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Integrating Jigsaw and Picture-and-Picture Cooperative Learning in Sprint Instruction

A One-Group Pre–Post Study in an Indonesian Madrasah Aliyah

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ABSTRACT

Sprint-running instruction in school physical education requires students to coordinate key technique phases (start, acceleration, arm action, and posture) while maintaining motivation, yet teacher-centred drills can reduce active learning time, feedback, and peer modeling. This study evaluated the feasibility of implementing a combined cooperative-learning approach (Jigsaw and Picture-and-Picture) in sprint-running lessons and examined whether learning outcomes improved from pretest to posttest. A one-group pretest–posttest design was conducted with 25 students from MAN 1 OKI (Ogan Komering Ilir, South Sumatra, Indonesia). The intervention was delivered across four class meetings during September–October 2025 by integrating peer-teaching through home/expert groups with sequenced visual representations of sprint technique. Learning outcomes were assessed using a composite score covering cognitive (multiple-choice test), affective (observation), and psychomotor (performance rubric) domains. Mean scores increased from 62.8 (SD = 11.78) at pretest to 67.6 (SD = 8.72) at posttest, and a paired-samples t-test showed a significant difference, $t(24) = 3.806$, $p = 0.001$, with a moderate-to-large within-subject effect (Cohen's $dz \approx 0.76$). The model was feasible to implement within regular PE lessons and offers a practical option to increase student involvement and clarify technique through step-by-step visuals. However, because the design lacked a comparison group, the improvement cannot be attributed solely to the intervention; future multi-site studies with control groups are recommended.

Keywords
Cooperative Learning
Jigsaw
Picture-And-Picture
Physical Education
Sprint Running

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Introduction

Sprint running is a foundational component of school physical education because it develops speed, coordination, movement efficiency, and broader physical literacy outcomes [1]. However, teaching sprinting in classroom settings is not straightforward. Students are required to coordinate several technical elements, including the start, acceleration, arm action, stride mechanics, and body posture, while also maintaining motivation during repeated practice. In many school contexts, sprint instruction still relies heavily on teacher-centered demonstrations and mass drills. Such approaches may reduce active learning time, limit individualized feedback, and provide fewer opportunities for peer modeling, corrective discussion, and reflective learning [2], [3], [4].

Recent physical education research increasingly emphasizes student-centered learning, cooperative learning, and active learning as pedagogical approaches that can improve engagement, time-on-task, and learning quality. Student-centered learning positions students as active participants in the learning process rather than passive recipients of teacher explanation[5], [6], [7]. In physical education, this approach allows students to observe, discuss, practice, evaluate, and refine movement skills through guided interaction[8], [9], [10]. Cooperative learning further strengthens this process by structuring students' work through positive interdependence, individual accountability, face-to-face interaction, and shared responsibility for group success[11], [12]. In this sense, cooperative learning is not merely group work, but a structured instructional approach that requires students to contribute actively, support their peers, and take responsibility for mastering learning tasks[13], [14], [15].

Active learning is also highly relevant to sprint instruction because sprinting is a practical motor skill that requires repeated movement experience, immediate feedback, and correction of technique[16], [17], [18]. Through active learning, students are encouraged to engage physically, cognitively, and socially in the learning process[19], [20]. They do not only perform sprint movements, but also analyze technique components, compare movement sequences, discuss errors, and reflect on performance improvement. Studies on cooperative learning in physical education have reported benefits for participation, social interaction, motivation, and skill-related outcomes when learning tasks are clearly structured and students

are guided to share roles and feedback [21], [22], [23]. At the same time, physical education research highlights the importance of instructional scaffolds, including visual cues, sequenced images, and stepwise representations, to support students' understanding of movement phases and improve the accuracy of practice[24], [25]. These findings suggest that combining interactive peer learning with clear visual representations may be particularly relevant for sprint-running lessons, where technical timing, body position, and movement sequencing are essential[26], [27], [28].

Within this pedagogical context, Jigsaw and Picture-and-Picture provide complementary instructional functions[29]. Jigsaw is a cooperative learning strategy that organizes students into home groups and expert groups, allowing them to learn specific material, discuss it with peers, and teach it back to their original group[30], [31]. This model reflects the principles of student-centered and cooperative learning because students are given active roles as learners, peer tutors, and contributors to group understanding[32]. In sprint instruction, Jigsaw can be used to divide technical components of sprinting into smaller learning tasks, such as starting position, acceleration, arm swing, stride mechanics, and finishing technique. Each student becomes responsible for understanding one component and helping peers understand it through explanation, demonstration, and feedback[33].

Meanwhile, Picture-and-Picture uses sequenced images to guide students' reasoning, discussion, and understanding of movement patterns [34], [35], [36]. This model is relevant to active learning because students are asked to observe, arrange, interpret, and explain visual information rather than simply listen to teacher instruction. In sprint learning, sequenced images can help students recognize the correct order of movement phases and compare proper and improper techniques. The visual structure also functions as a scaffold that supports students with different levels of prior knowledge and motor ability. Therefore, Picture-and-Picture can help make sprint technique more concrete, observable, and easier to discuss during practice.

The integration of Jigsaw and Picture-and-Picture is also consistent with an adaptive learning framework. In this study, adaptive learning is understood as an instructional approach that adjusts learning support, task structure, peer interaction, and feedback opportunities according to students' learning needs. The Jigsaw component provides social adaptation through peer teaching, role distribution, and collaborative responsibility, while the Picture-and-Picture component provides cognitive and visual scaffolding through sequenced movement representations. Together, these approaches allow students to learn sprint techniques through multiple pathways: observing visual cues, discussing technical elements, practicing movements, receiving peer feedback, and refining performance. This combination is

expected to support cognitive understanding, affective engagement, and psychomotor performance in a more balanced way than teacher-centered instruction alone.

Despite these potentials, a clear research gap remains in school-based sprint instruction[26], [37]. Existing studies often examine cooperative learning or visual-based models separately, or they focus on general engagement rather than sprint-specific learning outcomes and technique components[38], [39], [40]. In addition, many classroom trials in Indonesian secondary schools remain limited in scope and provide insufficient evidence about implementation feasibility, including teacher workload, classroom management, student roles, and lesson flow, alongside measurable learning gains. Therefore, evidence is still needed on whether a combined cooperative–visual model can be implemented realistically in sprint lessons and whether it can support observable improvement in students' learning outcomes [14], [41], [41].

Accordingly, this study aimed to evaluate the implementation of a combined Jigsaw and Picture-and-Picture learning model in sprint-running lessons at MAN 1 OKI. The objectives were to: (1) examine the feasibility of implementing the combined model in regular physical education lessons; (2) assess pre–post changes in students' sprint-running learning outcomes following the intervention; and (3) describe practical considerations for teachers related to student grouping, peer teaching, and the use of sequenced images during practice. This article contributes by offering an implementation-focused model for sprint instruction that integrates cooperative learning and visual scaffolding within a student-centered, active, and adaptive learning framework. It also provides context-specific evidence from an Indonesian madrasah setting. Nevertheless, the study is limited by its single-site context and one-group pre–post design, which restrict generalizability and causal inference. Future research should incorporate control or comparison groups and multi-school trials to strengthen the validity of the findings.

Material and Methods

A. Study design and setting

This study used a quasi-experimental one-group pretest–posttest design. The research was conducted at MAN 1 OKI (Ogan Komering Ilir, South Sumatra, Indonesia) during September–October 2025. The study was implemented across four class meetings within regular PJOK lessons. Meetings 1–2 served as baseline sessions (pre-intervention), while meetings 3–4 implemented the combined cooperative-learning intervention. Formal evaluations were administered at meeting 2 (pretest) and meeting 4 (posttest)[42].

B. Participants

Participants were 25 Grade 10 students from MAN 1 OKI. A total sampling technique was used (all students in the accessible class were included) [43]. Students participated during

scheduled PE lessons. Students who could not participate in physical activity on assessment days (e.g., due to health restrictions) were excluded from testing.

C. Intervention and procedures: Combined Jigsaw and Picture-and-Picture sprint lessons

The intervention integrated (1) Jigsaw cooperative learning (peer teaching through home and expert groups) and (2) Picture-and-Picture (sequenced images to support reasoning about sprint phases). The procedures were as follows:

1. Group formation (home groups): Students were assigned to heterogeneous "home groups."
2. Expert-group learning (Jigsaw): Each student received a different subtopic/technique element (e.g., start, acceleration/drive phase, arm action, posture, finish). Students moved into "expert groups" to study and discuss their assigned element and prepare a brief explanation.
3. Peer teaching in home groups: Students returned to their home groups and taught their assigned technique element to peers, ensuring positive interdependence and individual accountability.
4. Picture-and-Picture sequencing activity: Students were given a set of sprint-technique images representing phases (e.g., start position, drive/acceleration, upright sprinting, finish). Students arranged the images in correct order, discussed key cues, and justified their sequencing.
5. Teacher facilitation and safety: The teacher provided demonstrations, ensured safety procedures, managed time, facilitated discussion, and gave feedback during practice.
6. The combined approach aimed to improve students' conceptual understanding via peer explanation (Jigsaw) and strengthen movement representation via visual sequencing (Picture-and-Picture).

D. Outcome measures and scoring

Learning outcomes were assessed using a composite score across three domains (cognitive, affective, and psychomotor). The final learning-outcome score was calculated by summing the three domain scores and dividing by 3, producing a single overall score.

1. Cognitive domain
2. Sprint-running knowledge was measured using a 20-item multiple-choice test. Each correct answer was scored 10, and incorrect answers 0. Thus, the raw cognitive score ranged from 0–200. For consistency with other domains, the cognitive score may be reported as a percentage (0–100) using:

The cognitive score was converted into a percentage score using the following formula:

$$\text{Cognitive score (\%)} = \frac{\text{Raw score}}{200} \times 100 \quad (1)$$

Where the raw score refers to the total cognitive score obtained by each student, and 200 represents the maximum possible score.

1. Affective domain. Learning attitudes/ behaviors were measured using a structured observation sheet with five criteria: attitude toward learning, teamwork, communication, ethics/morals, and creativity. Each criterion was scored up to 20 points, then summed to produce an effective score ranging from 0–100.
2. Psychomotor domain. Sprint performance was assessed using a practical performance assessment of 100 m sprint-running, emphasizing both process (movement quality) and product (speed/time). For process assessment, a technique rubric was used with Yes (1) / No (0) scoring across essential indicators covering three phases: Initial position (legs, body, arms/hands, gaze), Movement execution (legs, body, arms/hands, gaze), Final position/finish (legs, body, arms/hands, gaze).

This resulted in 12 indicators in total, with a raw process score ranging from 0 to 12. The psychomotor score was then converted into a percentage score ranging from 0 to 100 using the following formula:

$$\text{Psychomotor score (\%)} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100 \quad (2)$$

where the score obtained refers to the total score achieved by each student, and the maximum score refers to the highest possible score across all psychomotor indicators.

After the three domain scores were obtained, the overall learning outcome score was calculated by averaging the cognitive, affective, and psychomotor scores using the following formula:

$$\text{Final score} = \frac{\text{Cognitive score} + \text{Affective score} + \text{Psychomotor score}}{3} \quad (3)$$

where the final score represents the average learning outcome score across the cognitive, affective, and psychomotor domains.

E. Data analysis

Descriptive statistics (mean, standard deviation) were computed for pretest and posttest scores. Assumptions were checked using Shapiro–Wilk for normality and Levene's test for homogeneity (reported where relevant). Pre–post differences were tested using a paired-samples t-test with $\alpha = 0.05$. Within-subject effect size was calculated using Cohen's dz:

$$d_z = \frac{t}{\sqrt{n}} \quad (4)$$

F. Ethical approval, permissions, and author agreement

This study involved human participants. Ethical approval was obtained from the Ethics Committee/LPPM of Universitas PGRI Palembang under Approval No. 1546a/UN/17/KP.12.00/2025. Prior to data collection, informed consent was obtained from all participants and/or their guardians where applicable. The study was conducted in accordance with relevant ethical guidelines for research involving human participants.

Results and Discussions

A. Assumption checks

Assumption testing was conducted before performing the paired-samples t-test. The results showed that both pretest and posttest composite learning-outcome scores were normally distributed based on the Shapiro–Wilk test, with p>0.05p > 0.05p >0.05. In addition, Levene's test indicated that the data met the homogeneity of variance assumption, with p>0.05p > 0.05p>0.05. These findings support the appropriateness of using a paired-samples t-test to examine differences between pretest and posttest scores.

From a practical perspective, the fulfillment of these assumptions indicates that the pre–post score changes could be analyzed using standard parametric procedures. Therefore, the statistical results are unlikely to be substantially affected by violations of normality or variance assumptions. This strengthens the reliability of the statistical interpretation regarding changes in students' composite learning outcomes after the intervention.

B. Pre–post change in learning outcomes

Table 1 presents the descriptive statistics and paired-samples t-test results for students' composite learning outcomes. The mean score increased from 62.80 at pretest (SD = 11.78) to 67.60 at posttest (SD = 8.72), with an average gain of 4.80 points. The paired-samples t-test indicated a statistically significant improvement after the implementation of the combined Jigsaw and Picture-and-Picture learning model, t(24)=3.806t(24) = 3.806t(24)=3.806, p=0.001p = 0.001p=0.001. In addition, the within-subject effect size was moderate to large, with Cohen's dz≈0.76d_z \approx 0.76dz≈0.76. This result suggests that the learning model was associated with a meaningful improvement in students' overall learning outcomes. However, because the study used a one-group pretest–posttest design, the improvement should be interpreted as evidence of pre–post change rather than definitive causal evidence.

Table 1. Pre–post change in composite learning outcome

Measure	Pretest M (SD)	Posttest M (SD)	t (df)	p
Learning outcome (composite)	62.8 (11.78)	67.6 (8.72)	3.806 (24)	0.001

From an instructional perspective, the improvement observed in this study can be explained by the complementary mechanisms of the combined Jigsaw and Picture-and-Picture model [2], [44]. The Jigsaw component structured learning through peer teaching, group responsibility, and individual accountability, which may have increased students' active participation, time-on-task, and opportunities to receive feedback from peers. In sprint instruction, these mechanisms are important because students need repeated practice, corrective interaction, and opportunities to understand specific movement components such as the start, acceleration phase, arm swing, stride mechanics, upright running, and finishing technique.

The Picture-and-Picture component further strengthened the learning process by providing sequenced visual cues that helped students organize sprint phases into a clearer and more meaningful movement pattern. Visual sequencing can support students in identifying the correct order of technical elements, comparing movement positions, and linking conceptual understanding with practical execution. Therefore, the integration of peer-based interaction and visual scaffolding may have contributed to improvements across cognitive, affective, and psychomotor learning outcomes. This finding is consistent with previous studies indicating that cooperative learning in physical education can enhance engagement, participation, and social interaction, while visual instructional support can improve students' understanding and execution of motor skills[45], [46], [47].

These findings also support the relevance of combining student-centered, cooperative, active, and adaptive learning principles in physical education. The combined model positioned students not only as performers but also as observers, discussants, peer tutors, and evaluators of movement performance. Through Jigsaw, learning became more socially interactive and responsibility-based, whereas Picture-and-Picture provided structured visual support that made technical sprint movements easier to understand and practice. In this way, the model created a more adaptive learning environment by offering multiple forms of support, including peer explanation, visual representation, repeated practice, and feedback. Such a learning structure is particularly useful in sprint instruction, where students may differ in motor ability, prior knowledge, confidence, and learning pace.

However, the findings should be interpreted with caution because this study employed a one-group pretest–posttest design. Without a comparison group, the observed improvements cannot be attributed solely to the intervention. Other factors, such as maturation, repeated testing, increased familiarity with the assessment procedure, or concurrent physical practice, may also have contributed to the pre–post gains. Therefore, future studies should employ controlled or quasi-experimental designs, such as comparison classes, randomized groups, or counterbalanced implementation, to strengthen causal inference. In addition, multi-site

studies involving different school contexts are recommended to improve the generalizability of the findings.

Conclusion

The combined Jigsaw and Picture-and-Picture approach was feasible to implement in sprint-running lessons at MAN 1 OKI and was associated with a significant pre–post improvement in learning outcomes. This study addresses the knowledge gap on whether a cooperative–visual hybrid model can be applied in school sprint instruction and yield measurable gains in an Indonesian Madrasah Aliyah context. The main contribution is practical implementation guidance alongside preliminary outcome evidence; however, the one-group design and single-site sample limit causal inference and generalizability. Future research should use controlled, multi-site studies and examine domain-specific effects and longer-term outcomes.

Conflict of Interest

There is no conflict of interest

References

[1] J. R. Rudd, C. Pesce, B. W. Strafford, and K. Davids, "Physical Literacy - A Journey of Individual Enrichment: An Ecological Dynamics Rationale for Enhancing Performance and Physical Activity in All," Front. Psychol., vol. 11, p. 533387, Jul. 2020, doi: 10.3389/fpsyg.2020.01904.

[2] M. V. Adegbija and M. A. Fakomogbon, "Instructional Media In Teaching And Learning: A Nigerian Perspective," Glob. media j., vol. 6, no. 2, Jan. 2013, doi: 10.5789/6-2-114.

[3] Amirudin Kassim and Mohd Norazmi Nordin, "An Effective Teaching Aids Using Visual, Auditory And Kinesthetic Learning Styles For Students With Special Needs," *Special Education* (SE), vol. 2, no. 1, p. e0009, Mar. 2024, doi: 10.59055/se.v2i1.9.

[4] M. M. Asad, N. Hussain, M. Wadho, Z. H. Khand, and P. P. Churi, "Integration of e-learning technologies for interactive teaching and learning process: an empirical study on higher education institutes of Pakistan," JARHE, vol. 13, no. 3, pp. 649–663, Jun. 2021, doi: 10.1108/JARHE-04-2020-0103.

[5] W. Ji, "A study of the effects of strategies for conducting cooperative games in kindergartens on the establishment of peer relationships in preschool children," SHS Web Conf., vol. 222, p. 04002, 2025, doi: 10.1051/shsconf/202522204002.

[6] T. Ngoc Tuong Nguyen and D. Thi Kim Oanh, "Cooperative learning and its influences on student engagement," Cogent Education, vol. 12, no. 1, p. 2513414, Dec. 2025, doi: 10.1080/2331186X.2025.2513414.

[7] T. Zhou and J. Colomer, "Cooperative Learning Promoting Cultural Diversity and Individual Accountability: A Systematic Review," Education Sciences, vol. 14, no. 6, p. 567, May 2024, doi: 10.3390/educsci14060567.

[8] J. Yan, B. Jones, J. J. Smith, P. Morgan, and N. Eather, "A Systematic Review Investigating the Effects of Implementing Game-Based Approaches in School-Based Physical Education Among Primary School Children," Journal of Teaching in Physical Education, vol. 42, no. 3, pp. 573–586, Jul. 2023, doi: 10.1123/jtpe.2021-0279.

[9] I. A. Essiet et al., "A systematic review of tools designed for teacher proxy-report of children's physical literacy or constituting elements," Int J Behav Nutr Phys Act, vol. 18, no. 1, p. 131, Oct. 2021, doi: 10.1186/s12966-021-01162-3.

[10] C. Poulin and M. Davis, "Advancing Quality Physical Education: From the Canadian PHE Competencies to the QPE Foundations and Outcomes Frameworks," Education Sciences, vol. 15, no. 10, p. 1376, Oct. 2025, doi: 10.3390/educsci15101376.

[11] I. Abduh, A. Saparia, J. Jumain, Z. Ziulhaq, and M. Usba, "The Creativity of Physical Education Teachers, Sports, and Health," Musamus Journal of Physical Education and Sport (MJPES), vol. 6, no. 2, Art. no. 2, Apr. 2024, doi: 10.35724/mjpes.v6i2.6060.
[12] R. Abusleme-Allimant et al., "Effects of Structured and Unstructured Physical Activity on Gross Motor Skills in Preschool Students to Promote Sustainability in the Physical Education Classroom," Sustainability, vol. 15, no. 13, p. 10167, Jun. 2023, doi: 10.3390/su151310167.
[13] S. Adipat, K. Laksana, K. Busayanon, A. Asawasowan, and B. Adipat, "Engaging Students in the Learning Process with Game-Based Learning: The Fundamental Concepts," International Journal of Technology in Education, vol. 4, no. 3, pp. 542–552, 2021, Accessed: Jan. 03, 2026. [Online]. Available: https://eric.ed.gov/?id=EJ1311472
[14] I. Fonseca, M. Caviedes, J. Chantré, and J. Bernate, "Gamification and Game-Based Learning as Cooperative Learning Tools: A Systematic Review," International Journal of Emerging Technologies in Learning (iJET), vol. 18, no. 21, pp. 4–23, Nov. 2023, Accessed: Jan. 03, 2026. [Online]. Available: https://www.learntechlib.org/p/223722/
[15] Y. P. Puspita, Zawaqi Afdal Jamil, and Jamilah, "Implementasi Model Pembelajaran Kooperatif dalam Mengembangkan Sosial Emosional Anak Usia Dini di Taman Kanak-Kanak Islam Terpadu Mutiara Hati Kecamatan Kota Baru Kota Jambi," PrimEarly, vol. 8, no. 1, pp. 35–46, Apr. 2025, doi: 10.37567/primearly.v8i1.3764.
[16] I. M. B. Andika, P. Nita, H. Fahritsani, and S. Sugarwanto, "Adaptive Sports Learning in Physical Education: Theory and Practice for Physical Education (PE) Students," 1, vol. 6, no. 2, Art. no. 2, Apr. 2024, doi: 10.35724/mjpes.v6i2.6098.
[17] N. Omarov, B. Omarov, Z. Azhibekova, and B. Omarov, "Applying an augmented reality game-based learning environment in physical education classes to enhance sports motivation," Retos, vol. 60, pp. 269–278, Aug. 2024, doi: 10.47197/retos.v60.109170.
[18] A. Stanciulescu, F. Castronovo, and J. Oliver, "Assessing the impact of visualization media on engagement in an active learning environment," International Journal of Mathematical Education in Science and Technology, vol. 55, no. 5, pp. 1150–1170, May 2024, doi: 10.1080/0020739X.2022.2044530.
[19] H. Tinmaz, M. Fanea-Ivanovici, and H. Baber, "A snapshot of digital literacy," LHTN, vol. 40, no. 1, pp. 20–23, Jan. 2023, doi: 10.1108/LHTN-12-2021-0095.
[20] A. K. Sharma, "Cognitive and Psychological Aspects of Physics Learning," Physics Journal | Farhangian University, vol. 2, no. 1, pp. 28–39, Jan. 2025, doi: 10.48310/esip.2025.18642.1011.
[21] Pelin Avcı and A. Bayrakdar, "Revolutionizing Sport - How Technology is Changing the Sports Industry?," in The Use of Developing Technology in Sports, Özgür Yayınları, 2023. doi: 10.58830/ozgur.pub315.c1476.
[22] D. Penney and M. Jess, "Physical education and physically active lives: a lifelong approach to curriculum development," Sport, Education and Society, vol. 9, no. 2, pp. 269–287, Jul. 2004, doi: 10.1080/1357332042000233985.
[23] M. Abarghoueinejad, D. Barreira, C. Dias, E. Guimarães, A. D. G. Baxter-Jones, and J. Maia, "Body Physique, Body Composition, Physical Performance, Technical and Tactical Skills, Psychological Development, and Club Characteristics of Young Male Portuguese Soccer Players: The INEX Study," IJERPH, vol. 18, no. 7, p. 3560, Mar. 2021, doi: 10.3390/ijerph18073560.
[24] M. Morral-Yepes, O. Gonzalo-Skok, T. Dos´Santos, and G. Moras Feliu, "Are change of direction speed and agility different abilities from time and coordinative perspectives?," PLoS ONE, vol. 18, no. 12, p. e0295405, Dec. 2023, doi: 10.1371/journal.pone.0295405.
[25] L. Yang, B. Gao, Y. Chen, Q. Xu, J. Zhou, and Q. Tang, "Comparing The Effects of Maximal Strength Training, Plyometric Training, and Muscular Endurance Training on Swimming-Specific Performance Measures: A Randomized Parallel Controlled Study in Young Swimmers," jsportscimed, pp. 128–141, Mar. 2025, doi: 10.52082/jssm.2025.128.
[26] R. Roth, L. Donath, L. Zahner, and O. Faude, "Acute Leg and Trunk Muscle Fatigue Differentially Affect Strength, Sprint, Agility, and Balance in Young Adults," Journal of Strength & Conditioning Research, vol. 35, no. 8, pp. 2158–2164, Aug. 2021, doi: 10.1519/JSC.0000000000003112.
[27] D. C. Mănescu, "Big Data Analytics Framework for Decision-Making in Sports Performance Optimization," Data, vol. 10, no. 7, p. 116, Jul. 2025, doi: 10.3390/data10070116.
[28] G. Nambi, W. K. Abdelbasset, B. A. Alqahtani, S. M. Alrawaili, A. M. Abodonya, and A. K. Saleh, "Isokinetic back training is more effective than core stabilization training on pain intensity and

sports performances in football players with chronic low back pain: A randomized controlled trial," Medicine, vol. 99, no. 21, p. e20418, May 2020, doi: 10.1097/MD.0000000000020418.
[29] P. Riyanto and D. D. Kuswoyo, "Pengaruh Model Pembelajaran Jigsaw Terhadap Peningkatan Kemampuan Drible Bola Basket," Musamus Journal of Physical Education and Sport (MJPES), vol. 2, no. 01, pp. 59–67, 2019, doi: 10.35724/mjpes.v2i01.2069.
[30] Z. Hasanah and A. S. Himami, "Model Pembelajaran Kooperatif Dalam Menumbuhkan Keaktifan Belajar Siswa," Irsyaduna, vol. 1, no. 1, pp. 1–13, Mar. 2021, doi: 10.54437/irsyaduna.v1i1.236.
[31] S. Sirait, A. Anim, R. Hayati, and S. Widya, "Praktik Cooperative Learning Berbasis Kearifan Lokal Dalam Meningkatkan Literasi Numerasi Disekolah Dasar," jurdimas, vol. 5, no. 3, pp. 314–319, Sep. 2022, doi: 10.33330/jurdimas.v5i3.1660.
[32] M. J. Van Ryzin and C. J. Roseth, "The Longitudinal Relationship Between Peer Relations and Empathy and Their Joint Contribution to Reducing Bullying in Middle School: Findings From a Randomized Trial of Cooperative Learning," Journal of Prevention and Health Promotion, vol. 3, no. 2, pp. 147–165, Apr. 2022, doi: 10.1177/26320770221094032.
[33] S. Khoiriyah, H. S. R. Khairani, R. R, A. N. K. Inthaha, and A. N. 'Ilmi Azizah, "Analysis of Gymnastics Activities in Stimulating Gross Motor Development in Early Childhood," Socius: Jurnal Penelitian Ilmu-Ilmu Sosial, vol. 3, no. 10, pp. 130–137, May 2026, doi: 10.5281/zenodo.20149677.
[34] Md. A. G. @ Charles, M. R. Abdullah, R. M. Musa, N. A. Kosni, and A. B. H. Musawi Maliki, "The Effectiveness of Traditional Games intervention program in the Improvement of Form One School-Age Children's Motor Skills Related Performance Components," MoHE, vol. 6, no. 2, Jul. 2017, doi: 10.15282/mohe.v6i2.142.
[35] S. Atasavun Uysal and T. Düger, "Motor control and sensory-motor integration of human movement," in Comparative Kinesiology of the Human Body, Elsevier, 2020, pp. 443–452. doi: 10.1016/B978-0-12-812162-7.00024-2.
[36] C. Brewer, Athletic Movement Skills: Training for Sports Performance. Human Kinetics, 2017.
[37] R. Kobal et al., "Effects of Different Combinations of Strength, Power, and Plyometric Training on the Physical Performance of Elite Young Soccer Players," Journal of Strength and Conditioning Research, vol. 31, no. 6, pp. 1468–1476, Jun. 2017, doi: 10.1519/JSC.0000000000001609.
[38] A. I. Abdul Jabbar and P. Felicia, "Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review," Review of Educational Research, vol. 85, no. 4, pp. 740–779, Dec. 2015, doi: 10.3102/0034654315577210.
[39] C. Akdeniz, "Effects of Cognitive Stimulation, Physical Arrangement of The Learning Environment, and Instructional Tendency on Student Engagement," 2024.
[40] P. Bitrián, I. Buil, and S. Catalán, "Enhancing user engagement: The role of gamification in mobile apps," Journal of Business Research, vol. 132, pp. 170–185, Aug. 2021, doi: 10.1016/j.jbusres.2021.04.028.
[41] J. Choi, D. W. Johnson, and R. Johnson, "Relationships Among Cooperative Learning Experiences, Social Interdependence, Children's Aggression, Victimization, and Prosocial Behaviors: INTERDEPENDENCE, AGGRESSION, AND PROSOCIAL BEHAVIOR," Journal of Applied Social Psychology, vol. 41, no. 4, pp. 976–1003, Apr. 2011, doi: 10.1111/j.1559-1816.2011.00744.x.
[42] Sugiyono, Metode Penelitian Kuantitatif, Kualitatif dan R&D. CV. Alfabeta, 2012.
[43] S. Arikunto, Arikunto, S. (2010). Prosedur Penelitian: Suatu Pendekatan Praktik (Edisi Revi). PT. Rineka Cipta.Prosedur Penelitian: Suatu Pendekatan Praktik, Edisi Revi. PT. Rineka Cipta, 2010.
[44] C. Sitinjak and Z. Canu, "The Importance Of Guidance And Counseling In Effective School Learning," JIGE, vol. 4, no. 1, pp. 12–19, Mar. 2023, doi: 10.55681/jige.v4i1.516.
[45] R. M. Fizi, S. Winarni, Guntur, and A. Hartanto, "A game model in physical education to improve motor skills, cooperation, and discipline of primary school learners," ppcs, vol. 27, no. 6, pp. 448–455, Dec. 2023, doi: 10.15561/26649837.2023.0602.
[46] K.-E. Chang, J. Zhang, Y.-S. Huang, T.-C. Liu, and Y.-T. Sung, "Applying augmented reality in physical education on motor skills learning," Interactive Learning Environments, vol. 28, no. 6, pp. 685–697, Aug. 2020, doi: 10.1080/10494820.2019.1636073.
[47] D. Jones, A. Innerd, E. L. Giles, and L. B. Azevedo, "Association between fundamental motor skills and physical activity in the early years: A systematic review and meta-analysis," Journal of Sport and Health Science, vol. 9, no. 6, pp. 542–552, Dec. 2020, doi: 10.1016/j.jshs.2020.03.001.

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