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Using Interactivity Principle to Improve Tactical Learning in Physical Education Context

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Abstract

Background: Educational videos are widely used in Physical Education (PE) to enhance motor skills and motivation, but they often increase cognitive load due to the transient nature of the information.

Objectives: To investigate the impact of redundant information and learner control over video pacing on tactical knowledge acquisition in PE.

Methods: Eighty third-year secondary school students (40 boys and 40 girls) were divided equally into four groups: "Audio non-control," "Audio + Text non-control," "Audio with control," and "Audio + Text with control. They were asked to memorize a basketball video game scenario, then completed recall and transfer tests.

Results: Higher recall and transfer scores were achieved with video plus audio-only instruction. However, introducing textual instruction decreased learning effectiveness, underscoring the negative effects of redundancy, reflecting a negative impact from information redundancy.

Conclusion: The results confirm the relevance of modality and redundancy principles in PE and highlight video control as a viable strategy to reduce redundancy effects.

Keywords: *Video, Redundancy, Video Control, Learning, Basketball, Modality.*

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1. Introduction

Videos are becoming a preferred educational tool in physical education (PE) noted for enhancing learning outcomes beyond what is typically achieved with traditional methods. Their effectiveness stems from their ability to provide clear, real-time demonstrations of physical activities and concepts – advantages that might be less effectively conveyed through static texts or images (1). Therefore, this dynamic presentation can make complex movements and techniques more understandable and accessible. However, the benefits of using videos in PE are countered by significant drawbacks, particularly regarding the cognitive load imposed on learners. This issue arises primarily because of the transient nature of video content; as information moves and changes rapidly, it can be difficult for learners to adequately encode and integrate this visual information (2).

Multimedia learning theory (3, 4) offers several principles aimed at improving video-based learning, one of which is interactivity. This involves various ways of engaging with video content, such as adjusting the sequence, choosing specific parts, or altering the speed of the video. This method encourages active cognitive participation, helping learners effectively absorb the information presented in the videos (5). This is in contrast to more passive learning approaches, like simply watching videos without interaction or attending traditional lectures, where active learning is often preferred. Active learning aids in the selection, organization, and integration of new data into existing knowledge bases, effectively reducing cognitive load and enhancing learning quality (6). However, caution is advised regarding the potential for redundant information. Research indicates that visual and verbal information are processed separately, and there's a limit to how much each channel can handle before it becomes overwhelmed. Some research highlights that presenting the same information through multiple sensory channels can lead to unnecessary cognitive strain, particularly affecting the visual channel and causing a diluted focus across multiple sources of information (7).

The primary aim of this study is to investigate methods for enhancing the effectiveness of instructional videos used in teaching tactical skills in PE, with a specific focus on basketball. We are particularly interested in examining two key factors: the role of interactivity and the impact of redundant information within the video content.

2. Materials and Methods

2.1. Participants

To determine the appropriate sample size for the experiment, we conducted an a priori power analysis using G*Power 3.1.9.7. This analysis considered various factors such as fixed effects, special effects, main effects, and interactions. We set the effect size at 0.40 (F = 3.13), with an alpha level of .05 and a power level of .95. The power analysis indicated that a sample of 80 participants was required. Consequently, 80 students, equally divided between girls and boys, were included in the study. The participants of the study were 80 tenth-grade students (Mage = 16,10; SD = 1.32months; 40 boys and 40 girls) from three secondary schools in Ariana, Tunisia. They were randomly assigned to one of four experimental groups: "Audio non-control" (N = 20), "Audio + Text non-control" (N = 20), "Audio with control" (N = 20), and "Audio + Text with control" (N = 20). All participants and their legal guardians gave their written or verbal consent for participation. The experiment was conducted according to the ethical guidelines of the Helsinki declaration and was approved by the local ethical committee of the High Institute of Sport and Physical Education of Sfax, Tunisia. It also complied with the ethical and procedural requirements of the journal for the conduct of sports medicine and exercise science research (8).

2.2. Protocol

The game scenario, with a duration of 20 seconds, depicted an offensive basketball situation and was developed in collaboration with two experienced PE teachers and a professional basketball coach (each with over 10 years of experience) to ensure its realistic representation. This scenario featured three offensive male players, numbered (1), (3), and (4), engaging in a clearly identifiable attacking situation involving various game actions such as passing, dribbling, and shooting, totaling 18 game actions. The scenario commenced with the team initiating an attack (action 1) and concluded when one of the players scored a basket (action 18). The scenario was enacted by three young, skilled players (mean age = 16.7 years) serving as models and was recorded using a Canon 1300d camera positioned 1 meter above the ground, at the center of the court. The camera maintained a fixed position without zooming or utilizing panoramic viewing during the recording. During the learning phase, the game scenario was displayed on a 32 x 20 cm screen of an HP Pavilion dv6 entertainment PC placed 30 cm away from the participant, with a viewing angle of approximately 45 degrees.

2.3. Experimental Versions

The material presented on the computer comprised a game sequence illustrated in four formats, with the factors "redundancy" and "control" manipulated across different groups. In the "redundancy" group, the text corresponding to the oral explanation was displayed on the screen, while in the "no redundancy" group, this text was omitted. The displayed texts were short, consisting of 2 to 3 sentences that appeared simultaneously at the beginning of each slide. For the "with control" group, learners had the ability to pause, rewind, or fast forward through the video. Conversely, in the "no control" groups, the slides transitioned automatically without the possibility for the users to interrupt the information flow.

2.4. Measures

2.4.1. Learning performances:

Two assessments were used to evaluate student learning outcomes: A recall-reconstruction test and a transfer test. In the *recall-reconstruction test*, participants were tasked with sequentially reproducing the evolution of the game system by correctly positioning the players and/or the ball. Each correct answer was awarded one point, with a maximum score of 18 points; incorrect answers received zero points. In the *transfer test*, learners were required to apply the knowledge acquired from the learning material on a half basketball court. Specifically, each participant was instructed to replicate the actions performed by a randomly selected player from the learning material (i.e., player ①, player ④, or player ③).

2.4.2. *Perceived Difficulty:*

Participants rated the difficulty associated with the learning task using a nine-point scale (9) ranging from "1 - very very low" to "9 - very very high", which is known to be a reliable measure of experienced mental effort

2.5. *Procedure*

During a regular PE session at the beginning of the school year, students from each class participated in the experiment. At the outset of the experimental session, students were briefed on the study requirements and completed the ethics protocols. They then completed a questionnaire requesting demographic information and inquiring about their prior experience in basketball and other team sports. Subsequently, each student was quasi-randomly assigned to one of four experimental conditions: "Audio non-control" (N = 20), "Audio + Text non-control" (N = 20), "Audio with control" (N = 20), and "Audio + Text with control" (N = 20). For each condition, students were informed that they would have 60 seconds to memorize the evolution of the game situation as accurately as possible. This duration corresponds to three times the real-time duration of the scenario. The decision to allocate 60 seconds was based on findings from a pilot test, which demonstrated that this duration was sufficient for comprehending the development of the game system. Immediately following this learning phase, students were instructed to perform, in sequence: (i) the difficulty test, (ii) the recall test, and (iii) the motor transfer test on the basketball field. The study was conducted in a single session lasting approximately 90 minutes.

2.6. *Statistical Analysis*

Data analyses were conducted using SPSS Version 21. We used a univariate analysis of variance (ANOVA) to assess between-group differences, and the significance level was set at $p = 0.05$. No consequential violations of normality or homogeneity of variance were detected. Tukey post-hoc test was used to compare the groups. We used partial η^2 as the effect size index, taking 0.01, 0.06 and 0.14 as the η^2 values for small, medium, and large effect sizes (10).

3. Results

Table 1 presents the mean scores and standard deviations of the three dependent variables (*i.e.,* recall scores, transfer scores, and perceived difficulty).

Table 1. Means (M) and Standard Deviations (SD) of recall, transfer, and difficulty Scores across four experimental conditions

	Non-control		With-control	
	Audio + Text (N =20)	Audio (N =20)	Audio + Text (N =20)	Audio (N =20)
Recall (0-18)	4.4 (1.698)	8.55 (2.79)	7.05 (3.845)	10.25 (2.35)
Transfer (0-9)	2.85 (1.268)	5.8 (1.02)	4.2 (1.151)	6.1 (1.31)
Difficulty (0-9)	7 (1.486)	5.55 (1.25)	5.3 (1.894)	4.8 (0.88)

The ANOVA on recall scores revealed a significant main effect of condition ($F(3, 76) = 13.354$, $p < 0.001$, $\eta^2 = 0.34$), indicating differences among the groups. Specifically, the 'Audio with control' group outperformed the 'Audio non-control' group ($p = 0.008$). Moreover, the 'Audio non-control' group surpassed the 'Audio + Text with control' group in performance ($p < 0.001$). Additionally, the 'Audio + Text with control' group achieved higher recall scores than the 'Audio + Text non-control' group ($p = 0.007$).

The ANOVA on transfer scores also indicated a significant main effect of condition ($F(3, 76) = 24.966$, $p < 0.001$, $\eta^2 = 0.49$). The 'Audio with control' group performed comparably to the 'Audio non-control' group ($p = 0.48$). Nonetheless, it significantly outperformed both the 'Audio + Text with control' group ($p < 0.001$) and the 'Audio + Text non-control' group ($p < 0.001$). Additionally, the 'Audio + Text with control' group achieved higher scores than the 'Audio + Text non-control' group ($p = 0.002$).

The analysis of perceived difficulty indicated a significant effect of condition ($F(3, 76) = 7.6046$, $p = 0.0016$, $\eta^2 = 0.23$). The results showed that the 'Audio + Text with control' group perceived a higher level of difficulty compared to the 'Audio with control' group ($p < 0.001$), the 'Audio non-control' group ($p = 0.003$), and the 'Audio + Text non-control' group ($p < 0.001$). However, there were no significant differences in perceived difficulty between the 'Audio with control' group, the 'Audio non-control' group, and the 'Audio + Text non-control' group ($p > 0.05$ for all comparison).

4. Discussion

The aim of this study was to assess the interactive principle when learning of basketball video. Results from recall and transfer tests clearly showed that students in in both with-control conditions ('Audio + Text' and 'Audio') performed better than those in the non-control conditions, thus confirming the effectiveness of interactive learning principles in the context of PE. This finding aligns with existing research emphasizing the crucial role of interactivity in enhancing learning outcomes through video-based instruction (11, 12).

Furthermore, the analysis of difficulty test results uncovered a significant trend: students in the control conditions encountered fewer difficulties compared to those in the non-control conditions. This difference can be attributed to the flexibility offered by pace control, enabling learners to tailor the speed of the presentation to match their cognitive processing capacity (13, 14). By enabling learners to regulate the information intake to their cognitive and perceptual ressources, video control promotes deeper cognitive engagement and more effective knowledge acquisition (15, 16). Moreover, a key focus of this study was to examine the impact of redundancy on learning performance. Results indicated that participants exposed to both redundant conditions (Audio + Text) performed worse (in terms of recall and transfer performances) compared to their counterparts in the non-redundant conditions. This finding corroborates existing research which underscores the detrimental effects of redundancy on learning performance (17-19). Additionally, examination of difficulty test results revealed that participants exposed to both redundant conditions perceived the learning situation as more challenging compared to their counterparts in the non-redundant conditions. This underscores the cognitive load imposed by redundant information, further highlighting its negative impact on learning outcomes.

5. Limitations

Despite the significant findings reported in this study, it's important to acknowledge certain potential limitations when interpreting the results. The learning material utilized in these experiments was presented through a single, brief video and focused solely on the acquisition of tactical knowledge. Therefore, future research is warranted to ascertain the robustness of these findings in delayed learning situations, particularly with materials involving the acquisition of motor knowledge. Additionally, the study design focused on a single PE session. Given that it takes many sessions for PE teachers to assess the robustness of a new pedagogical tool (20, 21), future studies should explore the effect of implementing interactive video learning throughout a compete cycle of PE on student engagement and performance.

6. Conclusion

In conclusion, the results of the current study confirm the relevance of interactivity and redundancy principles in PE and underscore the importance of considering them when designing instructional videos aimed at improving tactical awareness in the PE context.

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Ethical Approval and Consent to Participate

All participants and their legal guardians gave their written or verbal consent for participation. The experiment approved by the local ethical committee of the High Institute of Sport and Physical Education of Sfax, Tunisia.

Consent for Publication

The participants provided their written informed consent to participate in this study.

Availability of Data and Materials

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Competing Interests

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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Authors' Contributions

Both authors contributed equally to the writing of the manuscript, and both gave their final approval to the version that will be published.

Declaration

The authors declare that ChatGPT-4o was employed to enhance the academic English of certain sections of this manuscript (22).

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