Vol. XXVII, Issue 2/ 2026

G Y M N A S I U M

Scientific Journal of Education, Sports, and Health

Original Article

The Impact of Integrating Digital Technologies Through a Hybrid Model on Students' Motor Performance in Physical Education

Lungu Adrian Constantin [1]
Vizitiu Lakhdari Elena [2*]
Dobrescu Tatiana [3]

[1]*Institute of Physical Education and Sport, Moldova State University, 22, Andrei Doga, Chișinău, Republic of Moldova*
[2]*"Stefan cel Mare" University of Suceava, 13, Universității, 720229 Suceava, Romania*
[3] *"Vasile Alecsandri" University of Bacău, 157, Calea Marasesti, 600115, Bacău, Romania*

DOI: 10.29081/gsjesh.2026.27.2.3

Keywords: *learning; digital technologies; physical education; motor performance; primary school pupils*

Abstract

This study investigated the impact of integrating digital technologies through a hybrid teaching model on the motor performance of fourth-grade pupils during physical education classes. The research was conducted on a sample of 30 pupils from the Technological High School, Marginea, divided into an experimental and a control group. The intervention lasted seven weeks with two lessons per week. The experimental group followed a hybrid instructional approach based on video support, digital materials, visual guidance, and individualized feedback, while the control group was taught through traditional methods. Motor performance was assessed through speed, agility, explosive strength, endurance, and coordination tests. The results showed improvements in both groups, with significant intra-group progress in most variables. No statistically significant differences were identified between groups in the overall evolution of motor performance. The findings suggest that hybrid instruction is effective, but not clearly superior to traditional teaching under the conditions of this study.

1. Introduction

The rapid digitalization of education has generated significant transformations in teaching methodologies, including in physical education (PE). Hybrid education, which combines face-to-face instruction with digital learning environments, has emerged as a key approach for enhancing both pedagogical effectiveness and student performance (Lungu & Vizitiu Lakhdari, 2023; Kučera &

* *E-mail:* elenav@usm.ro

Haffner, 2025). This shift has been further accelerated by the COVID-19 pandemic, which forced educational systems worldwide to adopt flexible and technology-supported instructional models. In this context, the integration of digital technologies into PE is increasingly recognized as essential for modernizing pedagogy and improving learning outcomes (Xie, Chen, Li & Huang, 2025; Zhong et al., 2025). Hybrid and blended learning models provide opportunities to optimize motor learning, increase student engagement, and support individualized feedback processes (Wang, et al., 2023; Moon & Lee, 2025). Moreover, hybridization of pedagogical models allows educators to overcome the limitations of single-model approaches, leading to more effective learning outcomes in PE settings (Shen & Shao, 2022). At the same time, declining levels of physical activity and increasing sedentary behaviors among children and adolescents represent major public health concerns, exacerbated in the post-pandemic context (Quiñonero-Martínez, Cifo-Izquierdo, Sánchez-Alcaraz Martínez & Gómez-Mármol, 2023). Although physical activity is fundamental for motor development, traditional PE programs often fail to fully address the needs of this population (Bayburtlu Genç & Ünal, 2024). Recent evidence suggests that hybrid digital learning approaches can enhance motor performance and physical activity levels by incorporating innovative strategies such as gamification and personal and social responsibility frameworks (Hidayatullah, et al., 2025; Chen, 2025). Furthermore, Physical Education Teacher Education (PETE) programs are increasingly adopting hybrid instructional models to better prepare future teachers for the complex demands of contemporary education (Moon & Lee, 2025). These approaches not only improve pedagogical competencies but also support the development of adaptive, technology-enhanced teaching practices. Therefore, investigating the impact of hybrid digital models in PE is both timely and necessary, as it provides valuable insights into optimizing motor performance, increasing physical activity, and reducing sedentary behavior among students.

2. Material and methods

The aim of the study was to investigate the impact of integrating digital technologies, through the use of a hybrid teaching model, on the development of motor skills in fourth-grade pupils during physical education classes.

Hypothesis: It is assumed that the use of a hybrid model in physical education leads to significant improvements in students’ motor performance compared to traditional teaching methods.

Objectives of the study: assessing the initial level of motor skills; implementing a teaching program based on a hybrid model; comparing the results between the experimental and control groups; analyzing the influence of technology on motor progress; evaluating students’ engagement in the educational process.

Research methodology: The study was conducted on a sample of 30 pupils from the Technological High School in Marginea, divided into two groups: an experimental group - 15 pupils, and a control group - 15 pupils. The selection of participants was based on availability, with pupils being relatively homogeneous in terms of age and physical fitness level.

The research followed an experimental pretest–posttest design, conducted over a school module (7 weeks), with a frequency of two physical education lessons per week.

Didactic intervention - Experimental group (EG): Pupils in the experimental group participated in physical education lessons conducted using a hybrid model, which included the use of video support for exercise demonstration, access to digital materials (exercises and technical sequences), visual feedback on performance, and active involvement through interactive methods.

Control group (CG): Pupils in the control group participated in physical education lessons conducted through traditional methods, based on teacher demonstration, verbal explanations, and repetitive execution without digital support.

Assessment tools: To evaluate motor skills, the following tests were applied in both the initial (pretest) and final (posttest) stages: 20 m sprint run - assessment of movement speed; 10 × 5 m shuttle run - assessment of agility; standing long jump - assessment of explosive strength; 6-minute endurance run - assessment of cardiorespiratory endurance; Plate Tapping test - assessment of coordination and reaction speed.

Research variables: The independent variable was the teaching model (hybrid vs. traditional). The dependent variables were the performances obtained in the motor tests and the progress recorded between the initial and final assessments.

Procedure: The study followed several stages: application of the initial tests (pretest) for both groups; implementation of the differentiated instructional program during the intervention period; monitoring of students' participation and engagement; application of the final tests (posttest); comparison of results between groups.

Intervention program (7 weeks): The program included a total of 14 lessons, with identical content for both groups, the only difference being the teaching method (hybrid vs. traditional). The intervention was conducted over a period of 7 weeks, with a frequency of two lessons per week. The program targeted the development of key motor abilities, including speed, agility, explosive strength, endurance, and coordination.

In the first week, initial testing was conducted, followed by lessons focused on the development of speed and coordination. The second week included exercises aimed at developing speed (sprints) and agility through applied circuits. In the third week, the focus was on the development of explosive strength (jumps) and coordination (rhythmic exercises). The fourth week targeted the development of endurance (beep test-type running and continuous effort) and reaction speed. During the fifth week, combined activities for agility and coordination were introduced, along with strength exercises organized in circuit format. In the sixth week, lessons focused on endurance development through interval training and the consolidation of motor skills. The final week was dedicated to revision through mixed exercises and final assessment.

The difference between the two groups consisted in the teaching methodology. In the experimental group (EG), the lesson content was delivered through a hybrid model that integrated video demonstrations, visual guidance of exercises, digital applications, and individualized feedback on performance. Pupils benefited from visual support for learning technique, self-assessment, and progress monitoring.

In the control group, the same motor content was taught using traditional methods, based on teacher demonstration, verbal explanations, and direct correction of execution, without the use of digital support.

Motor performance was assessed at the beginning (initial testing - IT) and at the end of the intervention (final testing - FT), using the same tests for both groups.

3. Results and Discussions

The obtained results highlight the evolution of motor performance in both the experimental and control groups, analyzed at both the intragroup level (initial testing - final testing) and the intergroup level, by examining differences in progress and their statistical significance.

Table 1. *Motor test results – experimental group (initial testing vs. final testing)*

Performance Tests	Mean IT	Mean FT	SD IT	SD FT	CV% IT	CV% FT	Δ (FT-IT)	t	p	Cohen's d
25 m Sprint Run	5.23	5.10	0.43	0.39	8.29	7.67	-0.13	3.02	<0.01	0.78
10 × 5 m Shuttle Run	17.17	17.07	1.16	1.11	6.76	6.48	-0.10	1.39	>0.05	0.36
Standing Long Jump	1.47	1.48	0.08	0.08	5.52	5.25	+0.01	3.08	<0.01	0.80
6-Minute Endurance Run	980.33	1078.33	51.56	57.68	5.26	5.35	+98.00	44.03	<0.001	11.30
Tapping Test	38.93	40.20	4.18	4.33	10.74	10.77	+1.27	5.55	<0.001	1.43

The results presented in Table 1 highlight the evolution of motor performance within the experimental group. The comparison between initial testing and final testing revealed favorable changes for most of the investigated variables. Descriptive analysis indicated improvements in motor performance across several tests. In the 25 m sprint run, the mean value decreased from 5.23 s to 5.10 s, indicating an improvement in performance. This difference was statistically significant ($t = 3.02$, $p < 0.01$), with a moderate to large effect size (Cohen's $d = 0.78$), suggesting a meaningful impact of the intervention on movement speed. For the 10 × 5 m shuttle run, the mean decreased from 17.17 s to 17.07 s; however, this difference did not reach statistical significance ($t = 1.39$, $p > 0.05$). The effect size was small ($d = 0.36$), indicating a limited impact of the intervention on agility. Regarding the standing long jump, a slight increase in the mean value was observed, from 1.47 m to 1.48 m. This difference was statistically significant ($t = 3.08$, $p < 0.01$), with a large effect size ($d = 0.80$), suggesting a positive influence of the hybrid model on explosive strength. In the 6-minute endurance test, the mean distance covered increased from 980.33 m to 1078.33 m, representing the greatest improvement among all the analyzed tests. The difference was highly statistically significant ($t = 44.03$, $p < 0.001$), with an extremely large effect size ($d = 11.30$), indicating a substantial effect of the intervention on endurance capacity.

In the Plate Tapping test, the mean increased from 38.93 to 40.20, reflecting an improvement in reaction speed and segmental coordination. The difference was statistically significant ($t = 5.55$, $p < 0.001$), with a very large effect size ($d = 1.43$), confirming the effectiveness of the intervention in developing this motor component.

The coefficients of variation remained relatively low across all tests, indicating good group homogeneity at both the initial and final assessments. Overall, the results suggest that the implementation of the hybrid model, based on the integration of video support, had a positive effect on students' motor performance, with the most pronounced improvements observed in endurance, coordination, and speed.

Table 2. *Motor test results - control group (initial testing - final testing)*

Performance Tests	Mean TI	Mean TF	SD TI	SD TF	CV% TI	CV% TF	Δ (TF-TI)	t	p	Cohen's d
25 m Sprint Run	5.13	4.95	0.53	0.30	10.38	6.11	-0.18	2.49	<0.05	0.84
10 × 5 m Shuttle Run	16.85	16.66	1.22	1.19	7.26	7.12	-0.19	3.26	<0.01	0.64
Standing Long Jump	1.51	1.55	0.08	0.08	5.21	5.44	+0.04	3.60	<0.01	0.93
6-Minute Endurance Run	966.67	1100.67	47.16	70.76	4.88	6.43	+134.00	7.50	<0.001	1.94
Tapping Test	39.20	41.47	4.36	4.53	11.13	10.93	+2.27	7.55	<0.001	1.95

The results presented in Table 2 highlight the evolution of motor performance in the control group between initial testing and final testing, under the conditions of traditional instructional methods. In the 25 m sprint run, the mean decreased from 5.13 s to 4.95 s, indicating an improvement in performance. The difference was statistically significant ($t = 2.49$, $p < 0.05$), with a large effect size (Cohen's $d = 0.84$), suggesting a relevant influence of training on speed. For the 10 × 5 m shuttle run, a reduction in the mean value was observed, from 16.85 s to 16.66 s. This difference was statistically significant ($t = 3.26$, $p < 0.01$), with a moderate effect size ($d = 0.64$), indicating an improvement in agility. Regarding the standing long jump, performance increased from 1.51 m to 1.55 m. The difference was statistically significant ($t = 3.60$, $p < 0.01$), with a large effect size ($d = 0.93$), highlighting a significant development in explosive strength. In the 6-minute endurance test, a substantial increase in the distance covered was recorded, from 966.67 m to 1100.67 m. The difference was highly statistically significant ($t = 7.50$, $p < 0.001$), with a very large effect size ($d = 1.94$), indicating a considerable improvement in aerobic endurance. In the Plate Tapping test, the mean increased from 39.20 to 41.47, reflecting improvements in reaction speed and coordination. The difference was statistically significant ($t = 7.55$, $p < 0.001$), with a very large effect size ($d = 1.95$). The coefficients of variation indicate a good level of group homogeneity, with relatively similar values between the initial and final assessments. Overall, the results show that traditional teaching methods also led to significant improvements in motor performance, particularly in endurance, coordination, and explosive strength.

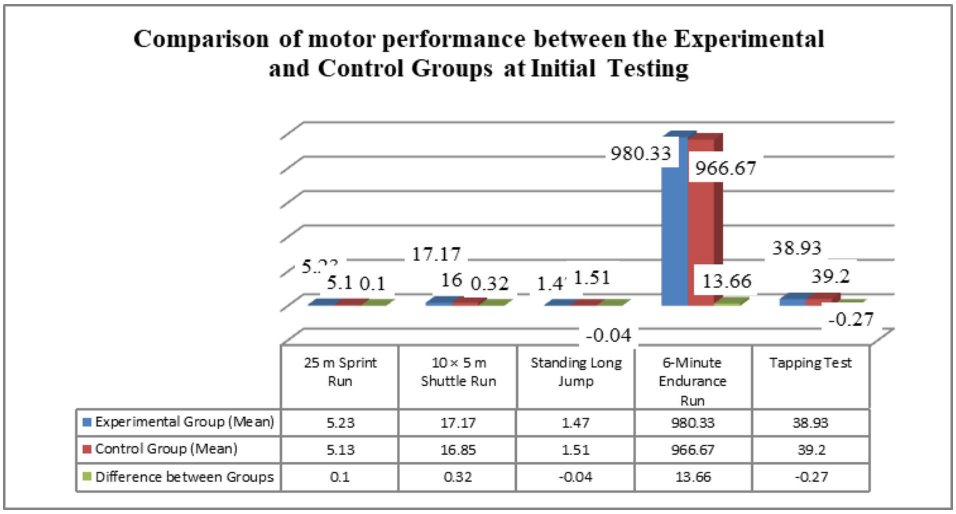

Figure 1. *Comparison of motor performance between the experimental and control groups at initial testing*

The results presented highlight the comparison of motor performance between the experimental and control groups at initial testing. The mean values indicate small differences between the two groups across all analyzed tests. In the 25 m sprint run, the experimental group recorded a slightly higher value compared to the control group (5.23 - 5.13 s), with a difference of 0.10 s. For the 10 × 5 m shuttle run, the difference was 0.32 s in favor of the control group, indicating a slightly better initial performance.

Regarding the standing long jump, the control group achieved a higher mean value (1.51 m) compared to the experimental group (1.47 m), with a difference of -0.04 m. In the 6-minute endurance test, the experimental group showed a slightly higher value (980.33 m) than the control group (966.67 m), with a difference of 13.66 m.

For the Plate Tapping test, the difference between groups was minimal (-0.27), indicating similar initial performance levels.

Overall, the results suggest a relatively homogeneous level between the two groups at baseline, with no practically relevant differences, confirming the comparability of the groups prior to the intervention.

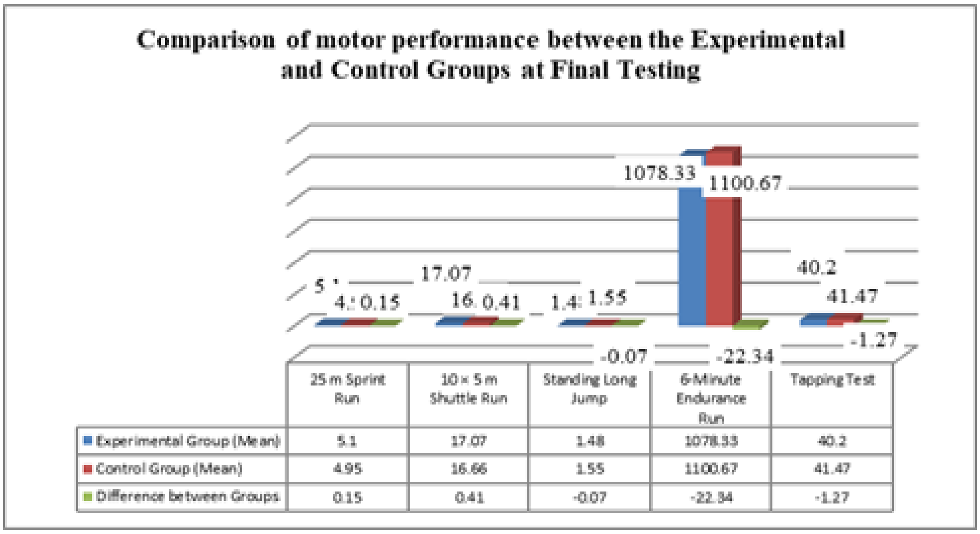

Figure 2. *Comparison of motor performance between the experimental and control groups at final testing*

The results obtained at final testing highlight the differences in motor performance between the experimental and control groups following the intervention.

In the 25 m sprint run, the control group recorded better performance (4.95 s) compared to the experimental group (5.10 s), with a difference of 0.15 s in its favor. For the 10 × 5 m shuttle run, a difference of 0.41 s was observed in favor of the control group (16.66 s - 17.07 s), indicating superior agility.

Regarding the standing long jump, the control group achieved a higher mean value (1.55 m) compared to the experimental group (1.48 m), with a difference of -0.07 m, suggesting an advantage in explosive strength. In the 6-minute endurance test, the control group also recorded a higher performance (1100.67 m) compared to the experimental group (1078.33 m), with a difference of -22.34 m.

In the Plate Tapping test, the mean values indicate an advantage for the control group (41.47) compared to the experimental group (40.20), with a difference of -1.27, suggesting better performance in reaction speed and coordination.

Overall, the final testing results indicate slightly superior values for the control group across all analyzed tests. However, these differences must be interpreted in the context of inferential analysis, which determines whether they are statistically significant.

Table 3. *Differences between groups in the evolution of motor performance (δ): independent t-test and effect size (Cohen's d)*

Performance Tests	Δ Experimental Group	Δ Control Group	Difference between Groups	t	p	Cohen's d
25 m Sprint Run	-0.13	-0.18	+0.05	0.92	0.37	0.34
10 × 5 m Shuttle Run	-0.10	-0.19	+0.09	1.21	0.24	0.44
Standing Long Jump	+0.01	+0.04	-0.03	-1.15	0.26	0.42
6-Minute Endurance Run	+98.00	+134.00	-36.00	-1.78	0.09	0.65
Tapping Test	+1.27	+2.27	-1.00	-1.62	0.11	0.59

The results presented in Table 3 highlight the comparison between the experimental and control groups regarding the evolution of motor performance (Δ), analyzed using an independent samples t-test and effect size (Cohen's d). In the 25 m sprint run, both groups showed improvements; however, the difference between groups was small (Δ = +0.05) and not statistically significant (t = 0.92, p = 0.37). The effect size was small (d = 0.34), indicating no clear advantage of either method. For the 10 × 5 m shuttle run, the control group recorded a greater improvement than the experimental group (Δ difference = +0.09), but this difference was not statistically significant (t = 1.21, p = 0.24). The effect size was small to moderate (d = 0.44). Regarding the standing long jump, progress was slightly greater in the control group (Δ = -0.03 in favor of CG), although not statistically significant (t = -1.15, p = 0.26). The effect size was moderate (d = 0.42). In the 6-minute endurance test, the control group showed greater improvement (+134 m) – (+98 m), with a difference of −36 m in its favor. However, this difference did not reach statistical significance (t = -1.78, p = 0.09), although the effect size was moderate (d = 0.65), suggesting a trend in favor of the control group. In the Plate Tapping test, progress was greater in the control group (Δ = -1.00), but the difference was not statistically significant (t = -1.62, p = 0.11). The effect size was moderate (d = 0.59). Overall, the results indicate that although both instructional methods led to improvements in motor performance, no statistically significant differences were identified between the experimental and control groups. The Cohen's d values suggest small to moderate effects, indicating the presence of practical differences, but insufficient to confirm the clear superiority of one intervention over the other under the conditions of this study.

Discussions

The results of the present study are consistent with the existing literature, which highlights the effectiveness of hybrid pedagogical models in physical education. Thus, combinations based on the Sport Education Model (SEM), particularly the "SEM + 1" structure, contribute to optimizing learning outcomes (Zhang, Geok Soh, Bai, Mohd Anuar & Xiao, 2024).

Moreover, hybrid interventions have demonstrated significant improvements in cardiorespiratory fitness, speed, agility, strength, and flexibility, alongside increased physical activity levels and reduced sedentary behavior (Melero-Cañas Morales-Baños, Manzano-Sánchez, Navarro-Ardoy, & Valero-Valenzuela, 2021), confirming the effectiveness of strategies based on gamification and personal and social responsibility. In partial agreement with these findings, the results of our study revealed significant improvements within the experimental group, particularly in movement speed, explosive strength, endurance, and coordination.

These findings suggest that the integration of video support and visual feedback can facilitate the development of students' motor skills. However, the comparison between the experimental and control groups did not reveal statistically significant differences between the two instructional methods, indicating that, under the conditions of this study, the hybrid model was not clearly superior to traditional teaching, although it provided a modern and engaging learning environment for students.

4. Conclusions

The results of the present study indicate that the integration of digital technologies through a hybrid teaching model had a positive influence on the motor performance of pupils participating in physical education classes.

Significant improvements were observed within the experimental group in speed, explosive strength, endurance, and coordination, which confirms the usefulness of digital support in the teaching process. At the same time, the control group also recorded significant progress in all assessed motor variables, showing that traditional teaching methods remain effective in the development of motor abilities at primary school level.

Although the hybrid model provided a modern and engaging instructional framework, the comparative analysis between groups did not reveal statistically significant differences in favor of the experimental intervention.

These findings suggest that the hybrid model can be considered a valuable alternative for improving the attractiveness and efficiency of physical education lessons, especially by supporting visual learning, active participation, and individualized feedback.

However, under the conditions of this study, its superiority over traditional teaching was not confirmed. The main limitations of the study are related to the small sample size, the relatively short duration of the intervention, and the restricted educational context.

Future research should include larger samples, longer intervention periods, and additional variables such as motivation, engagement, and long-term retention of motor skills.

References

1. BAYBURTLU, M.B., GENÇ, A., & ÜNAL, F. (2024). The effects of hybrid physical activity program on various motor skills in primary school children,

Pedagogy of Physical Culture and Sports, 28 (5), 456–467. https://doi.org/10.15561/26649837.2024.0514

2. CHEN, R. (2025). Managerial competence development of future physical education professionals through hybrid educational environments, *Педагогічна Академія: наукові записки*, 18. https://doi.org/10.5281/zenodo.15352884
3. HIDAYATULLAH, F., ANWAR, K., HANDAYANI, H.Y., PURWOTO, S.P., HIMAWAN, A., & WIDODO, H.M. (2025). Hybrid digital learning: Enhancing physical education student achievement in motor learning courses with synchronous and asynchronous session, *Proceeding International Conference on Digital Education and Social Science*, 2 (1), 170–177. https://doi.org/10.55506/icdess.v2i1.62
4. KUČERA, E., & HAFFNER, O. (2025). Competency-based hybrid learning: A modern approach to teaching programming and digital technologies subjects, *IEEE Access*, 13, 54892–54919. https://doi.org/10.1109/ACCESS.2025.3555333
5. LUNGU, A.-C., & VIZITIU LAKHDARI, E. (2023). Implementation of hybrid education in primary education – investigative approach, *Analele Universității „Ștefan cel Mare” din Suceava, Seria Educație Fizică și Sport. Știința și arta mișcării*, 16, 180–188. https://doi.org/10.4316/SAM.2023.0220
6. MELERO-CAÑAS, D., MORALES-BAÑOS, V., MANZANO-SÁNCHEZ, D., NAVARRO-ARDOY, D., & VALERO-VALENZUELA, A. (2021). Effects of an educational hybrid physical education program on physical fitness, body composition and sedentary and physical activity times in adolescents: The Seneb's enigma, *Frontiers in Psychology*, 11, 629335. https://doi.org/10.3389/fpsyg.2020.629335
7. MOON, J., & LEE, D. (2025). Investigating a hybrid learning approach to enhance track and field techniques in preservice physical education teachers, *Journal of Physical Education and Sport*. https://doi.org/10.7752/jpes.2025.12273
8. QUIÑONERO-MARTÍNEZ, A.L., CIFO-IZQUIERDO, M.I., SÁNCHEZ-ALCARAZ MARTÍNEZ, B.J., & GÓMEZ-MÁRMOL, A. (2023). Effect of the hybridization of social and personal responsibility model and sport education model on physical fitness status and physical activity practice, *Frontiers in Psychology*, 14, 1273513. https://doi.org/10.3389/fpsyg.2023.1273513
9. SHEN, Y., & SHAO, W. (2022). Influence of hybrid pedagogical models on learning outcomes in physical education: A systematic literature review, *International Journal of Environmental Research and Public Health*, 19 (15), 9673. https://doi.org/10.3390/ijerph19159673
10. WANG, C., OMAR DEV, R.D., SOH, K.G., MOHD NASIRUDDDIN, N.J., YUAN, Y., & JI, X. (2023). Blended learning in physical education: A systematic review, *Frontiers in Public Health*, 11, 1073423. https://doi.org/10.3389/fpubh.2023.1073423

11. XIE, D., CHEN, B., LI, H., & HUANG, Q. (2025). Enhancing table tennis performance and physical fitness through digital technology: A quasi-experimental study based on the TPACK framework, *Frontiers in Sports and Active Living*, 7, 1595455. https://doi.org/10.3389/fspor.2025.1595455
12. ZHANG, J., GEOK SOH, K., BAI, X., MOHD ANUAR, M.A., & XIAO, W. (2024). Optimizing learning outcomes in physical education: A comprehensive systematic review of hybrid pedagogical models integrated with the sport education model, *PLOS ONE*, 19 (12), e0311957. https://doi.org/10.1371/journal.pone.0311957
13. ZHONG, Q., JIANG, J., BAI, W., YIN, Z., LIAO, Z., & ZHONG, X. (2025). Application of digital-intelligent technologies in physical education: A systematic review, *Frontiers in Public Health*, 13, 1626603. https://doi.org/10.3389/fpubh.2025.1626603