

THE CONTRIBUTION OF TECHNOLOGIES TO PROMOTING PHYSICAL LITERACY IN DEVELOPMENTAL AGE

IL CONTRIBUTO DELLE TECNOLOGIE PER PROMUOVERE LA PHYSICAL LITERACY IN ETÀ EVOLUTIVA

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ABSTRACT

Physical literacy (PL) is a multidimensional concept that, building on physical-motor experiences, aims to develop in students a lasting awareness of the benefits of physical activity. New generations are growing up in socio-cultural environments enriched by communication technologies that influence learning methods. In this context, active video games (AVGs) can serve as a complement to physical exercise, helping to develop aspects of PL.

L'alfabetizzazione motoria (PL) è un concetto multidimensionale che, basandosi su esperienze corporeo-motorie, mira a sviluppare negli studenti una consapevolezza duratura dei benefici dell'attività fisica. Le nuove generazioni crescono in ambienti socio-culturali arricchiti dalle tecnologie della comunicazione che influenzano i modi di apprendere. In questo contesto, i videogiochi attivi (AVG) possono rappresentare un'integrazione dell'esercizio fisico, contribuendo a sviluppare aspetti della PL.

KEYWORDS

Physical Literacy, Active Video Games, Developmental Age
Alfabetizzazione motoria, Video Giochi Attivi, Età Evolutiva

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1. Physical Literacy, Reference Models, and New Educational Scenarios

Physical Literacy (PL) refers to the educational process of learning *through* the body and motor activities, which has gained increasing recognition in recent years. It has contributed to shaping new pathways for educational research, both internal and external projects in educational institutions, and connections with other fields such as sports, leisure, healthcare, and more.

To date, literature presents multiple definitions and interpretations of Physical Literacy (Grauduszus et al., 2023); however, the definition from the IPLA (International Physical Literacy Association, 2017) is widely accepted by many authors. This definition describes Physical Literacy as the motivation, confidence, physical competence, knowledge, and understanding needed to engage in physical activities mindfully and responsibly throughout life. This definition echoes that provided earlier by M.E. Whitehead (2013).

Physical Literacy is thus a multidimensional concept, grounded in physical-motor experiences, aiming to foster students' understanding of the lifelong benefits of physical activity. It involves acquiring and mastering fundamental motor skills, understanding principles of physical fitness, rules of games and sports, and making informed choices about physical activity across different contexts. It goes beyond simply learning sports skills or improving physical efficiency, constituting a true educational process through motor activity from early childhood and primary school. In this perspective, motor experiences serve as a medium in the educational process and are fundamental instructional tools for both disciplinary and cross-disciplinary learning.

This context highlights the need for instructional approaches (methodological and organizational) that value the whole person, with the core components of Physical Literacy closely aligning with those of motor competence (Carl et al., 2023). These include the interaction of skills, knowledge, and attitudes based on each person's motor abilities, cognitive, emotional, and social abilities in relation to the contexts in which they are applied (Colella, 2011). Indeed, as supported by the embodied cognition approach (Shapiro, 2019), movement occurs solely within a body situated in a physical environment, with changes in both elements altering action possibilities.

Skill acquisition broadens the individual motor repertoire, thereby generating further opportunities for exploration and learning. Reciprocally, new motor competencies require the development of perception, planning, problem-solving abilities, and engagement of executive functions (Adolph & Hoch, 2019).

To promote an understanding of the intrinsic meanings of PL and establish a shared terminology, the ministry has developed the Australian Physical Literacy Framework (APLF), published in August 2019. Physical Literacy is defined in this document as the integration of motor, psychological, social, and cognitive abilities that support an active and healthy lifestyle. The Framework identifies 30 elements divided across four domains: physical, psychological, social, and cognitive (Tab. 1).

Understanding children's level of Physical Literacy will help to identify the best ways to support young people, thereby increasing the likelihood that they remain physically active throughout their lives (Australian Sports Commission, 2019a).

Some elements of Physical Literacy, although significant, are challenging to measure objectively (e.g., "connection with place" in the psychological domain). For this reason, the tool is designed to allow children to express their perception through self-assessment, which holds substantial educational value, as scientific evidence shows that children's self-perception is closely related to their behavior in physical activity.

Physical Domain	Psychological Domain	Social Domain	Cognitive Domain
Locomotor Skills	Engagement and enjoyment	Relationships	Knowledge of content
Movement with equipment	Self-confidence	Collaboration	Safety and risk
Object control	Motivation	Ethics	Rules
Coordination	Connection to place	Society and culture	Reflection
Balance	Self-perception		Cognitive strategies and planning
Flexibility	Emotional regulation		Tactics
Agility	Self-control (of one's actions)		Perceptual awareness
Strength			
Muscular endurance			
Cardiovascular endurance			
Reaction time			
Speed			

Table 1 (Domains of Physical Literacy according to the Australian APLF model)

Promoting Physical Literacy from childhood, therefore, brings lasting benefits throughout life. In other words, it is essential that young people and adolescents acquire motor competence to understand the importance of maintaining an active lifestyle and increasing their level of physical activity (Cairney et al., 2019).

At a time when the study of various technologies is often at the center of interest to understand their real educational value, it is crucial not to underestimate the importance of Physical Literacy in the educational journey of children and adolescents.

New generations grow up in socio-cultural contexts rich in stimuli and knowledge, primarily determined by new communication technologies, which lead to different ways of experiencing and stimulate various learning styles and paces.

The introduction of new technologies in physical education and sports fosters a shift in the traditional disciplinary structure, setting, objectives, content, and organizational methods. The cultural and practical landscape, in this sense, is rich and constantly evolving.

Numerous technological applications related to promoting physical and sports activity are now available and easily accessible. In elite sports, technologies have been widely used for years, for example, to measure and assess various factors of performance and exercise intensity, such as through video analysis of performances and competitions, to the more recent and sophisticated equipment for training and functional recovery (Knjaz, Rupčić, & Antekolović, 2016).

In health promotion programs through physical activities, for different age groups, the use of smartphones, pedometers, and heart rate monitors connected through the web, GPS positioning systems (Global Positioning System), or participation in some modern outdoor games (geocaching) allows individuals not only to systematically monitor, daily and periodically, the quantity and types of physical activities but also to follow specific programs for the development of physical fitness through online tutorials, and acquire information on proper eating habits in relation to physical activity (Papastergiou, 2009).

The adoption of technology in school curricula has been gradual (and is still ongoing), driven by the continuous professional development of teachers, institutional funding, and the availability of infrastructure for practical activities. This process has promoted interdisciplinary integration and a cross-curricular teaching perspective. The presence of technology requires a requalification of teachers' skills to effectively integrate content, tools, and teaching methods,

fostering interdisciplinary learning environments and spaces that connect disciplinary knowledge with the technological devices used daily by students.

However, some questions arise to clarify the connection between promoting the educational process of Physical Literacy through the use of technologies.

Can technologies contribute to the improvement of all domains of PL?

How can the educational process and PL be promoted through technologies?

In what ways can we talk about the mind-body connection through technologies in school teaching?

2. Exergames, Differences and Comparisons Across Different Areas of the Metaverse

Technology in the form of digital games is clearly a problem when it comes to reducing daily outdoor physical activity, but it can provide young people with an opportunity to increase the amount of time spent on play-based physical activities (Hansen & Sanders, 2011). Physical inactivity in children and youth remains a significant health issue that can only be addressed through a multidisciplinary and multi-component approach.

This approach should include structured and integrated educational interventions across various disciplines, combined with attractive and fun opportunities such as walking school buses, active breaks, and sports initiation programs that encourage children and young people to engage in daily physical activity.

Unlike the active, healthy individual, those who use video games are often seen as isolated individuals sitting for long hours in front of a television or computer screen. However, challenging this dichotomy between video games and the motor abilities of the player, an alternative type of video game has been developed: Active Video Games (AVG) (Cece et al., 2023).

Active gaming seems to align well with the culture of children and adolescents, providing an enjoyable alternative to traditional exercise and allowing children to play digital games that offer fun through physical activity.

The new generation of Active Video Games (AVG) represents a technology recently introduced in the field of health promotion. Preliminary evidence supports the use of active video games as a fun way to engage in physical activity of low to moderate

intensity, with the key component of these games being human movement (Vagheti et al., 2018).

Vagheti and colleagues (2018) analyzed 25 active games for each of the three most popular gaming consoles on the market (Nintendo Wii, Xbox Kinect, and PS Move), specifying which motor abilities were targeted in each game, including: motor coordination (both gross and fine motor skills, upper and lower limbs), endurance, strength, balance, and flexibility. This knowledge can guide teachers in selecting games based on the motor abilities they wish to develop.

For scientific research, it remains to be proven how active video games can be effectively used in the long term to help motivate an increase in daily physical activity and a decrease in sedentary pastimes.

Teaching makes use of digital tools to promote learning, while also enabling students to acquire competencies in using these tools.

Ennis (2013) argues that active video games (AVG) could contribute to achieving multiple objectives related to physical education, in three distinct but interconnected approaches. First, AVGs promote participation and enjoyment in physical activity, particularly among less skilled and more reluctant students. These students may feel less intimidated when competing against an avatar rather than against more experienced classmates, and may also prefer to engage in such activities without being observed. This is referred to as the "recreational approach."

Second, AVGs can increase physical activity levels and bring health benefits related to greater energy expenditure and physical effort. This is known as the "public health approach."

Third, AVGs can facilitate learning through motor experience; this "educational approach" aims to develop the physical, cognitive, affective, and social dimensions.

Each approach has a specific goal in the development of the individual throughout life. It is evident that these three approaches address different needs, and each is influenced by the others. Without participation in motor activities for fun (recreational approach), health benefits (public health approach), and the development of physical, cognitive, affective, and social dimensions (educational approach), the benefits would not be achievable. Therefore, AVGs can potentially contribute to all three approaches (Ennis, 2013).

Moreover, among the types of technologies are those related to augmented reality. The metaverse is constantly evolving as a space that connects the real world,

integrating and/or expanding it with the virtual world. Recently, the idea has spread that the metaverse and the virtual world are the same thing; however, the prevailing opinion is that the real world and the virtual world are now fused and interconnected (Yu, 2022).

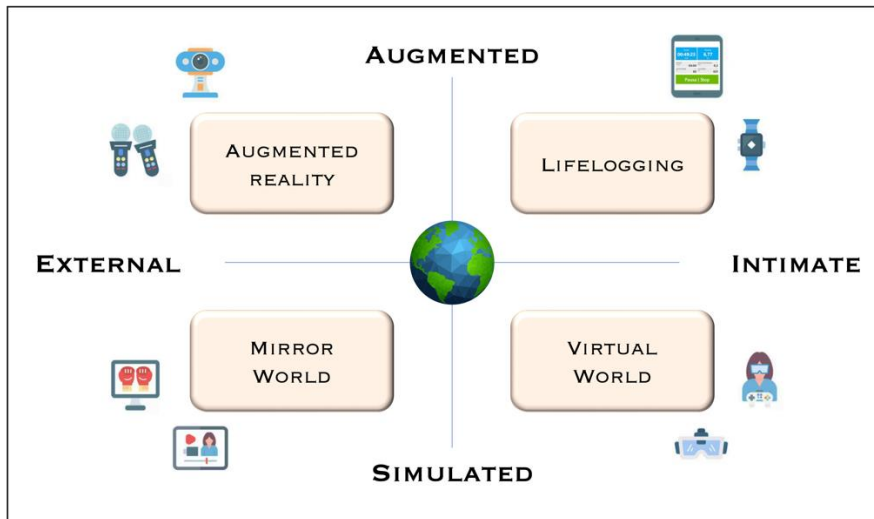


Figure 1 (Four Types of Metaverse. Adapted from Yu (2022))

As specified by the author, in Figure 1, the horizontal axis represents the degree of reflection of the surrounding environment and the devices used (external), with an intensification of the user's immersion (intimate). The vertical axis, on the other hand, distinguishes between the increase in reality, which is a space where information is implemented, and the simulation in the virtual world. Based on this criterion, the horizontal axis is divided into external and intimate elements, while the vertical axis is divided into augmentation and simulation.

Consequently, four categories can be classified: augmented reality, lifelogging, mirror world, and virtual worlds (Yu, 2022). Augmented reality is a technology that enhances the quality of practice by integrating virtual information into real spaces and times. This technology allows students to interact with enriched virtual content. Some examples of sports games using augmented reality through interactive screens include golf, tennis, baseball, ping-pong, yoga, dance activities, and more.

For example, a typical example of lifelogging is the smartwatch, which usually works independently or as a peripheral device connected to a smartphone. However, by being worn closely on the wrist, it can constantly collect physiological information from the human body, such as heart rate, blood pressure, metabolic consumption, body temperature, electrocardiogram, etc. (ibidem). It therefore allows real-time monitoring of the changes in our body caused by physical exercise, as well as the analysis, programming, and sharing of information about lifestyle and daily habits. Since not all students have the same physical abilities, it is essential that teachers are aware of this and adapt activities to meet their needs (Suriya & Arumugam, 2020).

Recall that during the Covid-19 pandemic, when outdoor recreational and sports activities were limited, some students were still able to engage in physical activities through virtual reality. Virtual reality sports can allow users to experience the real effects of physical exercise within a virtual system.

The mirror world is a simulation of the external world that represents virtual models of the real world, enriched with additional information. Think of Google Earth or Google Maps, which allow users to "move" and visit places anywhere in the world, or programs in tablets installed on treadmills or indoor bikes that simulate a route during exercise, or recorded fitness lessons. This type of metaverse transfers the appearance, information, and structure of the real world into a virtual context. Rather than being a simple replica of reality, it constitutes an efficient expansion of it. The mirror world is made possible by technologies such as lifelogging, tools and sensors for geospatial mapping and modeling, and location recognition technology that connects real and virtual spaces (Yu, 2022).

The benefits of augmented reality, lifelogging, and virtual reality include the possibility of use in small spaces and the rapid sharing of knowledge between teachers and students. The benefits of the mirror world are similar to those of the previous three types of metaverse, but the ability to share knowledge and feedback between teacher and student may be less functional or absent. The disadvantages of augmented reality, lifelogging, and virtual reality include the high cost of devices and technical complexity, which can be difficult to understand. The mirror world also has the disadvantage of functioning optimally only if supported by a 5G or higher computer network (ibidem).

In the context of metaverse technologies, lifelogging plays a significant role, especially in exercise physiology and sports training. Meanwhile, the mirror world

offers the possibility for teachers and a large number of students to pedal together and teach correct exercise methods directly on a screen.

In summary, “Active Video Games” (AVG) are evolving to go beyond their simple recreational purpose. Some of their features may offer new opportunities for physical education teaching. Despite two decades of experimentation and numerous studies on the impact of AVG on children and adolescents, no study has yet evaluated the results of these tools in the school context (Cece et al., 2023).

3. Literature review

Active Video Games (AVG) emerge as an effective tool for improving certain aspects of Physical Literacy (PL) and health-related fitness, representing a potential resource for enhancing motor competencies in children and adolescents—an important element in the fight against the triad of pediatric inactivity (Faigenbaum et al., 2018).

AVG can also be considered a complementary alternative to traditional exercise to promote well-being during childhood.

There are several reviews in the literature that have highlighted the potential of AVG in the physical domain (increasing physical activity levels and fitness), the psychological domain (pleasure, enjoyment, mood states), and the cognitive domain (content knowledge, strategy and planning, rules) (Vagheti et al., 2018; Cece et al., 2023; Ho et al., 2024).

However, there is a growing body of studies evaluating the effects of technological tools in the physical and psychological domains, but fewer studies investigate the social components.

Therefore, this study aims to clarify and provide an updated overview of the use of new technologies in recent years for the promotion of Physical Literacy.

The goal of this short review is to identify studies published in recent years (2017-2024) that have implemented interventions through Active Video Games (AVG) or exergames, in order to assess their effects across all domains of Physical Literacy according to the Australian Physical Literacy Framework (APLF), namely, the motor, psychological, cognitive, and especially the social domain, the latter of which has been less explored in the existing literature.

The research was conducted through the "sportdiscuss" and "googlescholar" databases, using the keywords "Physical literacy, technology or active video game or exergame."

Only articles with full text available were selected. Studies that used active video games or technological tools in school or university contexts and assessed all or at least two of the PL domains were included. Studies that only assessed components of the physical domain were excluded (Tab. 2).

Only 5 studies met the inclusion criteria, and none evaluated components of the Social Domain (Tab. 3).

Authors	Sample	AVG used	Results
Jenny et al. (2017) – U.S.A.	N: 89 (F=52,8%), EG: 43; CG: 46. Average age: 21.47	PlayStaion4 e Xbox One. Videogame: Don Bradman Cricket 14.	Experimental Group (EG) - CRICKET: rules, terminology, player positions ↑ - Intention to watch and practice CRICKET ↑
Guerrero & Chandler (2018) – Canada	N: 9 (F=33%). Average age: 9.11	Imagery techniques + motor practice: - Motivational imagery: on outcomes and goals (MS); general motivational arousal (MG-A); control, confidence, and mastery (MG-M); - Cognitive imagery: of skills (CS); strategies and routines (GC).	Post intervento: - Motivation ↑ - Confidence ↑ - Perceived self-efficacy ↑ - Motor competence ↑
Jenny et al. (2022) – U.S.A.	N: 34 (F=47%). Average age: 19.71	Videogame: Don Bradman Cricket 14.	Experimental Group (EG) - CRICKET: rules, terminology, player positions ↑ - Intention to watch and practice CRICKET in the future ↓

Goncalves et al. (2024) - Francia	N: 79 (F=43%) Age: 7-11	Warm-up: Groove app (JustDance Nintendo); Math session: Newton and Puzz apps; Cool-down: Gaia app	Post-intervention: - Physical literacy ↑ - Motivation ↑ - Classroom concentration ↑ - Academic performance = - Mathematical self-efficacy =
Ahmadi Noradinvand & Khajavi (2024) - Iran	N: 60 CG: 15; GS1: 15; EG2: 15; GS3: 15; Average age: 9.43	Xbox Kinect. Video games: bowling, athletics, tennis, soccer, volleyball, and basketball.	Experimental Group with AVG (EG2): - Physical fitness ↑ - Physical literacy ↑ - Motivation and confidence ↑ - Knowledge and perception ↑

Table 2 (Brief description of the included studies)

Authors	Physical Domain	Psychological Domain	Social Domain	Cognitive Domain
Jenny et al. (2017) – U.S.A.		✓ Enjoyment; Motivation.		✓ Knowledge of the content; Rules; Tactics.
Guerrero & Chandler (2018) – Canada	✓ Perceived self-efficacy; Motor Competence.	✓ Motivation; Self-esteem.		✓ Use of imagery; Imagination ability.
Jenny et al. (2022) – U.S.A.		✓ Enjoyment; Motivation.		✓ Knowledge of content; Rules; Strategy and planning; Tactics.
Goncalves et al. (2024) - Francia	✓ Physical Literacy	✓ Motivation; Mathematical self-efficacy; Concentration.		✓ Academic results.
Ahmadi Noradinvand & Khajavi (2024) - Iran	✓ Physical Literacy; Physical fitness.	✓ Motivation and Self-esteem		✓ Knowledge and perception

Table 3 (Domains of PL evaluated in the included studies)

4. Discussion

Physical Domain

Three out of five studies assessed the physical domain (Guerrero & Chandler, 2018; Goncalves et al., 2024; Ahmadi Noradinvand & Khajavi, 2024). In the first study, the results showed a significant increase in perceived self-efficacy and motor competence from pre- to post-intervention in children assigned to the experimental group with imagination and physical activity, but not in those who only participated in physical activity. The two variables were assessed using the Canadian Assessment of Physical Literacy Second Edition (CAPL-2; Longmuir et al., 2018) for the first, and the Canadian Agility and Movement Skill Assessment (CAMSA; Longmuir et al., 2015) for the second.

The positive effect of imagery on competence perception extends the findings of previous experimental studies on the use of imagery and perceived physical competence (Catenacci et al., 2015, cited in Guerrero & Chandler, 2018, p. 9), providing evidence for the effectiveness of combining imagery with physical practice to improve not only competence perception but also the performance of various motor skills.

In the second study, the Physical Literacy Assessment for Youth (PLAYself; Canadian Sport for Life, 2016) questionnaire was used to assess perceived physical competence, showing higher scores after 3 weeks of intervention, with physical activities using exergames lasting 30 minutes per session, four times a week.

In the third study, the CAPL-2 questionnaire was used to assess perceived competence, and the full protocol of the Canadian model was applied to assess motor skills and abilities, including the Canadian Agility and Movement Skill Assessment (CAMSA), Progressive Aerobic Cardiovascular Endurance Run (PACER), and PLANK. The intervention lasted 8 weeks with 3 sessions of 30 minutes per week. The results confirmed that active video games are effective in improving physical literacy and motor abilities in children.

Psychological Domain

All the studies included assessed the psychological domain, specifically elements such as motivation (5 studies), self-esteem (2 studies), math self-efficacy (1 study), concentration (1 study), and enjoyment (2 studies).

All authors concluded that, although not significantly, the intervention generally had a positive effect on motivation and self-esteem.

There was an overall improvement in concentration in class, but no changes were observed in math self-efficacy. However, allowing students to approach math through more playful modes, such as throwing balls to correctly hit calculation operations in interactive games, seems to foster an increase in interest in the subject (Goncalves et al., 2024).

Many participants reported having fun playing the video game and learning the basics of cricket through the gameplay process. One participant stated that they enjoyed it greatly, despite initially not having a clear understanding of the game's dynamics. Their limited familiarity with video games made the experience initially stressful. However, they found that they had gained much knowledge by the time of the post-intervention assessment, thus recognizing the effectiveness of the video game as a learning tool (Jenny et al., 2017).

Social Domain

None of the included studies assessed elements related to the social domain, such as relationships, collaboration, ethics, society, and culture, as cited by the APLF. No results linking physical literacy and the social domain were found in the search of studies through the mentioned databases.

The social domain of physical literacy focuses on interpersonal competencies related to interaction with others in the context of movement. Social aspects are crucial in creating an inclusive environment where children of various ages and skills can actively participate together. By incorporating activities and traditional games from other cultures, an enriching educational and cultural experience can be offered.

Creating a respectful and supportive culture is essential to ensure a safe learning environment, where participants can feel socially supported in learning, experimenting, and persevering despite mistakes. This support should come not only from educators but also from other participants, parents, and the surrounding community (Australian Sports Commission, 2019b).

Cognitive Domain

All the studies assessed elements of the cognitive domain, such as content knowledge (3 studies), rules (2 studies), strategies and planning (1 study), tactics (2 studies), academic performance (1 study), and the use of imagery and imagination skills (1 study).

In the experimental group, scores related to knowledge and perception did not differ significantly from pre-intervention values, but were slightly higher post-intervention compared to the scores recorded in the control group (Ahmadi Noradinvand & Khajavi, 2024).

Objective knowledge of cricket in the experimental group (EG) significantly increased, while the control group (CG) showed no significant differences between pre-test and post-test. Specifically, the experimental group showed a significant increase in knowledge regarding rules, terminology, player positions, and field layout. A significant difference was found in the subcategory of interest in “physically practicing cricket,” but no significant difference was found regarding the intention to watch cricket live or on television before and after the intervention (Jenny et al., 2017).

It emerged that acquiring a basic understanding of the rules of a sport through video games could later be applied in a real-life context. The results suggest that combining video games with authentic practice in real-life settings may offer greater advantages than the isolated use of either approach (Jenny, 2022).

No significant changes in overall academic performance were observed. However, surprisingly, the intervention facilitated the learning of French, a subject not included in the intervention program, with improvements in academic performance, concentration, and self-efficacy in French observed after the intervention. One possible explanation for this could be the marginal increase in overall concentration across the entire cohort, which showed an immediate improvement in concentration in students after physical activity. This overall increase in concentration may have positively influenced all subjects, especially those considered less complex than mathematics, such as French (Goncalves et al., 2024).

The intervention by Guerrero & Chandler (2018) did not result in improvements in the domain of physical literacy, specifically in imagination or visualization skills. The possible reason for this lack of improvement could be attributed to the intervention not following the PETTLEP model. The PETTLEP model, proposed by Holmes and

Collins (2001), is a guide for making mental imagery and visualization more effective, particularly in sports and rehabilitation contexts. According to the model, to maximize the benefits of mental imagery, seven distinct elements must be included in the imaginative experience:

- a) **Physical:** Imagery should include movements and actions similar to those performed in the real activity. For example, simulating the action of shooting while mentally imagining a basketball shot.
- b) **Environment:** It is important to imagine the real environment or context in which the activity takes place. For example, if an athlete imagines playing a match, they should visualize it in a specific field or stadium setting.
- c) **Task:** The imagery should replicate the exact task the person wants to improve, such as a free throw in basketball or a sprint in athletics.
- d) **Timing:** The visualization should follow the actual rhythm and timing. For example, if imagining a basketball shot, the mental movement should happen at the same speed as the real shot.
- e) **Learning:** Imagery should reflect the individual's current skill level. If someone is a beginner, they should visualize themselves performing skills at that level, then progressively imagine improvement.
- f) **Emotion:** Integrating the real emotions experienced during physical activity can make the imagery more realistic. Mentally experiencing the same level of focus, excitement, or anxiety as during a real performance can improve the effectiveness of the image.
- g) **Perspective:** The mental representation should reflect the individual's normal perspective when performing the motor task or activity. This can, in turn, improve physical literacy and mental representation abilities, allowing individuals to better visualize and understand their actions and improve their motor skills.

Conclusions

Physical activity and physical literacy are fundamentally interconnected in a circular cause-and-effect relationship, as those who enjoy and participate in physical activity are more likely to acquire motor skills, develop physical fitness, motivation, and knowledge to maintain this positive and active lifestyle throughout their lives.

In what terms can we speak of the interaction between mind and body with the use of these tools? The fundamental principle of Embodied Cognition states that most

mental processes develop through sensory-perceptual systems, creating a circular relationship between what is perceived, the object of thought, and the action that follows (Shapiro, 2019).

The various technological devices can be classified in relation to the interactions between body, physical environment, augmented reality, virtual reality, and tools. While all these tools interact with the body and space, some enrich the real environment with virtual constraints, others support the motor task in a totally real environment, and still others immerse the user in a completely virtual world. Therefore, the relationship between the individual and the environment varies depending on the type of metaverse.

This study aimed to investigate whether AVG (Active Video Games) or exergames could stimulate and support all these components of Physical Literacy, considering the elements of the four domains (Table 1) generated by the Australian Physical Literacy Framework within the context of Physical Literacy.

One of the main contributions of exergames is the ability to improve fundamental motor skills (FMS), essential components of physical literacy, as they facilitate the transition to more complex and specific movements required by sports and recreational activities. Through games that encourage movements such as jumping, running, throwing, or kicking, exergames allow participants to practice and refine basic motor skills in an interactive and safe virtual environment (Bailey et al., 2022).

Learning-based exergames can be valuable tools for supporting the implementation of Daily Physical Activity (DPA) policies in schools. However, for educational institutions and other agencies, one of the main barriers might be the high costs of these devices. The use of exergames aimed at learning for 30 minutes a day has shown promising results in increasing physical literacy and student motivation toward other subjects (Goncalves et al., 2024).

Exergames contribute to the improvement of cognitive domain components, as they require players to make quick decisions, plan strategies, and respond to visual and auditory stimuli in real-time, thus also enhancing psychological domain aspects such as attention, concentration, and problem-solving. In team games, the use of educational video games facilitates the understanding of offensive-defensive concepts, such as strategic ball placement and positional adaptation in response to opponents. Since players are not required to physically perform the skills, these games encourage a deeper learning of sports tactics and strategic decision-making skills (Jenny, 2017).

Although no studies specifically investigate the social domain, broadening the field of research reveals various contributions, such as that of Takahashi et al. (2018), which highlights the contribution of specific exergames to encourage and facilitate social and interpersonal interactions among children with neurodevelopmental disorders.

The Australian Physical Literacy Framework (2019a) recognizes the importance of this social dimension, defining it as a set of skills that enables people to communicate, interact, cooperate, and collaborate safely and respectfully during physical activities. This domain is crucial because it allows individuals to build relationships and develop a sense of belonging within a community through shared motor experiences.

It is clear that the social component not only supports the ability to participate in physical activities but also the desire to do so. Creating a positive environment in which participants feel respected and valued is essential for promoting long-term inclusion and motivation toward physical activity. For example, by encouraging children to work together in cooperative activities, the Australian Framework aims to develop social skills such as empathy, respect, and conflict management (Australian Sports Commission, 2019). These skills are not only essential for interactions in sports contexts but also for their application in everyday and future experiences.

Thus, the social domain of physical literacy goes beyond mere participation: it aims to make every motor experience an opportunity to grow, both physically and socially, helping to create individuals who are capable of navigating different social contexts with confidence and competence.

Students interpreted the video game as a stimulus to approach cricket, developing an interest in following the sport in the future, albeit in limited moments rather than a full match. However, the willingness to actively practice cricket was influenced by other factors: the enjoyment students perceive in playing the game, their confidence in their skills to play effectively, and various social factors (Jenny, 2022). Previous research has shown a significant increase in future intentions to participate in sports, both in terms of viewing and practice, among students who interacted with active video games (Jenny & Schary, 2014; Jenny et al., 2017).

The use of video games and, more generally, technologies in teaching motor activities, when well-supported methodologically and integrated through specific and distinctive teacher-student-student interaction modes, can contribute to increasing motivation and participation in daily practice, promoting all factors of

physical literacy across different ages. In this sense, the educational process gains cultural, pedagogical, and social depth.

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