



Effect of ball-launcher-assisted sport education on table tennis game performance in junior high school students

Sony Hasmarita^{1ABCDE*}, Yopi Merizal^{2ABCD}, Gugun Gunawan^{2BCE}, Heru Sulistiadinata^{2ABCDE}, Muchamad Ishak^{2EDC}

¹Physical Education, Health and Recreation, STKIP Pasundan Cimahi, Indonesia

² Master of Physical Education, STKIP Pasundan Cimahi, Indonesia

Received: 16 August 2026

Accepted: 5 October 2026

Published: 6 October 2026

Authors' Contribution:

A – Study design;

B – Data collection;

C – Statistical analysis;

D – Manuscript Preparation;

E – Funds Collection

Abstract: This study examined the effect of a Sport Education model supported by a ball launcher on table tennis game performance among Grade VII students in Cimahi, Indonesia. A quasi-experimental pretest–posttest control-group design involved 60 students (approximately 12–13 years; boys and girls) selected from an accessible population of 80 students at SMPN 13 Cimahi. Thirty students received a 16-session Sport Education season integrating persistent teams, student roles, formal competition, record keeping, a culminating event, and progressively variable ball-launcher practice; 30 students received conventional teacher-directed instruction of equivalent duration. Game performance was assessed using a table-tennis adaptation of the Game Performance Assessment Instrument, comprising decision making, skill execution, and base/recovery behavior. Posttest performance was analysed by ANCOVA with pretest performance as a covariate; assumptions, 95% confidence intervals, and partial eta squared were reported. In the illustrative simulated dataset, the intervention group achieved a higher adjusted posttest score than the control group (adjusted mean difference = 8.48 points, 95% CI [5.30, 11.66], $F(1,57) = 28.52$, $p < .001$, partial eta squared = .333). Secondary component analyses showed the same direction for decision making, skill execution, and base/recovery. The integrated approach may improve game performance by combining meaningful team-based participation with high-frequency, progressively variable practice.

Keywords: Sport Education Model, Ball-launcher training aid, Table tennis game performance, Game performance assessment, Junior high school physical education



This is an Open Access article distributed under the terms of the [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/)

Corresponding author: : Sony Hasmarita , Email : sonyhasmarita92@gmail.com

Introduction

Physical education should develop movement competence through meaningful, inclusive, and transferable learning. In net-and-wall activities such as table tennis, successful play depends not only on reproducing a stroke but also on perceiving ball flight, selecting an appropriate response, controlling racket–ball contact, recovering to a functional base position, and adapting to an opponent. Reviews of table tennis in children and adolescents emphasize its coordination, perceptual, cognitive, and health-related potential, while also showing that effective school

implementation depends on appropriately designed learning tasks and access to suitable equipment (González-Devesa et al., 2024; Ortega-Zayas et al., 2025). The sport therefore offers substantial educational value, but its pedagogical benefits are unlikely to emerge when students spend long periods waiting for a turn or execute decontextualized strokes with too few successful contacts.

The practical problem is particularly relevant in school settings where one teacher must organize heterogeneous classes with limited tables, balls, and instructional time. Contemporary JPJ studies show that instructional media can materially shape physical-education learning when media are deliberately embedded in pedagogy rather than treated as accessories (Huda et al., 2026). reported improved gymnastics learning through visual media, whereas (Adhi et al., 2026). examined digital animated video for volleyball skill instruction. At the junior-high-school level, found that the use of instructional media in public-school physical education remained only moderate overall, suggesting a gap between the availability of instructional technology and its pedagogically optimized use (Najib et al., 2026). working with Grade VII net-game learning, similarly demonstrated the relevance of structured learning resources for student engagement. Together, these studies indicate that innovation in Indonesian physical education should address not merely whether a tool is present, but how it changes students' opportunities to practice, make decisions, and participate (Makruf et al., 2026).

One pedagogical model capable of organizing those opportunities is Sport Education. Rather than treating a sport unit as a short sequence of isolated techniques, Sport Education uses a season structure with persistent team affiliation, student roles, formal competition, record keeping, festivity, and a culminating event. This organization redistributes responsibility and creates a social context in which practice has an identifiable purpose. A critical systematic review found that Sport Education commonly produces favorable outcomes across several learning domains compared with traditional instruction, although effects depend on content, implementation fidelity, and study design (Bessa et al., 2021). More recent empirical work has shown improvements in technical competence and game performance in volleyball (Li et al., 2022).

game-play ability in high-school basketball (Iserbyt et al., 2022). and meaningful participation across different sex and skill groups (Farias et al., 2022). further showed that learning within persistent Sport Education groups can support game-performance development across heterogeneous school learners (Mahedero et al., 2021).

However, the macro-structure of Sport Education does not automatically solve a micro-level practice problem: novice table-tennis learners still need repeated, sufficiently successful contacts with incoming balls. A ball launcher can standardize feed direction, speed, interval, and placement, thereby increasing the density and predictability of early practice. From an ecological and constraints-led perspective, equipment and task manipulations can be used to regulate task difficulty so that learners explore functional movement solutions rather than simply reproduce a fixed technique (Chow et al., 2021). Evidence from youth sport shows that appropriately scaled or modified equipment can facilitate skill learning, movement variability, and subsequent transfer when practice constraints are progressively returned toward competition conditions (Brocken et al., 2020; Buszard et al., 2020; Dancy & Murphy, 2020; Gorman et al., 2021). A launcher should therefore function as a temporary practice constraint, not a replacement for opponent interaction, before transfer to increasingly variable play.

Table-tennis research provides additional reasons to examine such an integration (Basiri et al., 2020). Showed that perceptual-motor and table-tennis-specific practice can influence forehand learning, while (Sanz Ferrández et al., 2021). Described the sport as a reaction-dominant activity with substantial perceptual and biomechanical demands and noted the use of ball-launcher systems in sport-specific testing. More recently, demonstrated that technology-supported, peer-mediated learning can improve table-tennis skill acquisition in elementary learners (Feng et al., 2025). These findings do not establish a launcher effect in schools, but they support a plausible mechanism: technology can increase task-specific information when embedded in feedback, peer interaction, and progressive transfer.

A second issue concerns measurement. Many school studies assess isolated technical products, such as the number of successful strokes, even though the educational outcome of a

games unit is the ability to play. The Game Performance Assessment Instrument (GPAL) was developed to capture observable tactical and skill behaviors within authentic game contexts (Oslin et al., 1998). Recent school assessment research continues to adapt GPAL principles to curriculum outcomes, emphasizing that game learning should be evaluated through decisions and skill execution rather than through technique tests alone (Dewanti et al., 2023). For table tennis, decision making, skill execution, and recovery to an effective base position provide a parsimonious representation of performance during rallies. This outcome is more closely aligned with the intended goal of a Sport Education season than a purely isolated stroke test.

The research gap is therefore specific. Evidence supports Sport Education as a model for game learning, supports task and equipment modification as a means of regulating practice difficulty, and supports instructional technology in table-tennis learning; yet little evidence has examined a deliberately integrated Sport Education season in which a ball launcher is used as a practice aid for junior-high-school table tennis and the primary outcome is authentic game performance. The novelty of the present study lies in combining a macro-level pedagogical architecture (Sport Education) with a micro-level practice constraint (progressively variable ball-launcher feeding), while evaluating transfer through game-based performance. Accordingly, the study aimed to examine the effect of ball launcher assisted Sport Education on table tennis game performance among Grade VII students at SMPN 13 Cimahi. It was hypothesized that, after controlling for baseline performance, students receiving the integrated intervention would demonstrate higher posttest game-performance scores than students receiving conventional instruction.

Materials and Methods

Design

A quasi experimental pretest posttest control-group design was specified because individual random allocation was not documented in the study information. The accessible population comprised 80 active Grade VII students at SMPN 13 Cimahi, West Java, Indonesia, aged approximately 12–13 years. The analytic sample consisted of 60 students, with 30 students

assigned to the experimental instructional group and 30 to the control group. The planned reporting assumes that two comparable Grade VII instructional groups were selected from the accessible population; the actual classroom-selection and group allocation procedure must be reported exactly from school records before submission. The intervention was conducted during regular physical-education lessons so that ecological validity was maintained while instructional exposure remained comparable between groups.

Sample

Eligible participants were active Grade VII students enrolled at SMPN 13 Cimahi, within the target age range, medically able to participate in regular physical education, and available for pretest, intervention, and posttest procedures. Students with a medical restriction preventing racket-sport participation, prolonged absence that materially reduced intervention exposure, or incomplete outcome data would be handled according to a prespecified missing data rule rather than removed after seeing results. Because 60 of 80 eligible students were included, the manuscript should identify the actual sampling mechanism (for example, intact-class selection or purposive sampling) before submission and should not describe the sample as random unless random selection was genuinely implemented. Sex composition in the illustrative dataset was balanced (15 boys and 15 girls per group), but real demographic counts must replace these values.

Data collection Intervention

The experimental condition was designed as an eight-week Sport Education season comprising 16 lessons of approximately 80 minutes (two lessons per week). Core Sport Education features were maintained throughout: persistent heterogeneous teams, student roles, formal competition, cumulative record keeping, festivity, and a culminating event. Students rotated through roles such as player, peer coach, referee, scorekeeper/statistician, equipment manager, and ball-launcher operator under teacher supervision. Role rotation was intended to distribute responsibility without reducing active practice time. Fidelity should be documented in the actual study using a session-by-session checklist based on the planned Sport Education features; the

percentage of completed features must be reported from real observations rather than estimated retrospectively (Gutiérrez et al., 2022).

Ball-launcher practice was embedded within team practice rather than delivered as a separate training program. During lessons 1–4, feeds were planned to be relatively predictable, emphasizing ready position, controlled forehand/backhand returns, and recovery to base. During lessons 5–8, feed placement was alternated between two zones and students were required to select forehand or backhand responses. During lessons 9–12, variability in placement and interval was increased and short sequences were linked to serve-return or third ball situations. During lessons 13–16, launcher use was reduced and practice shifted toward live opponent rallies, formal team matches, and the culminating event. This progression was designed to prevent dependence on machine-fed trajectories and to promote transfer from repetition to adaptive game play. The actual launcher brand/model, feed speed, frequency, spin, placement settings, safety distance, and number of balls per practice bout must be inserted from the research log before submission.

The control group received conventional teacher directed table tennis instruction for the same total lesson frequency and approximate duration. Lessons consisted of teacher explanation and demonstration, technique drills, paired practice, and end of lesson games. The control group used standard school equipment but did not receive the Sport Education season structure or ball-launcher practice. Both groups were intended to cover comparable curriculum content (ready position, forehand and backhand strokes, serving/returning, recovery, simple tactics, and game rules), thereby reducing the possibility that any group difference reflected unequal curricular exposure rather than instructional organization.

Outcome measure

The primary outcome was table tennis game performance, operationalized through a table-tennis adaptation of the Game Performance Assessment Instrument (GPAI). The original GPAI was developed and preliminarily validated as a multidimensional observational framework for assessing tactical understanding and skill behaviors during games (Oslin et al., 1998). In the present adaptation, three observable components were specified: (1) decision making the appropriateness of stroke/placement choices in relation to the incoming ball and opponent; (2)

skill execution the effectiveness of the selected stroke in returning the ball legally and functionally; and (3) base/recovery the appropriateness of recovering to a position that supported the next action. Each component was expressed as the percentage of appropriate/effective actions among scorable opportunities, and the composite game performance score was the mean of the three component percentages (0–100). This structure follows the principle that GPAI components should be selected to match the logic of the game and the intended learning outcome rather than mechanically applying every original component (Dewanti et al., 2023).

Pretest and posttest performances should be video recorded under the same standardized game protocol, with opponents or match pairings controlled as far as feasible. Two trained raters should independently code a prespecified proportion of recordings. Before submission, the manuscript must report the actual content validation process for the table tennis indicators (e.g., expert panel, item-content validity indices), interrater agreement or intraclass correlation coefficients with 95% confidence intervals, and rater training procedures. No psychometric coefficient is supplied in this working draft because inventing reliability or validity evidence would invalidate the measurement argument.

Data analysis

Descriptive statistics were specified as mean, standard deviation, minimum, and maximum for continuous outcomes and frequency/percentage for categorical characteristics. The primary analysis used analysis of covariance (ANCOVA) with posttest composite game performance as the dependent variable, instructional group as the fixed factor, and pretest composite game performance as the covariate. ANCOVA was selected because the research question concerns post intervention group differences while accounting for baseline variation; it is more directly aligned with this objective than relying only on raw gain scores. Model assumptions were evaluated using residual normality (Shapiro Wilk), homogeneity of residual variance (Levene), inspection of influential observations, and the group-by-pretest interaction to assess homogeneity of regression slopes. The adjusted group difference was reported with a 95% confidence interval, F statistic, p value, and partial eta squared. Secondary ANCOVAs examined decision making, skill execution,

and base/recovery; multiplicity should be controlled using the Holm procedure. Within-group paired comparisons and between-group standardized change (Hedges g) were treated as supportive rather than primary evidence. A two-sided alpha of .05 was used. The illustrative calculations in this manuscript were generated from a simulated complete dataset of 60 records solely to demonstrate the analysis and reporting framework..

Results

Descriptive Statistics

All 60 simulated records contained complete pretest and posttest outcomes. The two groups were similar in age and baseline composite game performance, and each contained 15 boys and 15 girls in the illustrative dataset. Table 1 summarizes the simulated participant characteristics. These values are used only to demonstrate the planned reporting format and should not be interpreted as observations from SMPN 13 Cimahi.

Table 1 participant characteristics at baseline

Group	n	Boys/Girls	Age, M (SD)	Game pretest, M (SD)
Control	30	15/15	12.51 (0.36)	45.39 (6.24)
Sport Education + launcher	30	15/15	12.49 (0.30)	46.39 (6.66)

Descriptive scores indicated improvement in both instructional groups, with a larger increase in the experimental condition. The experimental group increased from 46.39 to 65.08 points on the composite outcome, whereas the control group increased from 45.39 to 55.44 points. The unadjusted mean changes were 18.70 (SD = 6.41) and 10.05 (SD = 5.93), respectively. Component-level means showed a consistent pattern across decision making, skill execution, and base/recovery (Table 2).

Table 2. pretest and posttest game-performance scores

Outcome	Group	Time	M	SD	Min–max
Composite	Control	Pre	45.39	6.24	31.63–56.66
Composite	Control	Post	55.44	9.02	37.46–73.43
Composite	Sport Education + launcher	Pre	46.39	6.66	36.82–58.18
Composite	Sport Education + launcher	Post	65.08	10.30	48.73–90.65
Decision making	Control	Post	55.86	8.95	39.14–70.86
Decision making	Sport Education + launcher	Post	65.29	11.21	44.37–89.38
Skill execution	Control	Post	55.33	11.20	33.38–78.73
Skill execution	Sport Education + launcher	Post	65.18	10.59	50.11–95.00

The primary ANCOVA assumptions were compatible with the planned model: residuals did not show evidence of non-normality (Shapiro–Wilk $W = .982$, $p = .520$), residual variances were similar between groups (Levene $F = 0.54$, $p = .467$), and the group-by-pretest interaction was not significant ($F = 0.31$, $p = .578$), supporting the homogeneity-of-slopes assumption. Baseline performance was strongly associated with posttest performance, $F(1,57) = 87.56$, $p < .001$, which further supported baseline adjustment. At the pooled baseline score, the adjusted posttest mean was 64.50 (95% CI [62.26, 66.75]) for the Sport Education plus ball-launcher group and 56.02 (95% CI [53.78, 58.27]) for the control group. The adjusted difference was 8.48 points (95% CI [5.30, 11.66]), $F(1,57) = 28.52$, $p < .001$, partial eta squared = .333. Thus, within the simulated dataset, the prespecified hypothesis was supported. The standardized between-group difference in change was also large (Hedges $g = 1.38$), but this secondary estimate should not replace the baseline-adjusted primary analysis.

Table 3. baseline adjusted group effects

Outcome		Adjusted difference	95% CI	F	p	Partial eta ²
Composite performance	game	8.48	5.30–11.66	28.52	<.001	.333
Decision making		8.14	4.76–11.52	23.22	<.001	.289
Skill execution		8.57	4.93–12.22	22.18	<.001	.280
Base/recovery		8.84	5.31–12.38	25.07	<.001	.305

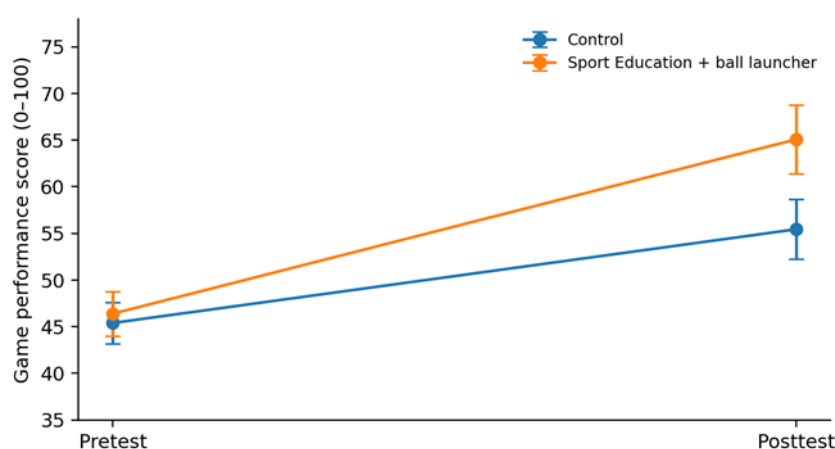


Figure 1. pretest and posttest composite game-performance means with 95% confidence intervals

Discussion

The purpose of this study was to examine whether a Sport Education season supported by ball launcher practice could improve table tennis game performance among Grade VII students compared with conventional instruction. In the illustrative analysis, the experimental group demonstrated a higher posttest composite score after baseline adjustment, with the same directional advantage for decision making, skill execution, and base/recovery. If replicated with observed data, this pattern would support the proposition that Sport Education combined with a deliberately constrained practice technology may enhance students' ability to use table tennis skills in play rather than merely reproduce isolated strokes. The interpretation must remain conditional because the present numerical values are simulated and the quasi experimental design does not provide the same causal protection as individual randomization.

The first explanatory mechanism concerns Sport Education itself. Traditional technique-led lessons can provide efficient teacher feedback, particularly for novice learners, but they often fragment learning into short drills that are weakly connected to meaningful game purposes. Sport Education extends the unit into a season, creates persistent affiliation, and gives practice consequences through team records and formal competition. Concluded that this model frequently offers advantages over traditional teaching across learning domains, although outcomes are contingent on implementation quality (Bessa et al., 2021). In volleyball reported stronger technical and game-performance gains under Sport Education (Li et al., 2022). Documented improved game play ability during a high-school basketball season (Iserbyt et al., 2022). Similarly showed that structured Sport Education environments can support game-performance development across different grouping arrangements (Mahedero et al., 2021). Collectively, these studies support interpreting learning as coordinated decisions and actions under game conditions rather than as a discrete technique score.

The second mechanism is the way persistent teams and student roles may increase the pedagogical density of practice. Within Sport Education, students observe teammates, record performance, provide peer feedback, officiate, and take responsibility for equipment. showed that Sport Education can support more equitable game play participation when contextual and learner characteristics are considered (Farias et al., 2022). however, emphasized that model fidelity matters: removing persistent teams or authentic roles changes the learning environment and may weaken intended outcomes (Gutiérrez et al., 2022). In the proposed table tennis season, the ball launcher becomes part of that team system. A student acting as launcher operator can regulate feeds according to the practice task, another can code target success or recovery behavior, and the player can receive immediate task-relevant feedback. This arrangement can convert equipment into a social learning resource and may also strengthen team cohesion (Kao, 2019).

The ball launcher may also address an exposure problem that is specific to early table-tennis learning. Novice pairs frequently produce short rallies, so a substantial proportion of lesson time can be spent retrieving balls rather than adapting to incoming trajectories. A controlled

launcher can temporarily increase the number of playable balls and reduce variability to a level that permits functional success. Constraints-led research provides a conceptual basis for such practice design (Chow et al., 2021). argued that modified games and task constraints should be designed to channel exploration without prescribing a single movement solution. Across youth sports, scaled or modified equipment has improved learning conditions and movement functionality also reported positive transfer after modified-equipment practice (Brocken et al., 2020; Buszard et al., 2020; Dancy & Murphy, 2020; Gorman et al., 2021). This transfer principle is central: the educational value of a table tennis launcher depends less on the device itself than on whether predictable feeds are progressively transformed into variable and opponent generated information.

Table tennis literature supports this emphasis on perception action coupling.) demonstrated that table tennis skill learning is sensitive to perceptual motor training conditions (Basiri et al., 2020). characterized table tennis as a high speed reaction sport with strong perceptual, coordinative, and biomechanical demands, meaning that successful play depends on anticipating and responding to rapidly changing ball information (Sanz Ferrández et al., 2021). similarly describe table tennis as a potentially valuable activity for young people because it combines motor coordination with cognitive and health related demands (González-Devesa et al., 2024; Ortega-Zayas et al., 2025). In school learning showed that technology supported peer learning can improve table-tennis skill acquisition (Feng et al., 2025). Technology is therefore most defensible when it expands meaningful information and feedback rather than converting a dynamic sport into context free hitting.

The component level pattern in the simulated data is theoretically useful. A difference in skill execution alone could be explained by increased repetition. Simultaneous differences in decision making and base/recovery would imply broader adaptation: learners would be selecting more functional responses and reorganizing after each stroke. Game based assessment is therefore essential. The GPAI was designed to represent tactical understanding and skill behavior within authentic play (Oslin et al., 1998). And contemporary physical-education assessment work

continues to emphasize context-specific adaptation of its components (Dewanti et al., 2023). In table tennis, decision making, execution, and recovery are sequentially coupled: an appropriate stroke choice is ineffective if poorly executed, and even a successful stroke may create disadvantage if the player fails to recover. A composite game-performance outcome therefore aligns more closely with Sport Education's aim of developing competent players than a stand alone accuracy test.

The findings would also extend previous Sport Education research by examining a technological practice aid without turning the intervention into a technology centered curriculum. (Guijarro et al., 2022). Demonstrated that Sport Education can be combined with other pedagogical structures to influence game performance and involvement. The present integration is different: the launcher is not a second pedagogical model, but a manipulable task constraint inside the season. This distinction is the principal novelty. At the macro level, Sport Education supplies affiliation, roles, accountability, competition, and a culminating purpose. At the micro level, the launcher regulates ball availability and progression of practice difficulty. The layers are complementary: repeated contacts make practice more learnable, while the season supplies reasons to apply those contacts in consequential play.

The Indonesian school context strengthens the practical relevance of this approach. JPJI research demonstrates active interest in instructional media and net game innovation showed that thoughtfully designed visual media can support skill learning (Adhi et al., 2026; Huda et al., 2026). Evaluated animated video as a tool for volleyball instruction (Najib et al., 2026). found that media use among public junior high physical education teachers in Yogyakarta was generally moderate and not yet optimal, especially for innovative technology (Makruf et al., 2026). further showed that structured net game learning resources can improve the quality of Grade VII participation. The implication is not that schools should purchase a launcher because it is technological. If available, it needs a protocol specifying who uses it, for which learning problem, with what progression, and when it is removed to test game transfer.

Several practical principles follow. First, launcher practice should be brief, distributed, and embedded in team rotations so that access is equitable and waiting time remains low. Second, feed settings should be individualized to the learner's current success rate and progressively varied; a fixed trajectory used for an entire unit risks creating device specific timing rather than adaptable play. Third, teacher feedback should shift from prescriptive body-position cues toward functional outcomes such as trajectory control, placement choice, recovery, and readiness for the next ball. Fourth, competition records should include learning indicators in addition to wins and losses, for example successful three ball sequences, appropriate recovery, or cooperative practice targets. These practices preserve Sport Education's educational goals while using the launcher to solve a practice problem rather than automate teaching.

The study has limitations. The quasi-experimental design is vulnerable to pre-existing class differences and teacher/classroom effects even when baseline performance is statistically controlled. Conducting the study at one school restricts external validity. The intervention is deliberately multicomponent, so an observed advantage could not identify the separate contribution of Sport Education versus the ball launcher. A third limitation concerns measurement: a table-tennis GPAI adaptation requires explicit content validation, rater training, and interrater reliability; without those data, apparent changes could partly reflect coding inconsistency. Fourth, game performance may depend on opponent pairing and match context, which should be standardized or modeled. Finally, the current result values are simulated and therefore cannot be interpreted as evidence of effectiveness. These limitations should be fully retained in the final manuscript unless the completed study provides stronger design controls.

Future research should therefore use multi-school samples and, where feasible, cluster-randomized or factorial designs. A 2×2 design separating Sport Education and ball-launcher exposure could determine whether their effects are additive or interactive. Retention tests after several weeks and transfer tests against unfamiliar opponents would show whether gains persist beyond machine-assisted practice. Process measures would also improve explanation: ball contacts per minute, proportion of successful rallies, time in active practice, fidelity to Sport

Education features, student role participation, and perceived task challenge could identify the mechanisms linking pedagogy to performance. Analyses stratified by baseline skill and sex may be particularly informative because Sport Education research has highlighted the importance of equitable participation across heterogeneous learners (Farias et al., 2022). These extensions could clarify how instructional organization and practice technology interact in physical education.

Conclusion

Ball launcher-assisted Sport Education provides a coherent framework for teaching junior high school table tennis because it combines persistent team participation, student responsibility, formal game purposes, and progressively controllable racket ball practice. In the illustrative simulated analysis, the intervention group achieved higher baseline-adjusted game performance than the control group, with consistent advantages across decision making, skill execution, and base/recovery. These numerical values are not empirical findings and must be replaced by the observed dataset. If the completed study confirms the same pattern with verified measurement quality and ethical documentation, the main practical implication would be to use ball launchers as temporary, progressively variable practice constraints within authentic Sport Education seasons rather than as substitutes for opponent based play. Further research should test retention, transfer, implementation fidelity, and the separate contributions of the pedagogical model and the practice aid.

Acknowledgments: The authors would like to thank the Dinas Pendidikan West Bandung Regency for research permission, all participating schools, teachers, and students, and STKIP Pasundan for institutional support.

Conflicts of Interest: The authors declare no conflict of interest.

References

- Adhi, B. P., Malik, A. A., Sholehudin, I., & Martins, A. (2026). The effectiveness of using digital animated videos in teaching underhand passing in volleyball at SMK 1 Jenangan, Ponorogo Regency. *Jurnal Pendidikan Jasmani Indonesia*, 22(1), 53–61. <https://doi.org/10.21831/jpji.v22i1.90252>

- Basiri, F., Farsi, A., & Abdoli, B. (2020). The effect of visual and tennis training on perceptual-motor skill and learning of forehand drive in table tennis players. *Journal of Modern Rehabilitation*, 14(1), 21–32. <https://doi.org/10.32598/jmr.14.1.3>
- Bessa, C., Hastie, P. A., Ramos, A., & Mesquita, I. (2021). What actually differs between traditional teaching and Sport Education in students' learning outcomes? A critical systematic review. *Journal of Sports Science and Medicine*, 20(1), 110–125. <https://doi.org/10.52082/jssm.2021.110>
- Brocken, J. E. A., van der Kamp, J., Lenoir, M., & Savelsbergh, G. J. P. (2020). Equipment modification can enhance skill learning in young field hockey players. *International Journal of Sports Science & Coaching*, 15(3), 382–389. <https://doi.org/10.1177/1747954120918964>
- Buszard, T., Garofolini, A., Reid, M., Farrow, D., Oppici, L., & Whiteside, D. (2020). Scaling sports equipment for children promotes functional movement variability. *Scientific Reports*, 10, 3111. <https://doi.org/10.1038/s41598-020-59475-5>
- Chow, J. Y., Komar, J., & Seifert, L. (2021). The role of nonlinear pedagogy in supporting the design of modified games in junior sports. *Frontiers in Psychology*, 12, 744814. <https://doi.org/10.3389/fpsyg.2021.744814>
- Dancy, P., & Murphy, C. (2020). The effect of equipment modification on the performance of novice junior cricket batters. *Journal of Sports Sciences*, 38(21), 2415–2422. <https://doi.org/10.1080/02640414.2020.1786992>
- Dewanti, G., Nompembri, S., Widiyanto, Hartanto, A., & Arianto, A. C. (2023). Development of physical education learning outcomes assessment instruments for volleyball materials based on Game Performance Assessment Instrument. *Physical Education Theory and Methodology*, 23(2), 170–177. <https://doi.org/10.17309/tmfv.2023.2.03>
- Farias, C., Segovia, Y., Valério, C., & Mesquita, I. (2022). Does Sport Education promote equitable game-play participation? Effects of learning context and students' sex and skill-level. *European Physical Education Review*, 28(1), 20–39. <https://doi.org/10.1177/1356336X211013832>
- Feng, D., Cossich, V. R. A., Abdelrasoul, E., Campelo, A. M., & Katz, L. (2025). The impact of video performance technology and peer-to-peer learning on table tennis skill acquisition in elementary students. *Frontiers in Sports and Active Living*, 7, 1653334. <https://doi.org/10.3389/fspor.2025.1653334>
- González-Devesa, D., Sanchez-Lastra, M. A., Pintos-Barreiro, M., & Ayán-Pérez, C. (2024). Benefits of table tennis for children and adolescents: A narrative review. *Children*, 11(8), 963. <https://doi.org/10.3390/children11080963>
- Gorman, A. D., Headrick, J., Renshaw, I., McCormack, C. J., & Topp, K. M. (2021). A principled approach to equipment scaling for children's sport: A case study in basketball. *International Journal of Sports Science & Coaching*, 16(1), 158–165. <https://doi.org/10.1177/1747954120954569>
- Guijarro, E., MacPhail, A., Arias-Palencia, N. M., & González-Víllora, S. (2022). Exploring game performance and game involvement: Effects of a Sport Education season and a combined

- Sport Education—Teaching Games for Understanding unit. *Journal of Teaching in Physical Education*, 41(3), 411–424. <https://doi.org/10.1123/jtpe.2020-0170>
- Gutiérrez, D., García-López, L. M., Hastie, P. A., & Segovia, Y. (2022). Adoption and fidelity of Sport Education in Spanish schools. *European Physical Education Review*, 28(1), 244–262. <https://doi.org/10.1177/1356336X211036066>
- Huda, A. M., Nasrulloh, A., & Rismayanthi, C. (2026). Penggunaan media pembelajaran kartu bergambar untuk meningkatkan hasil belajar senam guling depan peserta didik. *Jurnal Pendidikan Jasmani Indonesia*, 22(1), 1–12. <https://doi.org/10.21831/jpji.v22i1.80889>
- Iserbyt, P., Dehandschutter, T., Leysen, H., & Loox, J. (2022). Physical activity and game play ability in a high school Sport Education basketball season. *International Journal of Human Movement and Sports Sciences*, 10(2), 283–293. <https://doi.org/10.13189/saj.2022.100219>
- Kao, C.-C. (2019). Development of team cohesion and sustained collaboration skills with the Sport Education model. *Sustainability*, 11(8), 2348. <https://doi.org/10.3390/su11082348>
- Li, P., Wang, W., Liu, H., Zhang, C., & Hastie, P. A. (2022). The impact of Sport Education on Chinese physical education majors' volleyball competence and knowledge. *Sustainability*, 14(3), 1187. <https://doi.org/10.3390/su14031187>
- Mahedero, M. P., Calderón, A., Hastie, P. A., & Arias-Estero, J. L. (2021). Grouping students by skill level in mini-volleyball: Effect on game performance and knowledge in Sport Education. *Perceptual and Motor Skills*, 128(4), 1851–1871. <https://doi.org/10.1177/00315125211021812>
- Makruf, A., Guntur, & Nugroho, A. W. (2026). Pengembangan modul ajar Net Game untuk meningkatkan minat dan motivasi peserta didik mengikuti pembelajaran penjasorkes (PJOK). *Jurnal Pendidikan Jasmani Indonesia*, 22(1), 39–52. <https://doi.org/10.21831/jpji.v22i1.90137>
- Najib, H., Saryono, Utami, N. S., Broto, D. P., Rizkyanto, W. I., & Tanimoto, H. (2026). Analisis pemanfaatan media pembelajaran dalam pembelajaran pendidikan jasmani di SMP Negeri Kota Yogyakarta. *Jurnal Pendidikan Jasmani Indonesia*, 22(1), 83–91. <https://doi.org/10.21831/jpji.v22i1.91745>
- Ortega-Zayas, M. A., Cardona-Linares, A. J., Lecina, M., Ochiana, N., García-Giménez, A., & Pradas, F. (2025). Table tennis as a tool for physical education and health promotion in primary schools: A systematic review. *Sports*, 13(8), 251. <https://doi.org/10.3390/sports13080251>
- Oslin, J. L., Mitchell, S. A., & Griffin, L. L. (1998). The Game Performance Assessment Instrument (GPAI): Development and preliminary validation. *Journal of Teaching in Physical Education*, 17(2), 231–243. <https://doi.org/10.1123/jtpe.17.2.231>
- Sanz Ferrández, C., Marsan, T., Poulet, Y., Rouch, P., Thoreux, P., & Sauret, C. (2021). Physiology, biomechanics and injuries in table tennis: A systematic review. *Science & Sports*, 36(2), 95–104. <https://doi.org/10.1016/j.scispo.2020.04.007>