Exergames and motor skills learning: a brief summary

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Abstract

The term "exergames" refers to a category of video games in which the interaction is not based only on hand-eye coordination, but on the whole body, through the use of non-standard controllers, like Nintendo Wii remote or Balance Board and Microsoft Kinect sensor. The exergames were immediately hailed as a welcome development, for the contribution they offer as a weapon against a sedentary lifestyle and the level of user involvement, which adds to the traditional value of video games the attractiveness of natural interfaces. The current trend is to consider how the exergames present many potential advantages in the context of physical education and wellness promotion. However, the current generation of exergames is not designed specifically to support teaching of motor activities or rehabilitation. There are no products that can count on the basis of a robust theoretical framework and that are oriented to the acquisition of specific motor skills, for use in physical education teaching and rehabilitation. Knowledge of basic mechanisms of motor control and of dynamics connected to motor skills learning may be the theoretical support to the design and development of exergames.

Keywords: Exergaming, Gesture Recognition, Motor Learning, Natural User Interface, Physical Education

Introduction

The term "exergame" is used to define the combination of gaming dimension with exercise. In particular, "exergame" refers to a category of video games in which the interaction is not based only on the hand-eye coordination, but on the whole body. The interaction based on the whole body is made possible by a series of non-standard controllers, such as, for example, the Wii remote and Balance Board, connected to the Nintendo Wii console, and the Microsoft Kinect sensor, released as an accessory for the Xbox. Also the robotics give a technical contribution to exergame.

“Special tools, as haptics, with its kinesthetic haptic interfaces, and tactile actuators could be the proper solution for the activity that is both with in presence and without physical presence. Particularly, with the term haptics we refer to a set of hardware and software technologies able to elaborate in a way different from the human mind, and so to elicit in the humans’ physical perceptions through the sense of touch” (Raiola, 2012).

The exergames were immediately hailed as a positive development, for the contribution they offer as a weapon against a sedentary lifestyle (Chamberlin et al., 2008) and the level of user involvement, which adds to the traditional value of videogames (Baranowski et al., 2008) the attractiveness of natural interfaces (Wigdor et al., 2011).

Attention was initially focused on promoting healthy lifestyles and combating inactivity, and therefore the focus was on energy expenditure. (Siegel et al., 2009)

The aspect that is frequently emphasized in the studies that have dealt with energy expenditure is the attraction exerted by exergames on individuals normally reluctant to exercise.
“The current trend is to consider how the exergames present many potential advantages in the context of physical education and wellness promotion. However, the current generation of exergames is not designed specifically to support teaching of motor activities or rehabilitation. There are no products that can count on the basis of a robust theoretical framework and that are oriented to the acquisition of specific motor skills, for use in physical education teaching and rehabilitation.” (Di Tore et al., 2012)

“Exergaming is a term used to describe video games that provide encouragement to exercise, particularly for an audience that may be reluctant to engage in the more traditional forms of exercise. Exergames are a commonly accepted method of encouraging more physical activity to promote better health for those with high levels of sedentary screen time” (Whitehead et al., 2010)

The results are encouraging, considering that the energy expenditure doubles in subjects engaged in video games that involve the whole body as compared to individuals that use “traditional” games. (Lanningham-Foster et al., 2006) On the basis of positive results, research has explored other fields, showing how “exergaming may be useful for the management of behavioral disturbance and for Increasing cognitive control in children on the autism spectrum” (Anderson-Hanley et al., 2011) and paying attention to how “exergames’ boost brain function among seniors” (Anderson-Hanley et al. 2012)

Methods

This paper presents an excursus of the literature on exergames and summarizes the state of the art of research in this field, in an effort to identify the theoretical and didactic foundations of exergames design, in order to see if there are exergames that are attributable to a specific theoretical framework within Physical Education or that are specifically oriented to teaching or rehabilitation.

Results and Discussion

The findings of the studies mentioned above had the effect of subverting the traditional Skepticism with which playing electronic games has often been seen in Health Education (HE) and Physical Education (PE). The current trend is to consider how the videogames present “many potential benefits for HE and PE. […] Pulling together those benefits, it derives that major common strengths for both disciplines, which may positively influence young people knowledge, skills, attitudes and behaviours in relation to health and physical exercise, are the unique motivational appeal that those games possess as well as the opportunities that they offer for active, exploratory and experiential learning of concepts and skills, for rehearsal of skills within a safe environment, for individualized feedback and differentiated instruction, and for learning through social interactions. In addition, the new generation of physically interactive electronic games seems to be particularly valued in the overviewed literature as it can provide opportunities for actual physical exercise and motor skill learning within PE contexts.” (Papastergiou, 2009).

However, other studies have led to less exciting results and revealed the limits of exergames. A study by Hsu (Hsu et al. 2011) on “effects of adding Nintendo Wii® Bowling to a standard exercise regimen for residents of long-term care with upper extremity dysfunction” showed that “the only significant finding was a measure of enjoyment of activity When Compared to a standard exercise group.” (Tanaka et al. 2012) This leads to consider how the current generation of exergames is not designed specifically to support teaching of motor activities or rehabilitation. There are general purpose products, intended for large groups of users, but software products based on a robust theoretical framework, oriented to the acquisition of specific motor skills, for use in the teaching of PE and rehabilitation, are still prerogative of the research and have not enough spread to allow an overall estimate of cognitive and educational consequences of exergames.

Knowledge of basic mechanisms of motor control and motor skills learning dynamics could be the theoretical support to the design and development of exergames. Furthermore, designers must take into account neurobiological knowledge on the mechanisms of regulation of the various types and ways of imitation, learning, and gestural communication according to the research on mirror neurons. (Raiola et al., 2010)

Here reference is made to definition of motor control proposed by Schmidt & Wrisberg, "Motor learning is an internal process that reflects the level of individual ability and performance could be evaluated according to the relative stability of the execution of a task.” (Schmidt et al., 2008)
The motor control theories developed in cognitive psychology have generated a significant amount of educational applications. According to these theories, the human being has, at the cerebral level, a series of motor programs, or sequences of commands that at the level of the central nervous system, coordinate the execution of the movements.

Learning movements is to develop cognitive structures (motor programs) through information processing. These processes allow the possibility to compare in real time (closed loop) (Adams, 1971) or at a later time (open loop) (Schmidt, 1975) the results obtained and expected results, triggering a process of adjustment of the same motor program.

The generalized motor program "is a motor program that defines a model (pattern) of motion; this flexibility allows you to adapt it so as to produce variations of the motor pattern adapted to the changed demands of the environment" (Schmidt et al., 2008). Its structure is such that allows the performer to adjust the movement in order to deal with the changing needs of the environment.

As an alternative to such theories (cognitive approach) are to be counted other theories, ecological oriented, which consider learning as a form of dynamic interaction with the environment. They are the motor imagery, which finds scientific evidence in the mirror neurons system (Iacoboni, 2005; Rizzolatti et al., 2006) or, further back in time, the theory of degrees of freedom (Bernstein, 1967; Latash et al., 1996). Both consider motor learning originated by the performer as immersed in the learning environment without the intervention of the teacher/coach, and both are particularly functional in HCI (Human Computer Interaction).

"Because many exergames such as DDR or Wii Sports tennis require rapid hand–eye or foot–eye coordination, they may improve general coordination skills. However, the majority of research on coordination benefits involves elderly people playing sedentary video games, not exergames. Video game play increased perceptual-motor skills including hand–eye coordination, dexterity, and fine motor ability (Drew et al., 1986). At present, there is no exergame research on this topic." (Staiano et al., 2011)

The next step for researchers is to develop scientific-based exergames oriented to motor control and skills learning in order to suggest implementation practices for trainers and teachers.

References


