Digital games: outlining new interactive spaces for children with cerebral palsy

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Summary

Considering the importance of games for learning and development in childhood, this article aims to socialize the process of validation of digital games, conducted with children diagnosed with Cerebral Palsy. Participants were three children with cerebral palsy, aged between 7 and 10 years. The three digital games tested had the following themes: Sustainable Cities, Food Safety and Sanitation. The results of this research led to the redefinition of the production process of those games, contributing to the development of an expertise in this area.

Keywords: Cerebral Palsy - Digital Games - Augmented Alternative Communication

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1. Games, a cultural phenomenon

The presence of games in human history begins with the evolution of man, even before norms and rules of coexistence were established, to which the subjects complied or proposed other referrals that met their demands. It is important to stress that the rituals of hunting and of wars had a playful, entertaining, strength and power. For Huizinga, playing games constitute a universal activity prior to culture itself, since that "even in their least restrictive settings, they always presuppose human society" [2001] and that animals perform recreational activities, too. Over time, the games began to be understood by common sense only as entertainment. However, playing games goes beyond entertainment in that it can serve as spaces for reinterpretation. According to Huizinga [2001], games feature five basic characteristics and become an element of culture, a pillar of civilization. The first refers to being free, a choice of players, a peculiarity of any leisure activity, which is usually practiced in idle moments. The second feature, fully linked to the first, is the fact that the game is not "present" or "real" life. The child, adolescent and adult, when they surrender to the game, are sure that it is just an escape from "real" life, a break in daily life, although they take this activity seriously. The third characteristic is shaped by the distinction between the game and "ordinary" life, both by the place, and by the time it occupies. There is therefore a beginning and an end to the game as well as a space frontier with this "real" life.
As a fourth feature, Huizinga cites the fact that a game creates order and configures itself within itself, it is organized through orderly arrangements composed of elements such as tension, balance, compensation, contrast, variation, settlement, union and disunion, and the slightest disobedience to this order "spoils the game." The author also marks the game's approach to aesthetics:

> And finally, the fifth characteristic is the fact that the unpredictability, uncertainty and chance of the game generate tension. This can cause the passionate engagement that will result in the development of an ethical sense, as the establishment of the limits within the activity. These are rules that define what is possible, allowed to be done or not. To counteract these assumptions imply in jeopardizing the existence of the community of players. Perhaps here we find an explanation for the attraction that games have on individuals.

It is through the continued implementation of these activities, as well as its subsequent socialization, that the game may be considered a cultural phenomenon, in that, even after it ends, "it remains as a new creation of the spirit, a treasure to be retained by the memory "[Huizinga, 2001] and, when it is transmitted to others, it becomes tradition. These considerations question the position of many parents and teachers who argue that, when the children and teens are playing, they are just having fun. For many, there's just entertainment, which is often seen as a waste of time. Thus, the fact that playing meets the needs of children is often forgotten [Vygotsky, 1994; Freud, 1976]. However, with regard to theorists and specialists, there is unanimity around the cognitive and social [Piaget, 1978, 1983, 1990; WALLON, 1989, Vygotsky, 1993, 1994, 2001; Elkonin, 1998, among others], affective [Freud, 1976; Winnicott, 1975; Klein, 1995; Roza, 1999] and cultural [Huizinga, 2001; Benjamin, 1994], contributions potentiated by the various games.
For Vygotsky [1994], playing games and interacting enable the child to learn of rules and to surrender to impulsive actions by way of pleasure. So, for him, the games act as mediators between the knowledge already crystallized, constructed, present at the level of real development, and the possibilities and potentialities in the Zone of Proximal Development (ZPD). The ZPD is characterized by the intermediate range between what the subject is able to do alone without

the help of others and his ability to expand his development and learning. In this transitional space, the new knowledge is being prepared and, mediated by the tools, signs and speakers, will be consolidated and / or reevaluated. For the psychogenetic theories, playing games will allow the redefinition of intuitive thinking in that children can exercise adult world situations through make-believe, for example, and learning, thus, to live with social rules. So these subjects come from a state of anomie to the internalization and reinterpretation of the rules, using others and language, which characterizes the situation of heteronomy and, later, of individual autonomy.
Through the rules built in games, children learn to negotiate, to waive the impulsive action, to delay immediate gratification, which contributes to the fulfillment of desires, through assimilation and accommodation. These processes are understood here in the Piagetian perspective.
For this author,

> One can say that all necessities tend: first, to incorporate the things and people to the subject's own activity, that is, to 'assimilate' the outside world to the structures already built, and second, to readjust the latter depending on the changes that occurred, i.e., to 'accommodate' them to external objects [Piaget, 1978].

Thus, children develop the meaning of cooperation and competition among their equals. These are rules that can be transmitted from generation to generation, or be spontaneous, prepared for the moment by subjects of the same age or different ages. The game then becomes an activity that should be encouraged and taken seriously by adults, respecting the times when children and teens want to play with their toys, play their games, build something new, using the development of existing knowledge. Within this perspective, we can infer that games are intellectual technologies understood by Levy [1993, 1998] as elements that reorganize and modify the cognitive ecology of individuals, which promotes the construction or reorganization of cognitive functions like memory, attention, creativity, imagination, and helps to determine the mode of perception and intellection through which the subject knows the object. According to him, this ecology is formed by a collective thinking of men- things, with acting singularities and mutant subjectivities.
In the interaction with electronic games, these cognitive functions are intensified every day, which allows children, teenagers and adults to discover new forms of knowledge, which also occur today through the simulation of new worlds. The rules constructed in virtual spaces can be classified as spontaneous, since they are constantly rearranged. Teachers should be alert to the emergence of new ways that emerge daily in the lives of students, and that interact in the process of production and construction of knowledge and culture.
Within this context there is a group of children, adolescents and adults who can interact with video games as therapeutic and learning spaces. We are referring to people, especially children with special needs and in this article we will highlight those that have their development compromised by Cerebral Palsy (CP).

2. Digital games: spaces for Augmentative and Alternative Communication - AAC

We find several studies that discuss the interaction of games with CP children, like Silva [2006], Sameshima & Deliberato [2009], among others. However, it is still very scarce the number of publications that deal with this issue with digital games, that are now a cultural product of entertainment that surpasses the revenues from movies. Digital games are becoming spaces for learning cognitive, social, emotional, cultural and motor concepts, like the exergames. It is within this space that we present our article aiming to socialize the validation process we experienced with CP children interacting with digital games. It is important to stress that the games are being developed to expand THEIR communicative and cognitive possibilities.
The subjects with CP have damage in one or more parts of the brain that may have occurred during pregnancy, childbirth or after birth. Typically, subjects who exhibit this type of injury are motor and speech impaired, since they have difficulties to control the muscles involved in speech. Important: not all CP victims have cognitive impairment [Silva, 2006].
Technology to reduce speech impairment has been created to increase communication among these subjects, leading to the area of alternative communication. The Augmentative and Alternative Communication (AAC) can be understood as a clinical practice, scientifically proven, that aims to compensate the language deficit, proposing to supplement the existing communication of the individual with such a severe disorder, so that he can develop and reach his maximum communication potential [American Speech-Language-Hearing Association, 1989 cited in Walter, 2000]. Alert to the communication needs of CP children, we developed four digital games, of the casual type, i.e., fast games (short?), with simple narratives, requiring the player's answers to a problem at a time. The games were intended to constitute semiotic fields where the children interacted with the problem by developing cognitive skills and broadening their ways of communicating with each other. In this case the children had the presence of researchers, psychologists and speech therapists who followed and acted on the zone of proximal development of these subjects, allowing them to advance with the challenges presented by the game.
During the process of developing digital games for children with cerebral palsy and especial needs it was developed a specific hardware to improve the interaction and communication. The system consists of a handheld device with touch screen, similar to a tablet, equipped with software focused on

communication and education in various everyday situations. Due to its characteristics, this system replaces a portable electronic board and is able to offer its users an inclusion in social communicative contexts, such as at school, at home, at social events, in treatment centers and entertainment venues. So, the goal is to develop a device for use in common life situations.The interface was designed considering the information required for the professionals involved for assisting the children during the game activity. For instance, the time control to be monitored by the professional evaluating the children communication. Icons were use in the interface for a better navigation considering the children needs. According to the CEPRED specialists involved in the research the children have problems to read. It was involved different professionals from health sciences, therapists specialised in handicapped people or impaired children, educators, teachers and psychologists specialised in toys.

To check the effectiveness of these games, there were held 10 validation sessions that aimed to analyze the interaction of players, identifying possible changes to be made in games. Initially, three different games developed by the Research Group of Computational Modeling of SENAI/CIMATEC were tested.

The games have the following characteristics:

• Food safety game, in which the player must drag the food to the proper position as indicated on the plate, paying attention to food choices to ensure a balanced diet
• Jigsaw Puzzle Sustainable Cities: The player is challenged to solve the puzzle. During the interaction the player can be challenged to put together 4, 9 or 16 pieces. The challenge is to form the pictures indicating appropriate positions to preserve the planet.
• Environmental education game in which the player must perform a selective collection of garbage
• Personal hygiene: In this game the player must organize the situations presented paying atention to the temporal order of events, for example: what comes first, wash your hands or pick up food?

The research approach was qualitative, conducted through observations that were recorded with a video camera and a field diary. These records subsidize the validation process, giving feedback for the development.

The place of empirical research was CEPRED (Centro Estadual de Prevenção e Reabilitação de Deficiências), located in Salvador,
We followed the precepts of Resolution 196/1996 of the National Health Council in relation to the Guidelines and Norms Regulating Research Involving Human Subjects. the Committee of Ethics in research from the Secretaria de Saúde do Estado da Bahia - authorized the study and the parents of children involved in the research, signed a free consent authorizing the participation of their children in this research ..
The research process involved three subjects presented here as Juliana, Paul and Luke to protect their identities. According to the CEPRED experts, Juliana had no familiarity with computers, unlike Paul and Luke who are familiar with them.
The subject Paul is a 10-year-old male with cerebral palsy, and its main consequences are: moderate hearing loss, cognitive impairment (significant difficulty in reading and writing), memory and concentration impairment and mood changes.
The subject Luke is a 7-year-old male. The main limitations resulting from his cerebral palsy are: severe hearing loss (he wears a hearing aid), no speech, impaired motor coordination (head, torso and legs), visual impairment (he wears corrective lens), has involuntary movements and mood changes.
The subject Juliana is an 8-year-old female. This subject has cerebral palsy, and its main characteristics are: hemiplegia, mild hearing loss, normal peripheral hearing and no speech.
We emphasize that although the three subjects have PC, the limitations are different for each subject.

3. Immersed in the world of games

The first game to be validated was Sustainable Cities (previously described). This game consists of clicking actions on the piece you want to change the location of and click on the area where you want to position it. The challenge gains more complexity as the number of pieces increase (4, 9, 16), since the player is presented a greater number of images to place in the correct space and in the right side. The challenge is to form the standard image with parts available on his board. The interaction with the jigsaw puzzle requires the player to understand the logics of moving pieces. To perform this action, the player must click on the piece and on the space where he wants it moved to. In this game the three subjects had difficulty understanding the logics of moving the pieces, of clicking on the piece and then clicking where he/she wanted it moved to. It is possible that they were familiar with the actions of dragging the piece with the mouse, commonly used in digital memory games. Changing this dynamic was a path taken to lessen this difficulty.
As to the interface of the game, it was observed that the various colors present in the background of the puzzle could be changed to a single neutral color, which would probably facilitate the identification of an appropriate location to place the piece.
The Food Safety game challenges players to arrange the plate, presenting a balanced diet, paying attention to the diversity of foods, such as proteins, carbohydrates, fruits, vegetables and leaves; and drinks. Each food group had a color that filled the background image of each food. To score, the player should put the food in the appropriate spaces, making the association between the background color that

involves the food and adequate space of the same color.

Figure 1: Food Safety game

Figure 1 illustrates part of the Food Safety game. Regarding the association of colors, just one subject understood that she should associate colors to put food on the plate, this understanding happened from the initial adoption of the trial and error strategy. The other two subjects (Paul and Luke) did not understand the logics of linking the food image background color and needed assistance from a psychologist who followed the interaction. Lucas at times associated green food (lettuce) with the color of the sections of the plate, and the logic implemented in the game was to associate the background color with the color of the divisions of the dish. That seems to have generated dismay and lack of stimulation in the player. It was noticed that the number of foods to be placed on the plate was greater by considering the average of foods a child eats at a meal and also the time of a gaming session, since the time for concentration / attention was low, demanding fast answers to the game's actions. Because of that, a review of the food available to fill the dish was made. Thus, the number of foods available to choose had to match the exact number of spaces available in the dish (spaces where the player places the food). After decreasing the number of spaces available on the dish (slots), a smaller number of foods were used to fill it. It was also observed that these individuals are often motivated by positive reinforcement, by other people's approval. Juliana constantly demonstrated her joy after winning and looked at the Psychologist expecting a gesture of recognition for her achievement. Likewise, Lucas thumbed up after each of his actions him in the game, expecting a sign of recognition from his mother and from the psychologist. In the environmental education game the player has the challenge of organizing the objects (garbage) in specific bins (metal, paper, plastic, glass) organized by color, performing a selective collection of garbage. To score, the player should place objects (garbage) in the appropriate bins, making the association between object color and waste basket color.

In this game, the logic of combining the colors was easily understood by the three subjects. This possibly happened because the objects to be placed in the trash bins had the colors of their garbage in the composition of its own illustration, representing the material it was made of (paper, metal, glass, plastic). Because of that, everyone understood the logic of combining colors. Only Paul had difficulty in the game, however, it was related to his motor impairment. In some moments he dragged the object close to the garbage bin, but he would not approach the place that made the combination correct.
The three subjects did not perceive the progress of the game, in this case identified by changes in the scenery: As the player progressed in the game separating the recyclable waste, the environment (river and cityscape) became cleaner and more pleasant. However, the players did not realize that the landscape changes were related to their actions in the game. Considering this a bar was added to show the progress in the cleaning process. Julie and Luke had no difficulty in interacting with the game and stopped playing when they were tired. Constantly they shared their actions in the game with the psychologists who accompanied them.
It is important to stress that during a validation at CEPRED, in which the first test with the prototype of the PDA developed by engineering staff at SENAI-BA was held, we observed changes in behavior and strategies used by the children when interacting with the games. Although the gaming performance was highly compromised in this prototype, we identified how easy they used the device and their interaction with the elements on the screen, eliminating some of the difficulties that the children had before when using the mouse. This reveals the advances made in the interaction of these subjects with the games from the development of technologies conceived having in mind the accessibility of users. These technologies designed for the disabled are called assistive technologies. (...) AT [Assistive Technology] refers to both the production instrumental dimension and using of support materials to enhance or substitute human faculties and skills such as the critical, creative process, moving toward broader social inclusion and legitimation of PNEE human rights. It also includes creative and transforming uses of the instrumental bases installed, since its mere availability does not automatically guarantee that they are used with the political intent to include and change situations of social inequality [Lima Junior and Santana, 2010, p. 110].

The interaction of the subjects in this first moment was important because it helped to resize the games for children with CP, beyond the instrumental perspective as indicated by the authors referred to earlier. Thus, from observations made by researchers on the children's interaction with the three games mentioned above it was possible to perform the following modifications: a) change the background colors of the pictures in which the foods in the food security game are, making it easy to recognize the logic of combining and reducing the possibility of 'mistakes', as in the case of lettuce in which one of the subjects linked the green leaf to the area of the dish to be placed, b) creation of new reinforcement mechanisms within the games, allowing players to be rewarded immediately, regardless of other people's approval
Thus, this research showed the process of validation of three digital games developed for children with cerebral palsy. However, further studies are being

conducted to investigate the potential of digital games for the cognitive development of children with CP.

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