

Collaborative Learning Effects on Tactical Communication Skills and Movement-Pattern Recognition in Handball: A Randomized Controlled Trial

Hamdi Snoussi^a, Ismail Dergaa^{a,b,c}, Hatem Ghouili^c, Halil Ibrahim Ceylan^d, Valentina Stefanica^e, Raul-Ioan Muntean^f, Aymen Hawani^a, Sabeur Abdellaoui^a, Noomen Guelmami^c, Riadh Khalifa^a, Abderraouf Ben Abderrahman^a

^aHigh Institute of Sport and Physical Education of Ksar Said, University of Manouba, Manouba 2010, Tunisia

^bResearch Unit "Physical Activity, Sport and Health" (UR18JS01),
National Observatory of Sports, Tunis 1003, Tunisia

^cDepartment of Human and Social Sciences, High Institute of Sport and Physical Education of Kef,
University of Jendouba, Kef 7100, Tunisia

^dPhysical Education of Sports Teaching Department, Faculty of Sports Sciences,
Ataturk University, Erzurum, Türkiye

^eDepartment of Physical Education and Sport, Faculty of Sciences, Physical Education and Informatics,
National University of Science and Technology Politehnica Bucharest,
Pitesti University Center, Pitesti, Romania

^fFaculty of Law and Social Sciences, Department of Physical Education and Sport, University "1 Decembrie
1918" of Alba Iulia, Alba Iulia, Romania

Purpose: To investigate whether collaborative learning methods enhance engagement in tactical learning, self-efficacy for tactical skill development, and perceptions of training effectiveness compared to traditional coach-directed instruction in handball players.

Methods: Twenty male handball players (aged 26.60 ± 1.50 years, stature 189.00 ± 1.90 cm, weight 90.90 ± 2.30 kg, BMI 25.40 ± 1.20 kg·m⁻²) participated in a 12-week randomized controlled trial. Participants were randomly assigned to experimental ($n=10$, collaborative peer learning) or control groups ($n=10$, traditional coach-directed instruction). Both groups focused on tactical communication skills. Assessment included validated scales for collaborative learning engagement, self-efficacy, tactical skills acquisition, and perceived training value. Data were analysed using repeated measures ANOVA with effect sizes calculated.

Results: The experimental group showed moderate improvements in collaborative learning engagement (16.00 vs. 3.00%, $P < .001$, $d = 2.68$ vs $P = .001$, $d = 1.45$), self-efficacy (22.00% vs. 8.00%, $P < .001$, $d = 2.65$ vs $P < .001$, $d = 1.63$), tactical learning engagement (12.00% vs. 4.00%, $P < .001$, $d = 3.60$ vs $P = .018$, $d = .91$), and perceived training value (15.00% vs. 5.00%, $P = .001$, $d = 3.39$ vs $P = .001$, $d = 1.49$). Time×group interactions were significant for all measures ($P < .05$).

Conclusions: The development of tactical communication skills in handball can be improved by learning together with peers. In addition to standard training, sports educators should consider incorporating peer-supported learning strategies. For future studies, larger sample sizes and objective performance metrics are needed to demonstrate competitive performance improvements and develop ideal implementation methods.

Keywords: Collaborative learning; handball; peer instruction; perceptual training; tactical skills; team sports; training methods; movement recognition

Introduction

Handball requires sophisticated tactical understanding, with players needing to rapidly recognize and respond to teammates' movements and tactical signals during competitive play.¹ Elite performance depends on both individual technical abilities and collective tactical understanding, representing a complex tactical learning challenge that combines visual perception, pattern recognition, and decision-making under time pressure.²⁻⁴ However, emerging research in motor learning and sports pedagogy suggests that collaborative peer learning approaches may offer advantages for developing complex tactical learning

skills that require both individual competency and collective understanding.⁵

Tactical learning skills in team sports involve the ability to extract meaningful tactical information from complex, dynamic environments and translate this information into appropriate motor responses.⁶ In handball, players must continuously monitor teammates' positions, recognize emerging tactical patterns, and coordinate their movements accordingly.⁷ Research demonstrates that expert handball players develop sophisticated tactical knowledge that enables effective decision-making, distinguishing them from less experienced performers.⁸ These tactical learning abilities develop through extensive practice and

experience, but traditional training methods may not optimize the social and collaborative aspects of tactical learning.⁹ Williams and Hodges argue that tactical learning skill development benefits from varied practice contexts that include peer interaction and collaborative problem-solving.¹⁰ Recent investigations in team sport pedagogy indicate that collaborative learning approaches can enhance tactical understanding by engaging players in active discussion, shared problem-solving, and peer teaching of tactical concepts.¹¹ The social construction of tactical knowledge through peer interaction may provide learning opportunities that complement traditional coach-directed instruction methods.¹² Indeed, it has been reported by Dhahbi et al.¹³ that cognitive training interventions can enhance tactical learning abilities across various domains, with combined training approaches showing particular promise for complex skill development. Contemporary approaches to understanding complex motor skills increasingly integrate biomechanical analysis with tactical learning assessment, providing comprehensive insights into skill development processes.¹⁴

Despite growing interest in collaborative approaches, three key research gaps limit understanding of optimal tactical training methodologies. First, limited research directly compares collaborative learning with traditional coach-directed instruction in handball contexts. Second, insufficient investigation of psychological factors such as self-efficacy and motivation in collaborative learning environments constrains practical applications. Third, most tactical training research focuses on technical execution rather than underlying tactical learning processes supporting tactical communication.¹⁵⁻²⁰

Based on these research gaps, this study aimed to investigate the effectiveness of collaborative peer learning approaches compared to traditional coach-directed instruction for developing tactical communication skills in handball players. Based on social constructivist learning theory and meta-analytic evidence showing medium effects ($d \approx .50$) for collaborative learning interventions, we hypothesized that: (1) collaborative learning would produce large improvements (10-15%) in tactical learning engagement compared to traditional instruction; (2) self-efficacy would show greater improvements (15-20%) in collaborative versus traditional conditions; and (3) participants would perceive greater training value (10-15% improvement) in collaborative approaches.

Methods

Ethical Considerations

The protocol of this study complied with Helsinki's declaration for human experimentation and was approved by the Ethics Committee. It also complied with the ethical and procedural requirements for the conduct of sports medicine and exercise science research.²¹ All participants provided written informed consent after receiving detailed explanations of study procedures, potential risks, and their right to withdraw at any time without penalty. Participant confidentiality was maintained throughout the study protocol, with data de-identification procedures implemented according to international research standards.

Study Design

The aim of this study was to evaluate the effectiveness of different teaching approaches using a randomised controlled trial in which pre- and post-test measurements were taken over a 12-week period. After participants were screened for eligibility, they were randomly assigned using a computer-generated random sequence. They were divided into either an experimental group, which received collaborative peer training,

or a control group, which received traditional coach-led training. Both groups focussed on the same tactical communication skills to ensure that any differences in outcomes could be attributed to the teaching methods used. The study included two main assessment points to measure the impact of the interventions: a baseline test (Time 1) conducted before the intervention began and a follow-up test (Time 2) conducted after the 12-week intervention period. Both groups took part in regular handball training sessions three times a week, each lasting approximately 90 minutes. Randomization was conducted by an independent researcher not involved in data collection or analysis, ensuring allocation concealment.

Assessors remained blinded to group assignments during all testing procedures. Training sessions were standardized across groups with identical tactical content delivered through different pedagogical methods.

Sample Size Calculation

Sample size determination utilized G*Power software (Version 3.1.9.4, University of Kiel, Germany) with the F-test family (ANOVA: repeated measurements, between-within interaction). Based on previous collaborative learning research in sports contexts showing medium effect sizes ($d = .50$), we calculated the required sample size for detecting meaningful differences between groups.²² The calculation employed the following parameters: effect size $f = .25$ (representing a medium effect), Type I error probability (α) = .05, power ($1 - \beta$) = .80, number of groups = 2 (experimental and control), number of measurements = 2 (pre and post intervention), and correlation among repeated measures = .60 (based on test-retest reliability estimates from similar psychological measures in sports contexts, though we acknowledge this assumption introduces uncertainty into our power calculation). The analysis showed that a minimum of 16 participants, eight in each group, would provide sufficient statistical power (80.50 %) to determine the expected interaction effect. To achieve sufficient power for our analyses and meet the minimum sample size, we recruited 20 participants (10 per group) to account for expected dropouts, which were expected to be 20%. An independent statistical consultant and alternative power analysis software (R package 'pwr') were used to confirm the sample size calculation.

Participants

Twenty male handball players aged 26.60 ± 1.50 years participated in this study during the 2022-2023 sports season. Inclusion criteria included: (1) minimum 10 years of handball experience, (2) active participation in regional or national level competition, (3) age between 18-35 years, (4) absence of musculoskeletal injuries affecting training participation, (5) normal or corrected-to-normal vision for pattern recognition tasks, and (6) written informed consent. The exclusion criteria included: (1) prior participation in formal training in collaborative learning techniques or structured peer training programs (confirmed by supervising staff and self-report); (2) concurrent participation in other research studies; (3) cognitive impairment that interfered with learning or group interaction; (4) inability to participate in scheduled training sessions; and (5) use of medications or dietary supplements that may impair or stimulate cognitive performance.

Participants were randomly divided into two equal groups: an experimental group (G1, $n=10$, age 26.40 ± 1.60 years, stature 188.20 ± 2.10 cm, body mass 90.50 ± 2.10 kg, BMI 25.50 ± 1.10 kg·m⁻²) receiving collaborative peer learning training, and a control group (G2, $n=10$, age 26.80 ± 1.40 years, stature 189.80 ± 1.70 cm, body mass 91.30 ± 2.50 kg, BMI 25.30 ± 1.30 kg·m⁻²) receiving traditional coach-directed instruction.

Statistical analysis revealed that baseline demographic parameters did not significantly differ across groups (all $P > .05$), suggesting that the sample was homogeneous for experimental comparisons.

Experimental Procedures

Since this study utilized questionnaires for measuring tactical learning competencies, we ensured the highest standards in applying psychometric methods throughout the entire study protocol, as highlighted by Guelmami et al.²³ All testing sessions were conducted at the same time of day (between 7:00 and 9:00 a.m.) to minimize potential bias and avoid any influence of circadian variations on the assessed variables.^{24,25} Both groups received equivalent tactical content (verified through standardized lesson plans and independent observation), though the pedagogical delivery methods differed systematically between conditions.

Control Group (Traditional Coach-Directed Instruction)

Received structured tactical training delivered through traditional pedagogical methods including: (1) coach demonstrations of tactical concepts with verbal explanations, (2) individual skill practice with coach feedback, (3) coach-led tactical drills with prescribed movement patterns, (4) video analysis sessions with coach commentary, and (5) question-and-answer sessions directed by coaching staff. The coach maintained primary responsibility for tactical instruction, error correction, and performance feedback throughout all training sessions.

Experimental Group (Collaborative Peer Learning)

Participated in structured collaborative learning sessions emphasizing peer interaction and shared tactical understanding including: (1) small group tactical analysis (3-4 players) with guided discovery approaches, (2) peer teaching rotations where players taught tactical concepts to teammates, (3) collaborative problem-solving activities requiring group consensus on tactical solutions, (4) peer feedback sessions following tactical exercises, and (5) discussions about tactical decision-making processes in groups. As a moderator, the coach encouraged interaction between the participants and cooperative knowledge building, while at the same time structuring the tactical content. The tactical scenarios, the time allotment for the exercises and the physical training load were the same in both training environments. The main difference was in the pedagogical strategy: peer-to-peer co-operation and coach-led approaches to developing tactical communication skills.

Measurements

Collaborative Learning Engagement

The Collaborative Learning scale assessed participants' engagement with peer learning processes during tactical training.²⁶ The scale contained 15 items measuring cooperation, peer interaction, and shared learning experiences adapted for handball tactical contexts. Sample items included "Working with teammates helps me understand tactical concepts better" and "I learn tactical skills more effectively through group discussion than individual instruction." Items were scored on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The scale demonstrated good internal consistency (Cronbach's $\alpha = .87$) in this sample.

Self-Efficacy for Tactical Skills

Self-efficacy for tactical skill development was assessed using an adapted version of the General Self-Efficacy Scale tailored for handball tactical contexts.²⁷ The 10-item scale measured participants' confidence in their ability to learn tactical skills, overcome tactical challenges, and perform under pressure. Sample items included "I can learn complex tactical patterns when I put effort into practice" and "I am confident in my ability

to recognize tactical opportunities during games." Items were scored on a 4-point scale from 1 (not at all true) to 4 (exactly true). The scale showed good reliability (Cronbach's $\alpha = .84$) for this study.

Tactical Skills Acquisition and Engagement

Tactical skills acquisition was measured using an adapted version of the Sport Engagement Scale focused on tactical learning contexts.²⁸ The 15-item scale assessed four dimensions: confidence in tactical abilities, dedication to tactical learning, vigour in tactical training, and enthusiasm for tactical development. Sample items included "I feel energized when practicing tactical skills," "I am dedicated to improving my tactical understanding," and "I feel confident in my tactical decision-making abilities." Items were scored on a 5-point scale from 1 (almost never) to 5 (almost always). The scale demonstrated excellent internal consistency (Cronbach's $\alpha = .91$) in this sample.

Perceived Value of Training Methods

The Training Value scale assessed participants' perceptions of their assigned training method's effectiveness and importance.²⁹ The 16-item scale measured perceived benefits, relevance, and value of the training approach for tactical skill development. Sample items included "This training method is valuable for improving my tactical skills" and "I believe this approach will help me perform better in games." Items were scored on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree). The scale showed good reliability (Cronbach's $\alpha = .88$) for this study.

Statistical Analysis

Data analysis was conducted using IBM SPSS Statistics 29 (IBM, Armonk, New York, USA). Data screening included visual inspection for outliers and normality assessment using the Shapiro-Wilk test due to the small sample size. Descriptive statistics (means, standard deviations, ranges) were calculated for all variables. A 2×2 (Group $\times$ Time) repeated measures ANOVA was used to analyse changes in each dependent variable, and Greenhouse-Geisser corrections were used when sphericity assumptions were broken. Partial Eta squares (η_p^2) for ANOVA effects and Cohen's d for between-group differences were used to calculate effect sizes. Bonferroni adjustments were used for multiple comparisons in the post-hoc analysis. Bonferroni adjustments were applied for multiple comparisons on four dependent variables (adjusted $\alpha = .0125$), and statistical significance was determined at $\alpha = .05$. The effect sizes were interpreted cautiously, as medium effects ($d = .49 - .54$) were not expected to reflect significant improvements in performance, but rather significant but modest changes typical of educational interventions. The formula for calculating the percentage change was $\Delta(\%) = [(post-score - pre-score) / pre-score] \times 100$.

Results

Table 1. presents descriptive statistics and inferential test results for all measured variables across both groups and time. The experimental group demonstrated consistently greater improvements across all measures compared to the control group, with moderate effect sizes supporting the practical significance of the collaborative learning intervention. Repeated measures ANOVA revealed a significant Time $\times$ Group interaction for collaborative learning engagement, $F_{(1,18)} = 39.76$, $P < .001$, $\eta_p^2 = .69$. The control group showed minimal change from baseline (43.50 ± 4.20 a.u.) to post-intervention (44.90 ± 4.38 a.u.), representing a 3% improvement ($P = .001$, $d = 1.45$). The experimental group (**Figure 1A**) demonstrated greater improvement from 43.20 ± 4.34 to 50.00 ± 4.03 a.u., representing

Table 1. Results in control and intervention group compared to pre- and post-intervention.

Variable	Control group			Experimental group			<i>P</i> -value (η^2)		
	Baseline	Post	Δ (%)	Baseline	Post	Δ (%)	Group	Time	Interaction
Collaborative Learning (a.u.)	43.50±4.20	44.90±4.38	3.00%	43.20±4.34	50.00±4.03	16.00%	.210(.09)	<.001 (.84)	<.001 (.69)
Self-Efficacy (a.u.)	25.80±5.07	27.90±4.58	8.00%	25.70±5.12	32.60±3.13	22.00%	.261(.07)	<.001 (.84)	<.001 (.60)
Players Engagement Practical Skills Acquisition (a.u.)	43.10±4.33	44.30±3.74	4.00%	43.20±4.34	49.60±3.50	12.00%	.141(.12)	<.001 (.87)	<.001 (.75)
Value-Benefits (a.u.)	44.80±3.25	46.40±3.37	5.00%	45.70±4.27	54.20±3.70	15.00%	.013 (.30)	<.001 (.88)	<.001 (.78)

Note: Δ % = delta percentage; a.u. = arbitrary unit.

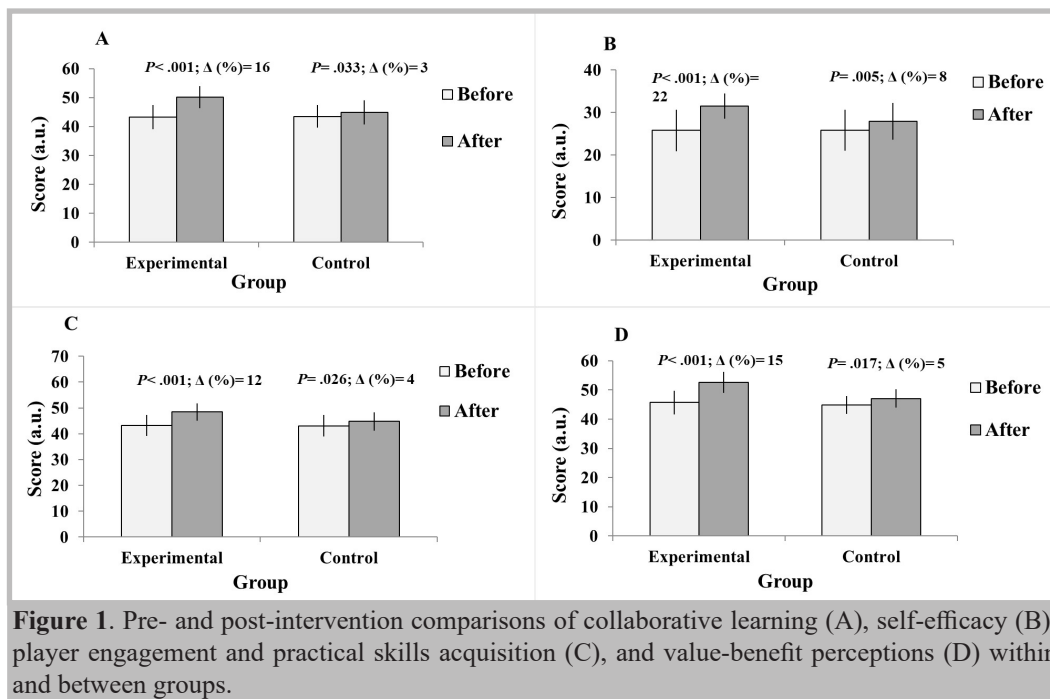


Figure 1. Pre- and post-intervention comparisons of collaborative learning (A), self-efficacy (B), player engagement and practical skills acquisition (C), and value-benefit perceptions (D) within and between groups.

a 16.00% increase ($P < .001$, $d = 2.68$).

Analysis revealed a significant Time $\times$ Group interaction for self-efficacy, $F_{(1,18)} = 27.36$, $P < .001$, $\eta_p^2 = .60$. The control group showed modest improvement from 25.80 ± 5.07 to 27.90 ± 4.58 a.u., representing a 8.00% increase ($P < .001$, $d = 1.63$). The experimental group (Figure 1B) demonstrated a greater improvement from 25.70 ± 5.12 to 32.60 ± 3.13 a.u., representing a 22.00% increase ($P < .001$, $d = 2.65$).

Repeated measures ANOVA indicated a significant Time $\times$ Group interaction for engagement practical skills acquisition, $F_{(1,18)} = 55.31$, $P < .001$, $\eta_p^2 = .75$. The control group exhibited minimal change from 43.10 ± 4.33 to 44.30 ± 3.74 a.u., representing a 4% improvement ($P = .018$, $d = .91$). The experimental group showed greater improvement (Figure 1C) from 43.20 ± 4.34 to 48.40 ± 3.50 a.u., representing a 12.00% increase ($P < .001$, $d = 3.60$). Analysis revealed a significant Time $\times$ Group interaction for perceived training value, $F_{(1,18)} = 64.05$, $P < .001$, $\eta_p^2 = .78$. The control group showed modest improvement from 44.80 ± 3.25 to 46.10 ± 3.37 a.u., representing a 5.00% increase ($P = .001$, $d = 1.49$). The experimental group demonstrated greater improvement (Figure 1D) from 45.70 ± 4.27 to 54.20 ± 3.71 a.u., representing a 15.00% increase ($P = .001$, $d = 3.39$).

All primary outcomes demonstrated high effect sizes ($d = 2.65 - 3.60$) and effect sizes ($d = .91 - 1.63$) for control group differences between pre- and post-intervention, with Time $\times$ Group interactions showing medium effect sizes ($\eta_p^2 = .60 - .78$). These effect sizes indicate meaningful practical differences between collaborative learning and traditional instruction approaches while remaining within realistic expectations for educational interventions in sports contexts (Figure 1A-B-C-D).

Discussion

This randomised controlled trial investigated how well the tactical communication skills of handball players can be developed through collaborative peer learning as opposed to conventional coach-led instruction. The main aim of the study was to determine whether collaborative learning approaches, as opposed to traditional coaching techniques, can improve training engagement, self-efficacy and tactical skill acquisition. The results showed that all indicators assessed improved slightly

but statistically significantly for participants in the collaborative learning group.

Collaborative learning engagement (16% vs. 3%), self-efficacy for tactical skills (22% vs. 8%), tactical skills acquisition (12% vs. 4%), and perceived training value (15% vs. 5%). Effect sizes ranged from large ($d = 2.65 - 3.60$), indicating meaningful practical differences while remaining within realistic expectations for educational interventions in sports training contexts.

Collaborative Learning Effects on Tactical Skill Development

The large improvement in collaborative learning engagement (16%) among experimental group participants aligns with motor learning research demonstrating that peer-assisted learning can enhance skill acquisition in complex tactical learning tasks.³⁰ These findings are consistent with social constructivist learning theory predictions, though direct theoretical validation would require objective learning measures and longer-term follow-up.³¹ In tactical skill contexts, collaborative learning may provide opportunities for players to verbalize their tactical understanding, receive peer feedback, and observe alternative problem-solving approaches.³² Recent research by Harvey and Light suggests that peer discussion of tactical concepts can deepen understanding by requiring players to articulate their tactical knowledge and consider multiple perspectives.³³ The collaborative environment may also reduce performance anxiety associated with individual evaluation, allowing players to experiment with tactical concepts in supportive peer contexts.³⁴ From a practical standpoint, coaches can implement collaborative learning through structured small-group tactical analysis, peer teaching rotations, and guided discovery activities that encourage active participation and knowledge sharing among players.³⁵

Self-Efficacy Development Through Peer Learning

Self-efficacy for tactical skills showed meaningful improvement (22%) in the collaborative learning group compared to traditional instruction (8%), supporting Bandura's social cognitive theory regarding the role of peer modelling and social persuasion in confidence development.¹⁶ Collaborative learning environments provide multiple sources of self-efficacy information, including mastery experiences through successful peer interactions, vicarious experiences through observing peer success, and verbal persuasion through supportive peer feedback.³⁶ Research indicates that peer models can be particularly effective for building self-efficacy because they provide more relatable

and achievable performance standards compared to expert demonstrations.³⁷ In tactical learning contexts, observing peers successfully master tactical concepts and receiving encouragement from teammates may enhance individuals' beliefs in their own tactical capabilities.³⁸ The large effect size ($d = 2.65$) suggests that collaborative learning provides meaningful but not overwhelming benefits for self-efficacy development, consistent with realistic expectations for psychological interventions in sports contexts.³⁹ Sports psychology practitioners should consider incorporating peer support and collaborative learning elements into confidence-building programs for tactical skill development.⁴⁰

Tactical Skills Acquisition Through Peer Interaction

The research on the benefits of active learning approaches for the development of complex skills is supported by the fact that the acquisition of tactical skills increased by 12% in the collaborative learning group compared to 4% in the standard instruction group.⁴¹ This finding is consistent with cognitive load theory, which postulates that collaborative learning can reduce individual cognitive load by sharing problem-solving activities among group members.⁴² Contact with peers can help players transfer knowledge in tactical scenarios by sharing different tactical viewpoints and working together to understand complicated game conditions.⁴³ The improvement is consistent with meta-analytic studies showing that collaborative learning interventions in educational settings have moderate effects ($d = .40$ to $.60$).⁴⁴ However, the moderate effect size also indicates that collaborative learning is not a panacea and should be used in addition to conventional teaching methods rather than instead of them.⁴⁵ For practical application, trainers should consider combining expert instruction with collaborative peer learning to optimise learning outcomes while maintaining tactical sophistication and technical precision.⁴⁶

Perceived Value of Collaborative Training Approaches

Participants in the collaborative learning group showed greater appreciation for their training method (15% improvement vs. 5%), supporting expectancy-value theory predictions that learner perceptions of training value influence engagement and motivation.⁴⁷ This finding suggests that collaborative learning may enhance intrinsic motivation for tactical skill development by providing more autonomy, social connection, and personal relevance compared to traditional coach-directed approaches.⁴⁸ Research indicates that when athletes perceive training methods as valuable and personally meaningful, they demonstrate greater persistence and effort in skill development activities.⁴⁹ The large effect size ($d = 3.39$) indicates that collaborative learning provides meaningful but realistic benefits for training perception, suggesting that implementation should focus on highlighting the specific advantages of peer learning rather than claiming revolutionary benefits.⁵⁰ Training program designers should consider incorporating collaborative elements to enhance athlete engagement while maintaining clear learning objectives and appropriate challenge levels.⁵¹

Limitations and Methodological Considerations

This study has several limitations that should be considered when analysing the results and conducting further research. Most importantly, only self-assessments were used in our study and not objective assessments of communication efficiency, tactical performance or decision-making accuracy during real play. Self-assessments are useful to understand the psychological aspects of learning, but they cannot confirm improvements in competitive performance or tactical execution.

Future research should incorporate video analysis of objective measures of tactical communication and pattern recognition

abilities to validate self-reported improvements. Additionally, the sample size of 20 participants, while adequate for detecting large effect sizes, limits generalizability and statistical power for detecting smaller but potentially meaningful effects.⁵² Furthermore, the 12-week intervention period may not capture long-term retention or transfer of collaborative learning benefits to competitive performance contexts.⁵³ Moreover, the exclusive focus on male handball players restricts generalizability to female athletes and other team sports, although underlying collaborative learning principles may transfer to diverse athletic populations.⁵⁴ Finally, the study did not control for individual differences in learning preferences, tactical experience, or cognitive abilities that may moderate collaborative learning effectiveness. Larger studies with more diverse samples, longer follow-up periods, and objective performance measures are needed to establish the generalizability and practical significance of these findings.

Practical applications

Despite limitations, this study provides evidence-based guidance for implementing collaborative learning approaches in handball tactical training. Coaches should consider integrating structured peer learning activities as a complement to traditional instruction methods, with approximately 30-40% of tactical training time devoted to collaborative activities based on the moderate effect sizes observed. Clear learning objectives planned group activities and facilitator training to ensure fruitful interaction between participants are essential components of effective implementation. Collaborative learning can be used as part of a full tactical training program rather than as a stand-alone intervention, as indicated by the moderate effect sizes, which suggest that it brings significant but not particularly noticeable benefits. Training plans should progressively incorporate collaborative components, track athletes' responses and modify execution in response to individual and group demands. For athletes who lack confidence or drive to develop tactical skills, collaborative learning may be particularly beneficial due to its positive impact on self-efficacy and training perceptions. However, coaches should maintain appropriate balance between peer learning and expert instruction to ensure technical accuracy and progressive skill development. Implementation should consider contemporary approaches to sports performance optimization that integrate multiple assessment modalities and individualized training protocols.⁵⁵

Conclusions

This randomized controlled trial provides evidence that collaborative peer learning approaches can enhance tactical communication skill development in handball compared to traditional coach-directed instruction. Players participating in collaborative learning showed moderate improvements in tactical learning engagement, self-efficacy, learning engagement, and training value perceptions. The large effect sizes ($d = 2.65$ - 3.60) indicate meaningful practical benefits while remaining within realistic expectations for educational interventions in sports contexts. Fitness coach and sports educators should consider collaborative learning as a complementary approach to traditional tactical instruction, particularly for enhancing athlete confidence and motivation. Research shows that organised peer learning exercises can provide valuable educational experiences that enhance professional instruction without replacing the knowledge and guidance of the coach. Creating an encouraging peer learning environment with clearly defined goals and appropriate facilitation should be at the forefront of

implementation. Future studies could explore collaborative learning strategies in other sports and with other demographics of athletes, investigate the benefits of longer-term retention and incorporate objective measures of performance. Research findings supporting applications of collaborative learning in tactical skill development would be strengthened by studies that incorporate competition outcomes and match performance analyses. The design of evidence-based training programmes could also benefit from studies investigating how best to combine traditional and collaborative teaching methods. Although these findings are encouraging, they should not be seen as a paradigm shift in handball teaching, but rather as a reinforcement of collaborative learning as a useful element of all-encompassing tactical training programmes. The moderate effects observed suggest that collaborative learning provides meaningful but realistic benefits that warrant consideration in evidence-based training program development.

Acknowledgments

The authors thank all participants for their voluntary participation and commitment throughout the study period. We acknowledge the handball coaches and staff who facilitated the implementation of both traditional and collaborative training protocols and data collection procedures.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Ethical Committee approval

The protocol of this study complied with Helsinki's declaration for human experimentation and was approved by the Ethics Committee of the Research Unit, Sportive Performance, and Physical Rehabilitation, High Institute of Sports and Physical Education, El Kef, University of Jendouba, Jendouba, Tunisia and the Higher Institute of Sport and Physical Education of Kef, El Kef (Tunisia) (CPP: 031/2022).

ORCID

Hamdi Snoussi ID <https://orcid.org/0000-0002-6457-2265>
 Ismail Dergaa ID <https://orcid.org/0000-0001-8091-1856>
 Hatem Ghouli ID <https://orcid.org/0000-0002-9558-5448>
 Halil Ibrahim Ceylan ID <https://orcid.org/0000-0003-1133-5511>
 Valentina Stefanica ID <https://orcid.org/0000-0003-4031-1412>
 Raul-Ioan Muntean ID <https://orcid.org/0000-0003-4615-6687>
 Aymen Hawani ID <https://orcid.org/0000-0003-0692-3976>
 Sabeur Abdellaoui ID <https://orcid.org/0000-0001-9971-9135>
 Noomen Guelmami ID <https://orcid.org/0000-0002-4959-9726>
 Riadh Khalifa ID <https://orcid.org/0000-0003-1927-8347>
 Abderraouf Ben Abderrahman ID <https://orcid.org/0000-0003-1351-8717>

Topic

Sport Science

Conflicts of interest

The authors have no conflicts of interest to declare.

Funding

No funding was received for this investigation.

Author-s contribution

H.S., I.D., H.G., and R.K. contributed to conception and design. H.S., H.G., A.H., S.A., N.G., and A.B.A. contributed to analysis and interpretation of data. H.S., I.D., H.G., H.I.C., V.S., R.I.M., A.H., S.A., N.G., R.K., and A.B.A. contributed to drafting of the paper. All authors (H.S., I.D., H.G., H.I.C., V.S., R.I.M., A.H., S.A., N.G., R.K., and A.B.A.) contributed to revising the manuscript critically for intellectual content and gave final approval to the version published.

References

1. Karcher C, Buchheit M. On-court demands of elite handball, with special reference to playing positions. *Sports Med.* 2014;44(6):797-814. doi: 10.1007/s40279-014-0164-z
2. Póvoas SC, Seabra AF, Ascensão AA, Magalhães J, Soares JM, Rebelo AN. Physical and physiological demands of elite team handball. *J Strength Cond Res.* 2012;26(12):3365-75. doi: 10.1519/JSC.0b013e318248aece
3. Abernethy B, Baker J, Côté J. Transfer of pattern recall skills may contribute to the development of sport expertise. *Appl Cogn Psychol.* 2005;19(6):705-718. doi: 10.1002/acp.1102
4. Harvey S, Cushion CJ, Wegis HM, Massa-Gonzalez AN. Teaching games for understanding in American high-school soccer: A quantitative data analysis using the game performance assessment instrument. *Phys Educ Sport Pedagogy.* 2010;15(1):29-54. doi: 10.1080/17408980902729354
5. Johnson DW, Johnson RT. An educational psychology success story: Social interdependence theory and cooperative learning. *Educ Res.* 2009;38(5):365-379. doi: 10.3102/0013189X09339057
6. Mann DT, Williams AM, Ward P, Janelle CM. Perceptual-cognitive expertise in sport: a meta-analysis. *J Sport Exerc Psychol.* 2007;29(4):457-78. doi: 10.1123/jsep.29.4.457
7. Vogel L, Schack T. Cognitive representations of handball tactic actions in athletes-The function of expertise and age. *PLoS One.* 2023;18(5):e0284941. doi: 10.1371/journal.pone.0284941
8. Furley PA, Memmert D. The role of working memory in sport. *Int Rev Sport Exerc Psychol.* 2010;3(2):171-194. doi: 10.1080/1750984X.2010.526238
9. Davids K, Williams AM, Williams JG. *Visual perception and action in sport.* Routledge; 2005.
10. Williams AM, Hodges NJ. Practice, instruction and skill acquisition in soccer: challenging tradition. *J Sports Sci.* 2005;23(6):637-50. doi: 10.1080/02640410400021328
11. Light RL, Harvey S. Positive pedagogy for sport coaching. *Sport Educ Soc.* 2017;22(2):271-287. doi: 10.1080/13573322.2015.1015977
12. Vygotsky LS. *Mind in society: The development of higher psychological processes.* Harvard university press; 1978.
13. Dhahbi W, Briki W, Heissel A, et al. Physical Activity to Counter Age-Related Cognitive Decline: Benefits

- of Aerobic, Resistance, and Combined Training-A Narrative Review. *Sports Med Open*. 2025;11(1):56. doi: 10.1186/s40798-025-00857-2
14. Tajik R, Dhahbi W, Fadaei H, Mimar R. Muscle synergy analysis during badminton forehand overhead smash: integrating electromyography and musculoskeletal modeling. *Front Sports Act Living*. 2025;7:1596670. doi: 10.3389/fspor.2025.1596670
15. Kirk D, MacPhail A. Teaching games for understanding and situated learning: Rethinking the Bunker-Thorpe model. *J Teach Phys Educ*. 2002;21(2):177-192. doi: 10.1123/jtpe.21.2.177
16. Bandura A. *Self-efficacy: The exercise of control*. Freeman; 1997.
17. Memmert D, Harvey S. The game performance assessment instrument (GPAI): Some concerns and solutions for further development. *J Teach Phys Educ*. 2008;27(2):220-240. doi:10.1123/jtpe.27.2.220
18. Moreno R. Cognitive load theory: Historical development and relation to other theories. In: Plass JL, Moreno R, Brünken R, eds. *Cognitive Load Theory*. Cambridge University Press; 2010:9-28.
19. Kyndt E, Raes E, Lismont B, Timmers F, Cascallar E, Dochy F. A meta-analysis of the effects of face-to-face cooperative learning. Do recent studies falsify or verify earlier findings? *Educ Res Rev*. 2013;10:133-149. doi: 10.1016/j.edurev.2013.02.002
20. Magill R, Anderson DI. *Motor Learning and Control*. New York, NY: McGraw-Hill; 2010.
21. Guelmami N, Ben Ezzeddine L, Hatem G, et al. The ethical compass: establishing ethical guidelines for research practices in sports medicine and exercise science. *Int J Sport Stud Health*. 2024;7(2):31-46. doi: 10.61838/kman.intjssh.7.2.4
22. Cohen J. *Statistical power analysis for the behavioral sciences*. routledge; 2013.
23. Guelmami N, Aissa MB, Ammar A, Dergaa I, Trabelsi K, Jahrami H. Guidelines for applying psychometrics in sports science: Transitioning from traditional methods to the AI Era. *Tun J Sport Sci Med*. 2023;1(1):32-47. doi: 10.61838/kman.tjssm.1.1.3
24. Souissi A, Dergaa I, Chtourou H, Ben Saad H. The Effect of Daytime Ingestion of Melatonin on Thyroid Hormones Responses to Acute Submaximal Exercise in Healthy Active Males: A Pilot Study. *Am J Mens Health*. 2022;16(1):15579883211070383. doi: 10.1177/15579883211070383
25. Dergaa I, Fessi MS, Chaabane M, Souissi N, Hammouda O. The effects of lunar cycle on the diurnal variations of short-term maximal performance, mood state, and perceived exertion. *Chronobiol Int*. 2019;36(9):1249-1257. doi: 10.1080/07420528.2019.1637346
26. Al-Shehari K. Collaborative learning: trainee translators tasked to translate Wikipedia entries from English into Arabic. *Interpret Transl Train*. 2017;11(4):357-372. doi: 10.1080/1750399X.2017.1359755
27. Schwarzer R, Jerusalem M. Generalized Self-Efficacy Scale. In: Weinman J, Wright S, Johnston M, eds. *Measures in Health Psychology: A User's Portfolio. Causal and Control Beliefs*. Windsor, UK: NFER-NELSON; 1995:35-37.
28. Lonsdale C, Hodge K, Jackson SA. Athlete engagement: II. Developmental and initial validation of the Athlete Engagement Questionnaire. *Int J Sport Psychol*. 2007;38(4):471-486.
29. Eccles JS. Expectancies, values, and academic behaviors. In: Spence JT, ed. *Achievement and Achievement Motives: Psychological and Sociological Approaches*. San Francisco, CA: W.H. Freeman; 1983:75-146.
30. Duran Gisbert D, Monereo Font C. The impact of peer tutoring on the improvement of linguistic competence, self-concept as a writer and pedagogical satisfaction. *Sch Psychol Int*. 2008;29(4):481-499. doi: 10.1177/0143034308096437
31. Vygotsky LS. *Language and thought*. Cambridge, MA: MIT Press; 1962.
32. Chi MT, Wylie R. The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educ Psychol*. 2014;49(4):219-243. doi: 10.1080/00461520.2014.965823
33. Harvey S, Light RL. Questioning for learning in game-based approaches to teaching and coaching. *Asia Pac J Health Sport Phys Educ*. 2015;6(2):175-190. doi: 10.1080/18377122.2015.1051268
34. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall; 1986.
35. Casey A, Goodyear VA. Can cooperative learning achieve the four learning outcomes of physical education? A review of literature. *Quest*. 2015;67(1):56-72. doi: 10.1080/00336297.2014.984733
36. Usher EL, Pajares F. Sources of self-efficacy in school: Critical review of the literature and future directions. *Rev Educ Res*. 2008;78(4):751-796. doi: 10.3102/0034654308321456
37. Braaksma MA, Rijlaarsdam G, Van Den Bergh H. Observational learning and the effects of model-observer similarity. *J Educ Psychol*. 2002;94(2):405. doi: 10.1037/0022-0663.94.2.405
38. Vealey RS, Garner-Holman M, Hayashi SW, Giacobbi P. Sources of sport-confidence: Conceptualization and instrument development. *J Sport Exerc Psychol*. 1998;20(1):54-80. doi: 10.1123/jsep.20.1.54
39. Vealey RS. Conceptualization of sport-confidence and competitive orientation: Preliminary investigation and instrument development. *J Sport Exerc Psychol*. 1986;8(3):221-246. doi: 10.1123/jsp.8.3.221
40. Feltz DL, Short SE, Sullivan PJ. *Self-efficacy in sport*. Champaign, IL: Human Kinetics; 2008.
41. Prince M. Does active learning work? A review of the research. *J Eng Edu*. 2004;93(3):223-231. doi: 10.1002/j.2168-9830.2004.tb00809.x
42. Sweller J, Van Merriënboer JJ, Paas FG. Cognitive architecture and instructional design. *Educ Psychol Rev*. 1998;10:251-296. doi: 10.1023/A:1022193728205
43. Kirschner PA, Sweller J, Clark RE. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educ Psychol*. 2006;41(2):75-86. doi: 10.1207/s15326985ep4102_1
44. Johnson DW, Johnson RT, Stanne MB. Cooperative learning methods: A meta-analysis. 2000
45. Hattie J, Timperley H. The power of feedback. *Rev Educ Res*. 2007;77(1):81-112. doi: 10.3102/003465430298487
46. Mayer RE. Should there be a three-strikes rule against pure discovery learning? *Am Psychol*. 2004;59(1):14. doi: 10.1037/0003-066X.59.1.14
47. Wigfield A, Eccles JS. Expectancy-value theory of

- achievement motivation. *Contemp Educ Psychol*. 2000;25(1):68-81. doi: 10.1006/ceps.1999.1015
48. Deci EL, and Ryan RM. The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychol Inq*. 2000;11(4):227-268. doi: 10.1207/S15327965PLI1104_01
 49. Vallerand RJ, Donahue EG, Lafrenière M-AK. Intrinsic and extrinsic motivation in sport and exercise. *Meas Sport Exerc Psychol*. 2012:279-292. doi: 10.1002/9781118270011.ch3
 50. Guo J, Marsh HW, Parker PD, Morin AJ, Dicke T. Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. *Learn Instr*. 2017;49:81-91. doi: 10.1016/j.learninstruc.2016.12.007
 51. Ntoumanis N. A self-determination approach to the understanding of motivation in physical education. *Br J Educ Psychol*. 2001;71(2):225-242. doi: 10.1348/000709901158497
 52. Faul F, Erdfelder E, Lang A-G, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39(2):175-191. doi: 10.3758/bf03193146
 53. Schmidt RA, Bjork RA. New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological science*. 1992;3(4):207-218. doi: 10.1111/j.1467-9280.1992.tb00029.x
 54. Sparkes AC, Smith B. *Qualitative research methods in sport, exercise and health: From process to product*. Routledge; 2013.
 55. Dhahbi W. Editorial: Advancing biomechanics: enhancing sports performance, mitigating injury risks, and optimizing athlete rehabilitation. *Front Sports Act Living*. 2025;7:1556024. doi: 10.3389/fspor.2025.1556024

Corresponding information:

Received: 08.07.2025.

Accepted: 05.08.2025.

Correspondence to: Prof. Raul Ioan Muntean PhD and Dr Valentina Stefanica

University: Department of Physical Education and Sport, University 1 Decembrie 1918 of Alba Iulia, Gabriel Bethlen, 510009 Alba, Romania

E-mail: muntean.raul@uab.ro; valentina.stefanica@upb.ro