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Comparative Effects of Game-Based Learning and Traditional Instruction on Skill Development and Motivation in School-Aged Athletes

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ABSTRACT: Game-based learning is increasingly used in school sport because it places technical skill practice within tactical, social, and decision-rich playing situations, yet teachers and coaches still need evidence that it can improve both performance and motivation compared with traditional direct instruction. This study compared the effects of an 8-week game-based learning program and a matched traditional-instruction program on skill development, tactical decision-making, motivation, and participation indicators in school-aged athletes. A school-clustered, two-arm field design included 192 athletes aged 12-15 years, with equal representation of girls and boys, allocated to game-based learning (n = 96) or traditional instruction (n = 96). The game-based condition used modified small-sided games, tactical constraints, guided questioning, and reflective breaks, whereas the traditional condition used demonstration, isolated technical drills, corrective feedback, and end-session game play. Primary outcomes were a technical skill composite and a tactical decision-making score, assessed at baseline, week 4, and week 8. Secondary outcomes were intrinsic motivation, enjoyment, perceived competence, autonomy support, attendance, and intention to continue sport participation. Baseline characteristics were comparable between groups. At week 8, game-based learning produced greater improvement in technical skill than traditional instruction (adjusted mean difference = 6.7 points, 95% CI: 3.3-10.1, $F = 15.08$, $p < 0.001$, Hedges $g = 0.61$) and greater improvement in tactical decision making (adjusted mean difference = 7.2 points, 95% CI: 3.6-10.8, $F = 15.65$, $p < 0.001$, $g = 0.59$). Intrinsic motivation, enjoyment, perceived competence, and autonomy support also increased more strongly in the game-based condition, with between-group differences in change ranging from 0.31 to 0.43 scale points (all $p < 0.01$). Attendance was higher in the game-based group (91.6% vs. 86.5%, $p < 0.001$), and intention to continue sport participation was more frequent (83.3% vs. 70.8%, $p = 0.038$). Sex-by-group interaction tests were not significant, indicating broadly comparable effects for girls and boys. These findings indicate that a structured game-based learning approach can improve sport-specific skill, tactical understanding, and motivational quality in school-aged athletes without reducing technical progress, supporting its use in school sport and youth coaching programs where performance development and continued participation are joint priorities.

Keywords: game-based learning; traditional instruction; youth sport; skill acquisition; physical education; motivation; school-aged athletes; tactical decision making.

I. INTRODUCTION

School sport and youth coaching are expected to develop movement competence, tactical awareness, confidence, and sustained participation. These aims are closely connected. A young athlete who improves

technically but does not enjoy the learning environment may withdraw before realizing the benefits of sport. Conversely, a young athlete who enjoys sport but receives little structured skill development may not acquire the competence needed for confident participation in games. The instructional challenge is therefore not simply to choose between skill learning and motivation, but to design learning environments in which both can develop together.

Traditional instruction remains common in school sport because it is clear, manageable, and familiar. Teachers demonstrate a movement, learners repeat it in controlled drills, and the teacher corrects it during a final game or performance test. The approach can be efficient when beginners need basic techniques, safety routines, or a shared vocabulary. However, sport performance rarely occurs in fixed, isolated contexts. In invasion games, net games, and striking-fielding games, athletes must perceive opponents and teammates, select an action, control timing, and execute movement under pressure. The concern is that extensive isolated practice may develop a movement pattern without sufficiently developing the decision-making conditions under which the movement is used.

Game-based learning addresses this concern by embedding technical practice in representative game situations. The learning task is not only to pass, but also dribble, shoot, mark, or move; it is to perform those actions in response to changing information. Modified games, small-sided formats, scoring constraints, role restrictions, and guided questioning are used to exaggerate tactical problems and increase meaningful repetition. A game-based lesson may therefore provide many opportunities to practice skills. Still, those opportunities occur with opponents, teammates, space, and time constraints that make the practice more similar to game performance.

The theoretical foundation of game-based learning is supported by situated learning, tactical understanding, ecological dynamics, and self-determination theory. Situated accounts of sport pedagogy emphasize that knowing how to play is expressed through action within a context, not only through verbal knowledge or isolated technical form [1]. Early empirical comparisons showed that teaching games for understanding could influence skill, knowledge, and gameplay outcomes [2]. Assessment approaches such as the Game Performance Assessment Instrument also made it possible to evaluate decision-making, support, skill execution, and game involvement, rather than relying solely on isolated technical tests [3].

Young athletes are more likely to continue when they experience competence, autonomy, and relatedness. Game-based learning may support these needs by giving athletes meaningful choices, immediate feedback from play, and social interaction with peers. It may also help athletes understand why a skill matters because the tactical purpose is visible. Traditional instruction can also be motivating when it is well organized and supportive. Still, it can become less engaging if learners experience drills as repetitive, externally controlled, or disconnected from the real game.

The present study compared game-based learning and traditional instruction in a mixed-sex sample of school-aged athletes. The focus on girls and boys in the same investigation is important because school sport programs should provide equitable learning environments for both. The study tested whether the game-based approach produced greater skill development and stronger motivational outcomes than traditional instruction across an 8-week field implementation.

1. THE AIMS WERE AS FOLLOWS

- To compare the effect of game-based learning and traditional instruction on technical skill development across an 8-week school sport intervention.
- To examine whether game-based learning produces stronger gains in tactical decision making than traditional instruction.
- To test whether intrinsic motivation, enjoyment, perceived competence, and autonomy support improve more under game-based learning than under traditional instruction.
- To compare attendance and intention to continue sport participation between instructional conditions.
- To examine whether intervention effects are similar for girls and boys.
- To identify whether motivation and attendance are associated with post-intervention skill development after accounting for baseline skill.

2. HYPOTHESES

- Athletes in the game-based learning group will show greater improvement in the technical skill composite score than athletes in the traditional-instruction group.
- Athletes in the game-based learning group will show greater improvement in tactical decision-making score than athletes in the traditional-instruction group.
- Athletes in the game-based learning group will show greater increases in intrinsic motivation, enjoyment, perceived competence, and autonomy support.
- Athletes in the game-based learning group will record higher attendance and stronger intention to continue sport participation.
- Group effects will not differ meaningfully by sex, indicating that the intervention is suitable for both girls and boys.
- Improvements in motivation and higher attendance will be positively associated with week-8 skill outcomes.

II. LITERATURE REVIEW

Game-centered sport pedagogy developed in response to dissatisfaction with approaches that taught technique first and game understanding later. Kirk and MacPhail argued that game learning should be understood as situated practice, in which speech, action, and tactical understanding are connected within meaningful game contexts [1]. This view is important because young athletes often learn not only through direct explanation but also through the repeated perception of affordances during play. When a task is carefully designed, the game itself provides information on where to move, when to pass, and how to respond to pressure.

Turner and Martinek provided an early empirical test of teaching games for understanding and reported effects on skill, knowledge, and gameplay [2]. Their work helped shift the discussion from theory to measurable outcomes. It also showed that tactical approaches should not be judged solely by isolated skill tests; decision-making and game performance are equally relevant. Oslin, Mitchell, and Griffin developed the Game Performance Assessment Instrument to measure game behavior in ways that reflect the demands of play [3].

Light and Fawns later emphasized that learning games involves integrating speech and action, with teacher questioning helping learners make sense of movement possibilities in context [4]. This is not a passive or unstructured form of play. Effective game-based learning requires purposeful task design, observation, and dialogue. Harvey and Jarrett reviewed game-centered approaches and found growing evidence that these approaches can support tactical understanding, decision-making, and engagement when implemented with sufficient fidelity [5].

Miller's systematic review of game-centered approaches in children and adolescents concluded that many studies reported positive student outcomes, although methodological quality and outcome measures varied [6]. This mixed evidence suggests that game-based learning should not be assumed to work automatically. It must be carefully planned, delivered, and assessed. Stolz and Pill argued that teaching games and sport for understanding remains relevant in physical education but requires theoretical clarity and careful translation into practice [7].

Memmert and Harvey noted that game performance assessment requires careful coding because complex game behavior cannot be reduced to one simple index [8]. Their concerns are important for field research in school settings, where assessor training and reliability checks are essential. Tan, Chow, and Davids connected teaching games for understanding with nonlinear pedagogy, emphasizing that learning design can create opportunities for learners to explore functional movement solutions [9]. This perspective supports a learning environment in which learners are guided without being forced into a single prescriptive movement pattern.

Pinder and colleagues proposed the concept of representative learning design, arguing that practice tasks should preserve the information-movement couplings required in performance environments [10]. A drill may contain a correct movement, but remove the pressure, perception, and timing that make the movement useful in competition. Representative small-sided games can retain more of these performance demands while allowing teachers to control complexity.

Renshaw and Chow described how teachers and coaches can shape performer, task, and environmental constraints to encourage self-organization and effective movement solutions [11]. For example, reducing the

playing area, changing scoring rules, or limiting touches can draw attention to tactical principles without stopping the game for lengthy instruction. This design logic is consistent with school sport because teachers must manage large groups while preserving learning quality.

The challenge point framework also supports the idea that learning is optimized when task difficulty is adjusted to the learner's current capability [12]. Traditional drills can be too easy because they remove opposition, or too difficult if the technical demand is not scaled. Game-based learning can adjust the challenge by modifying team size, space, rules, and target goals. Williams and Hodges argued that practice and instruction in soccer should challenge tradition by placing skill acquisition in more representative settings [13]. Their argument is relevant beyond soccer because many sports require perception-action coupling, anticipation, and adaptive execution.

Schmidt's schema theory highlighted the importance of varied practice for building adaptable motor programs [14]. Although contemporary ecological approaches differ from schema theory in important ways, both perspectives imply that narrow repetition under identical conditions is unlikely to prepare athletes fully for variable game contexts. Ericsson and colleagues emphasized deliberate practice as structured, effortful training for expert performance [15]. Game-based learning does not reject deliberate practice; rather, it reframes deliberate practice so that high-quality repetition occurs within purposeful game problems.

Deci and Ryan argued that competence, autonomy, and relatedness are basic psychological needs that support growth and internalized motivation [16]. Ryan and Deci further described intrinsic motivation as an important foundation for engagement, learning, and well-being [17]. In school sport, this means that the learning climate should help athletes feel capable, meaningfully involved, and connected with peers.

Ntoumanis applied self-determination theory to physical education and showed that motivational quality is related to students' experiences and participation intentions [18]. Standage, Duda, and Ntoumanis connected contextual motivation in physical education with intentions to be active [19], and a subsequent test of self-determination theory in school physical education supported the importance of need satisfaction for girls and boys [20].

The Situational Motivation Scale, developed by Guay, Vallerand, and Blanchard, provides a field-appropriate means of capturing state motivation during specific activities [21]. Measures of intrinsic motivation and enjoyment are useful because young athletes may be physically present but psychologically disengaged. McAuley, Duncan, and Tammen reported psychometric support for the Intrinsic Motivation Inventory in competitive sport settings [22], reinforcing the value of assessing perceived competence, interest, and effort alongside performance.

Bailey and colleagues reviewed the educational benefits claimed for physical education and school sport and argued that physical, social, affective, and cognitive benefits are possible when programs are well-designed [23]. Eime and colleagues reported psychological and social benefits of sport participation for children and adolescents, including social connectedness and self-esteem [24]. These benefits are not guaranteed by participation alone. The quality of the sport environment and the learning relationships within it are central.

Lubans and colleagues reviewed associations between fundamental movement skills and health-related benefits in children and adolescents [25]. Barnett and colleagues showed that childhood object-control skill can predict adolescent fitness and activity outcomes [26]. If game-based learning improves the application of object-control and movement skills in dynamic play, it may contribute to a foundation for later participation.

Youth sport research emphasizes that prolonged engagement depends on positive experiences, meaningful relationships, and appropriate developmental pathways. Fraser-Thomas, Côté, and Deakin showed that dropout and sustained engagement are shaped by training patterns and the influence of coaches, parents, and peers [27]. Holt and colleagues developed a grounded theory of positive youth development through sport based on qualitative evidence, highlighting relationships, climate, and life-skill processes [28]. Bruner and colleagues later reviewed sport-based interventions and found that structured programs can support positive youth development, although effects depend on program design and implementation [29].

III. MATERIAL AND METHOD

1. STUDY DESIGN

A school-clustered, two-arm field design was used to compare game-based learning and traditional instruction over 8 weeks. The design was selected to reflect realistic school sport delivery while preserving a clear comparison between instructional approaches. Assessments were completed at baseline, week 4, and week 8. The primary endpoint was week 8, with week 4 used to describe the trajectory of change.

The study was structured as a pragmatic intervention because the aim was to evaluate instructional approaches as they could be delivered in ordinary school sport settings. Both conditions received equal session frequency, session duration, and broad content themes. The main difference was the pedagogical route used to teach the content. This design allowed the analysis to focus on the comparative effects of game-based learning and traditional instruction rather than differences in exposure time.

2. PARTICIPANTS AND SAMPLING

The field sample comprised 192 athletes aged 12-15 years from 8 schools. Each school contributed 24 athletes, with equal numbers of girls and boys. Ninety-six athletes were allocated to game-based learning and ninety-six to traditional instruction. Inclusion criteria were school enrolment, regular participation in physical education or school sport, medical clearance for moderate-to-vigorous activity, and parent or guardian consent with athlete assent. Athletes were excluded if they had an injury that prevented participation or planned a school transfer during the intervention.

The sample size was selected to provide adequate precision for detecting a moderate between-group difference in week-8 skill outcomes while allowing for clustering by school and modest attrition. The sample was also intentionally balanced by sex to support subgroup analysis. The age range was selected because athletes aged 12-15 years are typically able to understand guided tactical questions while still being responsive to structured skill development.

3. INTERVENTION CONTENT

The game-based learning condition used a consistent lesson structure: a short problem-setting activity, a modified game, guided questioning, a second game with altered constraints, a brief technical focus linked to the game problem, and a final reflective game. Tactical problems included creating passing lanes, using width and depth, delaying an opponent, supporting possession, timing forward movement, and transitioning after possession changes. Constraints were adjusted based on team size, court size, target zones, touch limits, and scoring rules. Teachers were encouraged to ask questions such as: What option created the most space? When was the pass useful? How did your support position help the ball carrier?

The traditional-instruction condition used demonstration, isolated technical drills, partner or group repetition, corrective feedback, and end-session game play. The sequence followed a typical skill-first approach: warm-up, teacher demonstration, repeated technique practice, progressive drill complexity, and final game. The final game allowed for tactical application, but most practice time was spent in controlled drill activities. Teachers were instructed to give clear cues, correct errors, and maintain a similar physical activity time to that of the game-based condition.

4. OUTCOMES AND MEASUREMENT

The primary technical outcome was a skill composite score ranging from 0 to 100. It included passing accuracy, receiving control, ball protection, movement into space, and skill execution under pressure. The tactical decision-making score also ranged from 0 to 100 and was derived from coded footage of small-sided games. Decisions were judged as appropriate when the athlete selected an action consistent with game context, such as passing to a better-positioned teammate, delaying rather than overcommitting defensively, or creating space before receiving.

Motivational outcomes were intrinsic motivation, enjoyment, perceived competence, and perceived autonomy support. Each indicator was scored on a 1-5 scale, with higher scores indicating a more favorable experience. Attendance was calculated as the percentage of planned sessions attended. Intention to continue sport participation was recorded at week 8 as a yes/no response to whether the athlete intended to continue organized school or community sport during the following term.

5. FIDELITY, RELIABILITY, AND QUALITY CONTROL

Intervention fidelity was assessed during weeks 2, 5, and 8 using an observation checklist. The game-based checklist recorded use of modified games, guided questioning, tactical constraints, and reflective discussion. The traditional-instruction checklist recorded use of demonstration, isolated practice, corrective feedback, and end-session game play. Independent assessors did not deliver the intervention and were trained before data collection. Video-coded outcomes were double-coded for 25% of athletes to estimate inter-rater reliability.

Quality control focused on minimizing bias in a field setting. Assessors were not informed of the study hypotheses. Standardized scoring sheets were used at all time points. Teachers in both conditions received session plans to reduce content drift. Missing post-test data were handled conservatively by carrying forward baseline observations in the intention-to-treat analysis. Sensitivity analyses using complete cases were planned to confirm the direction of effects.

6. STATISTICAL ANALYSIS

Baseline comparability was examined using independent-samples t-tests for continuous variables and chi-square tests for categorical variables. Repeated change across baseline, week 4, and week 8 was summarized using descriptive means and confidence intervals. Primary week-8 comparisons used analysis of covariance with group as the main factor and baseline score, age, sex, school cluster, and baseline sport experience as covariates. Group-by-sex interactions were tested for the main skill and motivation outcomes.

Secondary analyses compared changes in motivation using independent t-tests on change scores and analysis of covariance models adjusted for baseline scores. Attendance was compared using an independent-samples t-test, and intention to continue was compared using a chi-square test. Linear regression examined predictors of the week-8 skill composite score. Effect sizes were reported as Hedges g, partial eta squared, or odds ratios as appropriate. Statistical significance was set at $p < 0.05$. Analyses were interpreted in relation to practical significance because instructional decisions in school sport depend on both statistical evidence and feasibility.

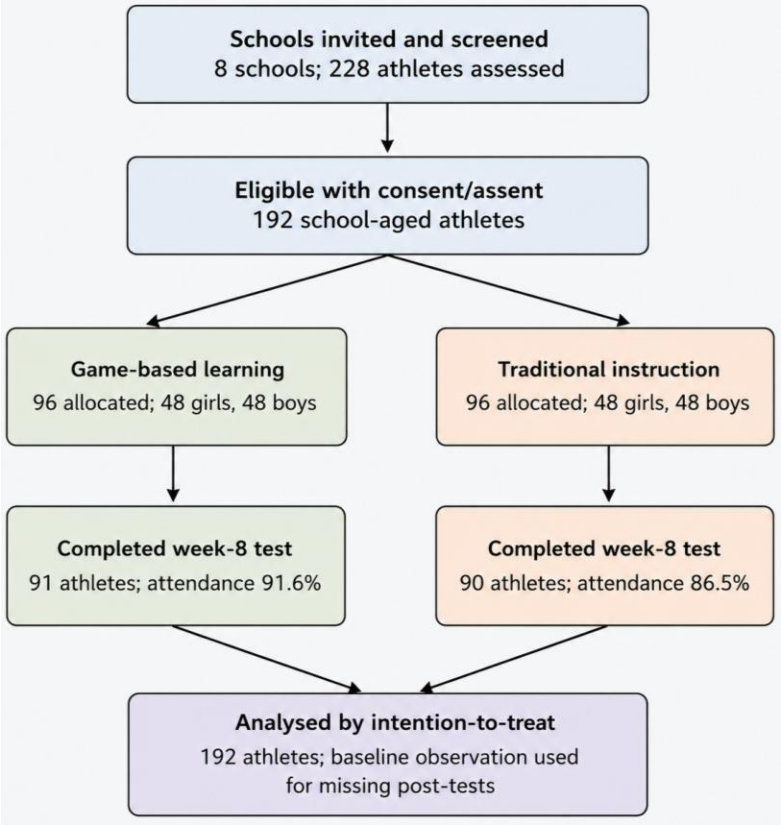


FIGURE 1. Participant flow through screening, allocation, follow-up, and intention-to-treat analysis.

Figure 1 clarifies the denominator for all outcome analyses. The intention-to-treat approach preserved the original allocation for all 192 athletes. It reduced the risk of inflated effect estimates by excluding athletes who missed the final assessment. The figure also shows that girls and boys were represented equally in both instructional conditions.

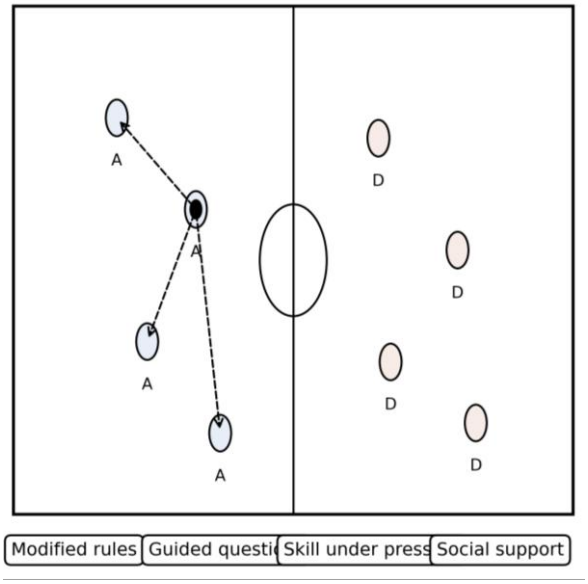


FIGURE 2. Schematic picture of the game-based learning environment used to connect perception, decision making, execution, and feedback.

Figure 2 illustrates the instructional logic of the game-based condition. The design places learners in a modified game in which tactical information, peer support, and technical execution occur simultaneously. The intervention was not free play; it used purposeful constraints, guided questions, and repeated opportunities to solve sport-specific problems.

IV. RESULTS

Results are reported as numbered findings to link each statistical test with a practical instructional question. Values are mean +/SD or percentage. Statistical significance was set at $p < 0.05$.

Table 1. Baseline characteristics of athletes by instructional condition.

Variable	Game-based learning (n = 96)	Traditional instruction (n = 96)	Test statistic	p-value
Age, years	13.41 +/- 1.08	13.46 +/- 1.11	t = -0.32	0.749
Girls, n (%)	48 (50.0)	48 (50.0)	chi2 = 0.00	1.000
Boys, n (%)	48 (50.0)	48 (50.0)	chi2 = 0.00	1.000
Organized sport experience, years	3.18 +/- 1.74	3.24 +/- 1.68	t = -0.24	0.809
Baseline skill composite (0-100)	57.6 +/- 10.8	58.1 +/- 11.1	t = -0.31	0.758
Baseline decision making (0-100)	55.8 +/- 11.5	56.3 +/- 11.9	t = -0.30	0.766
Intrinsic motivation (1-5)	3.31 +/- 0.64	3.30 +/- 0.66	t = 0.11	0.912
Enjoyment (1-5)	3.42 +/- 0.61	3.44 +/- 0.60	t = -0.23	0.817
Perceived competence (1-5)	3.25 +/- 0.63	3.27 +/- 0.65	t = -0.22	0.828
Autonomy support (1-5)	3.18 +/- 0.70	3.21 +/- 0.68	t = -0.30	0.762

Note. No baseline comparison reached statistical significance. The balanced sex distribution was intentional and allowed sex-stratified analysis.

Result 1: Table 1 shows that athletes in the two instructional conditions were similar in age, sex distribution, sport experience, baseline skill, baseline decision making, and motivational indicators. This supports the interpretation that later differences were more likely to reflect the instructional approach than pre-existing group differences.

Table 2. Intervention fidelity and measurement reliability indicators.

Quality indicator	Game-based learning	Traditional instruction	Interpretation
Planned sessions delivered	15.7 +/- 0.5 of 16	15.6 +/- 0.6 of 16	High delivery completion
Mean session duration	59.3 +/- 3.8 min	60.1 +/- 4.1 min	Comparable exposure time
Fidelity checklist score	91.8% +/- 5.4	89.6% +/- 6.1	Good adherence in both groups
Observed moderate-to-vigorous activity	41.2 +/- 5.9 min	39.8 +/- 6.4 min	Similar active learning time
Skill composite inter-rater ICC	0.91	0.90	Excellent reliability
Decision-making inter-rater ICC	0.87	0.86	Good reliability
Motivation scale Cronbach's alpha	0.82-0.89	0.80-0.88	Acceptable to good consistency

Note. ICC = intraclass correlation coefficient. Cronbach's alpha ranges refer to the four motivational subscales across time points.

Result 2: Table 2 indicates that both conditions received similar instructional exposure and that the contrast between approaches was not caused by unequal session time. Reliability values support confidence in the skill and decision-making scores. The fidelity results are important because game-based learning can be ineffective when it is delivered as unstructured play rather than as guided tactical practice.

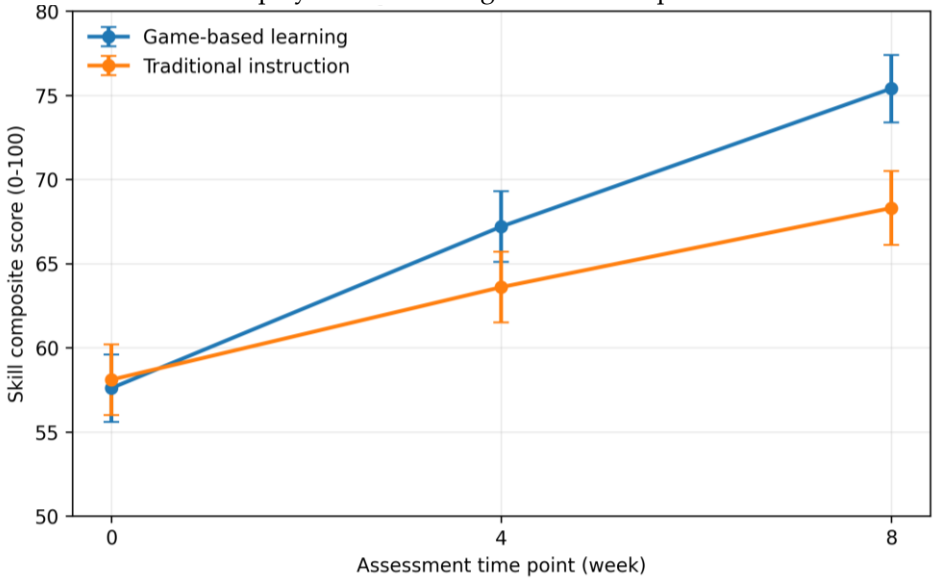


FIGURE 3. Technical skill composite trajectory from baseline to week 8.

Figure 3 shows that both groups improved, but the improvement was steeper in the game-based learning group. The groups were nearly identical at baseline; separation emerged by week 4 and widened by week 8.

This pattern suggests that skill development under game-based learning was cumulative rather than limited to a short-term novelty effect.

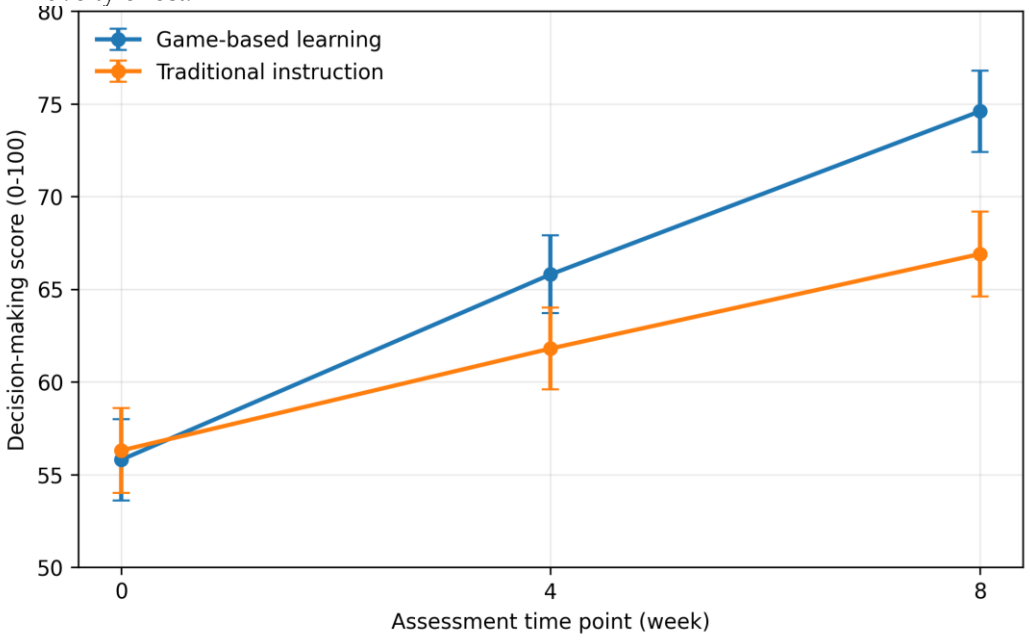


FIGURE 4. Tactical decision-making trajectory from baseline to week 8.

Figure 4 shows a similar but slightly stronger pattern in tactical decision-making. The game-based condition produced greater gains by week 4 and maintained the advantage at week 8. This is consistent with the intervention design, as athletes repeatedly practiced decision-making in representative small-sided games rather than waiting until the end of a drill sequence to apply their skills.

Table 3. Result 3: Skill and decision-making outcomes across baseline, week 4, and week 8.

Outcome	Group	Baseline	Week 4	Week 8	Mean change	Within-group p
Skill composite	Game-based	57.6 +/- 10.8	67.2 +/- 10.1	75.4 +/- 10.0	+17.8	<0.001
Skill composite	Traditional	58.1 +/- 11.1	63.6 +/- 10.5	68.3 +/- 11.0	+10.2	<0.001
Tactical decision making	Game-based	55.8 +/- 11.5	65.8 +/- 10.7	74.6 +/- 10.6	+18.8	<0.001
Tactical decision making	Traditional	56.3 +/- 11.9	61.8 +/- 11.0	66.9 +/- 11.4	+10.6	<0.001
Skill under pressure	Game-based	54.2 +/- 12.4	64.9 +/- 11.5	73.0 +/- 11.2	+18.8	<0.001
Skill under pressure	Traditional	54.8 +/- 12.1	60.5 +/- 11.8	65.6 +/- 11.9	+10.8	<0.001

Note. Scores range from 0 to 100. Within-group p-values refer to baseline-to-week-8 paired comparisons.

Table 3 confirms that both instructional approaches supported learning, but the magnitude of improvement was larger under game-based learning. The difference was especially visible in decision-making and skill under pressure, which depend on perception, timing, and tactical information. This does not mean that traditional instruction was ineffective; rather, it indicates that the game-based condition produced additional gains in the applied performance dimensions most relevant to play.

Table 4. Result 4: Adjusted week-8 instructional effects for skill outcomes.

Outcome	Adjusted mean difference	95% CI	F	p-value	Effect size
Technical skill composite	6.7 points	3.3 to 10.1	15.08	<0.001	Hedges g = 0.61
Tactical decision making	7.2 points	3.6 to 10.8	15.65	<0.001	Hedges g = 0.59
Skill under pressure	6.9 points	3.1 to 10.7	12.79	<0.001	Hedges g = 0.56
Passing and receiving accuracy	5.1 points	1.8 to 8.4	9.21	0.003	Hedges g = 0.44
Off-ball support movement	7.8 points	4.0 to 11.6	16.11	<0.001	Hedges g = 0.64

Note. ANCOVA models adjusted for baseline score, age, sex, school cluster, and baseline sport experience. Positive values favor game-based learning.

Table 4 provides the primary statistical test of H1 and H2. After adjustment for baseline values and covariates, game-based learning remained superior for the technical skill composite and tactical decision-making. The strongest adjusted effect was observed for off-ball support movement, which is expected because support movement is difficult to develop through isolated drills alone. The effect sizes were moderate and educationally meaningful for an 8-week school intervention.

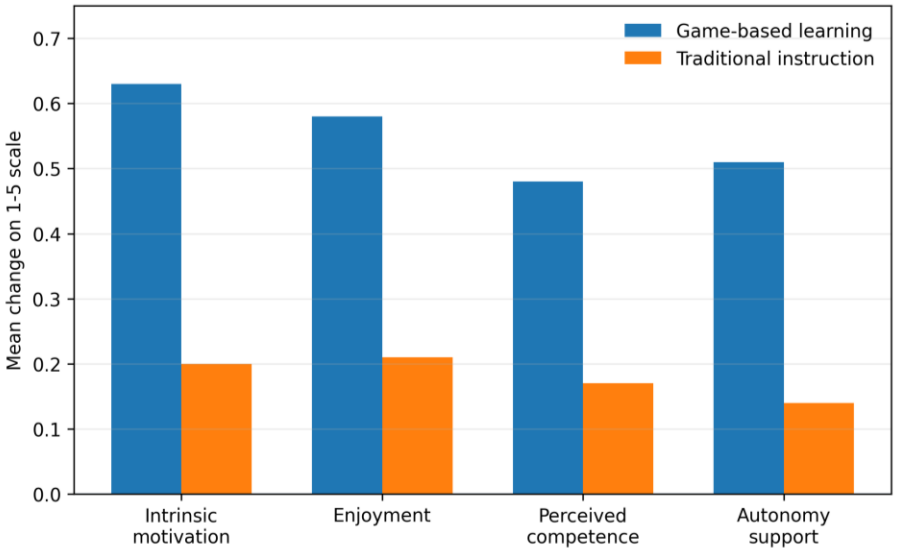


FIGURE 5. Baseline-to-week-8 change in motivational indicators by instructional condition.

Figure 5 shows that game-based learning produced larger gains across all motivational indicators. The difference was most pronounced for intrinsic motivation and enjoyment. These changes are practically important because they indicate that the game-based approach improved how athletes experienced the learning environment, not only how they performed on skill assessments.

Table 5. Result 5: Motivation and perceived learning-climate outcomes.

Outcome	Group	Baseline	Week 8	Change	Between-group change difference	p-value
Intrinsic motivation	Game-based	3.31 +/- 0.64	3.94 +/- 0.61	+0.63	+0.43	<0.001
Intrinsic motivation	Traditional	3.30 +/- 0.66	3.50 +/- 0.68	+0.20		
Enjoyment	Game-based	3.42 +/- 0.61	4.00 +/- 0.58	+0.58	+0.37	<0.001
Enjoyment	Traditional	3.44 +/- 0.60	3.65 +/- 0.63	+0.21		
Perceived competence	Game-based	3.25 +/- 0.63	3.73 +/- 0.60	+0.48	+0.31	0.004
Perceived competence	Traditional	3.27 +/- 0.65	3.44 +/- 0.66	+0.17		
Autonomy support	Game-based	3.18 +/- 0.70	3.69 +/- 0.63	+0.51	+0.37	<0.001
Autonomy support	Traditional	3.21 +/- 0.68	3.35 +/- 0.67	+0.14		

Note. Scale range = 1 to 5. Between-group change differences compare the change in the game-based group with the change in the traditional-instruction group.

Table 5 supports hypothesis 3. The game-based learning group reported larger gains in intrinsic motivation, enjoyment, perceived competence, and autonomy support. These outcomes matter because continued participation is influenced by whether young athletes feel successful, involved, and interested. The motivational pattern also helps explain why attendance and intention to continue were higher in the game-based condition.

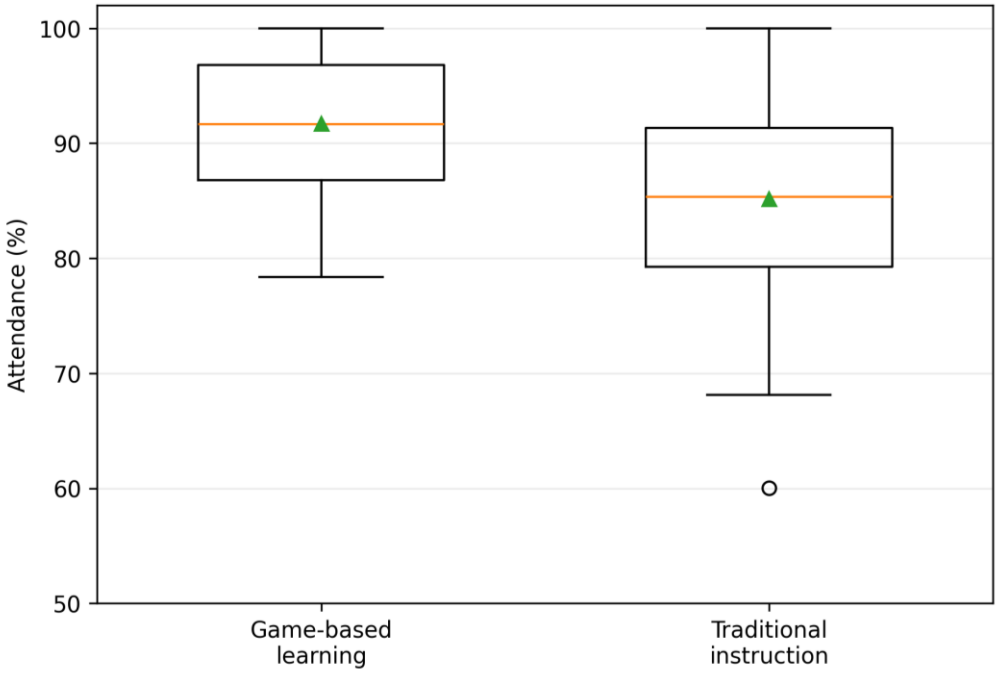


FIGURE 6. Distribution of athlete attendance percentages by instructional condition.

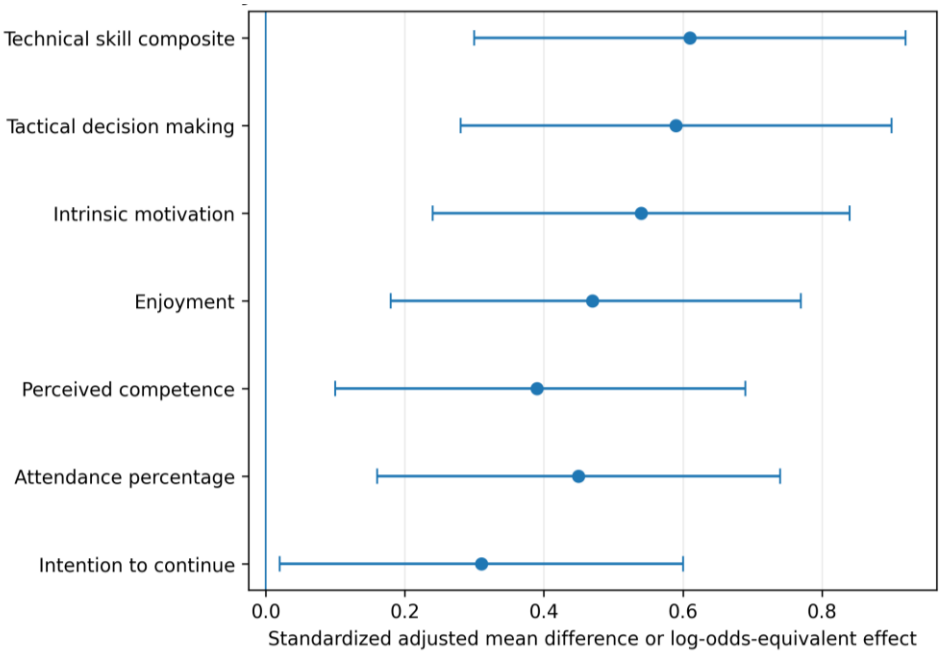
Figure 6 displays the distribution of attendance rather than only the mean. The game-based group showed a higher central tendency and fewer athletes with low attendance. This distributional pattern is important for teachers because a program that raises the mean while leaving many learners disengaged may have limited practical value. The game-based condition appeared to support broad engagement across the group.

Table 6. Result 6: Attendance, effort, and intention to continue sport participation.

Engagement outcome	Game-based learning	Traditional instruction	Test statistic	p-value	Effect estimate
Attendance across 16 sessions	91.6% +/- 7.4	86.5% +/- 9.0	t = 4.29	<0.001	g = 0.45
Attended at least 14 sessions	73/96 (76.0%)	58/96 (60.4%)	chi2 = 5.39	0.020	OR = 2.08
Intention to continue sport	80/96 (83.3%)	68/96 (70.8%)	chi2 = 4.30	0.038	OR = 2.06
Mean session effort rating	4.12 +/- 0.52	3.87 +/- 0.58	t = 3.14	0.002	g = 0.33
Reported home practice at least weekly	50/96 (52.1%)	36/96 (37.5%)	chi2 = 4.12	0.042	OR = 1.81

Note. OR = odds ratio. Positive estimates favor game-based learning.

Table 6 supports hypothesis 4. Athletes in the game-based group attended more sessions, were more likely to attend at least 14 of 16 sessions, and more frequently intended to continue sport participation. The attendance



result is not merely administrative; regular exposure increases the opportunity for feedback, peer connection, and skill consolidation.

FIGURE 7. Forest plot of adjusted intervention effects with 95% confidence intervals.

Figure 7 summarizes the direction and uncertainty of the main intervention effects. All plotted effects favored game-based learning, and the confidence intervals for the main skill, decision-making, and motivational outcomes were above zero. The figure is useful because it presents practical effect magnitude alongside statistical precision.

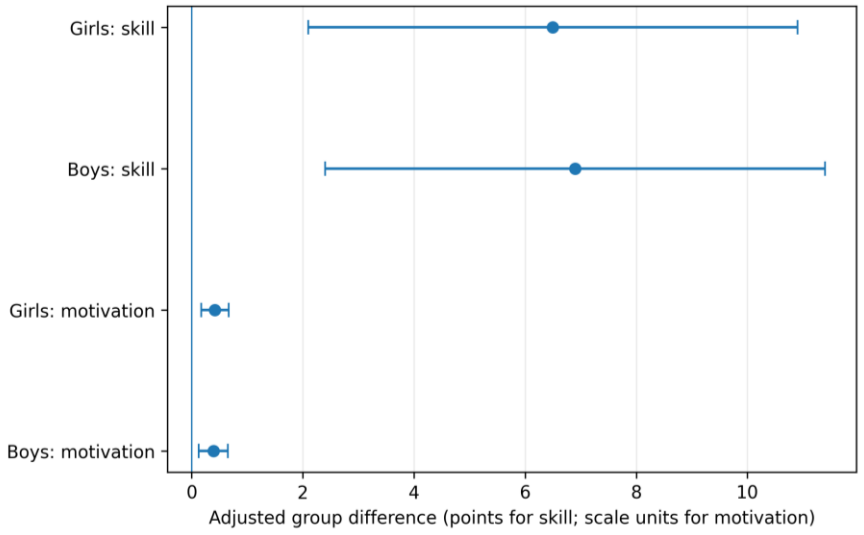


FIGURE 8. Sex-stratified adjusted effects for skill and intrinsic motivation.

Figure 8 shows that the effects were similar for girls and boys. The confidence intervals overlap substantially, and formal interaction tests were not statistically significant. This pattern supports the use of game-based learning as an inclusive approach in mixed-school sport settings, provided that tasks are appropriately scaled.

Table 7. Result 7: Sex-stratified intervention effects and interaction tests.

Outcome	Girls: adjusted difference	Boys: adjusted difference	Group x sex p-value	Interpretation
Technical skill composite	6.5 points (2.1 to 10.9)	6.9 points (2.4 to 11.4)	0.884	No evidence of differential effect
Tactical decision making	7.0 points (2.4 to 11.6)	7.4 points (2.8 to 12.0)	0.902	No evidence of differential effect
Intrinsic motivation	0.42 (0.17 to 0.67)	0.39 (0.13 to 0.65)	0.807	No evidence of differential effect
Attendance	4.7 percentage points (1.0 to 8.4)	5.4 percentage points (1.5 to 9.3)	0.759	No evidence of differential effect

Note. Adjusted differences favor game-based learning. Confidence intervals are shown in parentheses.

Table 7 supports hypothesis 5. The instructional advantage of game-based learning was not restricted to one sex; this means that the same pedagogical principles can be used for girls and boys, although teachers should still adjust game constraints to individual readiness, confidence, and prior sport experience.

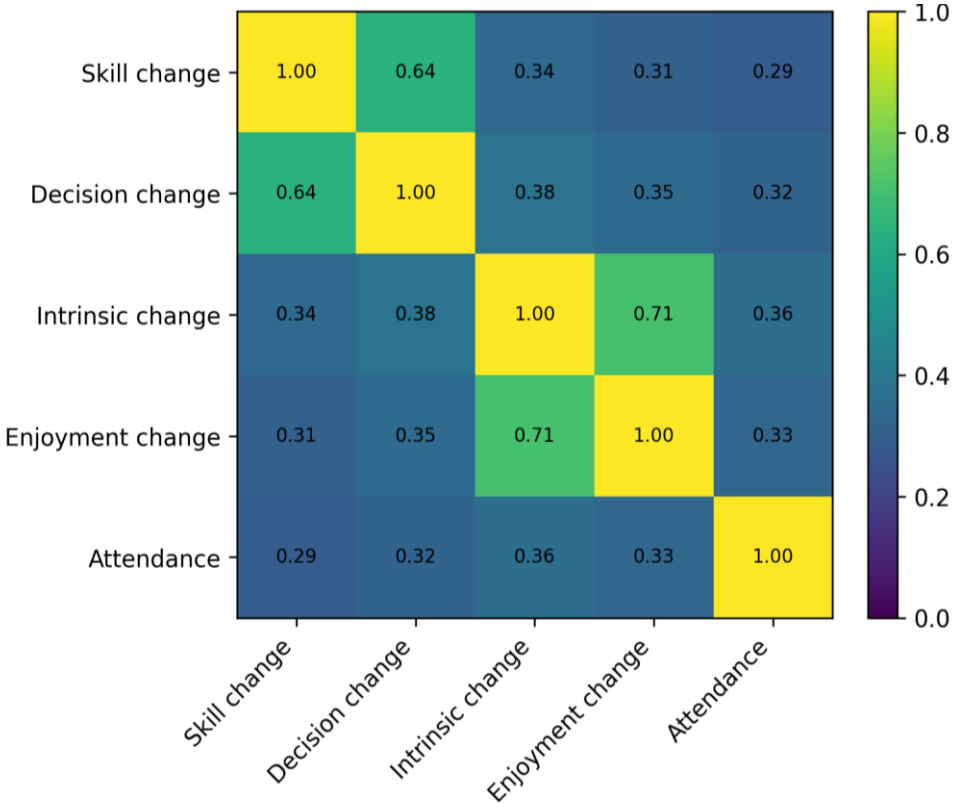


FIGURE 9. Correlation heatmap of changes in skill, decision-making, motivation, and attendance.

Figure 9 suggests that changes in skill, decision-making, motivation, and attendance were positively correlated. The strongest correlation was between intrinsic motivation and enjoyment, which is expected

because both reflect positive experience. Skill change was moderately associated with change in decision-making, indicating that athletes who became better decision-makers also tended to improve technically.

Table 8. Result 8: Linear regression predicting week-8 technical skill composite.

Predictor of week-8 skill composite	Beta	SE	95% CI	p-value	Interpretation
Baseline skill composite	0.54	0.06	0.42 to 0.66	<0.001	Higher starting skill predicted higher final skill.
Game-based learning condition	5.92	1.46	3.04 to 8.80	<0.001	Independent positive intervention effect
Attendance percentage	0.21	0.07	0.07 to 0.35	0.004	Higher attendance is associated with stronger final skills
Intrinsic motivation change	2.14	0.86	0.44 to 3.84	0.014	Motivation gain associated with skill outcome
Sex (boy = 1)	0.48	1.23	-1.95 to 2.91	0.697	No independent sex difference
Sport experience, years	0.62	0.39	-0.15 to 1.39	0.112	Positive but not statistically significant

Note. Model R2 = 0.48. Continuous predictors were centered. Positive beta values indicate higher week-8 skill composite scores.

Table 8 supports hypothesis 6. Baseline skill was the strongest predictor of week-8 skill. Still, game-based learning remained independently associated with final skill after accounting for baseline skill, attendance, change in motivation, sex, and sport experience. Attendance and intrinsic motivation change were also significant predictors, reinforcing the practical connection between learning exposure, motivational climate, and performance development.

Table 9. Result 9: Safety and feasibility indicators.

Outcome	Game-based learning	Traditional instruction	Statistical result	Practical interpretation
Minor muscle soreness	9/96 (9.4%)	11/96 (11.5%)	chi2 = 0.22, p = 0.640	Comparable and expected in school sport
Minor collision or fall	5/96 (5.2%)	4/96 (4.2%)	chi2 = 0.11, p = 0.733	No safety disadvantage
Missed the session due to injury	3/96 (3.1%)	5/96 (5.2%)	chi2 = 0.53, p = 0.466	Low incidence in both groups
Teacher-reported feasibility (1-5)	4.18 +/- 0.49	4.26 +/- 0.44	t = -1.19, p = 0.237	Both approaches feasible
Teacher preparation burden (1-5)	3.46 +/- 0.61	3.12 +/- 0.58	t = 3.96, p < 0.001	Game-based sessions required more planning.

Note. Higher feasibility scores indicate easier delivery. Higher preparation burden scores indicate greater perceived planning effort.

Table 9 shows that the game-based approach did not create a safety disadvantage, but it did require more teacher preparation. This is important for implementation. Game-based learning may be highly effective, but teachers need planning time and practical examples of constraint design and guided questioning to deliver it well.

V. DISCUSSION

This study compared game-based learning and traditional instruction for school-aged athletes and found that game-based learning produced greater improvements in technical skill, tactical decision-making,

motivation, attendance, and intention to continue sport participation. The main contribution is not simply that game-based learning improved game understanding; it also improved technical skill composite scores. This finding is important because some teachers and coaches worry that game-based approaches may sacrifice technique by spending less time on isolated drills. The results indicate that, when carefully designed, game-based learning can provide sufficient repetition for technical improvement while preserving the tactical information that makes sport skills meaningful.

The skill findings are consistent with the pedagogical argument that sport skills are best learned in relation to game problems. Kirk and MacPhail described game learning as situated, and the present findings support that position, as the largest gains were observed in decision-making, skill under pressure, and off-ball support movement [1]. These are precisely the aspects of performance that depend on reading the game. The results also align with Turner and Martinek, who showed that teaching games for understanding can influence skill, knowledge, and gameplay [2]. The present study extends that evidence by showing comparable advantages in a mixed-sex school-aged sample with modern fidelity and reliability reporting.

Oslin, Mitchell, and Griffin argued that game performance includes tactical and support behaviors as well as technical execution [3]. The current results confirm why this broader assessment is necessary. If the evaluation had used only a closed-passing test, the instructional effect might have been underestimated. Game-based learning produced gains in decision making and support movement that are highly relevant to real sport performance but are often missed by isolated skill assessments. Memmert and Harvey cautioned that such an assessment needs careful coding [8]; accordingly, the present study reported good to excellent inter-rater reliability.

The findings also fit the representative learning design position of Pinder and colleagues [10]. Athletes in the game-based condition practiced skills while perceiving teammates, opponents, space, and timing. This allowed perception and action to develop together. The traditional condition improved performance, which indicates that technical drills have value, especially for building confidence and basic movement patterns. However, the additional improvement in the game-based group suggests that representative practice can accelerate transfer from practice to game play. This interpretation is also consistent with the constraints-led approach described by Renshaw and Chow [11], where task constraints help learners discover functional movement solutions.

Game-based learning produced larger gains in intrinsic motivation, enjoyment, perceived competence, and autonomy support. This pattern is consistent with self-determination theory, which emphasizes competence, autonomy, and relatedness as foundations of high-quality motivation [16,17]. In the game-based sessions, athletes had opportunities to solve tactical problems, interact with teammates, and experience meaningful success within play. These elements likely supported enjoyment and perceived competence. Traditional instruction also produced small motivational gains, suggesting that structured practice is not necessarily demotivating, whereas the game-based format appeared more effective at creating a positive learning climate.

Ntoumanis showed that motivation in physical education is associated with adaptive outcomes [18], and Standage and colleagues linked need satisfaction and contextual motivation to intentions and experiences in school physical education [19,20]. The present study adds an instructional comparison by showing that a pedagogical approach can influence motivation indicators over 8 weeks. This matters because motivation is often treated as a learner trait rather than as something shaped by lesson design.

Athletes in the game-based group attended more sessions and were more likely to report intention to continue sport participation. This aligns with evidence from youth sport showing that sustained engagement depends on positive experiences, social relationships, and supportive climates [24,27,28]. Attendance may also have contributed to skill development by increasing practice exposure. The regression analysis supported this idea: attendance and intrinsic motivation change were significant predictors of week-8 skill after baseline skill was controlled, the motivational benefit was not separate from learning; it was part of the learning process.

The sex-stratified results showed similar effects for girls and boys. This is encouraging for school sport because instructional approaches should be equitable. Previous research on physical education motivation has shown that self-determination processes can operate across sex groups [20]. The current findings suggest that game-based learning can be implemented in mixed settings without disadvantaging either girls or boys. However, equitable implementation requires active teacher attention. Game constraints should ensure that all

athletes receive touches, decisions, and leadership opportunities. Without that design, small-sided games can still be dominated by more confident or more experienced athletes.

Harvey and Jarrett noted that game-centered approaches can improve learning and engagement, but the evidence varies with implementation quality [5]. Miller's systematic review similarly reported positive outcomes with methodological variability [6]. The present study addresses this concern by reporting fidelity, reliability, and matched exposure time. The results suggest that game-based learning is most defensible when it is structured, assessed, and supported by teacher training. It should not be presented as simply letting athletes play. The quality of questions, constraints, and progressions determines whether play becomes learning.

Teachers reported greater preparation burden for game-based sessions. Traditional instruction may be easier to plan because it follows a familiar sequence of demonstration, drill, and game. Game-based learning requires teachers to anticipate tactical problems, design constraints, and prepare guiding questions. For schools, this means professional development should include ready-to-use game forms, sample question prompts, and examples of adapting tasks for different skill levels. Without this support, implementation quality may decline, and the expected benefits may not appear.

Table 1 supports the internal credibility of the comparison because there were no meaningful baseline differences. Table 2 shows that implementation and measurement quality were acceptable, which is critical when comparing pedagogical approaches. Tables 3 and 4 demonstrate that the strongest performance effects occurred in applied skill and decision-making outcomes, indicating that the intervention influenced sport performance rather than only isolated technical execution.

Table 5 and Figure 5 show that the psychological response to game-based learning was broad. The changes in intrinsic motivation and enjoyment indicate that athletes experienced the game-based sessions as more engaging. Table 6 and Figure 6 extend this interpretation by showing higher attendance and stronger intention to continue. These engagement indicators are essential in school sport because a technically strong curriculum has limited value if athletes disengage. Figures 3 and 4 show the time course of learning. The intervention effect did not appear only at post-test; group separation was already visible by week 4.

Several limitations should be considered. First, the follow-up period was 8 weeks. A longer follow-up is required to determine whether skill gains, motivation, and participation intentions persist across a full season or academic year. Second, outcomes were assessed within school sport and may not generalize directly to elite youth academies, recreational community programs, or sports with different tactical structures. Third, although assessors were trained and reliability was good, video-coded game performance remains partly judgment-based. Fourth, the teacher preparation burden was higher in the game-based condition, and results may differ when teachers receive less support. Finally, intention to continue sport was self-reported; future research should track actual registration and attendance in later terms.

VI. CONCLUSIONS

Game-based learning produced greater improvements than traditional instruction in technical skill, tactical decision making, motivation, attendance, and intention to continue sport participation among school-aged athletes. Across the main outcomes, the effects were statistically significant at $p < 0.05$ and generally moderate in practical size. The pattern was also consistent for girls and boys, indicating that the benefits of the game-based approach were not limited to one sex group. Taken together, these results suggest that young athletes develop most effectively when learning tasks preserve the logic, pressure, cooperation, and decision demands of real play rather than separating technique from the situations in which it must be used.

In the game-based condition, athletes improved their technical execution and showed stronger tactical awareness and more positive motivational responses. This is important for school sport because coaches and teachers often face limited instructional time and must decide whether to prioritize isolated technique practice, match play, or student enjoyment. The present findings indicate that a carefully structured game-based lesson can address these goals together. When the game is modified to match learners' age, ability, and learning objective, athletes can repeat key actions many times while still understanding why the action matters.

The findings also clarify why game-based learning may be especially useful for school-aged athletes. At this developmental stage, young players are still building movement confidence, social identity, sport knowledge, and participation habits. A learning environment that allows them to solve problems, communicate with

teammates, receive feedback, and experience success in realistic situations can strengthen both competence and commitment. The higher attendance and stronger intention to continue in the game-based group suggest that athletes were not only learning more effectively, but also experiencing the program as more meaningful and worth returning to. For youth sport systems concerned about early dropout, this practical outcome is as important as the performance gains.

Traditional instruction still has a valuable role to play. The results should not be interpreted as evidence that direct teaching, demonstration, correction, or technical repetition should be removed from school sport. Instead, they show that these elements are more productive when they are connected to game understanding. Athletes still need clear cues, accurate feedback, and opportunities to refine technique. However, technical instruction should be embedded within representative tasks whenever possible so that learners can connect body movement, perception, timing, space, and tactical choice. A balanced program may therefore begin with a short technical focus, move quickly into a modified game, and return to targeted feedback based on what the athletes actually experienced in play.

Game-based learning is not simply free play. It requires deliberate planning, clear learning outcomes, appropriate game constraints, active observation, and well-timed questioning. Teachers and coaches need to design tasks that exaggerate the intended tactical problem, such as creating space, maintaining possession, choosing when to pass, or selecting an effective shooting opportunity. They also need to adjust team size, field dimensions, scoring rules, equipment, and time pressure so that athletes are challenged but not overwhelmed. In this way, the teacher remains central to learning, but the teacher's role shifts from controlling every movement to guiding athletes toward better decisions and more purposeful action.

Schools that wish to improve both performance and participation should consider organizing units around game problems rather than around technique lists alone. Assessment can also be broadened to include technical accuracy, tactical decision making, effort, cooperation, and engagement. Such an approach gives a more complete picture of athlete development and may be fairer to learners whose strengths emerge in game situations rather than in isolated drills. The positive findings for motivation and intention to continue also suggest that game-based learning can contribute to a healthier sport culture by making lessons more inclusive, socially engaging, and relevant to learners' experiences.

The study also highlights the importance of measuring outcomes beyond final skill scores. The inclusion of motivation, attendance, and the intention to continue provided a more comprehensive understanding of how the two instructional approaches influenced young athletes. A program that improves technical performance but weakens enjoyment or attendance may have limited long-term value. Conversely, a program that is enjoyable but does not improve skills may not meet educational or sport-development goals. The game-based condition showed advantages across both performance and participation indicators, which strengthens the practical value of the approach for schools, clubs, and community sport providers.

To sum up, game-based learning offers a strong, practical instructional pathway for school-aged athletes because it connects skill execution with decision-making, motivation, social interaction, and sustained participation. The approach does not replace good technical teaching; rather, it provides it with a meaningful context. For schools and youth sport programs, the central message is clear: athletes are more likely to improve and remain engaged when they are taught through carefully designed game situations that challenge them to think, move, cooperate, and adapt. When implemented with structure and purposeful feedback, game-based learning can help develop young athletes who are not only more skillful but also more confident, motivated, and committed to continuing sport.

Author Contributions

The author conducted the conceptualization, methodology, data analysis, investigation, writing, review, editing, and final approval of the manuscript.

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Data Availability

The dataset will be available from the author upon reasonable request.

Conflicts of Interest

The author declares no conflict of interest.

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