Tun J Sport Sci Med 2025; 3(3):1-12
https://doi.org/10.61838/tjssm.2025.3.3.1

Tunisian Journal of
Sports Science
and Medicine

Original Article

Video Feedback Combined with Verbal Instruction Enhances Motor Skill Acquisition and Positive Thinking in Adolescent Football Learners: A Randomized Controlled Trial

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Received:	Reviewed:	Revised:	Accepted:	Published:
2025-07-09	2025-08-18	2025-09-03	2025-09-17	2025-09-29

Abstract

Aim: This study examined the effects of video feedback combined with verbal instruction on motor skill acquisition and positive thinking among novice adolescent learners in a school-based physical education programme.

Methods: A randomized controlled trial was conducted with 50 male third-year middle school students (age = 15 ± 0.74 years) randomly assigned to experimental (n = 25) or control (n = 25) groups. Over four weeks, both groups received identical football skill instruction during weekly 120-minute sessions. The experimental group received video feedback demonstrating proper inside-of-the-foot kicking technique (presented at real-time and 50% slow-motion speeds from multiple viewing angles) combined with verbal instruction, while the control group received verbal instruction with live demonstration only. Outcome measures included maximal kicking distance and Soccer Positive Thinking Scale scores assessed at pre-test and post-test.

Results: The experimental group demonstrated significant improvements in kicking distance (mean increase = 6.32 m, 95% CI: 4.64-8.00 m, $t_{24} = 7.77$, $p < 0.001$, Cohen's d = 1.55) and positive thinking scores (mean increase = 0.89 points, 95% CI: 0.06-1.72 points, $t_{24} = 2.20$, $p = 0.037$, Cohen's d = 0.44). The control group exhibited no statistically significant changes in either outcome (kicking: $p = 0.054$; positive thinking: $p = 0.063$). Between-group comparison confirmed experimental superiority for motor performance ($t_{48} = 4.89$, $p < 0.001$, Cohen's d = 1.38).

Conclusion: Combined video feedback and verbal instruction substantially enhanced both motor skill acquisition and positive thinking in novice learners during authentic physical education settings. These findings support integrating video-based technologies into school curricula to optimize motor learning outcomes.

Keywords: Augmented feedback, cognitive development, educational technology, observational learning, psychomotor performance, neurocognitive function, skill retention, visual perception

How to cite this article:

Ekrevit NHI, Halouani J, Dhahbi W, Chtourou H. Video Feedback Combined with Verbal Instruction Enhances Motor Skill Acquisition and Positive Thinking in Adolescent Football Learners: A Randomized Controlled Trial. Tun J Sport Sci Med. 2025;3(3):1-12.

1. INTRODUCTION

Motor skill learning in PE is influenced by practice time, teacher optimization (1,2), and feedback mechanisms. Feedback involves actions taken by agents, such as teachers or peers, to provide information about various aspects of student performance (3,4). In PE classes, learning motor skills emphasizes exploration and practice of movement patterns, enabling students to refine abilities through continuous improvement and adaptation based on received feedback. Students require performance-related information to enhance learning, delivered through verbal, nonverbal, written, and visual/graphical formats (5,6). Feedback content varies from correct-incorrect assessments to normative information and praise, producing diverse effects on motor skill acquisition. For instance, Niźnikowski et al. (7) demonstrated that visual feedback surpasses verbal feedback for learning symmetrical movements, while performance-specific feedback proves more efficient than general praise for improving object control skills such as tossing (8).

Recent technological advancements have prompted sports educators to reassess movement-related feedback delivery methods, leading to increased experimentation with tools like VFB. As defined by Rucci and Tomporowski (9), VFB involves replaying a learner's own performance, allowing review of both static and dynamic self-images in action. This technology has become valuable for enhancing motor skill learning and performance analysis in sports and PE settings. VFB serves as an extrinsic or augmented feedback source (10), providing additional information about one's actions unavailable without external tools, contrasting with intrinsic feedback detected naturally without external aids. VFB particularly benefits learners who struggle to interpret intrinsic feedback or possess less stable movement patterns (11,12). Numerous studies demonstrate VFB effectiveness in acquiring various sports skills over short learning periods, including golf swing (13), flip turns in swimming (14), gymnastics (15), soccer skills (16), high jump (17), diving (18), hang power clean in weightlifting (9), spike jump in volleyball (19), and hurdling (20). However, VFB application varies depending on learning context.

Positive thinking involves perceiving stressors as opportunities for growth, which enhances motivation and confidence, leading to optimal arousal and heightened focus (21). This mindset improves stress management (22) and positively impacts mental health. The field of positive psychology, established by Seligman and Csikszentmihalyi (23), focuses on leveraging human strengths. By adopting positive thinking, individuals support both performance and mental well-being by capitalizing on these strengths.

While few studies have explored VFB impact on learning experiences in PE settings using qualitative methods, notable exceptions exist. Kretschmann (24) employed semi-structured interviews with 10-year-old students, finding that VFB benefited learning swimming skills. Similarly, O'Loughlin et al. (25) demonstrated that VFB positively affected motivation, self-assessment, and engagement among 9–10-year-old students learning basketball skills. Casey and Jones (26) highlighted VFB effectiveness in enhancing engagement and knowledge depth for disaffected Year 7 students learning throwing and catching skills. These studies underscore VFB potential to support student-centered learning in PE. Several studies confirm that VFB positively impacts motivation during PE learning (27,28,29). According to Deci and Ryan's Self-Determination Theory (30,31), VFB enhances learners' perceived control over actions, boosting intrinsic motivation, a factor essential for successful learning (32,33). Additionally, Legrain et al. (34) found that students using VFB in gymnastics reported higher self-determined motivation compared to those taught with traditional methods. The increasing engagement of young people with digital technologies presents an opportunity to engage students in personalized and attractive ways (35). Student engagement in learning tasks is influenced by situational interest and task perception, rather than personality or ability.

To our knowledge, no study has explored VFB and VI effects on both skill acquisition and positive thinking in football (kicking ball) during PE lessons. Therefore, this study assessed the effects of utilizing VFB and VI constraints on learning basic football skills (kicking the ball with the inside front part of the foot) on performance and positive thinking among middle school students (15 years old). The assessment occurred during lessons undertaken in an actual school PE programme under typical teaching conditions. We examined whether VFB use would impact positively on motor learning and positive thinking in children during PE lessons.

2. METHODS

2.1. Study Design and Ethical Approval

This study employed a two-group, parallel-design, randomized controlled trial conducted over a four-week intervention period. The experimental protocol was approved by the Institutional Review Board of Zuwayla Basic Education School and conformed to the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants and their legal guardians following a comprehensive explanation of the study purpose, procedures, potential risks, and benefits. Participants were informed of their right to withdraw from the study at any time without penalty.

All data were anonymized and stored securely in accordance with institutional data protection policies.

2.2. Participants

The study sample comprised 50 male third-year middle school students (age = 15 ± 0.74 years; mass = 45 ± 10.59 kg; height = 156 ± 0.13 cm) recruited from two intact classes at Zuwayla Basic Education School during the 2023-2024 academic year. Inclusion criteria required participants to be enrolled in regular PE classes, have no prior formal football training or competition experience, possess no musculoskeletal injuries or neurological conditions that would preclude participation in physical activities, and provide informed consent. Exclusion criteria included previous exposure to systematic video feedback training in any sport, concurrent participation in organized football programs outside school, or absenteeism exceeding one session during the intervention period. Both classes were characterized by their PE teacher as autonomous and motivated in physical education.

Random assignment was conducted at the class level to minimize contamination effects, with one class allocated to the experimental group (VFB combined with VI, n = 25) and the other to the control group (VI only, n = 25). A priori power analysis using G*Power 3.1.9.7 software (61) indicated that a sample size of 46 participants (23 per group) would provide 80% power to detect a medium effect size (d = 0.60) for between-group differences at α = 0.05 using independent samples t-tests. The recruited sample exceeded this minimum requirement, accounting for potential attrition. All participants were taught by the same certified PE teacher with 12 years of teaching experience to minimize instructor-related variability.

2.3. Intervention Procedures

Over a four-week period, both groups followed an identical lesson plan consisting of one 120-minute PE session per week, aligning with the standard school PE curriculum. Each lesson comprised a 15-minute warm-up routine (dynamic stretching and light aerobic activities), a 90-minute main phase focused on fundamental football skills (passing, receiving, shooting, and dribbling), and a 15-minute cool-down phase (static stretching and recovery activities). Lesson content, duration, practice opportunities, and instructor demonstrations were standardized across both groups to ensure equivalent exposure to football skill practice, with the sole difference being the mode of feedback delivery.

In the experimental group, participants received VFB combined with VI at the beginning of each session. The video model featured a local amateur football player demonstrating the inside-of-the-foot kicking technique with concurrent verbal explanations provided by the PE teacher. The demonstration video was presented at real-time speed four times (two lateral views, two frontal views) followed by slow-motion playback twice (one from each viewing angle) using the Slow Motion Video application set at 50% speed, consistent with methodologies shown to enhance tactical learning in basketball (36). The initial VFB session lasted four minutes; as participants gained familiarity with the technique, subsequent video presentations were reduced to three minutes to maintain engagement without redundancy. The control group received equivalent instruction time through live teacher demonstrations of identical kicking techniques with verbal explanations matching the content of the experimental group's video narration. Neither group received individualized feedback on their own performance during the intervention to isolate the effect of video modeling versus live demonstration.

Pre-test and post-test assessments were conducted one week before the first intervention session and one week following the final session, respectively. Assessments were administered by trained research assistants who were blinded to group allocation and who did not participate in the intervention delivery. All testing sessions occurred at the same time of day (morning, 9:00-11:00 AM) to control for circadian effects on motor performance (62).

2.4. Outcome Measures

2.4.1. Kicking Distance Test

Kicking performance was assessed using a maximal-distance kicking test from a stationary position. Participants were instructed to kick a standard size 5 football (FIFA-approved, circumference 68-70 cm, mass 410-450 g) placed on a marked starting line using the inside front part of their preferred foot, aiming to achieve maximal distance. Each participant performed two trials with a three-minute rest interval between attempts to minimize fatigue effects. Distance was measured from the starting line to the first point of ball contact with the ground using a calibrated 50-meter tape measure (precision ± 0.01 m) by a trained research assistant blinded to group assignment. The better of the two trials was recorded for analysis. Prior pilot testing with 10 participants from a different school established acceptable test-retest reliability (intraclass correlation coefficient [ICC] = 0.87, 95% confidence interval [CI]: 0.68-0.95).

2.4.2. Soccer Positive Thinking Scale

Positive thinking was assessed using the Soccer Positive Thinking Scale (SPTS) developed and validated by Tsutsui and Fujiwara (37). The SPTS is a self-report instrument designed to measure athletes' tendencies toward positive cognitive appraisal in football-related contexts. The scale comprises 12 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater positive thinking orientation. Items assess constructs including optimism, constructive self-talk, and solution-focused cognition. The SPTS has demonstrated acceptable internal consistency (Cronbach's α = 0.82) and construct validity in Japanese youth football populations (37). In the present study, the SPTS was administered in Arabic following forward-backward translation procedures. Internal consistency in our sample was satisfactory at pre-test (Cronbach's α = 0.79) and post-test (Cronbach's α = 0.81). Participants completed the SPTS immediately following the kicking distance test during both assessment sessions.

2.5. Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corporation, Armonk, NY, USA). Data were screened for outliers using boxplot visualization and z-score criteria ($|z| > 3.29$). Normality of distributions was assessed using Shapiro-Wilk tests and visual inspection of Q-Q plots. Homogeneity of variance was evaluated using Levene's test. Descriptive statistics were calculated as mean ± standard deviation (SD) for all continuous variables. Within-group changes from pre-test to post-test were analyzed using paired-samples t-tests. Between-group differences in change scores (post-test minus pre-test) were examined using independent-samples t-tests. Effect sizes were calculated using Cohen's d, with magnitudes interpreted as small (0.20-0.49), medium (0.50-0.79), and large (≥0.80) (63). The assumption of sphericity was assessed using Mauchly's test for repeated-measures analyses. Missing data were minimal (< 2%) and handled using pairwise deletion. Statistical significance was set at $\alpha = 0.05$ (two-tailed). All reported p-values less than 0.001 are presented as $p < 0.001$ rather than $p = 0.000$ to reflect appropriate precision in probability reporting.

3. RESULTS

All participants completed the four-week intervention without adverse events or dropouts, yielding complete data sets for both groups (experimental group: n = 25; control group: n = 25). Preliminary analyses revealed no significant baseline differences between groups for kicking distance ($t_{48} = 0.52$, $p = 0.608$) or positive thinking scores ($t_{48} = 0.11$, $p = 0.916$), confirming successful randomization. Data met assumptions for parametric analyses: Shapiro-Wilk tests indicated normal distributions for all variables ($p > 0.05$), and Levene's tests confirmed homogeneity of variance ($p > 0.05$).

3.1. Kicking Distance Performance

Pre-test and post-test kicking distances for both groups are presented in Table 1. The experimental group (VFB combined with VI) demonstrated a mean kicking distance of 30.22 ± 5.29 m at pre-test, increasing to 36.54 ± 4.77 m at post-test. Paired-samples t-test revealed a statistically significant improvement ($t_{24} = 7.77$, $p < 0.001$, Cohen's d = 1.55), representing a mean increase of 6.32 m (95% CI: 4.64-8.00 m) or 20.9% improvement from baseline. This effect size indicates a very large intervention effect according to conventional benchmarks (63).

The control group (VI only) exhibited a pre-test mean of 29.50 ± 5.36 m and a post-test mean of 30.72 ± 5.12 m. The observed increase of 1.22 m did not reach statistical significance ($t_{24} = 2.02$, $p = 0.054$, Cohen's d = 0.40), suggesting minimal improvement attributable to verbal instruction alone. Although the effect size fell within the small-to-medium range, the p-value exceeded the predetermined alpha criterion of 0.05. Between-group comparison of change scores (post-test minus pre-test) confirmed that the experimental group achieved significantly greater improvements in kicking distance than the control group ($t_{48} = 4.89$, $p < 0.001$, Cohen's d = 1.38), with a mean difference of 5.10 m (95% CI: 2.98-7.22 m).

Table 1. Comparison of Pre-test and Post-test Kicking Distance Performance in Experimental and Control Groups

Group	Pre-test (m)	Post-test (m)	Mean Diff (m)	95% CI	t	df	p	Cohen's d
Experimental (VFB + VI)	30.22 ± 5.29	36.54 ± 4.77*	6.32	4.64 to 8.00	7.77	24.00	<0.001	1.55
Control (VI only)	29.50 ± 5.36	30.72 ± 5.12	1.22	-0.02 to 2.46	2.02	24.00	0.054	0.40

Note: VFB = video feedback; VI = verbal instruction; CI = confidence interval; df = degrees of freedom. Values are presented as mean ± standard deviation. Mean difference calculated as post-test minus pre-test. Cohen's d interpreted as small (0.20-0.49), medium (0.50-0.79), or large (≥0.80). Between-group comparison of change scores: $t_{48} = 4.89$, $p < 0.001$, Cohen's d = 1.38. *Statistically significant within-group change at $\alpha = 0.05$.

3.2. Positive Thinking Scores

Pre-test and post-test SPTS scores for both groups are presented in Table 2. The experimental group recorded a baseline mean of 4.35 ± 1.18, which increased to 5.24 ± 1.09 at post-test. This improvement was statistically significant ($t_{24} = 2.20$, $p = 0.037$, Cohen's d = 0.44), representing a mean gain of 0.89 points (95% CI: 0.06-1.72 points) or 20.5% increase from baseline. The effect size indicates a small-to-medium intervention effect on positive thinking orientation.

The control group demonstrated pre-test and post-test means of 4.32 ± 0.95 and 4.82 ± 0.94, respectively. Although participants exhibited a numerical increase of 0.50 points, this difference did not achieve statistical significance ($t_{24} = 1.95$, $p = 0.063$, Cohen's d = 0.39), indicating that verbal instruction alone did not produce meaningful changes in positive thinking profiles. Between-group analysis of change scores indicated no statistically significant difference in positive thinking improvements between experimental and control groups ($t_{48} = 0.78$, $p = 0.440$, Cohen's d = 0.22), suggesting that while VFB combined with VI enhanced positive thinking within the experimental group, the magnitude of this advantage over the control condition was modest.

Table 2. Comparison of Pre-test and Post-test Soccer Positive Thinking Scale Scores in Experimental and Control Groups

Group	Pre-test	Post-test	Mean Diff	95% CI	t	df	p	Cohen's d
Experimental (VFB + VI)	4.35 ± 1.18	5.24 ± 1.09*	0.89	0.06 to 1.72	2.20	24.00	0.037	0.44
Control (VI only)	4.32 ± 0.95	4.82 ± 0.94	0.50	-0.03 to 1.03	1.95	24.00	0.063	0.39

Note: VFB = video feedback; VI = verbal instruction; CI = confidence interval; df = degrees of freedom. Values are presented as mean ± standard deviation. Scores derived from the Soccer Positive Thinking Scale (SPTS; Tsutsui & Fujiwara, 2015), rated on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Mean difference calculated as post-test minus pre-test. Cohen's d interpreted as small (0.20-0.49), medium (0.50-0.79), or large (≥0.80). Between-group comparison of change scores: t_{48} = 0.78, p = 0.440, Cohen's d = 0.22. *Statistically significant within-group change at α = 0.05.

4. DISCUSSION

The present investigation examined the effects of video feedback combined with verbal instruction on motor skill acquisition and positive thinking in novice learners during a school-based physical education programme. The principal findings demonstrate that the experimental group receiving VFB with VI achieved substantial improvements in kicking distance performance (mean increase = 6.32 m) and positive thinking scores (mean increase = 0.89 points) over a four-week intervention period. Conversely, the control group receiving VI alone exhibited no statistically significant changes in either outcome measure (kicking distance: p = 0.054; positive thinking: p = 0.063). Between-group comparison confirmed the superiority of combined VFB and VI for enhancing motor performance, though the advantage for positive thinking did not reach statistical significance in direct group comparison. These findings provide empirical support for the pedagogical integration of video-based technologies in authentic PE settings and extend the existing literature by simultaneously examining motor and psychological outcomes in youth learners.

The observed enhancement in motor skill performance aligns with previous experimental research demonstrating VFB efficacy across diverse motor learning contexts. Studies examining golf swing mechanics (13,47), swimming techniques (14), gymnastics movements (15,45), and volleyball spike jumps (19) have consistently reported accelerated skill acquisition when VFB augments traditional instruction methods. The very large effect size observed in the present study (d = 1.55) exceeds those reported in many previous investigations, potentially attributable to the novice status of participants and the relative simplicity of the target skill. Mérian and Baumberger (17) observed similar magnitudes of improvement when implementing VFB in school PE settings, suggesting that ecological validity does not compromise intervention effectiveness. The present findings contradict earlier propositions by Rothstein and Arnold (46) and Guadagnoli et al. (47), who argued that learners require baseline competency before VFB can optimize learning outcomes. The rapid progress demonstrated by complete novices in this study challenges the expertise prerequisite hypothesis and suggests that VFB may be particularly valuable during initial skill acquisition phases when movement patterns are not yet consolidated.

The mechanisms underlying VFB effectiveness in motor learning are multifaceted and likely involve both cognitive and motivational pathways. From a cognitive perspective, VFB provides learners with an external reference model that reduces reliance on proprioceptive feedback, which novices typically struggle to interpret accurately (11,12). Observational learning theory posits that visual demonstrations facilitate the development of internal cognitive representations of movement patterns (66), enabling learners to compare their intended actions with expert models. The repeated presentation of correct technique from multiple viewing angles in the present study likely enhanced the formation of accurate motor schemas, consistent with findings from Hodges et al. (12) demonstrating that visual feedback aids perception-action coupling in novel coordination tasks. Furthermore, the incorporation of slow-motion replay at 50% speed, inspired by Jarraya et al.'s (36) work on tactical learning, may have allowed participants to process temporal and spatial movement characteristics more thoroughly than real-time observation permits.

The additive effect of combining VFB with VI, rather than presenting video alone, warrants particular attention. Souissi et al. (48) argued that isolated feedback modalities produce suboptimal learning outcomes, a position corroborated by Nunes et al. (49), who found that elderly participants improved golf putting kinematics only when VFB was paired with descriptive verbal cues. The present findings support a complementary-processing framework wherein visual and verbal information channels synergistically enhance encoding depth. Dual-coding theory suggests that information processed through multiple sensory modalities creates redundant memory traces, improving retention and retrieval (67). Verbal instruction may direct selective attention to critical movement features that might otherwise be overlooked in visual observation, while VFB provides concrete visualization of abstract verbal concepts. This integration likely reduces cognitive load by distributing processing demands across visual and auditory working memory systems (68), particularly beneficial for novice learners who have not yet developed efficient attention allocation strategies.

The enhancement in positive thinking observed in the experimental group (p = 0.037, d = 0.44) represents a noteworthy psychological outcome, though the effect magnitude was smaller than that observed for motor performance and did not differentiate significantly from control group changes in between-group analysis. This finding extends limited existing research on VFB's psychological effects in PE contexts. Kretschmann (24) and O'Loughlin et al. (25) reported enhanced motivation and engagement following VFB exposure, while Legrain et al. (34) documented increased self-determined motivation in gymnastics students using video technology. The present results suggest that VFB may influence positive thinking through multiple psychological mechanisms. According to Self-Determination Theory (30,31), VFB enhances perceived autonomy and competence by providing learners with objective performance information that supports self-evaluation and goal-directed behaviour modification. This increased perceived control over learning outcomes likely contributed to the more optimistic cognitive appraisal patterns reflected in elevated SPTS scores. Additionally, VFB may enhance self-efficacy beliefs by providing concrete evidence of performance capabilities and progress. Social cognitive theory posits that mastery experiences constitute the most potent source of self-efficacy information (69). Observing one's own improving performance via video replay may strengthen efficacy beliefs more effectively than verbal encouragement alone, as it provides incontrovertible visual evidence of capability development. The novelty and technological appeal of video-based instruction may further enhance engagement and situational interest (35,50), creating affective states conducive to positive thinking. However, the modest effect size and lack of significant between-group differentiation suggest that VFB's influence on positive thinking may be more variable or context-dependent than its effects on motor performance. Individual differences in psychological responsiveness to feedback, baseline psychological profiles, and the relatively brief intervention duration may have attenuated between-group differences despite within-group improvements.

The present study possesses several methodological strengths that enhance confidence in the reported findings. The randomized controlled design with parallel groups minimizes selection bias and supports causal inference regarding VFB effects. The intervention was implemented within authentic school PE lessons under naturalistic teaching conditions, enhancing ecological validity and practical relevance. The use of standardized lesson plans, identical practice opportunities, and a single instructor across both groups controlled for numerous confounding variables that could otherwise obscure intervention effects. The inclusion of both motor performance and psychological outcome measures provides a more comprehensive evaluation of VFB impact than studies examining skill acquisition alone. Furthermore, the sample size exceeded the minimum required by a priori power analysis, providing adequate statistical power to detect meaningful effects.

Several limitations must be acknowledged when interpreting these findings. The absence of retention testing represents a significant constraint, as the study cannot determine whether observed improvements persisted beyond the immediate post-intervention assessment. Motor learning research traditionally distinguishes between temporary performance changes and relatively permanent learning, with retention tests conducted after practice-free intervals serving as the gold standard for assessing learning (10). Future investigations should incorporate delayed retention tests (minimally two weeks post-intervention) to evaluate learning permanence. The homogeneity of the sample (male students, single age group, single school, novice skill level) limits generalizability to other populations, including female students, different age ranges, varied skill levels, and diverse cultural contexts. The expertise reversal effect (57,58,59) suggests that instructional methods effective for novices may become less effective or counterproductive as learners gain expertise, necessitating caution when extrapolating these findings to intermediate or advanced learners. The study did not document participants' extracurricular football experiences or prior informal VFB exposure, which may have influenced baseline competencies and responsiveness to the intervention. The relatively brief four-week intervention period, while sufficient to detect significant performance improvements, may have been inadequate for observing ceiling effects or determining optimal intervention duration. The exclusive focus on a single motor skill (inside-of-the-foot kicking) limits conclusions about VFB effectiveness for other fundamental movement skills or more complex sport-specific techniques. The positive thinking measure, while psychometrically sound, assessed general tendencies toward positive cognition rather than domain-specific self-efficacy or motivation constructs more proximally related to motor learning outcomes. Future research employing sport-specific self-efficacy scales and intrinsic motivation measures may provide more nuanced insights into psychological mechanisms mediating VFB effects.

Future investigations should address these limitations through several methodological refinements. Longitudinal designs incorporating multiple retention intervals (e.g., one week, one month, three months post-intervention) would elucidate the durability of VFB-induced improvements. Comparative studies examining VFB effectiveness across different skill levels (novice, intermediate, advanced) would test expertise reversal hypotheses and inform developmentally appropriate implementation strategies. Research investigating optimal VFB parameters, including frequency, duration, presentation speed, viewing angle, and timing relative to practice, could optimize instructional efficiency. Studies incorporating neurophysiological measures (e.g., electroencephalography, functional magnetic resonance imaging) would clarify neural mechanisms underlying VFB-enhanced learning. Investigating individual difference moderators (e.g., cognitive ability, attentional capacity, learning style preferences) may identify learner characteristics that predict VFB responsiveness, enabling personalized instruction.

4.1. Practical Applications

The findings hold important implications for physical education practitioners seeking evidence-based strategies to optimize motor skill instruction. PE teachers should consider integrating VFB into regular lesson structures, particularly when introducing novel motor skills to novice learners. The demonstrated effectiveness of combining VFB with VI suggests that video technology should supplement, rather than replace, traditional verbal instruction and live demonstration. Practical implementation requires minimal technological investment, as tablet computers or smartphones equipped with slow-motion video applications can capture and replay demonstrations effectively. Teachers should present video models from multiple viewing angles and incorporate slow-motion replay to highlight critical movement features. The brief VFB duration required in this study (three to four minutes per session) suggests that meaningful benefits can be achieved without substantial disruption to lesson time allocation. Schools should invest in professional development opportunities enabling teachers to develop competencies in video recording, editing, and pedagogically sound integration of VFB into instructional sequences. These findings support broader educational technology integration initiatives while providing empirical justification for resource allocation decisions.

5. CONCLUSION

This randomized controlled trial demonstrated that combining video feedback with verbal instruction in authentic physical education settings substantially enhanced both motor skill acquisition and positive thinking among novice adolescent learners over a four-week intervention. The experimental group achieved very large improvements in kicking distance performance and small-to-medium enhancements in positive thinking, while the control group receiving verbal instruction alone exhibited no significant changes. These findings support the pedagogical integration of video-based technologies in school PE programmes and challenge previous assertions that learners require baseline competency before video feedback can optimize learning. The study advances understanding of feedback modalities in motor learning by simultaneously examining performance and psychological outcomes in ecologically valid contexts. Future research should incorporate retention testing, diverse populations, and investigation of optimal implementation parameters to refine evidence-based VFB practices.

Ethical Approval and Consent to Participate

The study protocol received approval from the local institutional ethics committee in accordance with the Declaration of Helsinki principles. All participants provided written informed consent after receiving comprehensive information regarding study objectives, procedures, potential risks, and the voluntary nature of participation.

Consent for Publication

Not applicable.

Competing Interests

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Funding

The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.

Authors' Contributions

All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

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