

# The Benefits of Active Video Games for Educational and Physical Activity Approaches: A Systematic Review

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## ABSTRACT

This article sets out to conduct a systematic review of the current literature on active video games as potential educational tools for physical education or physical activity. To begin with, research on active video games for educational and physical purposes has been examined with the purpose of verifying improvement of attitudes, intellectual skills, knowledge, motor skills and physical properties associated with physical activity and physical education. A second aim will be to determine the effectiveness of active video games compared with traditional approaches to physical activity. From this perspective, a systematic literature search from relevant international databases was conducted from January to July 2015 in order to find papers published in journals or conference proceedings from January 2010 onwards. Then, 2648 references were identified in database searches and 100 of these papers met the inclusion criteria. Two main conclusions are to be drawn from this research. Firstly, controlled studies demonstrate that active video games increase capacities in relation to physical activity and education. Secondly, Research also shows that physical activity interventions designed and measured using behavioural theories are more likely to be successful in comparison with traditional exercise activities.

**KEYWORDS:** SIMULATION GAMES, ELECTRONIC LEARNING, VIDEO GAMES, PHYSICAL EDUCATION, SPORTS

## 1 INTRODUCTION

In the early 1980s, a new type of digital game-based learning emerged (Johnson, 2008), “exergame” (a portmanteau word from “exercising” and “game”) also known as active video game (AVG), (Lieberman, 2006). Among the definitions of AVGs, Oh and Yang (2010) define them as “video games that require physical activity (PA) in order to play” creating the connection between AVGs and PA and motivating this review. Roemmich, Lambiase, McCarthy, Fedra and Kozlowski (2012) added to this definition that AVGs intrinsically encourage support shared learning among young players and challenge them at multiple levels of experience. Then, Nurkkala, Kalermo and Jarvilehto

(2014) also concluded that AVGs are a solution which inspires and motivates people to exercise. Finally, Abdul and Felicia (2015) explained that participants’ use of AVGs exerted great influence on both cognitive and emotional levels. These attributes might explain why several youths choose AVG play over traditional exercise (Papastergiou, 2009).

The trend of continuous improvement and innovation in education is an epistemological topic that has existed over a long period of time in the constructivist and sociocultural view of learning and teaching (Kaufman & Zahn, 1993). The innovation process has been associated with students’ motivation (Ames, 1992). Thus, the intrinsic motivation that young people show towards electronic games could be combined with educational content and objectives into “digital game-based learning” (Prensky, 2001) using the aid of particular languages and instruments. Among these instruments, the result of pedagogical actions with video games (Gee, 2004) implies a coordinated activity on the part of students and teachers (Mezirow, 2000).

Initially, serious games and educational computer games appeared within a teaching context as a new tool for physical education (Moreno & Mayer, 2004). However, there was insufficient experimental evidence to prove the effectiveness of serious games and educational computer games in the school practice (e.g., Tobias, Fletcher, Dai, & Wind, 2011; Vogel et al., 2006; Young et al., 2012) and the educational potential of commercial video games has increasingly become a subject for discussion and research. Different papers describe the educational advantages and disadvantages of video games in school (e.g., Egenfeldt-Nielsen, Smith, & Tosca, 2008; Mitchell & Savill-Smith, 2004).

At the beginning of 21st century, AVGs were mostly viewed as instructional media and were associated with teaching practices that used technology as tools to support knowledge structure (Birn, Holzmann, & Stech, 2014). In consequence, most of the current research has concentrated on what participants learn comparing the use of games versus some other forms of instruction or examining how teachers use video games in the classroom (Ennis, 2013). To address this situation, Amory (2010) argues that electronic games should rather be used as a tool to measure learning outcome in a constructivist psychological learning approach.

On the PA approach, the importance of encouraging physical activity behaviour among children relies on the underlying assumption that the behaviour will become part of the person’s life and continue into adulthood (Mitchell et al., 2013; Tzetzis, Avgerinos, Vernadakis, & Kioumourtoglou, 2001). Various

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research studies have demonstrated the significant effect of traditional motor skill development programs on the improvement of motor skills (Fahimi, Aslankhani, Shojae, Beni, & Gholhaki, 2013; Martin, Rudisill, & Hastie, 2009; Sheikh, Safania, & Afshari, 2011). Other studies have been conducted to identify the effects of skill-specific training on objective control skills and fundamental motor skills (Akbari et al., 2009; Mitchell et al., 2013; Robinson & Goodway, 2009). While the literature already suggests various traditional motor skill training programs, AVGs can be proposed as an alternative approach to motor skill instruction. The use of AVGs as a form of exercise incorporates fundamental elements of motor learning (Yen et al., 2009). It provides real-time practice of tasks and activities, and also opportunities to engage in intensive, meaningful, enjoyable and purposeful tasks related to real-life interests (Vernadakis, Gioftsidou, Antoniou, Ioannidis, & Giannousi, 2012; Yen et al., 2011). Physical activities in these games include motor tasks that involve a wide range of sensory feedback, adjustable motor amplitudes, speed and precision levels, and incorporation of a variety of visuospatial, cognitive and attention tasks (Salem, Gropack, Coffin, & Godwin, 2012). The practice of these activities is promising, as it may increase the child's motivation during exercise, and can constitute part of the child's training program. The literature on motivation suggests that student learning and performance is influenced by the motivational climate, and that positive benefits can be derived from exposure to a mastery motivational climate.

A growing body of literature shows that AVGs are considered a valuable additional component to programs enhancing general health, physical fitness and psychomotor functioning (Gioftsidou et al., 2013; Peng, Crouse, & Lin, 2013; Vernadakis et al., 2012) as well as therapy and rehabilitation procedures (Klompstra, Jaarsma, & Strömberg, 2013; Sin & Lee, 2013; Van Diest, Lamoth, Stegenga, Verkerke, & Postema, 2013). However, there is still very limited empirical evidence that exergames can facilitate motor skill acquisition, or can provide an alternative to motor skill enhancing physical activity (Barnett, Hinkley, Okely, Hesketh, & Salmon, 2012; Papastergiou, 2009).

In this regard, the review carried out in this article focuses on the evaluation of AVGs as potential educational tools within physical education or physical activity. In the first place, research production was examined in order to find evidence of how the AVGs could improve attitudes, intellectual skills, knowledge, motor skills and physical properties associated with physical activity and physical education. Secondly, active video games were compared with traditional approaches to determine their workability and effectiveness.

## 2 MATERIAL AND METHODS

### 2.1 Databases Searched

The databases searched included those identified as relevant to education, information technology and social science: Cochrane Central Database, ERIC, Google Scholar, ISI Web of Knowledge, MEDLINE/Pubmed, Scopus and SPORTDiscus. The latest search was carried out on 15/07/2015.

### 2.2 Grey Literature

The IADIS International Conference Mobile Learning, the Meaningful Play Conference Paper, the IEEE International Conference on Advanced Learning Technologies (ICALT), the

International Conference on Collaboration Technologies and Systems (CTS), the European Conference on Games Based Learning and the ERPA International Congress on Education from 2010 to 2014 were also searched for relevant studies.

### 2.3 Research Design

The search terms for the literature review resulted from a previous search approved on the evaluation of Papastergiou (2009) with some modifications for the purpose of this review.

The terms used for games were:

“Active video game” or “activity-promoting video game” or “exergame” or “Exergaming” or “Kinect” or “Nintendo” or “PlayStation” or “Wii” or “Xbox”.

To narrow down the search to focus on games for learning the following terms were also used:

“Education” or “learning” or “patient” or “skill” or “student” or “teaching”.

And to narrow down the search to papers relevant to PA the following terms were also included:

“Physical Education” or “health education” or “physical activity” or “sport”.

The time span selected for the papers was from January 2010 to 2015 as Papastergiou (2009) conducted a systematic review with a similar purpose and the papers she selected were published from 2000 to 2009.

### 2.4 Selection Criteria

To be included in the review, papers had to be published in journals or conference proceedings from January 2010 onwards. Due to feasibility issues, studies in languages other than English, Spanish, French or Portuguese were excluded.

Additionally papers had to include some element of qualitative empirical evaluation (Burguillo, 2010); only studies with objective outcome measures were included. Studies with only qualitative outcomes such as focus group studies or studies with only PA-related psychological outcomes but no quantitative PA outcomes were excluded.

Given that the study focused on the examination of AVGs as potential educational tools within Physical Education or PA, articles located through the database searches that did not fall within that focus were excluded from consideration.

The studies must have employed at least one off-the-shelf AVG; if the study only examined passive video games, it was excluded. For instance, there were articles referring to electronic games, (e.g., serious games or educational games) as an effective method against sedentary behaviours (e.g., Banos, Cebolla, Oliver, Alcaniz, & Botella, 2013) or articles that focused on promotion of health behaviours whose final results showed findings that were not actually related to electronic games (e.g., Busch, De Leeuw, & Schrijvers, 2013; Stroebele, McNally, Plog, Siegfried, & Hill, 2013); those articles were not included in this review.

Finally, only articles that were written with a research purpose were chosen, which means that they could be included in the first category of the following categorization made by Dempsey, Rasmussen and Lucassen (1996) in their review of the general instructional gaming literature:

**Table 1.** The number of papers identified from each database and included in the review

Databases searched	Identification	Screening		Eligibility			Included
	Keyword search	Papers excluded before 2010	Duplicates removed	Research	Papers excluded on the basis of title and abstract	Papers excluded on the basis of the full text papers	Final number of included papers
Cochrane Central Database	1	0	0	0	0	0	1
ERIC	637	436	6	159	21	1	14
Google Scholar	716	295	398	6	8	1	8
ISI Web of Knowledge	91	4	0	37	22	0	28
MEDLINE/Pudmed	951	509	92	261	54	4	31
Scopus	224	15	145	36	12	6	10
SPORT Discuss	24	1	7	6	2	4	4
Grey Literature	4	0	0	0	0	0	4
<b>Total</b>	<b>2648</b>	<b>1260</b>	<b>648</b>	<b>505</b>	<b>119</b>	<b>16</b>	<b>100</b>

Research (systematic approaches in the study of AVGs targeted at explaining, predicting or controlling particular phenomena or variables).

Theory (articles that explain the basic concepts or aspects or derived outcomes of gaming).

Reviews (syntheses of articles concerning general or specific aspects of gaming).

Discussion (articles that state or describe experiences or opinions with no empirical or systematically presented evidence).

Development (articles that discuss the design or development of games or projects involving gaming).

## 2.5 Categorization of Papers

Inasmuch as the majority of papers found by Papastergiou (2009) were included in the above-mentioned “Research” category, a second level of categorization was included following seven sub-categories that emerged in relation with the thematic found: disease awareness, prevention and management, nutrition education, first-aid education, injury awareness during sporting activities, acquisition of motor skills, improvement of fitness and educators’ knowledge and attitudes regarding electronic games.

In this review, two categories were kept (i.e., “acquisition of motor skills” and “improvement of fitness”); others were put together under a different name (i.e., disease awareness, prevention and management, and injury awareness during sporting activities were combined in “disease and injury awareness, prevention and management”), whereas some categories were included within the maintained categories (i.e., nutrition education and educators’ knowledge, and attitudes regarding active video games were included in “improvement of fitness”) and first-aid education was withdrawn.

Thereby, the papers were classified in the following three sub-categories:

Acquisition of motor skills. The purpose of these studies was to investigate the effectiveness of AVGs performance for improving gross or fine motor skills.

Disease and injury awareness, prevention and management. These studies evaluated the possibility of improvement, to reduce deterioration or to achieve rehabilitation for patients with different diseases or injuries through AVGs.

Improvement of fitness. These studies investigated the increase of health and wellness during the playing of AVGs.

Gagné (1984) set forth five categories of learning outcomes: verbal information, intellectual skill, cognitive strategy, attitude and motor skill. These categories classified the type of learning outcomes for which the game was used. In this review the types of learning outcome were modified into attitudes (e.g., time spent doing PA), intellectual skills (e.g., enjoyment is an ability that everybody can enhance as Goleman, & Cherniss (2000) explained), knowledge, motor skills (e.g., balance, running, jumping, hopping, leaping, galloping, and sliding) and physical properties (e.g., energy expenditure, heart rate and body mass index). This categorization was connected with significant or not significant results for achieving the twofold goal of this review.

## 3 RESULTS

### 3.1 Papers Identified and Papers excluded

Table 1 shows 2648 papers that were identified from each database along with the number of papers that were included in this review.

This same table 1 also shows how many papers were excluded and the reason for the exclusion.

### 3.2 Papers selected

100 papers were included in this review because they met the inclusion criteria explained in the subsection Selection Criteria. As an aid to the reader, Appendix A provides a summary of all studies included in the review and Appendix B includes a detailed summary of each study. The analysis was made following the already mentioned categorization of papers.

The number of studies published in 2010 (n=20), 2011 (n=20), 2012 (n=23), 2013 (n=14), 2014 (n=14), 2015 (n=9), show an increased trend over the years until 2012 and a decreased trend from then until the present time. The studies’ sample ranged from 0-50 participants (n=67), 51-100 (n=19), 101-200 (n=5) to more than 201 (n=9). According to the type of learner, articles included research on children (n=39), children and adolescents (n=2), children and adults (n=2), adolescents (n=16), adolescents, young adults and adults (n=1), young adults (n=12) young adults and older adults (n=1), adults (n=16) and older adults (n=11). Most studies were designed with comparisons

between control group and experimental group (n=70), whereas some did not include that comparison (n=30).

The indicators of interest represented in the included studies were acquisition of motor skills (n=28), disease and injury awareness, prevention and management (n=19) improvement of fitness (n=53). Type of learning outcomes measures were found as attitudes (n=11), attitudes and intellectual skills (n=2), attitudes and physical properties (n=9), intellectual skills (n=6), Intellectual skills, knowledge and motor skills (n=1), intellectual skills and motor skills (n=11), intellectual skills and physical properties (n=6), knowledge (n=2), motor skills (n=33), motor skills and physical properties (n=1) and physical properties (n=18). The results of these articles regarding the type of learning outcomes were:

- Attitudes (n=22) with comparison AVG and traditional games (n=22):
  - With significant improvement pre-test post-test (n=17).
  - Without significant improvement pre-test post-test (n=5).
  - With significant improvement of AVG over traditional games (n=16).
  - With significant declination of AVG over traditional games (n=2).
  - Without significant improvement or declination of AVG over traditional games (n=4).
- Intellectual skills (n=26) with comparison AVG and traditional games (n=18):
  - With significant improvement pre-test post-test (n=25).
  - Without significant improvement pre-test post-test (n=1).
  - With significant improvement in AVG over traditional games (n=15).
  - With significant declination of AVG over traditional games (n=2).
  - Without significant improvement or declination of AVG over traditional games (n=1).
- Knowledge (n=3) with comparison AVG and traditional games (n=0):
  - With significant improvement pre-test post-test (n=3).
  - Without significant improvement pre-test post-test (n=0).
  - With significant improvement of AVG over traditional games (n=0).
  - With significant declination of AVG over traditional games (n=0).
  - Without significant improvement or declination of AVG over traditional games (n=0).
- Motor skills (n=46) with comparison AVG and traditional games (n=28):
  - With significant improvement pre-test post-test (n=42).
  - Without significant improvement pre-test post-test (n=4).
  - With significant improvement of AVG over traditional games (n=12).
  - With significant declination of AVG over traditional games (n=1).
  - Without significant improvement or declination of AVG over traditional games (n=15).

- Physical properties (n=34) with comparison AVG and traditional games (n=26):
  - With significant improvement pre-test post-test (n=28).
  - Without significant improvement pre-test post-test (n=6).
  - With significant improvement in AVG over traditional games (n=17).
  - With significant declination of AVG over traditional games (n=3).
  - Without significant improvement or declination in AVG over traditional games (n=6).

As results, 87 studies showed participants' improvement from the beginning until the end, 39 studies supported AVG as an effective tool to significantly improved attitudes, intellectual skills, knowledge, motor skills or physical properties in relation with PA, 29 studies obtained no significant results of benefits, 5 studies obtained significant negative results and 27 studies did not investigate the difference between AVG and traditional fitness exercises.

#### 4 DISCUSSION

The first aim of this systematic review was to provide a comprehensive synthesis of the current state of knowledge pertaining to the potentials of AVGs for PA promotion. First of all, this literature review clearly suggests that most researchers were interested in the improvement of fitness because physical inactivity among adults (e.g., Bonetti, Drury, Danoff, & Miller, 2010; Diest et al., 2013) and children is a major contributor to diseases associated with obesity (World Health Organization, 2010). There was a great number of studies that have investigated AVGs participation in PA and its positive effects in reducing the risk of obesity (e.g., Maloney, Threlkeld, & Cook, 2012; Goersch et al., 2013), hypertension (e.g., Chen & Wilkosz, 2014), congestive heart failure (e.g., Klompstra, Jaarsma, & Strömberg, 2014; Tripette et al., 2014), atherosclerosis (e.g., Laufer, Dar, & Kodesh, 2014) and cardiovascular disease (e.g., Thompson, Gordon, & Pescatello, 2010). Controlled studies also showed that active video games increased capacities in relation to PA and education (Hammond, Jones, Hill, Green, & Male, 2014). Similarly, previous research has indicated that AVGs have an assortment of positive effects (Heidi et al., 2014) such as an increased moderate-vigorous physical activity (Biddiss, & Irwin, 2010), a decreased light activity (Lu, Kharrazi, Gharghab, & Thompson, 2013), a modest increase in sedentary screen time (Papastergiou, 2009) and a post-intervention energy compensation (LeBlanc et al., 2013; Peng et al., 2014). In addition, this review provides a comprehensive understanding of the influence of AVGs in multiple learning outcomes.

Another important fact is that eighty-seven articles obtained positive results in pre-test and post-test results, demonstrating the viability of this technology. Articles with significant results of improvement of gross motor skills corroborated amelioration balance for older adults as a rehabilitation tool (e.g., Kosse, Caljouw, Vuijk, & Lamothe, 2011; Nitz, Kuys, Isles, & Fu, 2010; Sato, Kuroki, Saiki, & Nagatomi, 2015). In contrast, there were studies with no significant improvement in energy expenditure, heart rate or body mass index after comparing the pre-test and post-test scores. These results could have been "contaminated" since participants did not perform the activity as they should have (Baranowski et al., 2012). Also, these results could be the consequence of small samples and short intervention periods,

focus on the wrong type of learner or underprovided design intervention (e.g., Chung, Vanderbilt, & Soares, 2015; Dixon et al., 2010; Gao, Hannon, Newton, & Huang, 2011).

Furthermore, AVGs are workable and a potentially effective alternative tool to traditional games. Research on corporal effects have shown that AVGs can obtain similar (e.g., Johnson, Ridgers, Hulteen, Mellecker, & Barnett, 2015; Sheehan & Katz, 2012; Vernadakis et al., 2012) or better results than traditional fitness exercises (e.g., Bailey & McInnis, 2011; Errickson, Maloney, Thorpe, Giuliani, & Rosenberg, 2012; Foley et al., 2014). Besides, there are some supplementary benefits from playing AVGs, such as weight loss (Leatherdale, Woodruff, & Manske, 2010), coordination ability improvement (Gao, Hannon, Xiang, Stodden, & Valdez, 2013) and health-related physical fitness reinforcement (Garn, Baker, Beasley, & Solmon, 2012). In addition, it has been suggested that AVGs can potentially encourage PA for inactive persons (Maddison et al., 2012). AVGs can also be used as an interventional instrument in experimental healing; for instance, in rehabilitation treatment of injuries (Vernadakis, Derri, Tsitskari, & Antoniou, 2014) or acquisition of gross motor skills for physical disease (Kempf & Martin, 2013). Certain recent research efforts have provided some evidence that AVGs may potentially have a positive impact on children’s motor skill acquisition. For instance, Barnett et al. (2012) investigated associations between preschool age children’s time spent playing physically interactive and non-interactive video games and their motor skills. Children’s physical activity, time spent on gaming, and motor skills (motor and object control) were assessed. The results showed that adjusted time in physically interactive video game use was associated with object control but not motor skills. Adjusted time in non-interactive video game use was not associated with object control or motor skills. Thus, greater time spent playing AVGs is associated with higher object control skills proficiency in preschool age children.

Staiano, Abraham, and Calvert (2012) examined the role of competitive versus cooperative exergame play on short-term changes in executive function skills, following a 10-week exergame training intervention. Low-income overweight and obese African American adolescents were randomly assigned to a competitive exergame condition, a cooperative exergame condition, or a no-play control group. Youths in the first condition improved their executive function skills more than those experiencing the other two conditions. Weight loss during the intervention was also significantly positively correlated with improved executive function skills.

In another study, Salem et al., (2012) examined the feasibility and preliminary effectiveness of a low-cost exergaming system for young children with developmental delay. Children were randomly assigned to an experimental group or to a control group. They were evaluated one week before and one week after a 10-week program involving balance, strength training and aerobics games of the Nintendo Wii console. Primary outcomes were gait speed, timed up and go test, single leg stance test, five-times-sit-to-stand test, timed up and down stairs test, 2-min walk test and grip strength. The Gross Motor Function Measure was used to assess gross motor skills. After the intervention, the experimental group exhibited significant improvements (compared to the control group) in single leg stance test, right grip strength and left grip strength. Although changes in other outcome measures were not significant between the groups,

there were trends towards greater improvements in the experimental group.

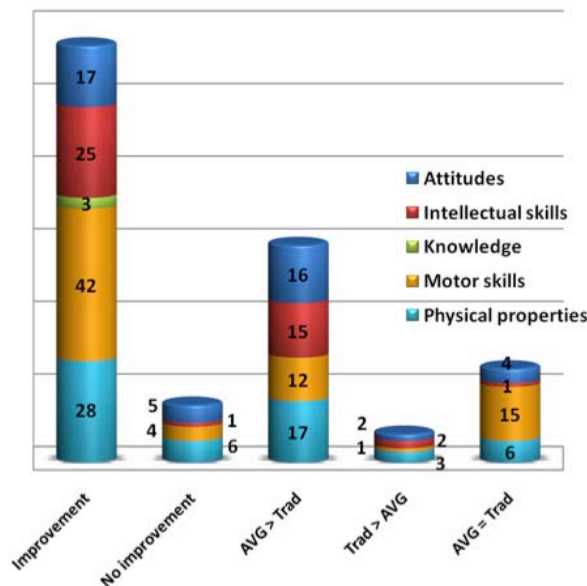


Figure 1. Papers’ results

Finally, AVG can significantly increase energy expenditure (Lyons et al., 2011), improve sports skills (Soltani, & Vilas-Boas, 2013) and can thereby battle against obesity (Staiano et al., 2012). Many schools are beginning to use AVG as an appointment work out for students in their physical curriculum (Finco, Reategui, Variani, & Zaro, 2013). The psychosocial effects of playing AVGs include promoting social interaction (Kosse et al., 2011), mood, PA (Vernadakis, Papastergiou, Zetou, & Antoniou, 2015), self-esteem and self-efficacy (Sun, & Gao, 2015). In addition, AVGs can achieve better results in relation to intellectual skills than traditional games in higher intervention because AVGs can help, for example, in developing spatial abilities (Vernadakis, Zetou, Derri, Bebetos, & Filippou, 2014), increasing participants’ motivation and enjoyment for PA (Fitzgerald, Trakarnratanakul, Smyth, & Caulfield, 2010), enhancing cognitive control and attention (Bofoli et al., 2012) and can even improve academic performance (Flynn, Richert, Staiano, Wartella, & Calvert, 2014).

#### 4.1 Strengths and Limitations

This review provides a systematic overview of the current state of knowledge and identifies a variety of opportunities for future research. Important guidelines were provided for future research and development in the physical activity area in order to optimize the educational value of AVGs. Finally, the most significant strength of this study is the use of large sample sizes to avoid being underpowered.

The main limitation to our study, and an area for future research, relates to the relatively low quality of studies in this field of research. The sixty-seven studies included in this review used a sample with less than 20 subjects at short intervention periods, making it difficult to elucidate the true effects of these technologies on different types of outcomes.



## 4.2 Future Review

In the light of the foregoing, evaluation of the long-term effects of AVG in intellectual promotion is needed. There is evidence that verifies physical and intellectual benefits. However, future studies must focus on investigating the new skills that Jenkins, Clinton, Purushotma, Robinson and Weigel (2006) designate as required for proper use of AVGs (e.g., play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking and negotiation).

From this approach, del Castillo, Herrero, García, Checa and Monjlat (2012) indicated that research streams should focus on the use of AVGs in transforming the classroom from a threefold perspective: physical, social and personal. In this way it could generate innovative educational environments that can develop in relation with new digital literacies skills

The three most popular video game systems (i.e., Xbox, Nintendo and Playstation) have AVG innovations and, consequently, these were materials used in physical activity interventions. In addition, mobile smart phones, tablet computers, augmented reality and other portable gaming devices are emerging as possible AVG alternative platforms.

## 5 CONCLUSIONS

The first and most important conclusion that we could note from the review conducted is that the controlled studies show that active video games increase motor, intellectual and physical capacities in relation with PA and education. Thereby, the incorporation of an interactive gaming console in a balanced training process probably constitutes an important and powerful tool available to the Physical Education professionals. Physical Education professionals can benefit from the features of the console and the opportunities it provides to improve the balance ability of their students or clients as effectively as the traditional training method.

It is also remarkable that active video games are workable and a potentially effective tool alternative to traditional games. Of course, the interactive gaming console cannot replace real sports games, but may promote audience participation in leisure activities that can lead to physical functional improvements as well as competence. It was noted during this research that not only does the use of video game based research programs increase patient enjoyment and engagement, but they also improve selected balance performance measurements.

We should highlight that AVGs have shown a high-quality potential to motivate people from all age groups to be more physically active. Therefore, participants are joyfully playing AVGs while they achieve a healthier lifestyle. The results shown in the research reviewed provide evidence that a mastery motivational climate can have a positive impact on children's fundamental motor skill performance and suggest that even young children who are at the initial stages of motor skill performance can benefit from a self-directed climate.

To sum up, we could conclude that PA interventions designed and measured using behavioural theories are more likely to be successful compared to traditional exercise modalities.

## DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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