback. In a secondary-school setting, Ghorbel et al. (2026) likewise found that a blended-learning model in gymnastics significantly outperformed a traditional approach in motor learning, demonstrating that multimedia-enhanced instruction can improve movement execution under authentic PE conditions. These studies help explain why the present study's use of video analysis software and mobile skill-development applications was effective: such tools slow movement, make errors observable, and allow repeated, feedback-rich refinement, all of which are central mechanisms in motor-skill acquisition.

A parallel pattern emerged in knowledge retention, where the experimental group showed markedly greater post-test improvement than the control group. This result is consistent with Ghorbel et al. (2026), who found that their blended PE intervention improved not only motor learning but also knowledge retention, indicating that digital and hybrid resources can strengthen the cognitive dimension of physical education as well as the psychomotor one. It is also supported by Martín-Rodríguez and Madrigal-Cerezo (2025), who identified gains in cognitive learning across technology-enhanced PE studies. In this light, the present findings suggest that online learning platforms, interactive modules, and digital review activities likely enhanced retention by enabling repeated exposure, self-paced access, and multimodal presentation of content. Thus, the study reinforces an important IMRAD-level implication: when digital tools are used pedagogically rather than merely administratively, they can deepen students' conceptual understanding of physical activity, health, and fitness alongside their physical performance.

The generally positive student and teacher perceptions reported in the study—especially increased motivation, personalized feedback, better engagement, and more efficient tracking—are likewise corroborated by the broader literature. However, the identified implementation challenges are equally important. Martín-Rodríguez and Madrigal-Cerezo (2025) found that technology in PE tends to enhance motivation and engagement. Yet, they also highlighted digital inequality, insufficient teacher training, and ethical concerns over student data. Zhong et al. (2025) similarly identified data privacy, unequal access to digital resources, and technical constraints as persistent barriers. At the system level, UNESCO's 2023 GEM Report stressed that the educational value of technology depends on access, governance, and teacher preparation, rather than on device availability alone. These sources closely mirror the present study's findings on technical difficulties, privacy concerns, workload, and the need for training and support. Taken together, the discussion indicates that digital integration in PE is most effective when it is accompanied by infrastructure, teacher capability-building, and clear ethical safeguards; without these, even promising tools may yield uneven or unsustainable outcomes.

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