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Original Article

Individual and combined effects of instruction and demonstration on tactical development in physical education

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Abstract
This study explores the individual and combined effects of verbal instruction and practical demonstration on the development of tactical skills in secondary school students during Physical Education classes. Thirty-three participants, aged 16–21, were randomly divided into three groups: the Instruction Group (IG), the Demonstration Group (DG), and the Instruction + Demonstration Group (IDG). Tactical performance was assessed using the Game Performance Assessment Instrument (GPAI) before and after a korfball intervention. Results showed IG had the best overall performance, except for game involvement, while DG demonstrated significant improvements in tactical indices. The IDG displayed higher engagement but lower tactical skill outcomes, suggesting that while both instruction and demonstration enhance performance, their combination may not always yield superior results. The structured verbal guidance provided by the IG appears to enhance the coherence of tactical decision-making, whereas the DG's emphasis on visual modeling contributes to improved motor skill execution. However, the engagement levels observed in the IDG group underscore the motivational advantages of integrating instructional approaches, despite the absence of significant improvements in tactical performance. These findings emphasize the importance of tailoring strategies to students' skill levels, particularly for less-experienced learners, by combining verbal and visual methods for consistent progress. The effectiveness of each approach may depend on prior knowledge, experience, and adaptability to instructional methods. Future research should explore the continuous application of these methodologies throughout lessons to maximize learning. Additionally, investigating adaptive feedback mechanisms, different instructional sequencing, and long-term effects of these approaches could further enhance skill acquisition and tactical understanding in Physical Education.
Key Words*:* **- Tactical skills, verbal instruction, practical demonstration, teaching strategies, game performance**

Introduction

Team sports play a crucial role in Physical Education curricula (Oslin et al., 1998). Recently, critics have argued that the traditional approach, emphasizing technical skill development, may reduce the integrity of these sports and restrict students' cognitive growth (Barker, 2010; Gray & Sproule, 2011). Insights from cognitive psychology suggest that tactical knowledge and mental processes are crucial for interpreting cues and making effective decisions during the game (Hodges et al., 2012). Consequently, teaching methods should also emphasize the development of tactical knowledge to enhance students' overall performance (Vickers, 2007).

Numerous studies have been conducted to identify the variables that influence improvements in technical and tactical performance. Regardless of the sport, motor learning is shaped by various factors throughout the training process, such as feedback (Chiviacowsky et al., 2009), verbal instruction, and demonstration (Ferraz 2023; 2024; 2024a). In demonstration-based methods, individuals benefit from the transfer of spatial and temporal information regarding movements, enabling the creation of a cognitive representation of concrete actions. In contrast, isolated verbal instruction, utilize verbal cues to enhance the cognitive understanding of a specific task (Bruzzi et al., 2006).

Through instruction in Physical Education, students encounter sensations and perceptions that can positively or negatively influence their behaviour and emotions. The structure provided during activities along with corrective feedback, plays a significant role in this process (Curran & Standage, 2017; Ryan & Deci, 2017). Adequate task presentation and corrective feedback are essential to the teaching process and are recognized as key indicators of pedagogical effectiveness (Rink, 2006). The way coaches communicate verbally with each athlete (or their intentional silence) can promote skill development, making task solutions easier to discover through the chosen type and style of interaction (Correia et al., 2018). The ecological approach aims to find effective solutions for specific tasks and relevant behaviours in performance by utilizing information as an action guide through practice (Seifert et al., 2017). During sports practice, athletes actively seek accurate information to

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effectively coordinate their actions and recognize potential opportunities for engagement - known as affordances. (Button et al., 2020).

Previous studies further highlight the importance of modeling and observational learning (Mödinger et al., 2021). Observational learning involves demonstrations, attempts to replicate a displayed behavior or movement. The foundational principle of this instructional approach is that the observer utilizes a cognitive representation to inform the execution of subsequent actions. Motor learning entails the development of conceptual representations, which are gradually transformed into symbolic codes through the continuous assimilation of observed behaviours. Consequently, these codes facilitate the storage of observed actions, allowing for their future reproduction (Mok et al., 2022; Sinigaglia & Butterfill, 2015).

The interplay between instruction and demonstration frequently debated as a central theme in educational contexts. Additionally, demonstration has been studied as tools employed in corrective sequences. It is essential to highlight that, the utilization of this approach in this context, can also be carried out by the teacher without reference to or grounding in the students' successful or unsuccessful performances (Evans & Reynolds, 2016; Silva et al., 2020; Silvino et al., 2024). Two primary attentional resources underpin the role of verbal guidance in motor skill acquisition: attentional focus and attentional shift. Attentional focus can vary across different dimensions-broad, narrow, internal, and external-along the directional range and continuity at any given moment. Simultaneously, attention must shift between different dimensions depending on the context during motor skill acquisition. Consequently, verbal guidance can be effective in helping students develop appropriate attentional patterns and facilitate transitions between different patterns (Cutton et al., 2007).

While research on instruction and demonstration often treats them as autonomous constructs, primarily focusing on technical skill enhancement, a significant gap remains regarding the manipulation of these pedagogical elements and their impact on students' tactical and cognitive development. Understanding the most effective instructional strategies in Physical Education is essential for optimizing teaching and learning processes. The role of verbal instruction and demonstration in tactical skill acquisition remains a subject of debate. Although both methods are widely applied, their relative contributions, as well as the effects of their isolated or combined use on students' tactical performance, are still underexplored. Thus, it is essential to provide eclectic research exploring the effects of manipulating instruction and demonstration, considering their isolated or combined use in students' tactical development. Therefore, the scopus of this study is to analyse and compare the effects of manipulating instruction and demonstration, considering both their isolated and combined applications, on the development of tactical skills in secondary school students. This study hypothesizes that combining verbal instruction with corresponding demonstrations will be more effective than using each method in isolation. By offering both a theoretical understanding and a visual representation of the movements, this integrated approach is expected to lead to significant improvements in student performance.

Material & methods

Participants

In this study, a convenience sample consisting of 33 secondary school students from a Portuguese institution was employed. Participants' ages ranged from 16 to 21 years, with a mean age of 17.48 ± 0.87 years. Parents or legal guardians of the students provided written consent for their participation. The inclusion criteria were (1) absence of health issues, (2) absence of injuries, and (3) regular participation in Physical Education classes. Consequently, any participant who failed to meet one of the specified requirements was excluded from the study. The participants possessed no prior experience or knowledge of korfball. All the procedures followed the guidelines of the Declaration of Helsinki for research involving human subjects.

Procedures

The 33 participants were randomly assigned to three distinct groups: Instruction Group (IG), Demonstration Group (DG), and Instruction + Demonstration Group (IDG). The IG received only verbal instruction, while the DG was exclusively exposed to practical demonstrations, emphasizing visual comprehension of the skills. In turn, the IDG experienced a combination of these two approaches.

An initial assessment (pre-test) was conducted, serving as a baseline to observe progress throughout the intervention. At the end, a post-test was administered to evaluate the participants' tactical skills based on the intervention conducted in each group. The students were filmed using video cameras during the pre-test and post-test, which consisted of a small-sided korfball game in a 4x4 format and were subsequently evaluated. The tactical performance of the students was assessed with the Game Performance Assessment Instrument (GPAI) (Oslin et al., 1988). Thus, appropriate and inappropriate actions of the students were identified, creating performance indices for six tactical components: decision-making index (DMI), technical skill execution index (SEI), support actions index (SI), guarding/marking index (GMI), game involvement index (GI), and game performance (GP). The calculation of these variables is detailed in Table II.

Definition of GPAI Variables

The Game Performance Assessment Instrument (GPAI), developed by Oslin et al. (1998), consists of seven observable components related to tactical problem-solving in gameplay. For the purposes of this study, four of these tactical components were employed, as detailed in Table I: Decision Making, Skill Execution, Support Actions, Guarding/Marking, Game Involvement, and Game Performance.

Table I- Description of indicators assessed by the GPAI

Game Component	Description
Decision-Making	- Upon receiving the ball, align with the basket - When unpressured, choose to shoot towards the basket - Pass to the unmarked teammate who is in a more offensive position - Make the right decisions with the ball, considering the positioning of the direct opponent
Skill Execution	- Set Shot - Shoulder Pass - Chest Pass
Support Actions	- Move to open spaces
Guard/Marking	- Adopt a defensive stance, seeking the direct opponent - Direct towards the direct opponent, disrupting their actions

The assessments were conducted by observing a 10-minute video (pre-test and post-test), where students' actions were classified as appropriate or inappropriate based on the observed context. To establish the indices, a table developed in line with the methodology of Memmert & Harvey (2008), as cited by López-Lemus (2023), was used.

Table II- Calculation of GPAI Indices (adapted from Oslin et al. (1998))

Decision-Making Index (DMI) = Number of Appropriate Decisions / (Number of Appropriate Decisions + Number of Inappropriate Decisions)
Support Actions Index (SI) = Number of Appropriate Moves to Create Space / (Number of Appropriate Moves to Create Space + Number of Inappropriate Moves to Create Space)
Guard/Marking Index (GMI) = Number of Appropriate Defensive Actions / (Number of Appropriate Defensive Actions + Number of Inappropriate Defensive Actions)
Skill Execution Index (SEI) = Number of Appropriate Technical Elements / (Number of Appropriate Technical Elements + Number of Inappropriate Technical Elements)
Game Involvement (GI) = Number of Appropriate Actions + Number of Inappropriate Actions (across all variables – DMI + SI + GMI + SEI)
Game Performance (GP) = (DMI + SI + GMI +SEI) / 4

Data analysis and Treatment

All statistical analyses were conducted using IBM SPSS Statistics Version 29. A range of descriptive analyses were conducted including the determination of mean, maximum value, minimum value, and standard deviation. Additionally, the delta (the subtraction between the post-test and pre-test scores) was analysed to provide a clearer perspective on each group's progress. The Shapiro-Wilk test was employed to assess normality, which is suitable for smaller samples. Consequently, the selection of a non-parametric t-test was essential, due to the sample not following a normal distribution. Therefore, to evaluate intergroup differences, a non-parametric methodology was adopted, applying the Kruskal-Wallis and Wilcoxon tests. Furthermore, Dunn's test was chosen, and Bonferroni correction was implemented to minimize Type I errors.

Results

Descriptive Analysis

The Instruction Group (IG) initially displayed the highest results across all GPAI indices, except for the SEI variable. The Group Instruction + Demonstration (IDG) exhibited the lowest performance across all dependent variables, except for the variables GMI and GI. The IG started with the best results in all dependent variables, except for the GI variable. Lastly, it is worth mentioning that the IDG began the intervention with a lower average final performance compared to the other groups. These results can be found in Table III. Thus, it was verified that the statistical analyses were not consistent with the initial hypothesis, which stated that the IDG would achieve better results.

Table III- *Descriptive Statistics Related to Performance in the GPAI Variables for the Three Groups Represented in the Sample*

	DG			***IG***			***IDG***		
Variable	*pre*	*post*	Δ	*pre*	*post*	Δ	*pre*	*post*	Δ
DMI	0.454±0.169	0.766±0.134	.312	0.455±0.149	0.853±0.10	.398	0.439±0.140	0.613±0.142	.174
SEI	0.465±0.330	0.613±0.145	.394	0.617±0.204	0.859±0.126	.205	0.368±0.214	0.638±0.134	.270
SI	0.478±0.250	0.775±0.252	.300	0.559±0.226	0.867±0.119	.301	0.400±0.237	0.617±0.190	.217
GMI	0.358±0.141	0.801±0.141	.445	0.743±0.131	0.876±0.131	.133	0.743±0.154	0.604±0.139	.120
GI	47.55±9.427	66±14.078	18.46	56.40±10.855	71.10±9.678	14.70	66.08±10.855	71.10±1.658	23.17
GP	0.434±0.180	0.800±0.115	.363	0.594±0.120	0.854±0.082	.261	0.423±0.141	0.618±0.132	.195

Legend: DMI - Decision-Making Index; SEI - Skill Execution Index; SI - Support Actions Index; GMI - Guard/Marking Index; GI - Game Involvement; GP - Game Performance; pre – pre-test; post – post-test

Intergroup Differences (Kruskal-Wallis)

In the initial measurements, it was observed that the dependent variables GMI, GI, and GP significantly differed among the three groups. In comparison between the DG and IG, only the GMI variable showed a significant difference (p = .001). Continuing with the analysis of the initial measurement results, it was found that the DG differed significantly for the GMI (p = .015) and GI (p < .001) variables compared to the IDG. Regarding the initial comparison between the IG and IDG, the GMI (p = .015) and GP (p = .046) variables stood out with significant differences. In this initial assessment, the IG excelled with the most favorable results for the GMI variables (compared to DG and IDG) and GP (compared to IDG). Regarding the GI variable, the IDG showed the best performance results compared to the DG and IG.

Analyzing the final measurement results, it was observed that no significant differences emerged among the final dependent variables when comparing the DG and IG. However, when comparing the DG with IDG, the SEI and GMI variables exhibited significantly different results, with DG achieving more favorable means. The GI variable stood out as more favorable for GID, in contrast to the other dependent variables. Similarly, between IG and IDG, all dependent variables differed significantly. The results indicate a more favorable performance for all dependent variables, except for the GI, in the IG. All results referenced are presented in Table IV.

Table IV- *Results Obtained from the Kruskal-Wallis Test and Dunn's Post-Hoc Test in Comparative Terms for the Three Groups*

	Kruskal-Wallis					
	pre		*Post*			
Variable	*T*	p	T	p	η^2	QS
DMI	0.57	.752	12.48	.002	0.35	Very Large
SEI	4.712	.095	11.83	.003	0.33	Very Large
SI	3.02	.221	13.12	.001	0.37	Very Large
GMI	18.45	<.001	13.61	.001	0.39	Very Large
GI	13.11	.001	21.78	<.001	0.65	Very Large
GP	7.12	.028	13.61	.001	0.38	Very Large

	DG vs. IG				DG vs. IDG				IG vs. IDG			
	Pre		*Pos*		*Pre*		*Pos*		*Pre*		*Pos*	
Variable	T	P	T	P	T	P	T	P	T	P	T	P
DMI	NA	NA	-6.12	.442	NA	NA	8.35	.115	NA	NA	14.46	.001
SEI	NA	NA	2.41	1	NA	NA	10.6	.031	NA	NA	12.99	.004
SI	NA	NA	-6.81	.319	NA	NA	-7.76	.182	NA	NA	14.57	.001
GMI	17.93	.000	-4.53	.282	-6.31	.015	10.15	.035	11.62	.015	14.68	.001
GI	6.81	.319	1.63	1	14.57	.001	17.01	.000	-7.76	.182	15.38	.001
GP	-9.44	.077	-4.16	.976	.614	1	10.46	.029	10.05	.046	14.62	.001

Legend: DMI - Decision-Making Index; SEI - Skill Execution Index; SI - Support Actions Index; GMI - Guard/Marking Index; GI - Game Involvement; GP - Game Performance; pre – pre-test; post – post-test; T – T-test Statistic; p – *p-value*; η2- *effect size*; QS – Qualitative Size

Intragroup Differences (Wilcoxon)

The intragroup analysis concluded that both the mean and the median for all groups significantly increased in the final measurement compared to the initial measurement across all dependent variables. Table V presents the results for each group across the different variables, categorizing them as positive, negative, or tied. Negative classifications indicate cases where the final index value is higher than the initial value, while positive classifications indicate cases where the final value is lower than the initial. Ties refer to cases where the final index value remains equal to the initial value. For all three groups, there is a general improvement in the final measurements for all dependent variables, as illustrated in Table V.

Table V- *Results of the Wilcoxon Signed-Rank Test for the Demonstration, Instruction, and Instruction + Demonstration Groups*

IG							
pre-post							
Variable	+	-	=	Z	P	r	QS
DMI	0	10	0	-2.803	.005	.88	Very Large
SEI	1	9	0	-2.497	.013	.79	Very Large
SI	2	8	0	-2.499	.012	.79	Very Large
GMI	2	8	0	-1.988	.047	.63	Large
GI	1	9	0	-2.654	.008	.84	Very Large
GP	0	10	0	-2.803	.005	.89	Very Large
DG							
pre-post							
Variable	+	-	=	Z	P	R	QS
DMI	0	11	0	-2.934	.003	.88	Very Large
SEI	0	11	0	-2.934	.003	.88	Very Large

SI	1	9	1	-2.654	.008	.80	Very Large
GMI	1	10	0	-2.845	.004	.86	Very Large
GI	2	9	0	-2.667	.008	.80	Very Large
GP	0	11	0	-2.934	.003	.88	Very Large

IDG

pre-post							
Variable	+	-	=	Z	P	r	QS
DMI	1	11	0	-2.824	.005	.82	Very Large
SEI	1	11	0	-2.903	.004	.84	Very Large
SI	0	9	3	-2.694	.007	.78	Very Large
GMI	1	11	0	-2.828	.005	.82	Very Large
GI	0	12	0	-3.062	.002	.88	Very Large
GP	0	12	0	-3.059	.002	.88	Very Large

Legend: DMI - Decision-Making Index; SEI - Skill Execution Index; SI - Support Actions Index; GMI - Guard/Marking Index; GI - Game Involvement; GP - Game Performance; pre – pre-test; post – post-test; p – p-value; z – z value; + - Positive Classification; - – Negative Classification; = - Tie; r – Effect size; QS – Qualitative Size

In summary, all approaches appear to influence the performance of the dependent variables, as evidenced by the results of the intragroup analysis. At the intergroup level, the IDG exhibited the least favourable outcomes in the final measurements for the DMI, SEI, GMI, SI, and GP variables compared to the IG. Notably, the IDG also showed significant divergence in the final measurements for the SEI, GMI, and GP variables. Thus, regarding final measurements, the DG and IG did not present significant differences. However, especially in descriptive statistics, differences in the means of most final indices, as well as some initial measures, suggest that the IG students performed better overall. Furthermore, the IDG demonstrated superior performance in the final GI variable, being the only group to show significant differences from the other two groups.

Discussion

The present study aimed to analyze and compare the effects of manipulating instruction and demonstration-both in isolation and in combination-on the development of tactical skills among secondary school students. The findings suggest that different pedagogical approaches can significantly influence students' tactical development in Physical Education classes.

Firstly, it is important to note that the Instruction Group (IG) began with higher initial scores in most variables, with the exceptions being the SEI and game involvement. As a result, the potential for intragroup progression was expected to be lower, which is reflected in the results. The other groups, starting with lower initial scores, might imply a greater potential for improvement. For instance, the Instruction + Demonstration Group (GID) achieved the lowest scores in most variables, suggesting that this group comprised students who faced challenges in understanding the game. Consequently, this group showed a reduced likelihood of achieving significant progress compared to the other groups. Research has indicated a similar trend, suggesting that students with very high or very low initial skill levels tend to exhibit fewer substantial improvements than those with intermediate proficiency levels (Mahedero et al., 2015).

Despite this limited progression, the IG consistently outperformed the IDG across all final variables, except for game involvement. Although players can independently make decisions and explore solutions to diverse game situations, they often rely on verbal instructions for their clarity in articulating challenges and corresponding solutions, thereby facilitating the internalization of tactical concepts. As a result, the informative content of these instructions is understood to assist players in discovering effective solutions (Williams & Hodges, 2023). However, in line with the approach adopted for this group, some researchers argue that verbal instruction should be applied judiciously, as excessive feedback and verbal corrections can hinder student development by negatively impacting their autonomy and capacity to generate creative responses to the diverse tactical challenges encountered (Hendry et al., 2015).

Conversely, in the Demonstration Group (DG), where only practical demonstrations were utilized, the results highlight the significance of visual learning in skill acquisition. Demonstrations offer students a clear visual model of the desired movements, enhancing their understanding and execution of technical skills. However, relying solely on demonstrations without accompanying verbal instructions may restrict students' ability to fully comprehend the tactical aspects of their performance. This underscores the necessity for a balanced approach that integrates both demonstration and instruction to optimize learning outcomes.

Additionally, this group exhibited significant differences in the DMI, SEI, GMI, and game performance variables when compared to the IDG. In line with these findings, Gonzalez-Artetxe et al. (2023) found that players engaged in free play displayed distinct tactical behaviors compared to those in structured conditions, suggesting that free play fosters the development of individual tactical skills. Other studies indicate that unrestricted free play enhances players' tactical behavior by fostering better coordination among teammates and greater adaptability to the positioning of both opponents and allies (Gonzalez-Artetxe et al., 2022). However, it appears that demonstrations alone are insufficient for establishing a well-structured teaching practice.

Although the DG showed greater improvement from the initial to the final assessment compared to the IG, it is important to note that the IG achieved higher final averages, resulting in superior performance across all analyzed variables. Despite the study incorporating feedback during practice for two of the groups, the results remained somewhat inconclusive. Thus, it would be beneficial to investigate how the provision of additional constructive information-such as verbal guidance, feedback, praise, and criticism-can be considered a vital psychological and pedagogical competency in teaching (Machado et al., 2024).

An intriguing observation emerged: IDG exhibited significant differences in game involvement compared to the other groups, suggesting that this approach was the most effective in enhancing motivation for sports practice. Literature underscores the role of demonstrations in fostering motivation, highlighting their positive impact on athletes' self-esteem, temperament, and anxiety levels. As a result, this approach encourages students to take greater risks, and reduces the fear of making mistakes (Bovenko, 2021). However, it is important to note that the combination of demonstration and instruction may not have fully captured the dynamic nature of the game context. Consequently, developing a model that closely resembles an ideal game scenario proves to be considerably more challenging.

Regarding intragroup analysis, all groups demonstrated significant improvements across all dependent variables, all groups exhibited significant improvements across all dependent variables. Conversely, the IDG recorded fewer students with poorer scores compared to their initial assessments, suggesting that the combination of instruction and demonstration may effectively reduce instances of performance below the initial level. Thus, the practical implications of this study highlight the need to tailor pedagogical approaches in Physical Education based on students' initial competency levels. For example, students who begin with lower skill levels may derive considerable benefit from strategies that integrate verbal instruction with demonstrations, thereby facilitating more consistent progress over time. In contrast, students with advanced tactical and technical skills may gain greater advantages from approaches that promote increased autonomy in gameplay. To nurture creativity, it is crucial for Physical Education teachers to minimize excessive feedback and verbal corrections, allowing students sufficient time to explore actions and the context of the game. This approach fosters independent decision-making and promotes the development of diverse solutions to the tactical challenges encountered. The intervention conducted in this study took place at the end of each class, specifically during the final exercise. However, during the preceding exercises in class, students were not restricted from receiving instruction or demonstration, which constitutes a potential limitation. Ethically, it was not possible to remove students from a conditioned teaching process. Furthermore, although the groups were formed randomly, notable differences were observed in their initial competency levels. Such limitations may have affected the results, constraining the accuracy of identifying the specific impact of each instructional strategy on the enhancement of participants' tactical skills. For future research, it is recommended to explore these methodologies continuously, applying the instructional strategies throughout all exercises in class rather than restricting the intervention to a single moment. This approach would facilitate a more comprehensive understanding of the effects. Additionally, it would be valuable to investigate how other variables, such as the duration of exposure to the interventions and the adaptation of strategies to the individual characteristics of the students, might influence the outcomes.

Conclusions

The findings of this study reinforce the importance of instructional strategies in development of tactical skills in Physical Education. Verbal instruction proved to be an effective method for enhancing decision-making and tactical awareness, while demonstration significantly improved technical execution. Although the IDG group showing higher engagement, it did not outperform the IG or DG in terms of tactical outcomes, suggesting that the effectiveness of combined strategies may depend on their structure and implementation. These findings highlight the importance of tailoring strategies to students' skill levels, particularly for less-experienced learners, by combining verbal and visual methods for consistent progress. The effectiveness of each approach may depend on prior knowledge, experience, and adaptability to instructional methods.

These results have significant implications for educators, emphasizing the need to adapt instructional approaches according to students' initial competency levels. The study underscores the importance of structured verbal instruction in fostering cognitive understanding and tactical decision-making, while also recognizing the value of demonstrations in reinforcing motor learning. Furthermore, the findings suggest that integrating both methods can enhance engagement but may require further refinement to ensure consistent tactical improvements. In practical terms, Physical Education teachers and coaches should consider implementing flexible instructional models that combine verbal instruction and demonstration in ways that adapt to students' evolving needs. Future research should explore the continuous application of these methodologies throughout lessons to maximize learning. Additionally, investigating adaptive feedback mechanisms, different instructional sequencing, and the long-term effects of these approaches could further enhance skill acquisition and tactical understanding in Physical Education. Furthermore, further investigations should examine how individualized feedback, game-based pedagogies, and adaptive and integrative instructional approaches can optimize skill acquisition and enhance long-term performance in sports education.

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