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Impact of Brainstorming-Driven Bounded Spaces Method on Developing Certain Creative Kinesthetic Abilities in Intermediate School Students

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ABSTRACT
Backgroud: Traditional physical education instruction in soccer frequently relies on decontextualized command drills that detach motor execution from perceptual problem-solving. This study investigates the pedagogical impact of an 8-unit brainstorming-driven small-sided games curriculum (bounded spaces method) on developing fundamental soccer skills (ball control, slalom dribbling, and target shooting accuracy) and motor decision-making among male intermediate school students.
Methods: A quasi-experimental non-equivalent control group pre-test/post-test design was conducted with 30 male second-intermediate students (aged 13–14 years) at Al-Haritha High School for Outstanding Students in Basra, Iraq, during the 2023–2024 academic year. Participants were assigned to an experimental group (n = 15, instructed via brainstorming-driven small-sided games across 4 weeks, 2 sessions/week, 45 min/session) or a control group (n = 15, instructed via conventional direct command drills). Skill batteries demonstrated high test-retest reliability (r = 0.86–0.89). Data were evaluated using paired and independent t-tests (df = 14 and df = 28), 95% confidence intervals, and effect size calculations (Cohen's d and Hedges' g).
Results: While pre-test baseline measures confirmed group equivalence ($p > 0.80$), post-test evaluations demonstrated statistically significant superiority for the experimental group across all technical measures: ball control (mean = 8.933 vs. 7.733 points, $t = 2.369$, $p = 0.025$, Cohen's $d = 0.866$, 95% CI [0.163, 2.237]), dribbling agility time (mean = 12.951 s vs. 14.289 s, $t = 3.229$, $p = 0.003$, Cohen's $d = -1.180$, 95% CI [-2.187, -0.489]), and shooting accuracy (mean = 9.066 vs. 7.866 points, $t = 2.662$, $p = 0.013$, Cohen's $d = 0.973$, 95% CI [0.277, 2.123]).
Conclusions: Brainstorming-driven small-sided games structure spatial task constraints that stimulate perceptual-motor exploration, rapid decision-making, and functional technical execution under representative match pressure. Transitioning from repetitive command drills to constraint-led small-sided games provides physical education teachers with an effective, low-cost methodology to advance youth athletic competencies.

Keywords: Small-Sided Games; Brainstorming Method; Ecological Dynamics; Nonlinear Pedagogy; Fundamental Soccer Skills; Physical Education.

INTRODUCTION

Physical education curriculums in secondary schools serve as foundational platforms for developing fundamental motor competencies, tactical literacy, and long-term athletic engagement. Within school sports programs across Iraq, soccer remains the most popular team sport, offering rich opportunities to cultivate technical proficiency and collaborative problem-solving among adolescent students (Basra Education Directorate, 2023). However, conventional

instructional practices in Iraqi physical education continue to rely predominantly on direct command methodologies. In these traditional classes, teachers prescribe rigid movement patterns, organizing students into static lines to perform repetitive drills such as passing between static cones or shooting against an uncontested goal. While direct instruction provides high teacher control, it detaches motor execution from dynamic perceptual cues, producing rigid technical habits that collapse when students encounter active defensive pressure in real match play (Chow et al., 2016; Renshaw & Chow, 2019).

To overcome the limitations of decontextualized instruction, modern sports pedagogy has embraced the ecological dynamics framework and nonlinear pedagogy (Davids et al., 2013; Renshaw et al., 2019). Under ecological dynamics, motor skill acquisition is not viewed as the mental rehearsal of an idealized technical template stored in the brain. Instead, skilled movement emerges through continuous interactions between the learner, the physical environment, and specific task constraints. Manipulating spatial task constraints specifically through the method of bounded spaces or small-sided games (SSGs) fundamentally alters player affordances. When playing areas are restricted (e.g., 15m x 15m or 20m x 20m) and player numbers are reduced (3v3 or 4v4), spatial-temporal pressure escalates dramatically. Students experience frequent ball touches, face immediate defensive challenges, and must continuously attune their visual perception to emerging passing lanes and open shooting spaces (Práxedes et al., 2018; Clemente et al., 2021).

Integrating a brainstorming methodology within small-sided game design introduces a powerful cognitive dimension to physical education. Originally conceptualized by Osborn (1953) and extended to motor learning by Torrance (1966) and Wyrick (1968), brainstorming in physical education shifts the student's role from a passive imitator to an active problem-solver. Before and during bounded game play, the physical education teacher presents open tactical questions (e.g., 'How can your team create space when defenders pack the center?' or 'What first-touch direction opens an immediate shooting angle?'). This instructional dialogue stimulates divergent thinking and tactical curiosity (Memmert, 2015). Students brainstorm alternative movement responses, test them in real-time play, and adapt their technical actions based on immediate environmental feedback. Consequently, motor creativity and fundamental technical mastery develop simultaneously as functional adaptations to spatial constraints.

Although extensive sport science literature has examined small-sided games among elite youth academies in Europe and Latin America (Castillo et al., 2021; Sarmento et al., 2018), empirical research investigating structured small-sided game interventions in Middle Eastern secondary school physical education remains scarce. In Iraq, physical education teachers frequently face constrained school yards, limited equipment, and large class cohorts, making full-pitch tactical practice impractical. Bounded small-sided games provide a practical, resource-efficient pedagogical alternative. By dividing a standard school yard into multiple restricted mini-pitches, teachers maximize active participation and technical repetition without requiring costly sports infrastructure.

To provide empirical evidence for this pedagogical transition, this study evaluates the impact of an 8-unit curriculum combining brainstorming prompts with bounded small-sided games on fundamental soccer skills (ball control, dribbling agility, and shooting accuracy) among second-intermediate students at Al-Haritha High School for Outstanding Students in Basra Governorate. The study tests two directional hypotheses: (1) H1: There are statistically significant differences between pre-test and post-test scores within both the experimental group and the control group across ball control, dribbling, and shooting skills; and (2) H2: The experimental group instructed via brainstorming-driven small-sided games demonstrates statistically significant superiority over the control group instructed via traditional command drills in post-test technical scores, characterized by large effect sizes (Cohen's d >= 0.80).

METHODS

Research Design and Methodological Classification

The study employed a quasi-experimental non-equivalent control group pre-test/post-test design. True random assignment of individual students was impossible without disrupting formal school administration and scheduled academic timetables. Consequently, intact classroom sections were randomly assigned to conditions: Section B served as the experimental group, while Section A served as the control group. While acknowledging the methodological limitations of non-randomized sampling, baseline homogeneity across physiological attributes and technical skill levels was empirically verified prior to the intervention (Thomas et al., 2015).

Participants and Context

The study was conducted at Al-Haritha High School for Outstanding Students, affiliated with the Basra Education Directorate, Iraq, during the first semester of the 2023–2024 academic year. The participant cohort comprised 30 male second-intermediate students (aged 13.4 +- 0.5 years; body height: 156.2 +- 4.8 cm; body mass: 48.6 +- 5.1 kg). Fifteen students in Section B constituted the experimental group (instructed via brainstorming-driven small-sided games), while fifteen students in Section A formed the control group (instructed via traditional command instruction). All students were medically cleared for vigorous physical activity and had no formal training in competitive soccer clubs outside regular school physical education.

Curricular Intervention Parameters (The 8 Learning Units)

The instructional intervention spanned 4 consecutive weeks from October 15 to November 12, 2023, comprising exactly 8 educational units (2 sessions per week: Sundays and Tuesdays, 45 minutes per session). Table 5 details the structural framework of the curriculum. Both groups followed the standardized 45-minute lesson duration mandated by the Iraqi Ministry of Education, divided into three distinct phases:

1. Preparatory Phase (10 minutes): Identical for both groups, consisting of 2 minutes of attendance and athletic greeting, followed by 8 minutes of general dynamic warm-up, joint mobilization, and light aerobic running.
2. Main Educational Phase (30 minutes): The instructional divergence occurred exclusively in this phase. The experimental group engaged in brainstorming-driven small-sided games within marked bounded spaces. Pitch boundaries were restricted to 15m x 15m (for 3v3 games) and 20m x 20m (for 4v4 games) using mini-goals. Each unit began with a 3-minute tactical brainstorming session where the teacher posed targeted problem-solving questions (e.g., 'How can we maintain possession when marked tightly in a 15-meter zone?' or 'What passing angle destabilizes a compact defense?'). Students actively discussed options, agreed on team strategies, and immediately tested their ideas under spatial constraints. Play was continuous, with mini-balls restarted rapidly to maximize ball contacts and active movement intensity. The teacher acted as a facilitator, using guided discovery rather than corrective commands. In contrast, the control group followed the traditional command instructional method across unconstrained pitch space. Instruction was entirely teacher-directed: the instructor demonstrated an isolated movement (e.g., instep pass or cone dribble), provided verbal commands, and directed students to execute decontextualized, repetitive drills in static pairs or single-file lines without defenders or spatial restrictions. No brainstorming or tactical problem-solving questions were applied.
3. Concluding Phase (5 minutes): Identical for both groups, involving calm-down walking, static stretching, and brief reflective dismissal.

Measurement Instruments and Test Reliability

Three standardized, sport-specific skill batteries were administered during pre-test and post-test sessions under identical environmental conditions on the outdoor school soccer pitch:

1. Ball Control Test: Evaluated first-touch control stability and ball mastery. Students received a rebounded ball delivered from a standardized kick board at an 8-meter distance and controlled the ball inside a marked 2m x 2m target zone. Successful control inside the zone without secondary bobbles was scored on a 10-point scale across 5 attempts (Ali, 2011). Test-retest reliability across a 7-day interval yielded $r = 0.88$.

2. Slalom Dribbling Test: Measured technical dribbling speed, agility, and foot-eye coordination. Students dribbled a soccer ball through 5 agility cones placed in a straight line spaced 2 meters apart over a total distance of 15 meters, executed as fast as possible. The completion time was recorded in seconds using an electronic digital stopwatch (precision: 0.01 s). Lower completion times indicated superior dribbling performance. Test-retest reliability was r = 0.86.
3. Target Shooting Accuracy Test: Assessed kicking technique and shooting accuracy under distance. Students took 5 shots with their dominant foot from a stationary ball placed at a 16-meter distance toward a regulation goal divided into designated scoring zones (corners = 3 points, side areas = 2 points, center area = 1 point, off-target = 0 points; maximum possible score = 15 points) (Hassanein, 2003). Test-retest reliability yielded r = 0.89.

Statistical Procedures

Statistical processing was conducted using IBM SPSS Statistics (Version 26). The analytical protocol included: (1) descriptive statistics (means, standard deviations, standard errors); (2) independent-samples t-tests to verify pre-test baseline equivalence between groups (df = 28); (3) paired-samples t-tests to evaluate within-group skill development from pre-test to post-test (df = 14); (4) independent-samples t-tests to evaluate between-group post-test performance differences (df = 28); (5) 95% confidence intervals (95% CI) for mean differences; and (6) standardized effect size calculations using Cohen's d and Hedges' g with small-sample correction (Cohen, 1988; Hedges & Olkin, 1985). Effect sizes were interpreted according to standard conventions: small (d = 0.20), medium (d = 0.50), and large (d >= 0.80).

RESEARCH RESULTS

Pre-Test Baseline Equivalence

To ensure internal validity, pre-test measurements were compared between the experimental and control groups using independent-samples t-tests (Table 1). Across all three variables, differences were minimal and statistically non-significant (p > 0.80, df = 28), confirming baseline homogeneity between the two cohorts prior to instructional intervention.

Table 1. Baseline Pre-Test Equivalence Between Experimental and Control Groups

Skill Variables	Unit	Exp Group (n=15)	Exp SD	Ctrl Group (n=15)	Ctrl SD	t-value (df=28)	p-value	95% CI of Difference
Ball Control	Points	3.333	1.632	3.200	1.656	0.222	0.826	[-1.096, 1.362]
Slalom Dribbling	Seconds	15.872	1.753	15.728	1.646	0.232	0.818	[-1.127, 1.415]
Target Shooting	Points	3.600	1.723	3.733	1.667	0.215	0.831	[-1.401, 1.135]

** Note: N = 30, df = 28. Critical tabular t at alpha = 0.05 is 2.048. All baseline differences are statistically non-significant (p > 0.05).*

Within-Group Skill Development (Hypothesis 1)

Paired-samples t-tests evaluated pre- to post-test improvements within each group. As detailed in Table 2, the experimental group achieved statistically significant gains across all technical skills (p < 0.001, df = 14), with exceptionally large effect sizes. Ball control improved by 5.600 points (t = 19.344, p < 0.001, dz = 5.00), slalom dribbling time decreased by 2.921 seconds (t = 6.486, p < 0.001, dz = 1.67), and target shooting accuracy rose by 5.466 points (t = 15.043, p < 0.001, dz = 3.88).

Table 2. Within-Group Skill Development for Experimental Group (Pre-Test vs. Post-Test)

Skill Variables	Pre Mean	Pre SD	Post Mean	Post SD	Mean Diff	t-value (df=14)	p-value	Cohen's dz
Ball Control (Points)	3.333	1.632	8.933	1.279	+5.600	19.344	< 0.001	5.00

Slalom Dribbling (Seconds)	15.872	1.753	12.951	0.554	-2.921	6.486	< 0.001	1.67
Target Shooting (Points)	3.600	1.723	9.066	1.032	+5.466	15.043	< 0.001	3.88

** Note: n = 15, df = 14. Critical tabular t at alpha = 0.05 is 2.145. For dribbling, negative mean difference denotes faster completion time.*

The control group also displayed statistically significant pre- to post-test progress (Table 3), confirming that conventional command drills produce motor gains: ball control gained 4.533 points ($t = 14.789$, $p < 0.001$, $dz = 3.82$), dribbling time dropped by 1.439 seconds ($t = 3.620$, $p = 0.003$, $dz = 0.93$), and shooting accuracy rose by 4.133 points ($t = 17.486$, $p < 0.001$, $dz = 4.51$). These results support Hypothesis 1.

Table 3. Within-Group Skill Development for Control Group (Pre-Test vs. Post-Test)

Skill Variables	Pre Mean	Pre SD	Post Mean	Post SD	Mean Diff	t-value (df=14)	p-value	Cohen's dz
Ball Control (Points)	3.200	1.656	7.733	1.486	+4.533	14.789	< 0.001	3.82
Slalom Dribbling (Seconds)	15.728	1.646	14.289	1.505	-1.439	3.620	0.003	0.93
Target Shooting (Points)	3.733	1.667	7.866	1.407	+4.133	17.486	< 0.001	4.51

** Note: n = 15, df = 14. Critical tabular t at alpha = 0.05 is 2.145.*

Between-Group Post-Test Comparison (Hypothesis 2)

To test Hypothesis 2, post-test performances were compared using independent-samples t-tests, accompanied by 95% confidence intervals, Cohen's d, and Hedges' g (Table 4). The experimental group demonstrated statistically significant superiority over the control group across all three skills ($p < 0.05$, $df = 28$), fully supporting Hypothesis 2.

Table 4. Post-Test Comparison Between Experimental and Control Groups

Skill Variables	Exp Post (M)	Exp SD	Ctrl Post (M)	Ctrl SD	Mean Diff	t-value (df=28)	p-value	95% CI of Diff	Hedges' g
Ball Control (Points)	8.933	1.279	7.733	1.486	+1.200	2.369	0.025	[0.163, 2.237]	0.842
Slalom Dribbling (Seconds)	12.951	0.554	14.289	1.505	-1.338	3.229	0.003	[-2.187, -0.489]	-1.148
Target Shooting (Points)	9.066	1.032	7.866	1.407	+1.200	2.662	0.013	[0.277, 2.123]	0.946

** Note: N = 30, df = 28. Critical tabular t at alpha = 0.05 is 2.048. Large effect sizes confirmed across all three skills (Hedges' g > 0.80).*

For ball control, the experimental group outperformed the control group by an average of 1.200 points ($t = 2.369$, $p = 0.025$, Hedges' $g = 0.842$, 95% CI [0.163, 2.237]). In slalom dribbling, experimental students were 1.338 seconds faster ($t = 3.229$, $p = 0.003$, Hedges' $g = -1.148$, 95% CI [-2.187, -0.489]). In target shooting accuracy, the experimental group achieved a 1.200-point advantage ($t = 2.662$, $p = 0.013$, Hedges' $g = 0.946$, 95% CI [0.277, 2.123]). In summary, all three technical variables exhibited large effect sizes exceeding the 0.80 threshold, demonstrating the clear pedagogical advantage of brainstorming-driven small-sided games.

Curricular Implementation Framework

Table 5 outlines the pedagogical progression across the 8 learning units, illustrating how spatial dimensions and tactical brainstorming questions were manipulated to promote motor problem-solving.

Table 5. Structural Progression of the 8-Unit Brainstorming-Driven Small-Sided Game Curriculum

Unit No. & Focus	Game Format	Spatial Constraints	Core Brainstorming Prompt	Tactical & Motor Objective
Units 1–2: Ball Control & First Touch	3v3 Possession Game	15m x 15m Bounded Pitch	How do we adjust body posture to cushion the ball away from an approaching marker?	Soft first touch into open space under immediate defensive pressing.
Units 3–4: Slalom Dribbling & Agility	3v3 + 1 Neutral Player	18m x 18m Bounded Pitch	When should you accelerate through a tight channel versus shielding the ball?	Close multi-surface ball manipulation and rapid directional changes.
Units 5–6: Target Shooting Under Pressure	4v4 with Mini-Goals	20m x 20m Bounded Pitch	What visual cues from the goalkeeper reveal the best angle for a low instep strike?	Rapid shooting execution within 3 seconds of entering the scoring zone.
Units 7–8: Tactical Integration	4v4 Free Play with Constraints	20m x 25m Bounded Pitch	How can off-the-ball runs create sudden scoring overloads in tight areas?	Fluid combination of control, dribble penetration, and accurate finishing.

DISCUSSION

The empirical findings provide solid evidence supporting the superiority of brainstorming-driven small-sided games over conventional direct command drills in secondary school physical education. Both instructional groups demonstrated statistically significant pre- to post-test technical gains, confirming that structured soccer practice inherently supports motor development. However, the experimental group achieved substantial, statistically significant advantages across ball control ($g = 0.842$), dribbling speed ($g = -1.148$), and shooting accuracy ($g = 0.946$). These large effect sizes confirm that manipulating spatial boundaries and embedding cognitive problem-solving prompts fundamentally transforms the motor learning process.

The substantial gain in ball control (8.933 vs. 7.733 points) is best explained through the lens of ecological dynamics and perceptual-action coupling (Davids et al., 2013). In traditional drills, students receive balls delivered at predictable velocities from static partners without active defenders. Consequently, learners develop passive receiving habits that decouple visual scanning from foot placement. In contrast, playing within a 15m x 15m bounded space creates an information-rich environment where defenders close down passing lanes rapidly. Students cannot execute delayed, two-stage control; they are compelled to attune their visual attention to opposing pressure, adjust body orientation prior to ball arrival, and cushion the ball directly into open space. As Renshaw and Chow (2019) noted, task constraints force learners to discover functional movement solutions organically, accelerating the attunement of perceptual variables to technical action.

Similarly, the marked improvement in slalom dribbling completion time (12.951 s vs. 14.289 s, an advantage of 1.338 seconds) demonstrates the value of dynamic, contested spatial constraints. Traditional slalom cone drills teach students to weave around stationary obstacles with predetermined, rhythmic touches. However, stationary cones do not tackle, intercept, or force unexpected directional shifts. In small-sided games, defensive players act as intelligent, reactive obstacles. To retain possession in tight zones, students must execute rapid decelerations, sharp changes of pace, and multi-surface foot adjustments using the inside, outside, and sole of

the foot (Práxedes et al., 2018; Castillo et al., 2021). This continuous exposure to unpredictable pressure builds functional agility and ball mastery that transfers directly to standardized agility courses.

The experimental group's superiority in shooting accuracy (9.066 vs. 7.866 points) illustrates the difference between isolated kicking drills and contextual decision-making. Conventional shooting instruction positions students at static distances with unlimited time to align their body posture toward an unguarded net. In contrast, the small-sided game curriculum required students to shoot within 2 to 3 seconds of entering the 20-meter offensive zone while navigating physical contests and tight angles. Under nonlinear pedagogy (Chow et al., 2016), executing technical skills under representative temporal pressure stabilizes motor patterns, training students to calibrate strike velocity and foot placement based on dynamic visual feedback from the target area (Oppici et al., 2018).

From an educational standpoint, the cognitive dimension introduced through tactical brainstorming acted as an instructional catalyst. Rather than passively following prescriptive commands ('pass here' or 'stand there'), experimental students engaged in structured 3-minute guided inquiry sessions before each unit. Posing open-ended problem-solving questions encouraged students to analyze spatial relationships, communicate tactical intentions, and explore unorthodox passing lanes. This active cognitive engagement aligns with Memmert's (2015) tactical creativity model: questioning broadens attentional breadth, enabling adolescent learners to identify unconventional motor solutions under match pressure. For physical education in developing regions like Basra, these findings confirm that representative small-sided games provide a pedagogically superior, resource-efficient alternative to repetitive command drills, maximizing student engagement within existing school facilities.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The empirical findings demonstrate that an 8-unit curriculum combining brainstorming prompts with bounded small-sided games produces statistically significant, large-magnitude improvements in fundamental soccer skills among male intermediate school students. Compared to traditional direct command instruction, small-sided games within restricted boundaries significantly enhance ball control efficiency (Hedges' $g = 0.842$), slalom dribbling speed (Hedges' $g = -1.148$), and target shooting accuracy (Hedges' $g = 0.946$). Manipulating spatial boundaries and engaging students in tactical problem-solving establishes functional perceptual-action coupling, encouraging agile decision-making and creative technical execution under representative game conditions.

Recommendations

Based on these empirical outcomes, five applied recommendations are formulated for physical education practice:

1. Curricular Modernization in Secondary Physical Education: The Ministry of Education and regional education directorates should formally integrate constraint-led small-sided games into secondary school physical education curriculums, reducing reliance on isolated, static drill practices.
2. Embedding Cognitive Brainstorming in Motor Instruction: Physical education teachers should incorporate 3- to 5-minute guided inquiry and tactical brainstorming sessions prior to gameplay, prompting students to formulate divergent strategic solutions before executing motor skills.
3. Progressive Spatial Constraint Manipulation: Teachers should systematically scale pitch dimensions (from 15m x 15m to 20m x 25m) and player ratios (3v3 to 4v4) to match students' developmental readiness, optimizing spatial-temporal pressure and ball contact frequency.
4. Teacher Professional Development Workshops: Regional physical education supervisory units should organize practical pedagogical workshops training instructors in nonlinear pedagogy, task constraint design, and formative questioning techniques.

5. Directions for Future Research: Subsequent investigations should expand empirical evaluations across female student cohorts, explore different grade levels (primary and preparatory), and examine transfer effects to other invasion sports such as basketball, handball, and futsal.

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