Moving Images, Moving Minds: A Qualitative Exploration of Cognitive Processing During Animation-Based Sports Learning

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ABSTRACT

*The introduction of digital technologies in physical education has opened new opportunities for delivering sports information and movement skills with the use of visually rich educational materials. Animated instructional movies can demonstrate movement sequences, emphasize technical aspects, and deconstruct complicated sports ideas. However, learning through animation requires cognitive processes such as selective attention, mental representation, information integration, memory and perceived cognitive burden**.** The study followed an exploratory qualitative research approach. The sample consisted of 15 people, both undergraduates and postgraduates, and was selected using convenience sampling. Participants viewed a brief animated instructional video on kickball illustrating game procedures and movement sequences. Open-ended structured interviews and retrospective verbalizations were utilized after the film to probe participants' attention, perception, mental imagery, understanding, recall, cognitive difficulties, and perceived application of the demonstrated skills. The acquired data were analyzed using reflexive thematic analysis, based on the approach of Braun and Clarke (2006), and NVivo 15 was used to systematically organize and code the data. The findings indicated that animation design and multimodal presentation supported participants' understanding and engagement with the sports-learning content. Rapid presentation of movement sequences, however, created processing challenges and made some information difficult to follow and visualise. The study highlights the importance of considering cognitive processing when designing animated instructional content for sports education.*

Keywords: *Animation, Cognitive Processing, Sports Learning, Physical Education, Multimedia Learning, Mental Imagery, Qualitative Research.*

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INTRODUCTION

Digital media is now an integral part of the daily lives of children and young people. They provide an opportunity to develop innovative teaching methods and to change traditional learning experiences (Kergel et al., 2021). Digital technologies are increasingly being used in teaching and learning in physical education (PE), to help in the presentation, understanding and practice of sport skills (Jastrow et al., 2022). However, despite the increasing use of technology in the daily lives of young people, physical education still depends on traditional instructional methods in many contexts. This lack of research indicates a need to explore how to effectively integrate digital learning resources into physical education to improve students' learning experiences (Casey & Goodyear, 2015).

Multimedia instructions are learning environments that combine text and visual to enhance learning. Examples include illustrated textbooks, narrated slide shows, animated stories online, and educational video games (Mayer, 2011). As student-athletes, they are often pressed for time and tired, which may impede their learning of theory and ability to balance their academic and athletic responsibilities (Thompson et al., 2024). Animated movies, for example, can speed up the learning process by

visualizing complex knowledge, with the use of educational technology. However, there is not enough evidence that it works for student-athletes (Chao et al., 2025). Therefore, it has been proposed that instructional interventions based on multimedia tools would be more adapted to their learning demands (Kao & Luo, 2020; Novan et al., 2024).

Observational learning or modelling is an important teaching strategy for motor skill acquisition. It is learning by observing a model carry out a certain behaviour and attempting to imitate that behaviour (Lirgg & Feltz, 1991; McCullagh & Meyer, 1997). Learning observation of physical education enables students to learn the pattern of movement, body position, coordination and technical aspects of sports skills before doing the skills. This can be supported by video-based educational resources which provide repetitive demos that can be viewed as many times as needed by learners. The repeated exposure could assist learners to gain a better grasp of movement patterns and the connection between different phases of skill performance (Ningthoujam, 2016).

The acquisition of motor skills is a complex process involving the development of movement patterns through observation, practice and experience. Research has shown that watching experts doing movements usually helps learning motor skills more than verbal instructions, because it helps to build mental representations (De Stefani et al., 2020). Also, visual images help to understand spatial relationships and movement dynamics, with animations showing important properties such as direction and time. However, the constant change of animations can be a difficulty for cognitive processing (Khacharem et al., 2014).

Video based education has been helpful to acquire motor skill and has shown better result in continuous video situation than static images while learning tough methods such as judo (H'mida et al., 2020). Especially video feedback can be useful for learners to find errors in their movements and understand the gap between the intended and executed movement (Mödinger et al., 2021; Trabelsi and Souissi, 2024).

The design of the instructional video is important for its effectiveness as the learners might not notice the important information unless it is well organized and broken down (Biard et al., 2017). Segmentation can aid learners to handle cognitive demands, and enhance procedural learning. Besides, the selective attention of learners is different and they tend to pay attention to visually salient features rather than relevant details, which affects their overall understanding (Lowe, 2003).

The effectiveness of instructional design is further illustrated by findings on segmentation and expertise, indicating that advanced learners benefit from tailored segmentation strategies (Khacharem et al., 2012). Overall, this body of research underscores the implications of visual information, instructional design, and learners' prior knowledge in enhancing motor learning outcomes.

To learn effectively, learners must be able to find relevant words and pictures, organize them meaningfully, and connect them to their prior knowledge (Sun et al., 2025). But when the information is changing quickly or visually complicated learners may find it difficult when many pieces compete for their attention. For example, in animated sports training, people must attend concurrently to body position, direction of movement, timing and sequences of actions. Even a movie that is correct and attractive can be educationally ineffective if the learners are not able to identify the key elements or the relationship between the many components of the action (Urquiza-Fuentes & Velázquez-Iturbide, 2013).

The current literature indicates that further research is needed on learners' cognitive experiences with these videos. Research has also shown that selective attention plays a role in processing dynamic visual

information. These findings have important implications for instructional design, but they are limited in the extent to which they clarify how learners view animated demonstrations, locate relevant material, create mental models, recall sequences, and solve cognitive difficulties.

The present study attempts to fill this gap by evaluating learners' cognitive processing while viewing an animated video for teaching kickball skills. It examines how learners process visual information, learn movement sequences, integrate the provided information, remember important details, and solve cognitive challenges.

Theoretical Framework

The study is based on five key theories. These theories describe the usefulness of animated instructional movies for the understanding of the learners.

Cognitive Theory of Multimedia Learning (CTML)

Cognitive Theory of Multimedia Learning (CTML) explains the processing of information through visual and linguistic channels underlining the significance of animated instructional films in enhancing learning by combining visual and audio data. Given the limits of cognitive ability (Mayer & Anderson, 1991), skillful performance of animation, narration, and text is necessary. Principles of multimedia learning such as modality, signaling and coherence suggest that well-structured information helps learners to process knowledge in an efficient way. Studies have shown that when you combine animation with narration, you achieve a better understanding since the visuals provide cues to the words being spoken. However, an excess of multimedia elements can overload cognitive capacities and hinder understanding (Mayer & Moreno, 2003). Therefore, in multimedia design, it is important to reduce cognitive load so that learners can pay attention to the important information and work on design factors such as complexity, pace, and integration of visual and verbal elements (Mayer et al., 1999).

Cognitive Load Theory (Sweller, 1988)

It states that learning is constrained by the limited capacity of the human cognitive system and the performance of challenging cognitive activities requires much processing capacity, decreasing the resources available for the acquisition of new knowledge. The idea emphasizes the importance of managing cognitive loads, especially in animated instructional films, because learners need to digest several forms of information, such as movement, graphics, narration, and text. Good animated videos might thus help learners to focus on important material and learn it well (Sweller, 1988).

Social Cognitive Theory / Observational Learning

In physical education, observational learning is a significant method of learning motor abilities by watching demonstrations of movements from other people. Observational learning may be a useful factor in the acquisition of motor skills as visual demonstrations allow the learner to see key components of a movement such as body position, sequence of movement and timing. This perspective is particularly relevant for animation-based sports learning, since animated instructional videos are able to present movement skills in a clear, controlled, and repetitive fashion. This implies that observational learning provides a useful theoretical framework for attempting to understand how learners interpret displays of animated sports movements and how this processing may lead to an effective skill acquisition (Han et al., 2022b)

Mental Representation / Mental Imagery

Mental imaging is an important cognitive mechanism in motor-skill learning, as it enables learners to replicate a movement mentally before or in conjunction with physically performing it. (Guillot & Collet, 2008) the Motor Imagery Integrative Model in Sport, focused on the function of motor

imagery in motor learning, performance, strategies and problem-solving. Their approach implies that mentally picturing a movement can help in planning and executing motor skills. Evidence for this view is found in Effectiveness of mental imagery as an adjunct to physical practice in the acquisition of sport-specific motor skills: a systematic review and meta-analysis. When considering animation-based learning of sports, viewing an animated example may give learners with visual information that helps them develop an internal image of the movement that can then be mentally rehearsed before to the actual performance. Thus, mental imagery and internal representation are a suitable theoretical framework to analyze the cognitive processing of animated demonstrations of sports motions by learners (Lindsay et al., 2021).

Objective

- To explore how animation design and multimodal features support learners' understanding and engagement.
- To identify the cognitive load and processing challenges experienced during animation-based sports learning.
- To examine learners' comprehension, memory, and mental representation of game procedures and movements.
- To examine the interrelationships among animation design, cognitive load, selective attention, mental representation, and comprehension and memory during animation-based sports learning.

METHODOLOGY

Research Design

This study conducts a qualitative exploratory research design (Creswell, 2014) to explore the cognitive processing and learning experiences of undergraduate and postgraduate students while watching an animated instructional video. This approach helped the researcher understand participants' perspectives, interpretations, and experiences. The study involved 15 undergraduate and postgraduate students selected through convenience sampling. An animated instructional video on Kickball (wikiHow, 2021) was used as the learning stimulus. After watching the video, participants responded to 10 open-ended questions through structured interviews. The questions focused on participants' attention to the instructional content, mental representation of the demonstrated movements, integration of visual and verbal information, understanding and recall, perceived cognitive difficulty, and perceptions of animation design features that supported or hindered learning. This procedure allowed participants to describe their experiences and explain how they understood the information presented in the video. The collected responses were analysed using thematic analysis to identify recurring patterns and themes related to participants' cognitive processing during animation-based sports learning (Braun & Clarke, 2006). The exploratory design provided an opportunity to gain an in-depth understanding of how undergraduate and postgraduate students perceived and processed information presented through the animated Kickball instructional video.

Data collection Procedure

A research instrument is a tool used to collect and document data for a study. In the present study, a set of 10 open-ended structure interview questions is used to explore participants' experiences and cognitive processing while learning through an animated instructional video. The researchers initially showed the chosen animated instructional video on kickball to the participants, instructing them to watch it carefully. They answered ten open-ended, structured questions about their educational experience after watching the video. The questions were about how the visual, verbal, and animation elements helped or hindered the participants' learning, as well as what they saw, comprehended, remembered, and found challenging while watching the animation. Qualitative coding and theme exploration was conducted on fifteen undergraduate and graduate student responses collected and sorted in NVivo.

Further, the identified patterns were classified into themes related to the learners' experiences of animation-based sports education and cognitive processing.

Analysing of Data

The qualitative data were analysed using an inductive thematic approach to identify periodic patterns in participants' experiences of learning through an animated instructional video on Kickball. The analysis involved reading the responses, assigning initial codes to meaningful statements, grouping related codes into categories, and organising these categories into main themes. The themes were developed from participants' responses rather than being assigned solely on the basis of the theoretical framework. This approach is consistent with the flexible and systematic use of thematic analysis described by (Braun & Clarke, 2006).

The analysis was organised into five main themes: (1) Selective Attention and Engagement, (2) Animation Design and Multimodal Learning, (3) Mental Representation and Embodied Learning, (4) Comprehension and Memory of Game Procedures, and (5) Cognitive Load and Processing Challenges. Together, these themes represent participants' reported experiences of attending to the animated content, interpreting visual and spoken information, imagining game actions, recalling game procedures, and identifying aspects of the video that were difficult to process. NVivo 15 software was used to organise the participants' responses, apply the established codes, and group them under the respective themes. The researcher reviewed and interpreted the coded data to identify patterns relevant to the study objectives.

RESULT AND FINDINGS

The thematic co-occurrence analysis was employed to comprehend the emergence of the five themes in participants' responses and their interrelations during the learning process facilitated by the animation-based sports film. The five themes recognized included Animation Design and Multimodal Learning, Cognitive Load and Processing Difficulties, Comprehension and Retention of Game Procedures, Mental Representation and Embodied Learning, and Selective Attention and Engagement.

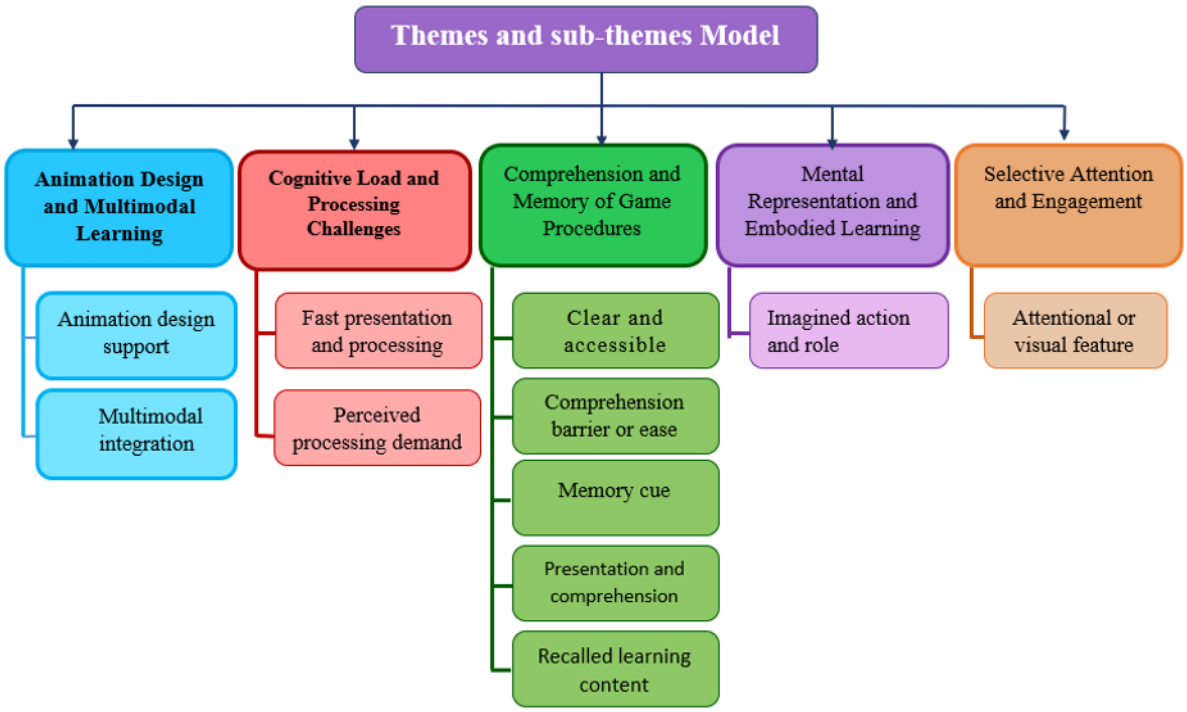

Figure 1. *Model of themes and sub-theme.*

Objective 1. Animation Design and Multimodal Learning in Supporting Understanding and Engagement

The area of Animation Design and Multimodal Learning was signified by 32 coded references, indicating that participants often addressed the significance of animation, visual representation, and the integration of many information modalities in their educational experience. This theme exhibited four co-occurrences with the comprehension and memory of game procedures and three co-occurrences with selective attention and engagement. The correlation between Comprehension and Memory of Game Procedures indicates that the presentation of information through animation and various visual components occasionally influenced participants' capacity to grasp and retain the game procedures. Similarly, the co-occurrence with Selective Attention and Engagement suggests that animation and multimodal presentation were similarly connected to how participants focused on and interacted with the instructional content. The results indicate that animation design served not only as a presentation tool for the game, but also played a crucial role in aiding learners to concentrate on the content and comprehend the operations illustrated.

Objective 2. Cognitive Load and Processing Challenges During Animation-Based Sports Learning

Cognitive Load and Processing Challenges includes 13 coded references. The theme did not directly co-occur with any of the other four themes. This indicates that participants mainly described cognitive difficulties and processing challenges as independent experiences, rather than in combination with animation design, comprehension, mental representation, or attention. However, the 13 coded references indicate that some parts of the animated instructional content required greater mental effort from learners. For example, participants may have had difficulties when information or motions were presented rapidly, when they had to follow a series of activities, or when a particular movement was difficult to imagine. But the animation helped learning on many levels, and the results also suggest that some portions of the video required additional cognitive processing demands from learners.

Objective 3. Comprehension, Memory, and Mental Representation of Game Procedures and Movements

Comprehension and Memory of Game Procedures were the most prevalent theme, with 61 coded references. This means that for the participants, mastering the rules, processes and chronology of the game was fundamental to their experience of learning. The theme had 4 co-occurrences with Animation Design and Multimodal Learning, and 3 coded references with Selective Attention and Engagement. This suggests that the participants' comprehension and recollection were rarely addressed in combination with the manner in which information was conveyed and the focus they allocated to the video. 14 coded references were for Mental Representation and Embodied Learning, with participants describing experiences of mentally visualizing, understanding or reflecting the physical motions portrayed in the video. However, there was no direct co-occurrence between Mental Representation and Embodied Learning and Comprehension and Memory of Game Procedures. Thus, participants described learning the game processes and cognitively visualizing physical motions as two related but independent aspects of their learning experience. These findings together suggest that learners were not just striving to remember what to do in the game, but were also building a knowledge of how the actions may be accomplished.

Objective 4. Interrelationships Among Animation Design, Attention, Cognitive Load, Mental Representation, and Comprehension

Overall, the five themes together provided a clear picture of how participants experienced, understood, and processed the animated sports-learning content during the learning process. The strongest co-relation was between Animation Design and Multimodal Learning and Comprehension and Memory of Game Procedures with 4 co-occurrences. It was followed by the correlation between Animation Design and Multimodal Learning with Selective Attention and Engagement and Selective Attention and Engagement with Comprehension and Memory of Game Procedures with 3 co-occurrences. The associations suggest that distribution of animation, learner attention and involvement, and learner understanding and retention were related in the participants' divisions. Conversely, Cognitive Load and Processing Challenges and Mental Representation and Embodied Learning seemed to be more separate features of the educational experience. The results emphasize that sports education with the use of animation activates various cognitive functions- attention, multimodal processing, understanding, memory, mental visualization of movement, the regulation of cognitive load.

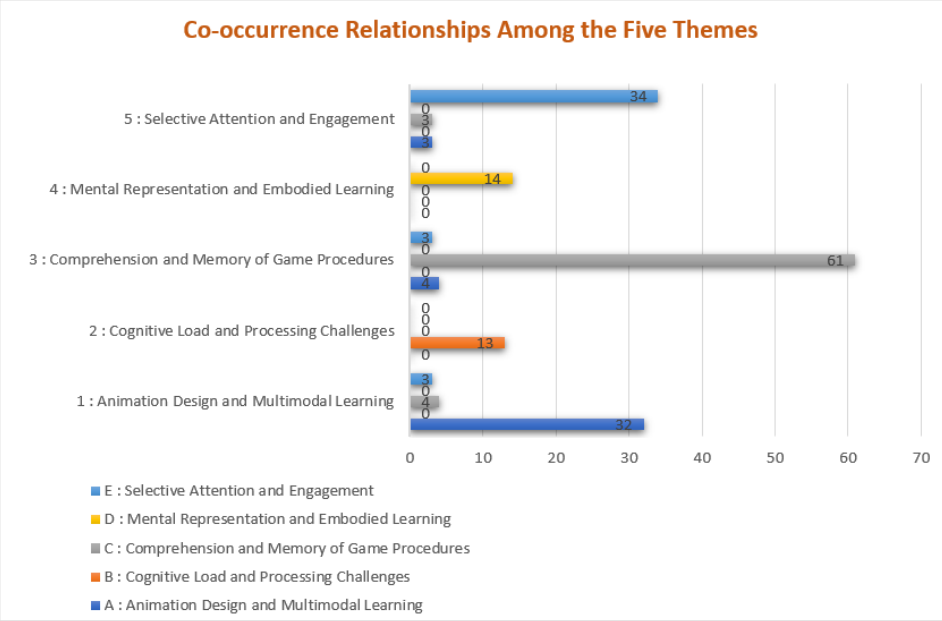

Figure 2. *Co-occurrence Relationship Among the Five Themes*

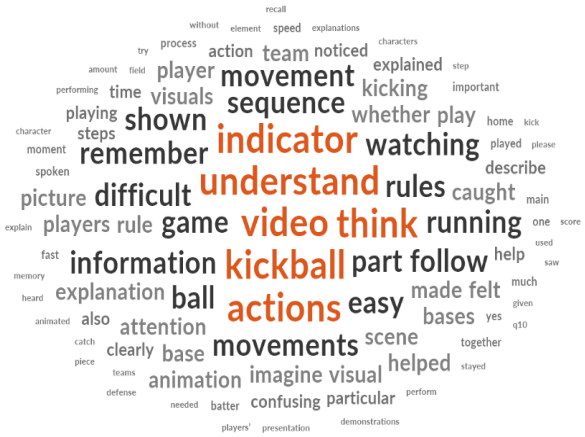

Figure 3. *Word cloud of participants' responses to animated kickball learning*

DISCUSSION

The findings of the present study provide insight into how learners cognitively processed an animated instructional video

while learning kickball. Among the five themes, Comprehension and Memory of Game Procedures was the most prominent, with 61 coded references, followed by Selective Attention and Engagement (34), Animation Design and Multimodal Learning (32), Mental Representation and Embodied Learning (14), and Cognitive Load and Processing Challenges (13). These findings suggest that participants' experiences were mainly centred on understanding and remembering game procedures, maintaining attention, and processing the visual and multimodal information presented in the animation. This is consistent with the Cognitive Theory of Multimedia Learning, which explains that learners process visual and verbal information through separate but interacting channels and actively select, organise, and integrate relevant information during learning (Mayer & Moreno, 2003; (Mayer and Anderson 1991, 1992) also point to the importance of coordinating animation with verbal information. They suggest that the meaningful integration of visual movement and verbal explanation can facilitate understanding.

The co-occurrence analysis showed the connection between these learning experiences. The strongest correlation was between Animation Design and Multimodal Learning and Comprehension and Memory of Game Procedures with four co-occurrences. Animation Design and Multimodal Learning also co-occurred 3 times with Selective Attention and Engagement, and Selective Attention and Engagement co-occurred 3 times with Comprehension and Memory of Game Procedures. This pattern suggests that the presentation of animated information was related to what learners attended to and how they understood and remembered the game procedures. (Lowe 2003) also found that learners selectively process dynamic visual information and may attend to elements that are visually salient rather than those most salient to understanding. Therefore, animation should not only attract attention but should also guide learners towards relevant information. Previous studies have also demonstrated the value of dynamic demonstrations in sports learning. (De Stefani et al. 2020) concluded that learning new sports actions was more effective with expert demonstrations than with verbal explanations plus static images. (H'mida et al.2020) found that continuous video was better than static pictures for teaching a complex judo technique.

Mental Representation and Embodied Learning, 14 coded references, further demonstrates that learners were not simply recalling the rules and procedures, but were mentally visualizing and representing the movements demonstrated in the animation. This is consistent with the theory that observation may help learners to construct an initial mental model of a movement before its physical enactment (Jeannerod, 2006). Studies on mental imagery have also shown that mentally simulating movements can be useful for the planning and learning of sport-specific motor skills (Guillot & Collet, 2008; Lindsay et al., 2021). Thus, animated demonstrations may provide learners with visual information that helps them understand how a movement should be performed and mentally rehearse its sequence.

At the same time, Cognitive Load and Processing Challenges accounted for 13 coded references and did not directly co-occur with the other themes. This suggests that processing difficulties appeared as a relatively distinct part of participants' learning experiences. Cognitive Load Theory explains that learners have limited cognitive processing capacity, and excessive or poorly organised visual, verbal, or movement information can place unnecessary demands on this capacity (Sweller, 1988). Segmentation and appropriate pace can help in procedural learning (Biard et al., 2017), and design of animation, segmentation and previous knowledge of the learners can influence mental effort and learning in the case of animated sports situations (Khacharem et

al., 2012). To summarize, the results suggest that visual and multimodal processing, selective attention, comprehension and memory, mental representation, and cognitive effort are all interrelated processes in animation-based sports learning. Therefore, animated instructional videos should not simply be visually attractive; they should follow appropriate multimedia and animation principles, use clear and high-quality visuals, maintain suitable pacing, coordinate visual and verbal information, and direct learners' attention towards important movements and procedural steps. Such design considerations may make animated sports instruction easier to process and more supportive of meaningful learning.

CONCLUSION

The study found that the viewing of animated sports instructional videos has an impact on the learners' understanding and processing of information. Watching animated sports instructional videos is kickball. This study finding shows that animation helped participants understand game procedures, pay attention to visual information, and imagine themselves performing the action. Some participants experience difficulty processing the information when presented too fast. In this study five main themes highlight the importance of animation and cognitive load, comprehension and memory, mental representation, and attention in animation-based sports learning. All finding suggest that well- design animated instructional videos help learners understand and easily gain new information about sports skills. This study also highlights the importance of proper guidelines when creating animated instructional videos for students.

The visual and verbal information should be easy for learners to understand. Animation helps learners to form a better mental image of sports movements before they actually practice them. The findings could help teachers and instructional designers to develop more effective instructional materials for physical education. However, findings are based on participant experiences and do not prove improvements in actual sports performance. Future research should investigate the influence of animation-based learning on the acquisition of practical skills and on long-term memory, and the role of animated videos and live demonstrations should be compared to better understand the role of both in sports education.

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