Athens Institute for Education and Research
ATINER

ATINER's Conference Paper Series
EDU2017-2219

Games to Assist People with Mobility Limitations in the School Inclusion Process

Regina Heidrich
Professor
Universidade Feevale
Brazil

Marsal A. Branco
Universidade Feevale
Brazil

João B. Mossmann
Universidade Feevale
Brazil

Anderson Schuh
Universidade Feevale
Brazil

Emely Jensen
Universidade Feevale
Brazil

An Introduction to ATINER's Conference Paper Series

ATINER started to publish this conference papers series in 2012. It includes only the papers submitted for publication after they were presented at one of the conferences organized by our Institute every year. This paper has been peer reviewed by at least two academic members of ATINER.

Dr. Gregory T. Papanikos
President
Athens Institute for Education and Research

This paper should be cited as follows:

Heidrich, R., Branco, M. A., Mossmann, J. B., Schuh, A., and Jensen, E. (2017). **"Games to Assist People with Mobility Limitations in the School Inclusion Process",** Athens: ATINER'S Conference Paper Series, No: **EDU2017-2219.**

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209 Email: info@atiner.gr URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm
Printed in Athens, Greece by the Athens Institute for Education and Research.
ISSN: 2241-2891
30/06/2017

Games to Assist People with Mobility Limitations in the School Inclusion Process

Regina Heidrich

Marsal A. Branco

João B. Mossmann

Anderson Schuh

Emely Jensen

Abstract

A Brain-Computer Interface (BCI) allows a person to transfer commands to a computer directly. Instead of using a keyboard, mouse or other input device, the user of this interface simply sends commands via brain waves and the computer responds to them. This paper aims to present a game developed to assist the process of educational inclusion of people with motor coordination problems, especially cerebral palsy. The school inclusion process has been widely discussed in all fields and it has been observed that behind the discourse of teachers not feeling prepared, lack of accessibility and training in digital inclusion area is still incipient. One solution is to partner with groups and research projects of universities that can collaborate in this process. This project aims to design Digital Learning Constructs (DLC) as a model implemented by use of BCI. A DLC is any entity or device devised or built in a multidisciplinary way in the form of an educational game, helping players to build their knowledge. To develop this research, we chose a case study with qualitative research approach. In this game, the player takes the figure of an elder, who aims to get to the other side of town to disable a mechanism, and thus, to free his people from machines that brought destruction to his once thriving kingdom. To progress in the game, players use concentration and eye blinking, allowing them to interact with objects in the scene. The study (BCI) seeks to improve the interaction between humans and machines and allow people with motor coordination problems to benefit in the inclusive education process.

Keywords: Brain Computer Interface, Digital Inclusion, Motor Impairments.

Introduction

The inclusion process refers to an educational process that aims to maximize the capacity of disabled children in school and in the regular classroom. It is a constant process that needs to be continually revised. For inclusion to really occur, Carvalho (2004) warns that we must reflect on the formation of our teachers in general, because we know that Brazilian education faces serious challenges that reflect the structural problems with which we have lived. According to the same author, every teacher, as a learning professional, must be an expert in the student, as a being who evolves, who builds knowledge, who has feelings and desires, and brings to the school his baggage of life experiences and information.

All games share four characteristics: target, rules, feedback system, and voluntary participation (Medina et al, 2013). The target is the reason that justifies the player participating in any of the activities; in other words, the element by which the participants of a game concentrate their attention in order to reach the set goals. The rules adjust the player's complexity level considering the activity to be undertaken, "releasing creativity and stimulating strategic thinking [...] therefore, they have the role of defining the way in which the player shall behave, or in which way the player will organize its actions in order to fulfill the challenges brought on by the game" (Medina et al., 2013). The feedback system advises players in regard to their relationship with the various aspects that regulate their interaction with the activity. This system is also responsible for encouraging motivation and keeping participants aware of their progress and their target (Medina et al., 2013). According to the same author, in any game, whether digital or otherwise, one can observe that there is no need for an agreement between the conditions proposed and the player.

Literature Review

While there is yet little research, Granic et al. (2014) point out the benefits of playing video games, the roles and benefits of which, in a more generalized manner, having been studied over decades. Evolutionary psychology has long emphasized the adaptive functions of play (Piaget 1962), and in developmental psychology, the positive function of games has been a recurring topic for some of the most respected scholars in the field (Erikson 1977; Vygotsky 1978; Gottman, & Mettetal 1986; Johnson 2005). Erikson (1977) showed that the context surrounding games allows children to simulate and experience social and emotional alternatives that can bring on feelings of resolution outside of the game context. Similarly, Piaget (1962) theorized that the game of make-believe offers children opportunities to play out real-life conflicts, to devise optimal resolutions for their own pleasure, and to alleviate negative feelings. Both Piaget (1962) and Vygotsky (1978) advocated strong theoretical links between play and a variety of elements that favor the development of social cognition.

Besides social cognition, developmentalists have emphasized that the game is an emotionally meaningful context, whereby the themes of power and domination, aggression, nutrition, anxiety, pain, loss, growth, and joy can be enacted productively. Johnson (2005) and Granic et al. (2014) provided a study analysis based on existing data regarding the positive effects of playing video games. They said that these games promote wellbeing, including the prevention and treatment of mental health issues. The same authors also said that playing video games promotes a series of social, emotional and cognitive skills, and assists in problem solving, in addition to enabling creativity and a persistently optimistic motivational style, which contributes towards success and personal fulfillment. Researchers also acknowledged that video games are changing the way in which students and teachers approach learning, and are being used by doctors to improve patients' health. They suggested that video games could have a similar impact on the field of mental health, and recommended that psychologists, doctors and game designers collaborate to include video games in traditional therapies.

We now turn to the motivational, emotional and social benefits of playing video games. From an educational point of view, Johnson (2005) argues that it does not matter what the player is thinking while playing, but the way in which the player is thinking. This statement is strengthened by Dewey (1997) when he argues that the greatest of all pedagogical fallacies is perhaps the notion that a person learns only that particular thing that he or she is studying. He highlights collateral learning as a path to building long-lasting attitudes, often more important than grammar lessons, geography lessons, or even history that is being learned. Thus, when playing, users are building from the collateral learning. Considering the difficulties faced by people with functional limitations and taking into account the multi-benefit of learning, some companies have attempted to develop low-cost devices, to enable use at a personal level. For some time, companies have attempted to develop low-cost devices, to enable use at a personal level. In this project, games and the BCI can also be classed as a type of Assistive Technology. Assistive technology refers to any item, piece of equipment or system of products, commercially acquired or homemade, produced in series, modified or custom-made, that is used to increase, maintain or improve the abilities of people with functional limitations, whether physical or sensorial.

Thus, an inclusive educational context, which favors the functionalities of students with motor deficiencies, needs to resort to support and social facilitators, such as assistive technology, in the following categories: Assistance in Activities of Daily Living; Adapted School and Pedagogical Supplies; Augmentative and Alternative Communication; Accessible Computing; Accessibility and Architectural Adaptations; Furniture: Postural Adequacy and Mobility (SEESP/SEED/MEC, 2007).

Thus, children with physical disabilities cannot be in a world apart to develop motor skills. They must receive the technological and rehabilitation benefits in constant interaction with the environment to which they belong. It is much more significant for the children to develop speech skills if they have someone to communicate with. In the same sense, it is more significant to develop a walking ability if they are guaranteeing their right to come and go (SEESP/SEED/MEC, 2007:17, our translation).

The first BCI was described in 1964 by Walter Grey, when he implanted electrodes directly into the motor area of the cortex of a human patient. The experiment consisted of recording the patient's brain activity as he pressed a button. This action would make the slides of a projected slide show move forward. Then the scientist developed a system that would make the slides advance whenever the patient's brain activity indicated that they wanted the button to be pressed. Interestingly, besides testing the equipment and checking its effectiveness, he also discovered that there was a need to input a small delay in presenting the slide show, as the slides were advancing slightly ahead of time of the button being pressed Graimann et al. (2010).

According to Graimann et al. (2010), until the 90s, progress on the study of BCIs was slow. For example, in the early twentieth century, there were around 10 research laboratories, on a worldwide scale, that were devoted to this study. However, there has been a rapid growth over recent years regarding research on BCIs, and there are currently more than 100 related research projects worldwide. Most importantly, this area of research could prove that it is possible not only to rehabilitate, but also to extend the capabilities of human beings. On the other hand, BCIs are not yet completely conventional, nor are they easy to use. As such, there is still a need to improve these systems.

A BCI provides an alternate means for natural communication of the nervous system; it is an artificial system that surrounds efferent pathways of the body. It directly measures brain activity associated with the user's intention, and translates this into application control signals. Typically, it has four characteristics: it must record direct brain activity; it must have feedback; it must be in real time; and it should be controlled by the voluntary initiative of the user (Graimann et al. 2010). The term BCI and its definition are well accepted in scientific circles. Nevertheless, it is possible to find in literature other ways to describe this particular form of HMI (Graimann et al. 2010).

According to Wolpaw et al. (2002), "a direct brain-computer interface is a device that gives the brain a new non-muscular communication and control channel." According to Donoghue (2002), "one of the main goals of a brain-computer interface (HMI [Human Machine Interface] or BMI - brain-machine interface) is to provide a command signal from the cortex. This command serves as a new functional output to control body parts with disabilities or physical devices, such as computers and robotic limbs." In line with this, Levine et al. (1999) state "a direct brain interface accepts voluntary commands directly from the human brain without the need for physical movement and can be used to operate a computer or other technologies."

When starting this study, we searched for scientific literature regarding BCIs. We found many articles and papers in the medical field and some in education, however none that mentioned people with physical disabilities and/or cerebral palsy using BCI.

Cerebral Palsy

Willian John Little, an English orthopedist, first described static encephalopathy in children in 1843. He defined it as a pathology related to different causes and characterized especially by muscular stiffness. In 1862, the relation between this condition and abnormal birth was established. Later, in 1897, Freud suggested the use of the expression cerebral palsy (CP), which was consecrated by Phelps when referring to a group of children with more or less severe motor disorders due to central nervous system (CNS) injuries, similar or not to Little's disease (Diament, 1996; Rotta, 2001).

Cerebral palsy (CP), or static encephalopathy of infancy and childhood (SEIC), is a consequence of a static lesion that affects the central nervous system in the phase of structural and functional maturation. It is a predominantly sensorimotor dysfunction, involving disorders in muscle tone, posture and voluntary movement, and may also be associated with other alterations such as mental, visual, and convulsive disorders among others (Schwartzman, 2004; Geralis, 2007). The Executive Committee for the Definition of Cerebral Palsy (2006) has updated the concept of cerebral palsy as a group of disorders of the development of movement and posture, causing activity limitations, which are attributed to a non-progressive disturbance occurring in the developing fetal or infant brain. The motor disorder of cerebral palsy is usually accompanied by disturbances of sensation, cognition, communication, perception, behavior, epileptic crisis and secondary musculoskeletal problems (Rosenbaum et al., 2007).

According to Piovesana et al. (2002), CP is a condition with multiple etiologies. It can be caused by hereditary factors or events occurring in the pre-, peri- or postnatal periods up to two years of age (Mancini et al., 2004; Piovesana et al., 2002; Allegretti et al., 2002). The causes can be genetic, congenital, inflammatory, infectious, or due to anoxic, traumatic and metabolic events (Sankar and Mundkur, 2005).

Premature or very small children are prone to cerebral palsy due to vascular lesions, because their blood vessels have very fragile walls, which may lead to intraventricular hemorrhage (Finnie, 2000). Problems such as lack of oxygen before, during, or after birth; toxic harm or poisoning from alcohol or drugs used by the mother during pregnancy; encephalic trauma (by falling, car accident or other); metabolic disorders; infections of the nervous system, such as encephalitis or meningitis, can also cause cerebral palsy (Finnie, 2000; Levitt, 2001; Geralis, 2007). Several viruses have a capacity for neuroinvasion (central nervous system invasion) and neurovirulence (the capacity to infect and provoke disturbances in the neural cell function), which may impair the maturational development of the child's brain (Miller and Clark, 2002).

The identification of the etiology of CP is still a nebulous factor. Although clinical and gestational histories often allow this identification, many others are left without answers. According to Souza and Ferrareto (2001), the major cause of CP is perinatal anoxia due to abnormal or prolonged labor. Prematurity is the second major cause of SEIC. In contrast, Sankar and Mundkur (2005) state that between 75% and 80% of cases occur due to pre-natal damage, and less than 10% are due to birth trauma or asphyxia.

According to Himmelmann et al. (2010), regarding gestational age (GA), 36% of children born at less than 28 weeks have cerebral palsy. In children born between 28 and 32 weeks' gestation, this rate drops to 25%, decreasing to 2.5% in children with gestational age between 32 and 38 weeks. The characteristics and disturbances of children with cerebral palsy are marked by heterogeneous clinical syndromes (Gauzzi and Fonseca, 2004). According to Rotta (2001) and Miller and Clark (2002), encephalopathies of children can be classified in several ways, considering the moment of lesion, the location of the damage, etiology, symptomatology or topographic distribution. Considering the anatomical and clinical aspects, which are the main elements of the clinical condition, cerebral palsy can be classified as: spastic or pyramidal; non-spastic or extrapyramidal; ataxic and mixed. The spastic form is the most frequent, affecting 72% to 91% of CP children (Odding, Roebroeck and Stam, 2006).

According to Miller and Clark (2002), spastic CP leaves the child with weak and stiff limbs and subdivides into: tetraplegia, when all four limbs are severely affected, with an incidence from 9% to 13%; hemiplegia, when a hemibody is affected (left side or right side), which occurs between 25% and 40% of cases (Finnie, 2000); and diplegia, when the lower limbs are more affected than the upper limbs, with an incidence from 10% to 33% (Miller and Clark, 2002).

Given that cerebral palsy influences how children develop, it is known as a developmental disorder (disability). Therefore, many phases of neuropsychomotor development will be omitted, which may compromise the functionality of activities of daily living (ADLs), independence, autonomy and social participation (Mancini et al., 2004; Finnie, 2000; Geralis, 2007).

Miralles et al. (2015) are the people responsible for the project BackHome, which is aimed at moving BCIs from being laboratory devices for able-bodies users towards being practical devices used at home by people with severe limited mobility. A research study between Coventry University and the Universidad Veracruzana, conducted by Rebolledo-Mendez and Dunwell (2009), presented a usability evaluation of the device known as MindSet (MS), by NeuroSky. An interesting aspect was to assess whether MS readings can be combined with the data generated by the user. Already the research group at the University of Oulu, Finland, in partnership with the Human-Computer Interaction Institute, of Carnegie Mellon University, formed by Haapalainen et al. (2010), conducted a study on the assessment of cognitive charge. The group of researchers from the LISTEN Project at Carnegie Mellon University, Mostow, Chang and Nelson (2011) showed that EEG data from the NeuroSky device could identify the frequency bands that were sensitive to difficulty and were able to discriminate between easy and difficult sentences with, better than by chance, among samples (adults and children) and modalities (oral and silent reading). They identified frequency bands susceptible to difficulties and various properties of lexical problems, which suggests that they may detect transient changes in cognitive demand or specific aspects of lexical access. Xu et al. (2011), from University of California, used the device to develop a Wearable Assistive System Design for the Prevention of Falls, which can detect the risk of falls by monitoring the EEG signals from users and releasing an alerts prior to the actual fall occurring. Crowley et al. (2010), from the University College Cork, Ireland, conducted two psychological tests to assess the suitability of the headset to measure and categorize a user’s level of attention and meditation while playing. Wolpaw (2007) states that brain-computer interfaces (BCIs) are a fundamentally new approach to restore communication and control to people with severe motor disorders, such as Amyotrophic Lateral Sclerosis (ALS) and spinal cord injuries, as well as other degenerative diseases. And he said, in 2007, that it could be an excellent assistive technology.

Schuh et al. (2013) developed a study and prototype of a simulator for wheelchairs in a three-dimensional environment, controlled by non-invasive brain-computer interface. To this effect, we used a low-cost EEG, NeuroSky Mindwave, as a signal acquisition device. For the development, we used Unity, a game engine. Through the prototype developed, we could detect blinking, and thus use this feature as a command for the simulator.

In the experiments, we will use the NeuroSky MindWave (MW). NeuroSky is a company that was founded in 2004, in Silicon Valley, and which is focused on developing BCI devices. MW is a portable EEG machine that currently costs USD 129.90. In general terms, this machine can record brain waves, process the information, and scan it. It then makes this information available to the user in applications.

This device is based on the NeuroSky ThinkGear technology, which consists of an electrode positioned in the Fp1 region, an electrode as point of reference in the ear clip, and an inside chip that processes all data as well as removes noise and interference. The device features a proprietary algorithm called eSense. It is through this that some features are extracted from the scanned signals, providing some alternative commands directly in the applications. One can, for example, quote the attention and meditation levels.

Known as a neuro-headset, due to its similarity in design to a headphone (earpiece) as can be seen in Figure 1, it has a Bluetooth interface with easy connectivity using serial ports, with support for Microsoft Windows platforms, OS X, Android and IOS. It does not have an internal battery and needs an AAA battery to operate. Other features to consider are: no need to use conducive gel on the electrode, no connection cables, extremely light, all of which makes it an easy-to-use device.

Heidrich at al (2015) says:

"The hardware used in this project is called MindWave. It is developed by NeuroSky and works as a BCI (Brain-computer Interface). Its objective is to use the brain as a communication interface with the machine. It converts electrical brainwaves and analog processes into digital signals to make measurements available to feed the user interface of games, computers, and medical research applications. 1. Easy to use 2. Non-invasive 3. Single dry sensor 4. Allows for mobility 5. Access to both the raw data or data filtered through optimized algorithms 6. Platform open for any industry Every interaction between neurons creates a tiny electric discharge, measured by EEG machines. By themselves, these charges are impossible to measure on the outside of the skull. However, a ruling mental state, driven by the activity of neurons collectively, created by hundreds of thousands of simultaneous discharges, can be measured. The motor control of limbs occurs at the top of the brain, for example. Vision is processed at the back of the brain. From an evolutionary point of view, these basic functions are present in most animals. Since humans have evolved, the prefrontal cortex at the front of the brain is where higher thoughts take place. Emotions, mental states, concentration, etc., are all dominant in this area. This is the main reason for installing the main sensor in a known position NeuroSky as frontal parietal 1. Different brain states are the result of different patterns of neural interaction. These patterns are characterized by waves of different frequencies and amplitudes. As examples, the brain waves between 12 and 30 Hz, beta waves, are associated with concentration, while waves between 8 and 12 hertz alpha waves are associated with relaxation, calm. Often overshadowing brain waves, muscle contraction is also associated with single wave patterns, referred to as EMG. It is by isolating these EMG patterns that some NeuroSky (2013) devices can detect eyes blinking"

Figure 1. *MindWave Mobile Device*

Source: Neurosky official website (http://neurosky.com).

Methodology

Twenty children with cerebral palsy with motor coordination difficulties participated in this study.

To develop this research, we chose a case study with a qualitative research approach. We justified our choice because the case study is an in-depth, multi-faceted research of a unique social phenomenon. We worked with Observational Case Studies. According to this author, the participatory work within the classroom and the new teaching methods can be objects of participant observation. Stake (1995) suggests that the case study is the study of the particularity and complexity of a case in understanding its activities within circumstances.

The objective of the experiment was to verify how this type of hardware helps children with motor coordination problems. Nothing is done for people with disabilities, all games and toys are meant for ordinary children. The purpose of the study was explained to all participants.

Before each game there was an explanation of the purpose and mode of interaction (Attention/Meditation) and interviews and questionnaires. We are collecting data related to the needs and expectations of users evaluation of design alternatives, games and the final game. We collecting data related to the sequence of work to be performed with the game. Evaluation of alternative designs and gaining additional information about user needs and expectations to game. The participants with CP performed the test individually in the presence of researcher and her interns.

Findings/Results

The game developed is called Questing Ruins. This game has two versions: one that works with the blink of the eyes and concentration levels (standard version) and a version that works just with the concentration levels. Below is shown (see Figure 2) the execution of some of the tests conducted with the sample, while playing the standard version (to the left) and the concentration-only version (to the right).

Figure 2. *Sample Playing Question Ruins Game*

Source: Personal archive.

In the game Questing Ruins, the player assumes the figure of an ancient, which aims to get to the other side of town to disable a mechanism, and thus free his people from machines that brought destruction to the once thriving kingdom. To advance in the game, one makes use of concentration and blinks of the eyes, allowing the character to interact with the objects in the scene. Below is shown an image (Figure 3) with these objects and scenery.

Figure 3. *Questing Ruins Scenery*

Source: Questing Ruins print screen.

For example, when hitting an obstacle, the player must concentrate or control the intensity of his/her wink, so as to overtake it. Along the way, the player encounters puzzles, and only after beating them can the character continue walking. These puzzles consist of a disc that automatically rotates, having locks of different formats. When the player selects (by blinking) the correct lock and key, the game continues. At the end of each level, the player also finds another puzzle, composed of pieces that must be rotated through concentration, in order to guide a water supply inlet to its output. Below is a reference image (Figure 4).

Figure 4. *Questing Ruins Puzzle*

Source: Questing Ruins print screen.

Conclusions

BCI (Brain-Computer Interface) technology provides a means for interaction with machines, products, systems, and as such, its study is shown as something of major importance. On one hand, through BCI it is already possible to adapt machinery, products and systems to people with mobility problems to improve their performance, turning disabilities into mere differences of execution, but with averages of performance like those of ordinary people. On the other hand, the study of BCI ergonomics allows for analyzing levels of mental burden, instantly and objectively. The study on brain computer interfaces seeks to improve the way of interaction between humans and machines. It is important to remember that the expansion and recovery of motor and cognitive functions are the focus of research in this area. It can be stated that the EEG, although developed a long time ago, is still a key tool to support clinical diagnoses. However, researchers are conducting new approaches to this device. It is believed that soon we will see such approaches allied to games, including for educational purposes.

It was observed after testing that this equipment has a very low precision when the game needs the input of the blink of an eye. People with motor impairments had difficulties playing. It is believed that BCI equipment with more electrodes can solve this problem. In terms of ergonomics, materials need to be flexible so there is a better fixation on the user's head. For many people in the sample, it was not possible for MindWave to stay steady throughout the entire test period, as it slid into smaller encephalic perimeters.

When MindWave is used only with the concentration levels, it works better. Because of this, MindWave was presented at this stage of testing only as a leisure tool, although our ultimate goal is to assist in the education of people with cerebral palsy. More information can be found on Youtube (https://www.youtube.com/watch?v=BHUkky0r0EA).

References

Allegretti, A. L. C.; Mancini, M. C.; Schwartzman, J. S. 2002. Estudo do desempenho funcional de crianças com paralisia cerebral diparéticas espásticas utilizando o Pediatric Evaluation of Desability Inventory (PEDI) [Study of the functional performance of children with spastic dipartic cerebral palsy using Pediatric Evaluation of Desability Inventory (PEDI)]. *Arq. Bras. Paral. Cerebral*. 1, 1 (2002) 35-40.

Carvalho, R. E. 2004. *Educação inclusiva: com os pingos nos "is"* [Inclusive education: with the dots in the "is"]. Editora Mediação, Porto Alegre.

Crowley, K., Sliney, A., Pitt, I., Murphy, D. 2010. Evaluating a Brain-Computer Interface to Categorise Human Emotional Response. In *IEEE Computer Society, Advanced Learning Technologies (ICALT), 2010 IEEE 10th International Conference Proceedings* (2010). 276-278.

Dewey, J. 1997. *Experience and Education*. Free Press, New York

Diament A. 1996. Encefalopatia crônica na infância (paralisia cerebral) [Chronic encephalopathy in childhood (cerebral palsy)]. In Diament A.; CYPEL A. (Eds.), *Neurologia Infantil*. 3. ed. Atheneu, São Paulo.781-798.

Donoghue, J. P. 2002. Connecting cortex to machines: recent advances in brain interfaces. *Nat. Neurosci*. 5, 1085-1088

Erikson, E.H. 1977. *Toys and reasons: Stages in the ritualisation of experience*. Norton, New York.

Finnie, N. R. 2000. *O manuseio em casa da criança com paralisia* cerebral [*Home handling of the child with cerebral palsy*]. 3. ed. Manole, São Paulo.

Gauzzi, L. D. V, Fonseca, L. F. 2004. Classificação da Paralisia Cerebral [Classification of Cerebral Palsy]. In: (Orgs.). *Paralisia Cerebral: Neurologia, Ortopedia, Reabilitação* [Cerebral Palsy: Neurology, Orthopedics, Rehabilitation]. Guanabara Koogan, Rio de Janeiro.

Geralis, E. 2007. *Crianças com paralisia cerebral: guia para pais e educadores* [*Children with Cerebral Palsy: A Guide for Parents and Educators*] . 2. ed. Artmed, Porto Alegre.

Gottman, J.M. , & Mettetal, G. (1986). Speculations about social and affective development: Friendship and acquaintanceship through adolescence. In J. Gottman & J. Parker (Eds.), Conversations of friends. Speculations on affective development (pp. 91-113). Cambridge, UK: Cambridge University Press .

Graimann, B., Allison, B., Pfurtscheller, G. 2010. Brain-Computer Interfaces: A Gentle Introduction. In Graimann, B., Allison, B., Pfurtscheller, G., (eds.) *Brain–Computer Interfaces, The Frontiers Collection*. 1-27. Springer Berlin Heidelberg, Berlim.

Granic, I., Lobel, A., Engels, R.C.M.E. 2014. The benefits of playing video games. *Am. Psychol*. 69, 1. 66-78.

Haapalainen, E., Kim, S., Forlizzi, J., Dey, A. 2010. Psycho-Physiological Measures for Assessing Cognitive Burden. In Bardram, J.E., Langheinrich M. (eds.), *Ubicomp '10 Proceedings of the 12th ACM international conference on Ubiquitous computing*. 301-310.

Heidrich, Regina O. et al . A comparative study: use of a Brain-computer Interface (BCI) device by people with cerebral palsy in interaction with computers. An. Acad. Bras. Ciênc., Rio de Janeiro, v. 87, n. 4, p. 1929-1937, Dec. 2015. Available from <http:// www.scielo.br/scielo.php?script=sci_arttext&pid=S0001-37652015000501929&

lng=en&nrm=iso>. access on 09 June 2017. Epub Oct 30, 2015. http://dx.doi.org/10.1590/0001-3765201520130413.

Himmelmann, K.; Hagberg, G., Uvebrant, P. 2010. The changing panorama of cerebral palsy in Sweden. X. Prevalence and origin in the birth-year period 1999–2002. *Acta Pediátrica*. 99, 9, 1337-1343.

Johnson, S. 2005. *Surpreendente: a Televisão e o Videogame nos Tornam Mais Inteligentes* [*Amazingly: Television and Videogame Make Us More Intelligent*]. Campus, São Paulo

Levine S.P., Huggins J.E., BeMent S.L., Kushwaha R.K., Schuh L.A., Passaro E.A., Ross D.A. 1999. Identification of electrocorticogram patterns as the basis for a direct brain interface. *Clin. Neurophysiol*. 16, 5, 439-47.

Levitt, S. 2001. *O tratamento da paralisia cerebral e do retardo motor*. [*Treatment of cerebral palsy and motor retardation*] 3. ed. Manole, São Paulo.

Mancini, M. C. et al. 2004. Gravidade da paralisia cerebral e desempenho funcional [Severity of cerebral palsy and functional performance]. *Rev Bras Fisioter*. 8, 3, 253-260.

Medina, B., Vianna, Y., Vianna, M., Tanaka, S. 2013. *Gamification Inc.: como reinventar empresas a partir de jogos* [*Gamification Inc.: how to reivent companies from games*] (1st ed). MJV Press, Rio de Janeiro.

Miller, G.; Clark, G. D. 2002. *Paralisias cerebrais: causas, consequências e conduta* [*Cerebral Palsy: causes, consequences and conduct*]. Manole, São Paulo.

Miralles, Felip et al. 2015. Brain computer interface on track to home. *The Scientific World Journal*, 2015, 2015. DOI= http://dx.doi.org/10.1155/2015/623896.

Mostow, J., Chang, K., Nelson, J. 2011. Toward Exploiting EEG Input in a Reading Tutor. In G. Biswas, S. Bull, J. Kay, & A. Mitrovic (eds.) *Artificial Intelligence in Education*. 301-310. Springer Berlin Heidelberg, New York.

Odding, E.; Roebroeck, M. E.; STAM, H. J. 2006. The epidemiology of cerebral palsy: incidences, impairments and risk factors. *Disabil Rehabil*. 28, 91-183.

Piaget, J. 1962. *Play, dreams and imitation*. Norton, New York.

Piovesana, A. M. S. G. 2002. Encefalopatia Crônica Paralisia Cerebral [Chronic Cerebral Palsy Encephalopathy]. In: Fonseca, L. F.; Pianetti, G.; Xavier, C. C. *Compêndio de Neurologia Infantil*. Medsi, Rio de Janeiro.

Rebolledo-Mendez, G, Dunwell, I. 2009. Assessing NeuroSky's usability to detect attention levels in an assessment exercise. In Jacko J.A. (ed.) *Human-Computer Interaction New Trends*. 149-158. Springer Berlin Heidelberg, New York.

Rosenbaum, P. et al. 2007. A report: the definition and classification of cerebral palsy April 2006. *Developmental Medicine & Child Neurology*. 8-14.

Rotta, N.T. 2001. Encefalopatia crônica da infância ou paralisia cerebral [*Chronic childhood encephalopathy or cerebral palsy*]. In: Porto, C. C. *Semiologia Médica*. 4. ed. Guanabara Koogan, Rio de Janeiro.

Sankar, C.; Mundkur, N. 2005. Cerebral Palsy - Definition, Classification, Etiology and Early Diagnosis. *Indian J Pediat*. 72.

Schuh, A.R., Lima, A., Heidrich, R.O., Mossmann, J., Flores, C., Bez, M.R. 2013. Development of a Simulator Controlled using Non-Invasive Brain-Computer Interface for Training in the Use of a Wheelchair. *Revista Novas Tecnologias na Educação*. 11, 3, 1-9.

Schwartzman, J. S. 2004. Paralisia cerebral [Cerebral Palsy]. *Arq bras Paral Cerebral*, 1, 1, 4-17.

SEESP/SEED/MEC. 2007. *Atendimento Educacional Especializado* [*Specialized Educational Services*]. Editora Cromos, Curitiba.

Souza, A. M. C.; Ferrareto, I. *Paralisia: aspectos práticos* [*Palsy: pratical aspects*]. 2. ed. Memmom, São Paulo.

Stake, R.E. 1995. *The Art of Case Study Research*. Sage, London.

Vygotsky, L. 1978. *Mind in society: The development of higher psychological functions*. Harvard University Press, Cambridge.

Wolpaw, J.R., Birbaumer, N., McFarland, D.J., Pfurtscheller, G., Vaughan T.M. 2002. Brain–computer interfaces for communication and control. *Clin. Neurophysiol*. 113, 6, 767-91.

Wolpaw, J.R. 2007. Brain–computer interfaces as new brain output pathways. *J. Physiol*. 579, 3, 613-619.

Xu, W., Gong, F., He, L., Sarrafzadeh, M. 2011. Wearable Assistive System Design for Fall Prevention. 2011. *3rd Joint Workshop on High Confidence Medical Devices, Software, and Systems & Medical Device Plug-and-Play Interoperability* (HCMDSS/MDPnP 2011). http://eda.ee.ucla.edu/fang/publi cation/hcmdss11_ ucla.pdf