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Application of the Hybrid TGfU and TGT Model through Volleyball on the Learning Outcomes and Executive Function of Elementary School Students

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Abstract. This study aimed to examine the effect of a hybrid Teaching Games for Understanding (TGfU) and Teams Games Tournament (TGT) model, delivered through volleyball, on the learning outcomes and executive function of elementary school students. A quasi-experimental nonequivalent control group pretest-posttest design was used. The sample consisted of 58 sixth-grade students from a public elementary school in Bandung, selected through cluster random sampling: an experimental class (n = 29) and a control class (n = 29). The experimental class received ten sessions of hybrid TGfU-TGT volleyball instruction, while the control class received conventional direct instruction. Learning outcomes (psychomotor domain) were measured using the Game Performance Assessment Instrument (GPAI), and executive function was measured using the Short Executive Function Scale (SEFS). Data were analyzed using nonparametric and parametric tests, N-Gain, and effect sizes. Both groups showed significant improvements in GPAI scores, but the between-group difference in posttest scores was not significant ($p = 0.401$), nor was the difference in N-Gain ($p = 0.069$). The experimental group had significantly higher posttest executive function scores ($p = 0.012$; $d = 0.685$). The hybrid model shows potential for improving executive function; however, its effect on game performance requires further testing with equivalent groups.

Keywords: hybrid TGfU-TGT; volleyball; learning outcomes; executive function; elementary school

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INTRODUCTION

Physical Education, Sports, and Health (PJOK) plays an important role in supporting the holistic development of elementary school students, not only in fitness and physical ability but also in thinking skills, emotional regulation, and social skills (Kamaruddin, 2023). Nevertheless, the implementation of PJOK in elementary schools still faces obstacles such as limited facilities and infrastructure, a lack of variety in learning models, and teaching methods that tend to be monotonous, so that students are less interested and less active (Prayitno & Winarno, 2021). In volleyball lessons, this condition is evident from the many students who still do not understand the rules, player positions, and game strategies because instruction focuses more on technique drills than on applying them in real game situations (Wibowo & Nurhasono, 2022).

One approach to addressing these problems is the Teaching Games for Understanding (TGfU) model, which emphasizes understanding game concepts through play so that students learn technique, strategy, cooperation, and decision-making at the same time (Pan et al., 2023). The Teams Games Tournament (TGT) model is a cooperative model that divides students into teams to learn before participating in a simple tournament, thereby training cooperation, responsibility, and sportsmanship while increasing motivation and learning outcomes (Slavin, 2014). The two models have complementary strengths: TGfU is strong in tactical understanding, whereas TGT is strong in teamwork and motivation, so combining them in a hybrid model can offset the weaknesses of each (Bundu & Saman, 2023).

In addition to motor skills, structured physical activity at elementary school age also supports the development of cognitive function, particularly executive function, which refers to higher-order cognitive abilities encompassing planning, inhibition, working memory, shifting, and emotional control (Karr, 2024). Physical activity has been reported to help improve concentration, attention, and executive function in elementary school students (Altamimi et al., 2025). Volleyball, which demands decision-making, cooperation, and interaction with peers, has the potential to be a suitable context for developing executive function and learning outcomes at the same time.

Theoretically, the hybrid TGfU-TGT model can be expected to influence executive function through three complementary mechanisms. First, TGfU starts from modified small-sided games that present tactical problems to solve (Bunker & Thorpe, 1982), so students must keep track of the positions of teammates and opponents, hold the

game situation in working memory, choose among alternative actions, and inhibit impulsive responses; these demands correspond to working memory, inhibition, and cognitive flexibility, the core components of executive function (Diamond, 2013). Second, physical activity that is cognitively engaging, rather than purely repetitive, is considered more effective for executive function because it requires goal-directed and adaptive thinking during movement (Pesce, 2012; Diamond & Ling, 2016), a feature that technique drills lack. Third, TGT adds a cooperative structure in which team members help one another learn and then compete in tournaments (Slavin, 2014), so students must plan together, take turns, follow rules, and regulate their emotions when winning or losing, which draws on planning and emotional control. In addition, the progressive sequence of the hybrid model, from small 3-versus-3 games to a final tournament, increases task demands gradually, which is considered important for sustained improvement in executive function (Diamond & Ling, 2016). The theoretical contribution of this study is therefore to combine the tactical decision-making demands of TGfU with the social-regulatory demands of TGT in one instructional model, and to extend game-based PJOK research from skill outcomes to a cognitive outcome in elementary school students. These mechanisms provide the theoretical basis for the hypothesis on executive function (Ha1); they were not measured directly in this study.

Previous studies have examined TGfU and TGT in PJOK, but with different scopes. TGfU significantly affected the soccer shooting skills of secondary school students (Idrus, 2019); TGT and TGfU affected the psychomotor learning outcomes of sprinting, but they were applied to different groups and not combined (Pramuji et al., 2026); studies of TGT have mostly focused on motivation and critical thinking in non-PJOK subjects (Alifia et al., 2023); and TGfU and TGT have been compared in volleyball only for underhand passing learning outcomes among junior high school students (Setiyawan, 2025). A hybrid model of TGfU and Sport Education in basketball increased the motivation of elementary school students, but it did not measure learning outcomes or executive function (Gil-arias et al., 2020). Meanwhile, research on the impact of game-based learning on the executive function of elementary school students in the PJOK context remains very scarce (Kolovelonis et al., 2023).

The novelty of this study lies in testing the hybrid TGfU-TGT model through volleyball with elementary school students on two variables simultaneously: learning outcomes in the psychomotor domain (game performance) and executive function. The

hypotheses of this study are that the hybrid TGfU-TGT model affects (1) the learning outcomes and (2) the executive function of elementary school students. The statistical hypotheses are H_0: there is no effect of the hybrid TGfU-TGT model on learning outcomes; Ha: there is an effect of the hybrid TGfU-TGT model on learning outcomes; $H_0$1: there is no effect of the hybrid TGfU-TGT model on executive function; and Ha1: there is an effect of the hybrid TGfU-TGT model on the executive function of elementary school students. The aim of this study was to determine the effect of the hybrid TGfU-TGT model on the learning outcomes and executive function of elementary school students in volleyball lessons.

METHOD

Design and Participants

This study used a quantitative approach with a quasi-experimental nonequivalent control group pretest-posttest design, because the unit of treatment was intact classes, which made individual randomization impossible (Handley et al., 2018). The population was all sixth-grade students at one public elementary school in Bandung (87 students). The sample was drawn using cluster random sampling (Sugiyono, 2018), resulting in two classes, 6A and 6B, with a total of 58 students. One class was randomly assigned as the experimental group (n = 29), which received the hybrid TGfU-TGT model, and the other as the control group (n = 29), which received conventional volleyball instruction (a technical/direct instruction model). The sampling frame consisted of all sixth-grade classes at the school (87 students). Because students were enrolled in intact classes, each class was treated as one cluster, and two clusters (classes 6A and 6B) were selected through cluster random sampling. The two selected classes were then allocated to the experimental and control conditions by a random spin, so that treatment allocation was determined by chance and not by the preference of the researcher or the teacher. The participants were 58 sixth-grade students aged 11–12 years; each group consisted of 15 boys and 14 girls. Prior experience with volleyball varied: some students already knew the game and others did not. The research procedure is presented in Figure 1.

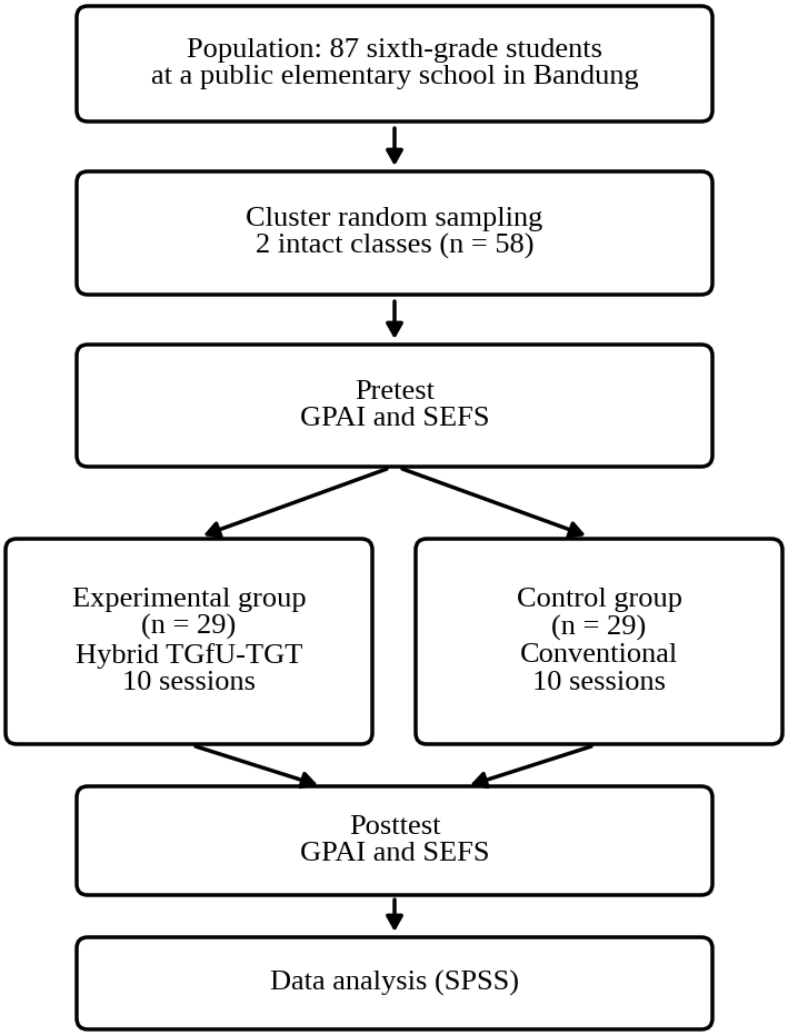


Figure 1. Research Procedure

Instruments

Learning outcomes in the psychomotor domain were measured with the Game Performance Assessment Instrument (GPAI) (Oslin et al., 1998) through direct observation while students played. The components used were limited to the three that are relevant to volleyball as a net/wall game: skill execution, decision making, and support. Each component was scored 10, 8, 6, 4, or 2 based on a rubric, and the final score was the mean of the three components (range 2–10). Assessment was conducted by a single observer (the researcher), so inter-rater reliability could not be calculated and reference is made to the coefficients reported by the instrument developers, namely 0.84–0.99 (Dewanti, G., 2023).

Evidence of validity for the GPAI comes from the instrument developers. Oslin et al. (1998) reported face validity (95% favorable ratings from undergraduate physical

education majors on the appropriateness and fairness of the instrument), content validity (consultation with a panel of six teachers/coaches, each with 10–30 years of experience, followed by revision of the component definitions), and construct validity (the GPAI differentiated students rated by their teachers as high or low in game-playing ability, most clearly in soccer and volleyball), together with inter-observer agreement coefficients of 0.84–0.99 across three studies (Mitchell, 2022; Oslin et al., 1998). The GPAI is also designed to be flexible: researchers and teachers select the performance components to be assessed, the criteria are based on what has been taught, and a rubric format is used for most net/wall games (Mitchell, 2022). In line with this, the present study limited the assessment to three components relevant to volleyball (skill execution, decision making, and support), matched the criteria to the content taught in the ten treatment meetings, and scored each component on the 10, 8, 6, 4, and 2 rubric. No separate expert validation of the adapted rubric was conducted in this study, and this is noted as a limitation.

Executive function was measured with the Short Executive Function Scale (SEFS), which consists of 15 self-report items covering five constructs (planning, inhibition, working memory, shifting, and emotional control; three items each), with a four-point scale (scores of 0–3 per item), so that the total score ranges from 0 to 45 (Karr, 2024). The developer's psychometric evaluation in a sample of university students (N = 717) showed good model fit (CFI = 0.941; RMSEA = 0.079), omega coefficients of 0.68–0.81, and ICCs of 0.75–0.89 (Karr, 2024). The wording of the items was adapted for elementary school students, while its reliability and validity refer to the developer's evaluation and have not been re-tested in the sample of this study. To make the wording suitable for elementary school students, the adapted items were reviewed by a language lecturer, who checked that the language matched the comprehension level of sixth-grade students. This review concerned wording only and was not a psychometric test.

Treatment

Both groups underwent 12 meetings: one pretest meeting, 10 treatment meetings, and one posttest meeting, each lasting 2 lesson periods (2 × 40 minutes). The material was arranged progressively from underhand passing, overhead passing, underhand serving, simple smash, and simple blocking to combined techniques, and finally mini volleyball games and a final tournament. The syntax of the hybrid TGfU-TGT model in the experimental group combined the stages of TGfU and TGT: an initial game with class presentation, game appreciation with team learning (5–6 students), tactical awareness

through small-group games, decision-making through inter-team tournaments, skill execution through two-station drills, and performance with team recognition. In meetings 1–9, matches were played 3 versus 3 on a small court with a low net. The control group received teacher explanation and demonstration, repetitive technique drills, and games at the end of the lesson, with equivalent material and time allocation.

Data Analysis

The analysis was conducted using SPSS with a significance level of 0.05. Normality was tested with the Shapiro-Wilk test, homogeneity with Levene's Test, and pretest equivalence with an independent-samples t-test or the Mann-Whitney U test. When parametric assumptions were met, hypotheses were tested with paired- and independent-samples t-tests; otherwise, the Wilcoxon Signed-Rank Test and the Mann-Whitney U test were used. Because the groups were not equivalent on the GPAI pretest, improvement between groups was compared using N-Gain = (posttest − pretest) ÷ (maximum score − pretest), with the categories high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), and low ($g < 0.3$) (Nissen et al., 2018). N-Gain was not calculated for the SEFS because both groups were equivalent on the pretest. Effect size was calculated as $r = Z \div \sqrt{N}$ for the Wilcoxon test (0.1 small; 0.3 medium; 0.5 large) (Peres, 2026) and Cohen's d for the t-tests. Learning outcomes and executive function were analyzed separately.

RESULTS AND DISCUSSION

Results

Descriptive Statistics

Table 1 and Figure 2 show that the GPAI score of the experimental group increased by 2.88 points (from 3.56 to 6.44), while that of the control group increased by 1.86 points (from 4.28 to 6.14). The SEFS score of the experimental group increased by 4.62 points (from 31.07 to 35.69), while that of the control group increased by 2.59 points (from 28.48 to 31.07).

Table 1. Descriptive Statistics of Learning Outcomes (GPAI) and Executive Function (SEFS)

Variable	Group	Pretest M (SD)	Posttest M (SD)
GPAI	Experimental	3.56 (1.01)	6.44 (1.30)
	Control	4.28 (0.90)	6.14 (1.48)
SEFS	Experimental	31.07 (7.76)	35.69 (5.91)
	Control	28.48 (6.74)	31.07 (7.49)

Note: n = 29 per group; GPAI score range 2–10 and SEFS 0–45.

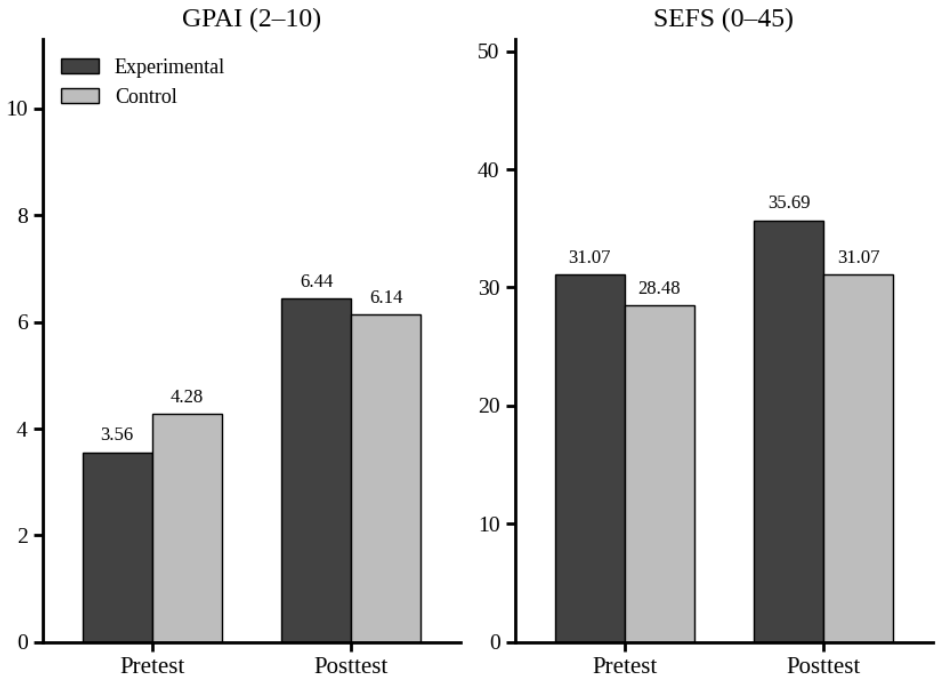


Figure 2. Mean Pretest and Posttest Scores of GPAI and SEFS

Prerequisite Tests

The results of the prerequisite tests are presented in Table 2. The GPAI data were not normally distributed in three of the four data sets and the two groups were not equivalent on the pretest, so nonparametric tests and N-Gain analysis were used. In contrast, the SEFS data were normally distributed, equivalent on the pretest, and homogeneous, thus meeting the requirements for parametric tests.

Table 2. Results of Prerequisite Tests

Test	Result	Conclusion
GPAI: normality (Shapiro-Wilk)	Pretest p = 0.045 (E), 0.010 (C); posttest p = 0.351 (E), 0.035 (C)	Not normal
GPAI: pretest equivalence (Mann-Whitney)	U = 270.000; Z = −2.410; p = 0.016	Not equivalent
SEFS: normality (Shapiro-Wilk)	Pretest p = 0.249 (E), 0.351 (C); posttest p = 0.089 (E), 0.067 (C)	Normal
SEFS: pretest equivalence (t-test)	t(56) = 1.355; p = 0.181	Equivalent
SEFS: homogeneity (Levene)	Pretest p = 0.304; posttest p = 0.273	Homogeneous

Note: E = experimental; C = control.

Learning Outcomes (GPAI)

In the experimental group, 26 of 29 students showed an increase in GPAI score, none decreased, and 3 students did not change. In the control group, 23 students increased,

1 decreased, and 5 did not change. The Wilcoxon test showed a significant improvement in both groups with large effect sizes (Table 3). However, the between-group posttest comparison was not significant (mean rank 31.34 for the experimental group and 27.66 for the control group; $p = 0.401$).

Because the control group had higher initial ability, an N-Gain analysis was conducted. The mean N-Gain of the experimental group (0.436; 43.6%) was higher than that of the control group (0.309; 30.9%), both in the medium category. The proportion of students with medium improvement in the experimental group (65.5%) was larger than in the control group (37.9%), while low improvement was less frequent (24.1% versus 51.7%); the high category was the same (10.3%). Nevertheless, the N-Gain difference was not yet significant ($p = 0.069$), with a small-to-medium effect size ($d = 0.486$). The N-Gain data were normally distributed ($p = 0.257$ and 0.127) and homogeneous (Levene $F = 2.994$; $p = 0.089$). Thus, H_0 failed to be rejected: the hybrid TGfU-TGT model has not been shown to have a significant effect on learning outcomes at $\alpha = 0.05$, although there is a positive tendency.

Table 3. Results of Hypothesis Tests for Learning Outcomes (GPAI)

Test	Statistic	p	Effect
Wilcoxon, experimental	$Z = -4.469$	< 0.001	$r = 0.830$
Wilcoxon, control	$Z = -3.968$	< 0.001	$r = 0.737$
Mann-Whitney, posttest	$U = 367.000$; $Z = -0.840$	0.401	–
t-test, N-Gain	$t(56) = 1.852$	0.069	$d = 0.486$

Note: r = Wilcoxon effect size (classified as large); d = Cohen's d (small to medium).

Executive Function (SEFS)

The paired-samples t-test showed a significant increase in SEFS scores in both groups, with a larger mean difference in the experimental group (4.621 points) than in the control group (2.586 points) (Table 4). Because both groups were equivalent on the pretest, the posttests were compared directly. The posttest score of the experimental group (35.69) was significantly higher than that of the control group (31.07), $t(56) = 2.608$; $p = 0.012$, with a medium-to-large effect size ($d = 0.685$). Thus, H_01 was rejected and Ha1 was accepted.

Table 4. Results of Hypothesis Tests for Executive Function (SEFS)

Test	Statistic	p	Effect
Paired t-test, experimental	t(28) = −2.839	0.008	d = 0.527
Paired t-test, control	t(28) = −2.199	0.036	d = 0.408
Independent t-test, posttest	t(56) = 2.608	0.012	d = 0.685

Note: a negative t indicates that the posttest score was higher than the pretest score.

Discussion

Both groups showed significant improvements in learning outcomes, but the hybrid TGfU-TGT model has not been shown to be superior to conventional instruction in posttest scores or N-Gain. This finding should be interpreted with caution because the experimental group started from a lower initial ability. According to (Ortiz et al., 2023), tactical understanding and decision-making in games develop gradually through repeated playing experience, so their impact on the game performance measured by the GPAI may not yet be evident within 10 meetings. However, because executive function changed significantly over the same duration, duration is not the only explanation. Other explanations include unequal initial conditions, a GPAI scale of 2–10 that is insensitive to small changes, assessment by a single observer, and a limited sample size. The significant improvement in both groups is consistent with (Asmarita, 2023), who reported improved volleyball underhand passing learning outcomes through TGfU among junior high school students in a classroom action research design, and (Pramuji et al., 2026), who found that TGfU and TGT significantly affected psychomotor learning outcomes, so that game-based volleyball instruction, whether hybrid or conventional, has the potential to improve game performance. (Gil-arias et al., 2020) also showed that the benefits of models based on game understanding are not always visible in skill achievement alone.

The non-significant GPAI results should be read as inconclusive rather than as evidence that the hybrid model has no effect. First, the mean N-Gain of the experimental group was 0.127 higher than that of the control group (0.436 versus 0.309), with a 95% confidence interval of −0.010 to 0.264; this interval barely includes zero and is compatible with anything from no difference to a meaningful advantage, and the observed effect size (d = 0.486) is small to medium. Second, the study had limited statistical power: with 29 students per group, a two-tailed independent-samples t-test at $\alpha = 0.05$ reaches 80% power only for effects of about d = 0.75 or larger, and about 68 students per group would be needed to detect an effect the size of the one observed. Third, the experimental

group started from a lower GPAI level (3.56 versus 4.28) yet ended with a slightly higher posttest mean (6.44 versus 6.14), so it had to close an initial gap before any additional benefit could appear in posttest scores. Fourth, the contrast between conditions was narrowed because the control group also played games at the end of each lesson and received equivalent material and time. Taken together, the GPAI findings indicate a positive but statistically inconclusive tendency that needs to be confirmed in a larger, adequately powered study with groups that are equivalent at baseline or with covariance analysis (ANCOVA), and they do not justify a conclusion that the two models are equally effective.

For executive function, the experimental group achieved significantly higher posttest scores with a medium-to-large effect. Equivalence on the pretest strengthens, but does not by itself establish, attribution of this result to the treatment, for the reasons discussed below. This finding is in line with (Salinas-gallardo et al., 2025), who explained that inhibition, working memory, and cognitive flexibility can be trained through activities that demand quick and adaptive decisions. The structure of TGfU, which places students in real game situations, combined with the team competition in TGT, requires students to read situations, weigh alternative actions, and control impulsive responses, thereby providing greater cognitive stimulation than repetitive technique drills. This result is also consistent with (Kolovelonis et al., 2023), who reported that cognitively engaging physical activity in elementary school PJOK improved cognitive flexibility and total executive function scores, and with (Altamimi et al., 2025), who showed that physical activity helps improve the concentration and attention of elementary school students. The control group also improved significantly, so part of the experimental group's improvement was probably influenced by student maturation, the effect of repeatedly completing the questionnaire, and the volleyball activity itself.

The significant SEFS result should also be interpreted in light of alternative explanations. First, the SEFS is a self-report measure, and students in the experimental class knew they were taking part in a new learning model, so expectancy and social desirability may have raised their self-ratings; blinding was not possible in this type of intervention. Second, the team, tournament, and recognition elements of TGT may increase motivation, engagement, and perceived competence, which can raise self-rated planning and self-control without a corresponding change in executive performance on tasks. Third, only one intact class was allocated to each condition, so the treatment is

confounded with class-level factors such as classroom climate, the homeroom teacher, and the daily schedule, and pretest equivalence ($p = 0.181$) cannot rule these out; the experimental class was also numerically higher at baseline (31.07 versus 28.48). Fourth, the SEFS wording was adapted for children and its psychometric properties were not re-tested in this sample, so the scores may not measure the same construct as in the original university sample. Fifth, the estimate is imprecise: the 95% confidence interval of the posttest difference (4.62 points) ranged from 1.07 to 8.17 points. Therefore, these findings suggest a potential benefit of the hybrid model for executive function, but they do not establish that it was caused by changes in executive function itself.

Theoretically, the two variables are related: the decision-making component of the GPAI requires choosing actions based on the positions of teammates, opponents, and the game situation, in line with planning and attentional shifting in executive function. However, this study did not analyze the relationship between GPAI and SEFS scores, so this link remains conjectural. Practically, PJOK teachers can consider implementing the hybrid TGfU-TGT model gradually as an alternative for volleyball instruction that is oriented not only toward motor skills but also toward developing students' cognitive function, while paying attention to the equivalence of the groups' initial abilities.

This study has several limitations. Learning outcomes were limited to the psychomotor domain, so the cognitive and affective domains were not covered. The groups were not equivalent on the GPAI pretest because intact classes were used, so differences in posttest and N-Gain cannot be fully attributed to the treatment. Executive function was measured with a self-report instrument developed on a sample of university students and not re-tested in the sample of this study, so the scores reflect students' perceptions and are not necessarily equivalent to performance on task-based tests. The GPAI assessment was conducted by a single observer, and the 10-meeting quasi-experiment at a single school limits the generalizability of the findings. In addition, the adapted GPAI rubric was not validated separately by experts, only one class was allocated to each condition, so treatment effects cannot be separated from class-level differences, and the sample of 29 students per group provided 80% power only for effects of about $d = 0.75$ or larger.

CONCLUSION

The hybrid TGfU-TGT model through volleyball has not been shown to have a significant effect on the learning outcomes (game performance) of elementary school students compared with conventional instruction (posttest $p = 0.401$; N-Gain $p = 0.069$), although both groups improved significantly from pretest to posttest ($p < 0.001$) and the experimental group showed a tendency toward better improvement, whereas for executive function the model had a significant effect with a medium-to-large effect size ($p = 0.012$; $d = 0.685$). These results indicate that the hybrid TGfU-TGT model has the potential to be an alternative for volleyball instruction that supports the development of students' cognitive function. This conclusion should be interpreted with caution because executive function was measured through self-report, the groups were not equivalent on the learning outcome pretest, and the GPAI assessment was conducted by a single observer. Future research is advised to use groups that are equivalent at baseline (or analysis of covariance/ANCOVA), a longer intervention duration, more than one GPAI observer, task-based measurement of executive function in addition to self-report, and a direct analysis of the relationship between learning outcomes and executive function. The non-significant GPAI result should be read as inconclusive rather than as evidence of no effect, because the study was not powered to detect effects smaller than about $d = 0.75$.

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