Original Article

Exergames in motor skill learning

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Abstract

Exergaming, by joining physical activity with Natural User Interfaces and Gesture Recognition technology, addresses the fundamental questions of perception and phenomenology in a digital context, with awareness that embodied actions within a digital media interface are “fluid and functional crossings between virtual and physical realms.” (Hansen 2006) The potential of computer games in improving learning and even leading to the enhancement of motor skills is documented in the literature, but, at present, the exergames are not considered natively as tools oriented to teaching movement or to rehabilitation. There are studies that have used in this field products originally aimed at the gaming market, but are not diffused softwares designed specifically for educational or rehabilitative use. This prevents a comprehensive assessment of cognitive and educational implications of exergames, and addresses researchers to develop exergames specially designed for the teaching of physical education and rehabilitation, in order to provide a flexible tool to trainers and teachers

Keywords: exergaming, phenomenology, natural user interface, motor control and learning, gesture recognition

Introduction

Exergaming, by joining physical activity with Natural User Interfaces and Gesture Recognition technology, addresses the fundamental questions of perception and phenomenology in a digital context, with awareness that embodied actions within a digital media interface are “fluid and functional crossings between virtual and physical realms.” (Hansen 2006)

“Natural User Interface is the next metaphysical paradigm shift in man machine interaction (MMI) also known as human computer interaction (HCI). Beginning with the Command Line Interface (CLI) and followed by the Graphical User Interface (GUI), we are now in the midst of discovering the next phase of a more organic interfaces which are based on more traditional human interaction paradigms such as touch, vision, speech and most importantly creativity.” (NUIGroup 2009)

The Natural User Interfaces include input and output based on touch, voice, movements and move towards an efficient use of the senses in the interaction with machines.

Fig. 1 - Kidplayng didactic exergame

The origin of term “exergame” is uncertain: as noted Sinclair, earliest citation of “exergame”, according to Wordspy website, is by RajuNudhar on the Toronto Star in 2004. In a bid to unite jocks with nerds in a way never seen before, Toronto-based Nexfit has introduced Canada's first exer-gaming bike. ...

At its most basic, the product is an exercise bike that hooks up to a personal computer. The bike serves as a giant joystick. You use the handlebars as the controller, and above the right hand grip are the traditional joystick controls with a trigger button. For racing games, the pedals of the bike serve as the accelerator. There are also "force feedback" simulators so the rumble effect you get on a console's controller is emulated by the entire bike.

RajuNudhar, "In hot pursuit of the Holodeck," The Toronto Star, April 20, 2004

Sinclair also noted as “exergames are also referred to using the following terms; Activity promoting video games (Lanningham-Foster, Jensen et al.); interactive video games (Hoysniemi, 2006; Luke, 2005), and exertion interfaces (Mueller, Agamanolis et al. 2003 2003, Yang, Smith et al. 2008).”(Sinclair 2011)

In a study on the definition of exergames, Oh and Yang(Oh and Yang 2010) have proposed a classification of terms with which exergames are referred in scientific studies, distinguishing between health-related contexts and non health-related contexts. These terms are: Exergame, Exertainment, Dance simulation video game , Interactive video game, Activity promoting video game, Active video game, Physical gaming, Kinaesthetic of video gaming, Physical activity-change games.

Given this state of the art, we agree with Yang (Yang, Smith et al. 2008), in affirming that this area of study “is still in its infancy”.

The definition of exergame used herein was provided by Bogost:

“Exergaming is the combination of exercise and video games” (Bogost 2007)

It should be emphasized, however, as exergames involve the whole body of the player in the human-machine interaction process, making use of special devices such as Microsoft Kinect, the Nintendo Wiimote and BalanceBoard, just to mention the most well-known. (Di Tore and Raiola 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.

This work intends to provide a preliminary analysis of the scientific literature on the subject of exergames, in order to verify whether there are scientific works in which have been studied and presented exergames specifically designed for educational purposes or rehabilitation purposes.

Results

Since the first deployment, exergames have received, in science, a positive reception, by virtue of two factors:

involvement in the field of gaming the entire body of the player is a powerful tool in the longstanding battle against sedentary lifestyle (Chamberlin and Gallagher 2008);

the level of user involvement, already high in traditional videogames, with exergames becomes even more valuable due to the NUIs (Baranowski, Buday et al. 2008 & Baranowski, 2008, Wigdor and Wixon 2011).

Staiano and Calvert noted that

“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 and Waters 1986). At present, there is no exergame research on this topic.” (Staiano and Calvert 2011)

The potential of computer games in improving learning and even leading to the enhancement of motor skills is documented in the literature:

“Through visualization, experimentation, and the creativity involved in game playing(Betz 1996), so-called video or computer games can enhance learning and even lead to improvement in complex real-world motor skills such as driving on highways or flying airplanes”. (Colcombe and Kramer 2003).

Several studies have demonstrated that training using video games has transfer effects to real-life activities (Silberman 2009)

Furthermore, “new discoveries on the brain have changed the scientific scenario of psychopedagogy theories concerning how the mind functions in the movements and how the children learn trough the motor

activities”(RAIOLA 2011)

Greenfeld has pointed out as a video game player to become a producer of content, and this is all the more true in the case of exergames, in which the player controls, with the movements of the whole body, an avatar on the screen.

The skills acquired through exergaming become skills that players can spend in the real world: “Exergames interpret a player’s bodily movements as inputs associated with specific meanings for game play, translating movement in three-dimensional space onto the two-dimensional screen. Because the exergame player is distanced from the character on the screen, he or she must use visual-spatial skills, hand-eye or foot-eye coordination, and quick reaction time to operate and successfully play the game.” (Staiano and Calvert 2011)

At present, the exergames are not considered natively as tools oriented to teaching movement or to rehabilitation. There are studies that have used in this field products originally aimed at the gaming market, but are not diffused softwares designed specifically for educational or rehabilitative use. This prevents a comprehensive assessment of cognitive and educational implications of exergames, and addresses researchers to develop exergames specially designed for the teaching of physical education and rehabilitation, in order to provide a flexible tool to trainers and teachers.

“To understand video games as learning environments, it is essential to look carefully at the qualitative descriptions of learning in video game environments and apply to it what we know from learning theory about how people think and learn. An ecological psychology view of learning from video games would highlight principles focusing on the primacy of goals and intentions that guide perception-action within the constraints of the game design and user interface. From an ecological perspective, then, the task of game design become some of selecting goals and creating environments in which those goals can optimally be pursued, while taking into account those things that gamers tell us are keys to enjoyable, engaging experience.”(Young 2004)

Discussion and Conclusions

If we consider motor learning “as an internal process that reflects the level of individual ability and performance [that] could be evaluated according to the relative stability of the executions of a task.” (Schmidt and Wrisberg 2008), we must put the knowledge of the mechanisms of motor skills learning at the base of designing educational exergames.

The current theory of motor control system has a significance analogy with the mechanisms and processes of these technologies, particularly the closed loop theory by Jack Adams and the open loop theory by Richard Schmidt give some practice responses to how the mind can work when it has merged in virtual environment. (Raiola and Di Tore 2012) As noted Dyle and Kelly, “poor exercise technique and lack of adherence during home exercise are implicated in preventing a full recovery to peak physical function during rehabilitation. It is widely believed that therapeutic exergaming has the potential to solve these issues. However, the field is still young and there is little empirical evidence supporting, in particular, its effectiveness in helping the patient to maintain correct technique”. (2011 (Doyle, Kelly et al. 2011)) In a study about Gesture Recognition for an Exergame Prototype, Gracem et al. pointed out that, in an exergame built on gesture recognition, it’s crucial “investigating how a gesture can best be determined: 1. Trigger based. Is a particular gesture executed? 2. Quality based. Is a particular gesture executed correctly?” (Gacem, Vergouw et al. 2011) In a learning or rehabilitation context, measures for defining gestures, such that they can be determined both absolutely as well as qualitatively (Gacem, Vergouw et al. 2011), can not ignore the knowledge of paradigms on motor control and motor learning and experience in teaching physical education and in rehabilitation.

Designing and implementing exergames according to scientific paradigms on motor control and motor learning is an essential step for scientific research in order to assess the real effectiveness of exergames in training and rehabilitation programs

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