

# Effects of Video-Based Feedback Instruction on Tactical Learning, Interest, and Self-Efficacy in Handball Education

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**Purpose:** This study examines the impact of video use in three different formats: continuous playback without interruption, self-paced control, and feedback-based format, on situational interest, self-efficacy, and the development of tactical knowledge in handball among students in physical education.

**Methods:** Sixty secondary school students, (age  $14.47 \pm 0.44$  years) were divided into three groups of 20 students each, with 10 girls and 10 boys per group: The Continuous Video Group (CVG;  $n=20$ ), the Video Control Group (CTR;  $n=20$ ), and the Video Feedback Group (VFB;  $n=20$ ). Students viewed a handball video scenario and then completed recall and transfer tests, as well as situational interest and self-efficacy questionnaires.

**Results:** Non-parametric analyses (Mann-Whitney U tests) showed that the Video Control Group had significantly better recall than the Video Continuous ( $U=52, P<.001$ ) and Video Feedback groups ( $U=71.5, P<.001$ ). For transfer and efficacy tests, both the Control and Feedback groups outperformed the Continuous group (transfer:  $U=47, P<.001$ ;  $U=73, P<.001$ ; efficacy:  $U=118.5, P=.026$ ;  $U=110, P=.014$ ). Situational interest was significantly higher in the Continuous group compared to the Feedback group ( $P=.027$ ), suggesting continuous video exposure elicits greater interest than delayed feedback.

**Conclusions:** These results suggest that, although the continuous reading group demonstrated higher situational interest, their memorization and transfer performance was lower than that of the groups using video control or video feedback. Therefore, video control and video feedback appear to promote both self-efficacy and performance. Therefore, to optimize results, the use of these teaching tools should be progressively structured and adapted to the cognitive abilities of physical education students.

**Keywords:** Physical Education; Video Feedback; Tactical Learning; Motor Skills; Team Sport.

## Introduction

In recent years, technological advancements have significantly transformed the field of sport sciences, both in term of research and applied intervention practices<sup>1</sup>. Among these emerging technologies, dynamic visualizations, such as videos, have become increasingly popular in the field of physical education, playing a central role in students' learning process enhancing the learning experience compared to traditional teaching methods<sup>2,3</sup>. It has been suggested that videos may offer critical information on the movement techniques to be performed, supporting motor imagery by showcasing limb movements, postural adjustments, and the handling of objects or tools<sup>4</sup>.

The use of self-recorded videos, example through digital tablets, may introduce innovative teaching and learning strategies in physical education. Such methods encourages student autonomy

and self-awareness while improving both the quantity and quality of practice<sup>5</sup>. Indeed, video technology in physical education and sports contributes at boosting students' intrinsic motivation leading to improve performance<sup>6</sup>. Furthermore, the study by<sup>7</sup> showed that applying artificial intelligence to movement analysis in sport helps improve motor performance and precision of movements, confirming the value of visual aids in optimising learning. Allowing students to be filmed or to film themselves, particularly using digital tablets, enables them to take a more active role in their learning process<sup>8</sup>. From this perspective, it has been shown that the use of video self-control feedback also promotes the development of self-efficacy among students<sup>9</sup>.

Furthermore, digital images can support the creative process, guide students through the stages of composition, and provide feedback by allowing comparisons between their actual

performance and their mental representation of the desired movement. They promote the development of precise mental coding of the actions to be reproduced<sup>10</sup> and offer the possibility of recording the activities of teachers and students, thereby contributing to the improvement of teaching practices. Among these tools, video feedback stands out as an effective means of self-assessment: it allows learners to observe their own actions, associate their internal sensations with external cues, and correct their movements<sup>11</sup>. Numerous studies show that video feedback improves students' accuracy, motivation, and performance<sup>12,13</sup>, although its benefits are sometimes limited for beginners faced with complex models. These limitations can be mitigated by adding visual cues or by using teaching approaches that combine several modalities<sup>14</sup>.

Although instructional videos have become a central cognitive tool for conveying information in physical education, they are not always effective for learning, as they impose significant cognitive loads due to their transient nature<sup>15,16</sup>. This is why, in some studies, static presentations have been found to be more effective than their dynamic counterparts. For example,<sup>16</sup> studied the effect of using football videos on learning tactics and noticed that it increased the mental load of students. Their results indicated that learning from photographs was more effective than learning from videos, although this effect was reversed for expert learners. Some studies have shown that cognitive and visual abilities play a key role in the execution of complex motor actions. For example, certain cognitive and visual abilities directly contribute to the performance of forehand and backhand strokes in tennis, emphasizing the overall importance of leveraging these skills in the acquisition of complex motor actions<sup>17</sup>.

Furthermore, research has shown that learners often watch instructional videos passively, meaning they do not actively engage in the necessary cognitive activities<sup>9,18</sup>. These observations highlight the importance of cognitive abilities in learning and performing complex motor skills. Active control of instructional videos allows learners to regulate the pace and order of sequences, thereby facilitating the management of information flow and reducing cognitive load<sup>19,20</sup>. The interactivity offered by these videos promotes active learning, motivation, and student engagement, although if poorly managed, it can increase cognitive load<sup>15,21,21,22</sup>. Situational interest has been studied as a motivational variable influenced by these tools, based on the cognitive-affective theory of media learning<sup>23,24</sup>, and measured according to its five dimensions<sup>25</sup>. Previous studies confirm that video feedback and video control enhance situational interest in physical education<sup>6,25,26</sup>, while highlighting the need for balanced use to avoid cognitive overload and disengagement. These theoretical principles are supported by empirical research showing that autonomous video control reduced unnecessary cognitive load and improved performance, and that video control combined with textual supports strengthened the learning of tactics and knowledge transfer in a sports context<sup>27,28</sup>. These results confirm that activating students' cognitive capacities is essential for effective learning. This presents a significant challenge for physical education teachers, who must continuously develop strategies to boost student motivation and engagement. However, beyond video control, there are complementary tools aimed at enhancing students' self-assessment. The literature mainly refers to forms of video feedback focused solely on self-observation of one's own performance<sup>11</sup>. In our study, model-guided video feedback constitutes a distinct and complementary approach: the student observes an expert model, performs the task, and then compares their performance to the model video,

thereby forming an enriched form of self-assessment.

Given that handball requires a sophisticated level of tactical understanding, where players must rapidly recognize and respond to teammates' movements and tactical cues during competitive play<sup>29</sup>, a series of teaching methods has been suggested to improve learning from videos, particularly to reduce the cognitive overload associated with animated presentations. Two methods stand out in particular: video control, which allows students to manage the pace and sequence of information to promote engagement and understanding, and model-guided video feedback, which offers enriched self-assessment by comparing the student's performance with that of an expert model. These two complementary devices are proposed in our study to reinforce active learning and the acquisition of tactical skills in handball, as well as the transfer of knowledge in the context of physical education teaching. Similarly, the use of specific training methods in team sports, such as 'rondo' possession games, has been shown to improve cognitive skills and creative thinking in young players, thereby supporting our choice of a team sport to study the impact of active methods on tactical and cognitive learning<sup>30</sup>.

## Methods

### *Participant*

This study involves 60 first-year students from local High School, (age  $14.47 \pm 0.44$  years, stature  $161.60 \pm 3.32$  cm, body mass  $52.36 \pm 2.84$  kg). Anthropometric measurements were taken by a physician. Body height was measured in centimeters without shoes, with heels together, and with the subject's back parallel to the stadiometer (Model 214 height rod; Seca, Hamburg, Germany). Body mass (BM) was evaluated to the nearest .1 kg using a digital scale (Tanita, Tokyo, Japan).

All participants completed an expertise questionnaire to identify novices in handball. Participants were randomly assigned into three experimental groups of 20 students each, with 10 girls and 10 boys per group: the "Continuous Video Group" ( $n=20$ ), the "Video Control Group" ( $n=20$ ), and the "Video Feedback Group" ( $n=20$ ). Inclusion criteria were enrolment in physical education, absence of any injury or medical condition limiting activity, and be availability for the full protocol, including video viewing, and questionnaire completion. Exclusion criteria were absence from one or more sessions or regular competitive handball practice, which could bias the results. Parental consent was obtained prior to participation.

### *Experimental Design*

The experimental situation involved a tactical handball task involving four offensive players (a center half, a pivot and two wingers) performing a nine-step attack sequence totaling 17 actions, from the start of the attack to the final shot on goal. This sequence was performed by four young specialist players (age  $14.66 \pm 0.57$  years) serving as models and filmed in a fixed shot by a camera placed 1 meter above the ground in the center of the court, without zoom or panning. During the learning phase, the video was played on a  $32 \times 20$  cm screen via an HP computer (Intel Core, 4 GB RAM), placed 30 cm from the participant, with a viewing angle of approximately  $45^\circ$ .

The experiment, which lasted approximately 50 minutes, took place during physical education classes at the beginning of the school year, with each participant sitting individually in front of a computer. The protocol consisted of four successive phases: (1) completion of a demographic questionnaire, (2) presentation of task-related learning material, (3) interaction with the learning situation, and (4) completion of recall and transfer tests

to assess knowledge retention and application. At the end of the experiment, participants completed a Likert scale measuring self-efficacy and the Situational Interest Scale in Physical Education (SIS-PE) to gather their subjective perceptions of the activity.

Three experimental conditions were proposed: in the "Continuous Video" group ( $n=20$ ), the learners watched the sequence four times in a row without control, for a total duration of 1 min 20 s; in the "Controlled Video" group ( $n=20$ ), they benefited from the pause, rewind and fast-forward functions, allowing them to manage the viewing pace over the same duration; finally, in the "Video with Feedback" group ( $n=20$ ), After watching the expert model video, the students replicate the actions on the field while recording themselves on video. They then compare their performance to that of the model using a computer system, which allows them to carry out an independent self-assessment.

### **Instruments**

Tactical learning performance was measured using several tools: a recall and reconstruction test, a transfer test, a self-efficacy scale (Table 1) and a situational interest questionnaire (Table 2). In the reconstruction test, participants were given a document with nine empty fields representing a handball court and had to reproduce the progression of the tactical system in 17 actions by placing players and the ball in the appropriate positions; one point was awarded for each correct answer (maximum score: 17). The transfer test consisted of applying the knowledge acquired on half a court, interacting with four semi-professional players (age  $14.47 \pm .44$  years; with more than 5 years of experience). Participants reproduced the actions of a designated player, except for the pivot, with a maximum score of 6 points.

Situational interest was assessed using a 19-item questionnaire developed by<sup>31</sup>, including five dimensions (novelty, immediate pleasure, intention to explore, demand for attention and challenge), each comprising three items, as well as an overall score comprising four items. The questions were presented in random order and rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Self-efficacy was measured using a Likert scale ranging from 0 ('not at all confident') to 9 ('extremely confident'), an approach used in several instruments such as the CDSES<sup>32</sup>. In line with the concept of task-specific self-efficacy, which assesses students' belief in their ability to perform a given behaviour in a specific context, all participants were asked to answer the following question: "How confident do you feel in your ability to correctly perform the complete tactical handball attack sequence, from the beginning of the action to the final shot on goal?" The time taken to complete the tests was also timed to assess performance efficiency.

### **Statistical analysis**

Statistical analyses were conducted using IBM SPSS Statistics software (Version 28.0, IBM Corp., Armonk, NY, USA). The normality of the data distribution was verified using the Shapiro-Wilk test. Where variables did not meet the normality assumption, non-parametric tests were applied: the Kruskal-Wallis test was used to compare the three groups overall, and post hoc comparisons were made using the Mann-Whitney test. Where the conditions of normality and homogeneity of variances were met, a univariate ANOVA was conducted, followed by post hoc tests with Bonferroni correction. The significance level was set at  $P < .05$ . Effect sizes were reported using eta squared ( $\eta^2$ ) for the ANOVA, and eta-squared with ranks ( $\eta^2_H$ ), was used to complete the interpretation of the results.

## **Results**

### **Learning and Performance Tests**

The results in Table 1 show significant differences among the three groups using three different video modalities for the variables: recall, transfer, efficiency, and time. After checking the normality of the distributions of the studied variables, the non-parametric Kruskal-Wallis test was used for global comparison, and the Mann-Whitney test for pairwise comparisons. For the Recall variable, statistical analysis shows a significant difference ( $\chi^2=20.58$ ,  $P=.000$ ) in favor of the Control Video group, which obtained the highest score ( $11.05 \pm 3.12$  a.u.). For Transfer, the Control Video group also obtained the highest score ( $4.50 \pm 0.94$  a.u.) with a significantly considerable difference observed ( $\chi^2=22.11$ ,  $P=.000$ ). Regarding the Efficiency variable, a significant difference was detected between the groups ( $\chi^2=7.46$ ,  $P=.024$ ). Concerning the Time variable, a significant difference was also found ( $\chi^2=6.76$ ,  $P=.034$ ). This result indicates that the Continuous Video group took more time to complete the task ( $4.75 \pm 0.96$  sec), while the Control Video group was the fastest ( $3.70 \pm 1.12$  sec), followed by the Feedback Video group ( $4.34 \pm 1.75$  sec).

The post-hoc analysis via the Mann-Whitney test revealed that the Video Control Group had significantly better recall than the Video Continuous Group ( $U=52$ ,  $P=.000$ ,  $r=.636$ ) and the Video Feedback Group ( $U=71.5$ ,  $P=.000$ ,  $r=.554$ ). For the transfer test, both the Video Control Group and the Video Feedback Group achieved significantly higher scores than the Video Continuous Group ( $U=47$ ,  $P=.000$ ,  $r=.674$  and  $U=73$ ,  $P=.000$ ,  $r=.560$ , respectively). However, no significant difference was found between the Video Control Group and the Video Feedback Group ( $U=151$ ,  $P=.157$ ). The same results were obtained for the efficacy test, where the Video Control Group and the Video Feedback Group had significantly higher scores than the Video Continuous Group ( $U=118.5$ ,  $P=.026$ ,  $r=.353$  and  $U=110$ ,  $P=.014$ ,  $r=.389$ , respectively). Again, no significant difference was found between the two groups (Video Control Group and Video Feedback Group) ( $U=187.5$ ,  $P=.732$ ). Regarding the time test, the Video Control Group required significantly less time than the Video Continuous Group ( $U=101.5$ ,  $P=.005$ ,  $r=.443$ ), and took less time than the Video Feedback Group, although the difference did not reach statistical significance ( $U=159.5$ ,  $P=.259$ ). However, no significant difference was observed between the Video Control Group and the Video Feedback Group ( $U=159.5$ ,  $P=.259$ ). These results show that the control video is more effective in improving recall and transfer of learning. Video feedback improves performance efficiency compared to the continuous video group; however, it does not surpass the control video group. The time taken to complete the task is significantly reduced for the control video group. No significant difference is observed in the perception of difficulty, suggesting that all groups experienced a nearly similar cognitive load during the task execution.

### **Situational Interest Scale in Physical Education (SIS-PE) Analysis**

The statistical tests revealed significant differences between the three groups for certain dimensions of the SIS-PE. Since five dimensions did not follow a normal distribution, non-parametric tests were applied, namely the Kruskal-Wallis test for comparisons among the three groups and the Mann-Whitney test for pairwise comparisons. For the "Total Interest" dimension, where the conditions for normality and homogeneity of variances were met, a univariate ANOVA comparison was conducted. The results in Table 2 show a significant difference between

**Table 1.** Comparison of Learning and Performance Test Results Among the Three Groups.

Variables	CVG (Group 1)		CTR (Group 2)		FBG (Group 3)		H	P	$\eta^2_H$	Sig. Post-hoc b/w groups 1, 2 and 3
	M	SD	M	SD	M	SD				
Recall (a.u.)	6.00	3.21	11.05	3.12	7.60	3.06	20.58	.000**	.590	1-2** 2-3**
Transfer (a.u.)	2.65	1.13	4.50	0.94	4.10	1.02	22.11	.000**	.612	1-2** 1-3**
Difficulty (a.u.)	4.20	1.32	4.20	2.44	3.60	2.70	1.335	.508	.152	NA
Effectiveness (a.u.)	4.90	1.77	6.35	2.08	6.55	2.03	7.46	.024*	.356	1-2* 1-3*
Time (s)	4.75	.96	3.70	1.12	4.34	1.75	6.76	.034*	.338	1-2**

Note: M = Mean; SD = Standard Deviation; H = Kruskal-Wallis H-test value;  $\eta^2_H$  = Eta-squared effect size for ranks; Sig. Post-hoc = Significance of post-hoc tests between group 1, 2 and 3 (Mann-Whitney test for pairwise comparisons). CVG= Continuous Video group; CTR = Control Video group; VFB = feedback Video group. Variables: (Recall, Transfer, Difficulty, Effectiveness) =Sores; (s)=second. “\*\*” -  $P < .05$ ; “\*\*\*” -  $P < .01$ .

the groups for "Instant Pleasure" ( $\chi^2(2) = 11.32, P = .003$ ), and "Intention to Explore" ( $\chi^2(2) = 88.44, P = .015$ ). The analysis of "Total Interest" using ANOVA reveals a significant effect ( $F_{2,57} = 4.11, P = .021, \eta^2 = .126$ ), with a post hoc significant difference between the Continuous Video Group and the Feedback Video Group ( $P = .027$ ). This result suggests that continuous exposure to video generates significantly higher interest than delayed video feedback.

A post hoc analysis using the Mann-Whitney test confirmed that instant pleasure was significantly higher in the Continuous Video group compared to the Control Video group ( $U = 101, P = .007, r = .427$ ) and the Feedback Video group ( $U = 87, P = .002,$

$r = .488$ ). These results suggest that the continuous video modality promotes a more immediate sense of pleasure among students. Regarding "Intention to Explore," the results show a significant difference in favor of the Continuous Video group compared to the Feedback Video group ( $U = 99, P = .006, r = .437$ ). This result suggests that the continuous video mode encourages more active and autonomous exploration of the task by students, compared to the other two video modalities. In contrast, the results showed no significant differences for the dimensions "Attention Demand" ( $\chi^2(2) = 3.78, P = .151$ ) and "Novelty" ( $\chi^2(2) = 2.758, P = .276$ ).

**Table 2.** Comparison of scores on the French 19-item Situational Interest Scale across the three groups.

SIMS Dim	CVG (Group 1)		CTR (Group 2)		FBG (Group 3)		F/H	P	$\eta^2/\eta^2_H$	Sig. Post-hoc b/w groups 1, 2 and 3
	M	SD	M	SD	M	SD				
Pleasure (a.u.)	2.55	.93	1.78	.91	1.66	.67	11.32 (H)	.003**	.438	1-2** 1-3**
Intention to Explore (a.u.)	2.75	.88	2.23	.77	2.00	.88	8.44 (H)	.015*	.378	1-3*
Novelty (a.u.)	1.76	1.04	2.25	1.47	1.36	.56	4.37 (H)	.112	.272	NA
Attention Demand (a.u.)	2.28	1.29	1.95	.73	1.60	.67	3.78 (H)	.151	.253	NA
Challenge (a.u.)	2.75	.87	3.16	1.06	3.13	.97	2.57 (H)	.276	.209	NA
Total Interest (a.u.)	2.57	.89	2.00	.80	1.86	.78	4.116 (F)	.021*	.126	1-3*

Note: Values (scores 7-point Likert scale) are presented as Mean  $\pm$  SD. SIMS = Situational Motivation Scale. Dim = Dimensions; M = Mean; SD = Standard Deviation; F = ANOVA Fisher value; H = Kruskal-Wallis H-test value;  $\eta^2$  = Eta-squared effect size;  $\eta^2_H$  = Eta-squared effect size for ranks; Sig. Post-hoc = Significance of post-hoc tests between group 1, 2 and 3 (Bonferroni for ANOVA Fisher value or Mann-Whitney test for pairwise comparisons). CVG= Continuous Video group; CTR = Control Video group; VFB = feedback Video group. “\*\*” -  $P < .05$ ; “\*\*\*” -  $P < .01$ .

## Discussion

As mentioned earlier, video in physical education serves as a crucial didactic and pedagogical tool. However, its often complex and fast-paced nature can lead to cognitive overload if not adapted to the learners' capacity for assimilation. In this

context, interactivity, particularly through control over video pacing and the integration of feedback, emerges as an effective strategy to overcome these challenges and optimize learning. Acknowledging the critical importance of tactical competencies and their key role in the effectiveness and collective performance of team sports<sup>33</sup>, our study aligns with this approach, assessing

the effect of different video presentation modalities on tactical handball learning, based on three main hypotheses.

First, we hypothesized that the groups with “video control” and “video feedback” would perform better in terms of recall, learning transfer, and efficiency compared to the group watching a “continuous video”. Our results largely confirm this expectation. Specifically, the “Video Control” group demonstrated outstanding performance in both recall and tactical knowledge transfer tests, significantly outperforming both the “Video Continuous” and “Video Feedback” groups. This modality, which allows learners to interact actively with the content by adjusting the pace, revisiting complex sequences, or slowing down the video, provides a clear advantage in managing cognitive load. As noted by<sup>19,21</sup>, the ability to control the flow of information enables students to process and integrate elements more thoroughly. By adjusting the time allocated to each segment of the sequence, handball players were able to enhance their memorization and better extract relevant information for learning tactical movements. This autonomy in processing information helps reduce cognitive overload, allowing learners to build more robust mental schemas and transfer their acquired knowledge more effectively to real-game situations. Our findings align with the study by<sup>25</sup>, which showed that using video control to teach basketball tactics in physical education had a positive impact on students' learning, as measured by recall and transfer tests. Their study highlights that controlling the video pace helps students retain information better while minimizing the extraneous cognitive load caused by the transient nature of video. This conclusion is consistent with our own observations, where video control facilitated cognitive load management and improved learning efficiency.

Furthermore, the “Video Control” group demonstrated that self-regulation in learning leads to increased efficiency<sup>27</sup>. highlight the importance of active engagement in the learning process, which enhances self-efficacy and learners' confidence. By managing the video's progression, students do not simply receive information but reorganize and adapt it to suit their individual needs. This approach, supported by<sup>34</sup>, not only strengthens knowledge acquisition during viewing but also facilitates the transfer of skills to new situations. As a result, the improvement in recall and transfer test scores observed in the “Video Control” group confirms that interactive control is a powerful tool for more sustainable assimilation and the effective application of tactical skills in physical education. The “Video Feedback” group also achieved better results than the “Video Continuous” group, albeit through a slightly different mechanism and with less pronounced effects than those observed in the “Video Control” group. This group benefited from delayed feedback, which gave learners the opportunity to self-assess their performance and correct mistakes after reviewing their actions. As noted by<sup>6,26</sup>, video feedback helps students recognize their weaknesses and identify specific technical aspects that require improvement. This self-correction process encourages deeper reflection on the movements performed, reinforcing the retention of correct techniques and enhancing the transfer of knowledge to various game situations. Although the interaction mechanism in the “Video Feedback” group is less immediate than in the “Video Control” group, the integration of feedback structures the learning process by providing objective analysis and clear reference points. This results in improved recall and transfer test performance. Our findings align with the study by<sup>35</sup>, which compared the effectiveness of verbal and video feedback in enhancing dance skills among children aged 6 to 12. While their results showed variability in the effectiveness of these interventions depending

on the individual, video feedback was particularly beneficial for certain dancers. These dancers demonstrated significant improvements in movement execution, a trend also observed in our study, where video feedback supported self-assessment and error correction, leading to better recall and skill transfer performance. These findings further support the notion that, while the effectiveness of video feedback may vary among individuals, it remains a powerful tool for supporting learning, particularly in contexts where visual analysis and performance reflection are crucial.

In summary, the two interactive modalities, “Video Control” and “Video Feedback”, prove to be significantly more effective than simple continuous video exposure (Video Continuous) for tactical learning in handball. While video control optimizes cognitive load management by allowing autonomy in regulating the viewing pace (as confirmed by<sup>19,21</sup>, video feedback enhances learning by enabling precise, corrective self-evaluation<sup>6,25</sup>. Similarly, optimizing parameters in small-sided games, particularly the number of players and the duration of training, has been showed to directly influence participants' technical performance and emotional balance<sup>36</sup>. This analogy illustrates that adjusting the parameters of a pedagogical intervention, here the type of video, the level of interactivity, and the control of pace, can have a significant impact on learning. Although the “Video Control” group achieved superior results compared to the “Video Feedback” group, both approaches contributed to a significant improvement in learning performance, particularly in recall and transfer. This highlights the importance of incorporating interactive modalities into physical education instruction.

In the context of our second hypothesis, we anticipated that participants with access to “video control” would report higher situational interest than those in the other groups. However, our results revealed the opposite trend: the “Video Continuous” group reported higher situational interest than both the “Video Control” and “Video Feedback” groups. More specifically, the analyses showed that immediate enjoyment and the intention to explore were significantly higher in the “Video Continuous” group, indicating that this modality encourages a more spontaneous and autonomous interaction with the task. These findings contrast with our initial assumption and suggest that the continuous video presentation, by providing a smooth and uninterrupted experience, fosters a more enjoyable perception of learning. According to situational interest theory<sup>37</sup>, a learner's engagement can be influenced by the structure of the task itself. While we expected video control to stimulate interest by allowing active regulation of the learning pace, our results suggest that the additional cognitive effort required by this modality may have reduced the immediate enjoyment perceived by the students. This observation aligns with cognitive load theory<sup>15</sup>, which suggests that increased cognitive demands, particularly through control over the learning medium, can lead to mental overload, thereby diminishing learners' immediate motivation. In other words, while video control and video feedback offer a structured and effective framework for learning, they seem to result in a less enjoyable experience due to the more demanding cognitive processing required. Our results are consistent with the findings of<sup>27</sup>, who demonstrated a positive effect of video control on students' situational interest in basketball. Similarly, studies by<sup>6,25</sup> showed that video feedback, by encouraging reflection on performance and error correction, could enhance learners' motivation. However, in our study, this more analytical interaction with the task appears to have reduced the effect on immediate enjoyment, which is a key component of situational

interest according to<sup>26</sup>.

However, these results do not diminish the value of “video control” and “video feedback” but rather suggest that their implementation should be optimized to prevent cognitive overload and maximize student engagement. Several avenues for improvement can be considered. First, it may be helpful to pair the use of video control with clear instructions and prior training to assist learners in managing their exploration of the content without feeling overwhelmed. Second, video feedback could be enhanced by incorporating guided comments or visual cues that help students identify errors and understand the necessary corrections.

Lastly, a gradual approach where video control and feedback are introduced progressively after an initial phase of continuous video exposure may allow students to benefit from these tools while preserving their situational interest<sup>15,38</sup>. Thus, our results emphasize the importance of balancing the structuring of learning with maintaining immediate enjoyment to ensure optimal learner engagement. While “video control” and “video feedback” remain valuable educational tools, provided their use takes into account learners’ cognitive limitations and is implemented gradually and appropriately within the context of physical education learning<sup>26,38,39</sup>.

Regarding our third hypothesis, we predicted that the group with access to “video control” would exhibit higher self-efficacy scores and complete tasks more quickly than the other groups. Our results confirm this hypothesis in terms of self-efficacy: the “Video Control” group achieved the highest self-efficacy scores among the three groups, suggesting that the ability to freely adjust the “video continuous” and regulate their own learning plays a crucial role in building confidence in their abilities. By allowing students to revisit specific sequences or accelerate their understanding at their own pace, “video control” promotes a stronger sense of mastery and autonomy - key elements in developing self-efficacy. These findings align with the work of<sup>23</sup>, who demonstrated that interactivity and “video control” enhance students’ self-efficacy in physical education.

Regarding task execution time, our results also reveal significant differences. In fact, the “Video Control” group completed tasks in less time, confirming that the ability to control the video content (by adjusting the speed or revisiting specific sequences) facilitated more efficient learning compared to the other groups. These results align with self-regulation theory, which suggests that giving learners control over their learning process enables them to optimize their performance<sup>40</sup>. The “Video Feedback” group also showed a significant improvement in self-efficacy compared to the “Video Continuous” group, although it did not reach the same level as the “Video Control” group. This difference may be explained by the fact that “video feedback” helps students identify their errors and adjust their approach, but it does not provide full autonomy over the learning process. Therefore, while feedback strengthens students’ confidence in their abilities, it is less effective than direct control over the video in fostering a sense of mastery. Our results are consistent with the study by<sup>9</sup>, which demonstrated that self-regulation through “video feedback” significantly contributes to improving students’ self-efficacy.

Finally, our results support the notion that both “video control” and “video feedback” are effective tool to enhance students’ self-efficacy and performance in learning tasks. However, “video control” appears to have a more pronounced effect on reducing task execution time, suggesting that allowing students to regulate their own learning is a powerful means of optimizing their performance.

## Practical Applications

Physical education teachers can leverage interactive videos to enhance learning effectiveness. The “video control” modality allows learners to progress at their own pace, fostering autonomy and reducing time spent on technical execution. Conversely “video feedback” promotes self-assessment and facilitates error correction. Non-interactive videos remain valuable for stimulating immediate interest and enjoyment, particularly at the start of a learning cycle. To optimize outcomes, it is advisable to tailor video modalities to specific educational goals: prioritize video control for complex technical skills and non-interactive videos to boost motivation and engagement. Gradual introduction accompanied by clear, adapted instructions helps mitigate cognitive load. Finally, adjusting video duration and session frequency balances learning efficiency with student enjoyment.

## Conclusions

This study highlights the pivotal role interactive modalities, such as “video control” and “video feedback”, in optimizing tactical learning in physical education, especially in handball. These tools enhance autonomous regulation of learning pace and provide valuable performance feedback, significantly improving recall and knowledge transfer. Notably the “video control” group exhibited superior efficacy, increased self-efficacy, and reduced task execution time due to greater learner autonomy. Although “video feed back” showed slightly lower outcomes, it remains integral in fostering self-assessment and error correction. Interestingly, the simplest, non-interactive video elicited higher situational interest, engaging students through uninterrupted content flow and immediate enjoyment, thus fostering intrinsic motivation for autonomous exploration. These findings suggest best practices for integrating interactive videos: introduce “video control” and “video feedback”, gradually will precise instructions to manage cognitive demands and enhance engagement. Moreover, fine-tuning video length and session frequency ensures a seamless learning experience that maximizes pedagogical effectiveness while preserving enjoyment. Careful adaptation to learners’ cognitive capacities and needs is essential to maximize the tools’ educational impact.

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## Informed Consent Statement

Parents of the students were informed about the scope of the study, and their consent was obtained.

## Ethical Committee approval

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## Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Author-s contribution

Conceptualization, M.B.R. and M.S.B.; methodology, M.B.R.; investigation, M.B.R. and M.S.B.; formal analysis, K.T., I.M.; validation, K.T.; resources, M.S.B. and M.B.R.; data curation, G.R.; writing—original draft preparation, M.B.R.; writing—review and editing, M.S.B.; visualization, G.R., I.M.; supervision, J.P.; project administration, J.P. All authors have read and agreed to the published version of the manuscript.

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