LED-ME Project – A Design Report

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Image 1: LED-ME game screenshots

Abstract

This paper presents a design project of a computer game for integration in multisensory stimulation environments, to be played by children with intellectual disability. The LED-ME prototype is based on accessible technological solutions and dispenses the manipulation of peripheral devices resorting to Camspace® software. The different stages of the project are presented, from the design problem, to the definition of design guidelines, the pilot test and discussion of results. The LED-ME game is suitable for use in multisensory environments, enabling moments of play that require basic cognitive and motor skills.

Keywords: Computer game, Design, Intellectual Disability, Multisensory Stimulation Environments, Play skills

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1. Introduction

Ludic Experiences in Design for Multisensory Environments (LED-ME) is a project developed with students of Informatics Engineering, enrolled in the 1st year discipline of Games Design and Development. This project represents an expansion of the ideas previously presented by the authors about the integration of the computer-mediated ludic experience in multisensory stimulation environments (MSE) [Castelhano & Roque 2009].

MSE are spaces for intervention that are used by Occupational Therapists, Psychomotricists, Special Education Teachers, Physiotherapists, and other professionals within the area of disability. In MSE the control of interaction with multimodal stimuli is the common base for intervention that aims for a large variety of objectives, whether educational, therapeutic, developmental or recreational. The computer-mediated ludic experience is compatible with this premise of functionality of the multisensory room, because it depends on the reception and interpretation of mostly visual and auditory stimuli.

The challenge presented to the design team stems in the potential use of the computer game in MSE, as a mediator for intervention with children with intellectual disability. The design problem was to create a computer-mediated ludic activity suitable to generate enjoyment and to support the performance of general play skills, considering two structural orientations: the usage of freeware and accessible technological solutions and the comprehensiveness and adaptability to different contexts of implementation, within the reality of MSE. This computer game, allowing the performance of play skills, would also be expected to foster the development of communication skills and cognitive competences, like object permanence, perceptive-motor coordination and object-symbol association.

This paper presents the LED-ME Project in its different stages, from the definition of the design problem facing the requirements it should respond to, the game production and technical tests, to the prototyping and pilot test. In the first section we will describe some of the contextual factors bordering the design problem and grounding a set of design guidelines. In the following we present a detailed description of the resulting prototype and the results of a pilot test.

2. Bordering the design problem

Three core assumptions are supporting the requirements presented to the development team: the versatility of MSE as a context for intervention in the complex area of disability, the potential of MSE as a ludic space and the characteristics of the computer-mediated ludic experience, that amplified by technological devices work as mediator for personal development of children with intellectual disability, within the scope of the intervention of Occupational Therapy and Special Education.

MSE result from the evolution of Snoezelen rooms. These were created in the late 70's by two staff members of an organization delivering care services to severely disabled persons in the Netherlands. The original motivation inspiring the creation of these spaces was to deliver moments of relaxation, well-being and interaction with the caregiver, as an answer to the difficulty in finding value activities for this particular target group [G.E. Lancioni et al. 2002] with no focus on therapy or development [Hulsegge and Verheul 1988]. The fact is that in our days MSE are a daily resource used in many schools, residential homes, hospitals, clinics, or in other organizations providing services in the area of disability. Eventually, the Snoezelen original philosophy might still be found grounding the activities carried out, however, the MSE are now considered as a diversified context, welcoming leisure, recreation, education or therapy [Pagliano 1999].

This means that in time, the use of the Snoezelen room was made available to other target-groups among the complex reality of intervention in disability. The success of MSE was strongly favored by the notion that the multisensory stimulation was an innovative approach with positive impacts on everyone [Stephenson 2002]. So far, the research literature hardly supported some short-term positive impacts with specific populations [Glenn et al. 1996; Shapiro et al. 1997; Houghton et al. 1998; Singh et al. 2004; McKee et al. 2007].

Intellectual disability is a term widely accepted as a euphemism for mental retardation that comprehends multiple health and development conditions, affecting the normal development of mind, and disturbing two or more areas of adaptive behavior, like communication, leisure, work, self-care, among others. Children with intellectual disability have a development potential to be explored, attending to their personal needs of functionality, among which the play competence is recognized and valued [Lollar & Simeonsson 2005]. MSE are all compatible with the expected tendency of the child to play and explore; their nature is ludic and rare, most likely different from any other environment where the child has played before. The configuration of the context is essential to support and facilitate play: the importance of a safe environment, the existence of interesting objects, materials and activities is recognized in several play definitions [Parham & Primeau 1997].

The effort of design a computer game considering these boundaries must understand how intervention is structured for children with intellectual disability within the fields of Occupational Therapy and Special Education because these are the most frequent actors operating inside MSE. On the other hand, this design challenge must also take in consideration the characteristics of the ludic experience as an individual production that might be shared and demanding of cognitive and motor competences within players.

2.1. Intervention in Occupational Therapy and Special Education

Occupational Therapy and Special Education are two of the many areas of expertise that comprehend practice in the area of intellectual disability in their domain of action especially concerned with child development. Practice is here understood as the set of knowledge, methods and strategies that are organized by a professional, or a group of professionals, to attend the particular needs of an individual or even the expectations of its representatives.

The domain of intervention of Occupational Therapy aims for the heath support and participation in life through engagement in occupation [AOTA, 2008] considering a particular environment or context. Occupation is structured in areas, like activities of daily living, education, work, leisure, social participation, and rest/ sleep, among which Play is also emphasized. In regards of practice with children with intellectual disability, the concern of occupational therapy is with functionality in these areas. The intervention is based in a circular model of "evaluation – intervention – results" that includes features related to the context, the particular client, the required skills and patterns for occupation and activity performance.

Practice within the area of occupational therapy is grounded in a moment of assessment, which discriminates the preferred areas in need for adaptation. As already mentioned, the intervention should be planned to respond individually to the real needs of the client as well as to their expectations and their representatives. Once this context is assessed, the practice of the occupational therapist may focus on the body structure, but most likely will concentrate on the body functions. This view connects to an emergent paradigm of understanding disability as a disruption in the functional limitations of any person, requiring individual supports to personal skills and adaptation, aiming for well-being [Schalock 2004]. Disability is therefore understood a universal experience, i.e. not particular to any social group or health/ developmental condition.

The area of Special Education has been assumed as a priority in formal education contexts, as the concept of inclusion is put into practice. The ideal of inclusion is the provision of specialized support for students with special educational needs within regular schools, not separating these students in specific classes or in other external organizations. A set of technical and specialized resources is usually configured to meet the individual needs of these students, which leads to a personal development framework of support. This framework takes the form of an individualized development plan with emphasis on the curricular learning contents that are achievable and important to the functionality of the individual.

The professional practice, both in Occupational Therapy and in Special Education, points out to individualized aspects of development of the child with intellectual disability, from which different types and degrees of impairments are expected, with impacts in activities of daily living, education, work, leisure, social participation. These are themes that are frequently transferred to computer game contexts, for example in several educational games.

2.1. The Computer-mediated Ludic Experience

The ludic experience emerging from the participation in a computer game is individual and marked by the construction of contextual meaning, although it might be shared with others. This experience is therefore influenced by the personal characteristics of the player, e.g. his age, his background or his personal choices [Fernandez 2008]. Each individual bares a context with more or less compatibility with a ludic challenge.

Using a structural approach to identify different phases of this construction process, the player begins by placing himself in the proposed space environment, identifies his locus of control and tests the purpose to achieve. The passage through these stages requires the mobilization of cognitive skills. These skills are necessary, for example, to discriminate between sound and visual stimuli, to locate objects in the space, to construct their understanding as symbolic objects associated with a representation of reality, and even the ability to handle them as external and independent. This construction process shows some connection to the idea of immersion as proposed by Thon [2008], as a withdrawal of the real environment, while enabling the definition of mental representations of the game.

According to the model of Ermi & Mäyrä [2005], immersion is considered to be the essential part of gameplay experience as the player interpretation of the act of playing. This model helps to understand gameplay experience by proposing three different types of immersion: sensory immersion, resulting from the audio-visual execution of games, the challenge immersion, resulting from interaction, and the imaginative immersion, related with the enjoyment of the fantasy world created by the game context.

These views of the gameplay experience are connected with a more holistic understanding of play behavior, in the perspectives of the decision of engagement and maintenance of a ludic activity: although play remains an elusive concept, Rubin and Col. [1983] argue that intrinsic motivation appears to be a characteristic of play that is commonly accepted among several play definitions. Bundy argues that playfulness, as disposition to play, is one of the most important aspects of play, as a behavior that is also internally controlled, and marked by the freedom of choice to suspend reality at any time.

For the sake of the integration in MSE, the design of the gameplay experience for children with intellectual disabilities must include a strong investment in the sensory immersion. As for the challenge immersion and the imaginative immersion, they should be adequate to the skills of the target audience and be set from a very basic level, without prejudice of the equilibrium between challenge and competence [Csíkszenmihályi 1990], and considering that all children have similar approaches and attitudes to play, without regards to intellectual impairment [Hughes 1991]. Several technological possibilities allowing the use of the gameplay experience in MSE are available, among which the GestureTek solutions have been prominently featured in the literature as Virtual Reality systems [D. T. Reid 2002; Miller & D. Reid 2003; Kizony et al. 2003; D. Reid 2004; Yalon-Chamovitz & Patrice L. Weiss 2008]. However, the financial cost of this equipment is significant, when compared to the possible adaptation of other technological solutions, eventually easier to implement, respecting the particularities of each MSE.

In fact, the MSE are virtually different from each other, as their configuration depends on creativity of staff members, their areas of expertise and the financial budget of the organization. However, a common set of artifacts might be found, like a sound and light system, the colored ball pool, the musical water mattress, the fiber-optics bundle, pillows, and cushions. These among other types of objects and artifacts are responsible to create the stimulation environment. The use a computer game as a mediator of therapeutic or educational objectives in MSE is expected to generate some competition with the other devices and artifacts available. The person responsible for the intervention has the responsibility to ensure that the activities carried out are compatible with the pursued objectives; therefore he/she is a privilege actor to involve as a facilitator.

3. Design guidelines

Considering the previously described contextual factors of implementation, and the objectives of the final product, i.e., to create a computer-mediated ludic activity suitable to generate enjoyment and to support the performance of general play skills for integration in MSE, the following design guidelines were presented to the development team as reference features of the project:

- The game will be working in a video projection, without the necessary use of peripherals, like joystick, mouse, or switches.

This design guideline ensures that the game can be set in any MSE, provided the existence of the following devices correctly configured: a video projector, a computer and a web cam. Player movement would be, therefore, the main source of manipulation of the game mechanics.

- The game sends out ludic cues in the passive mode, as invitations to play, with random sounds and images or responding to a basic movement of the player.

The ludic cue is an integral part of the concept of playfulness as suggested by Bundy [1997]; it consists in the necessary skills involved in giving and interpreting social cues that contribute for the maintenance of the context of play. This design guideline will ensure that the engagement of the child in the computer game may happen on his/her own choice.

- Flexibility of performance and continuous gratification

The game should automatically adapt to the skill of the user while in performance, dynamically controlling the speed or quantity of objects in space and the time used in achieving a minor goal. This possibility is expected to maximize a principle of continuous gratification, necessary in the game to maintain the interest on the ludic activity.

- Coordination of sensory stimulation as positive reinforcement

The MSE provide for integrated socialization experiences with different sources of stimulation. A combined multisensory stimulation answer when any of the game goals is achieved will reinforce the ludic context and work as a facilitator of the game integration in the room.

- Calibration of difficulty levels

This configuration option allows the adjustment of a starting point for the difficulty level of the game. This allows a greater control over the challenge proposed on the different skill levels of the end users.

4. The LED-ME design proposal

The project was entirely developed within a three months frame, with periodical meetings for follow-up, in which the design team presented ideas and accomplishments. The final prototype is now described.

- General description and key features:

The proposed prototype can be best presented as a "Eat-the-good, Don't-eat-the-bad" game, inspired in "Pac-Man" [Iwatani et al. 1980] and in "Flow" [Chen and Clark 2006]. It was developed in Adobe Flash®, over Action Script®. The player controls an object in a two-dimensional environment and by making any loud vocalization sends out radar waves through the controlled object, which allows him/her to disclosure "edible" actors in the environment. These actors appear randomly in time and trajectory, and only become visible by the waves emitted. The green actors change the shape of the players object by growing it; red actors will produce the opposite effect (in image 3).

Image 2: Inside the small blue circle, a yellow ball will grow when a green actor is absorbed. The object emits radar waves after a loud sound produced by the player

- Target platform

A current PC, equipped with a webcam and a video projector.

- Game mechanics and goals

In the absence of a prior explanation or demonstration in the game, as soon as the player absorbs one of the creatures, he/she receives an enhanced sound that indicates success or failure.

The repeated success will gradually transform the shape controlled by the player up to a certain moment in which the whole game area is visible. At this point, a sensory explosion of color and sound will take place, indicating that the game's main goal has been reached.

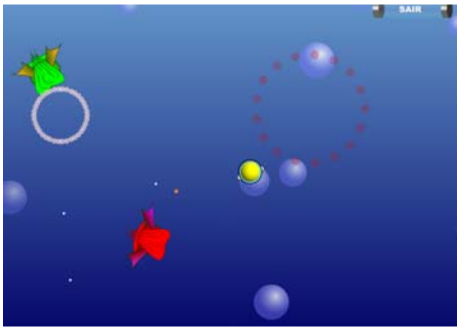

Image 3: The game environment disclosures for a sensory blast when the golden goal is achieved

- Characters and gameplay elements

In the game there is only the object controlled by the player and the emergent edible actors. We also highlight the radar waves to locate these actors and the colorful shapes accompanying the demonstration of success. Three separate environments with different actors were created: Feluides (Ocean), Harenes (Desert sands) and Laines (City Traffic).

- User interface

User interface is based on the hand/arm control and movement of any colorful contrasting object (like small ball) enabling the mouse movement on the computer. The prototype used Camspace® freeware software [CAM-TRAX Technologies 2011].

- Sound and music

Sound works mainly as a stimulation resource, over a constant musical/environmental base. Different sounds were selected to signal positive and negative actions.

5. Pilot test and preliminary results

The general purpose of the pilot test was centered in evaluating the general technological solution and the adequacy of the designed computer game to the environment and the target-group. The test was conducted in the MSE of CERCIMIRA, a Portuguese organization that provides special education services to children with intellectual disability since 1978. The activities undertaken in this room are organized by a Special Education Teacher, and, depending on the child, the room may be used for recreational purposes and for the development of perceptual-motor skills. In the following image we present a schema of the hardware disposition. The video projector was placed on the left side of the play area. In the test we used a laptop computer showing no image, with an integrated webcam.

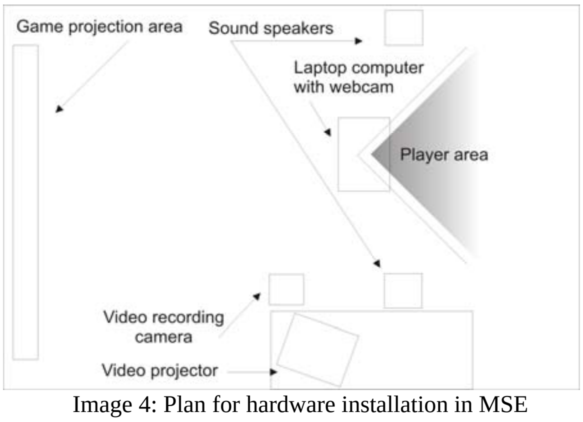

Image 4: Plan for hardware installation in MSE

One child was invited to participate in the test, after informed consent of his parents. In the following we provide for a brief description of the client functional profile, keeping this information strictly about its relevance to his expected performance in the test; the name was changed to respect confidentiality.

Philip is 14 years old and has a moderate/ severe impairment of the cognitive functions in general, due to Down syndrome. He has low tolerance to physical efforts due to congenital heart disease, and also a physical deformity in the distal left upper limb (no hand). Vision is conditioned by myopia and hypermetropia. In regards to activity and participation, Philip has conscience of his identity and the identity of the persons living with him. Philip reveals serious difficulties in oral expression, compensated by the use of gestures and facial expressions. He has not acquired basic notions of time and space. Philip was also previously observed in the MSE to gather information about his ludic profile, using the Test of Playfulness [Skard & Bundy 2008] in his Portuguese pilot version (in press). This test was developed in the area of Occupational Therapy and is composed by 21 items to score a child's playfulness. This assessment, in short, shows a youngster with a good level of playfulness and a fair level of control of his play activities, but with difficulties in negotiating and accepting suggestions. Philip has a very communicative approach, although sometimes he does not accept ludic cues from others. He uses several sources of motivation to maintain the playful context, with more emphasis on objects than personal movement. No original "make believe" actions where accounted for in this assessment.

Philip has never played a computer or a console game before. He and his Teacher use the MSE room regularly with recreational purposes; in a regular session they use the MSE to play, although most of the times some equipment is used to reinforce the learning of very elementary curricular content, like color names or counting.

The test of the design was prepared to happen in one individualized session of 15 minutes, registered in video for future evaluation, in the presence of one of the researchers. All the technological devices were previously installed in the space inside the "white module" (an isolated corner of the multisensory room that has no visual stimulation) and the game was set in the passive mode. Once inside the room, the Teacher was instructed to deliver the session in the multisensory room as any other, proposing the new computer-mediated ludic activity when considered pertinent, with clear instructions to respect the child's will at any time. Once inside the room, Philip waited for the instructions of his Teacher that proposed immediately the experimentation of the game. After a brief explanation in which the Teacher talked about the presence of the Researcher, and the novelty in the multisensory room, Philip was playing holding a yellow ball, with a close support from the Researcher.

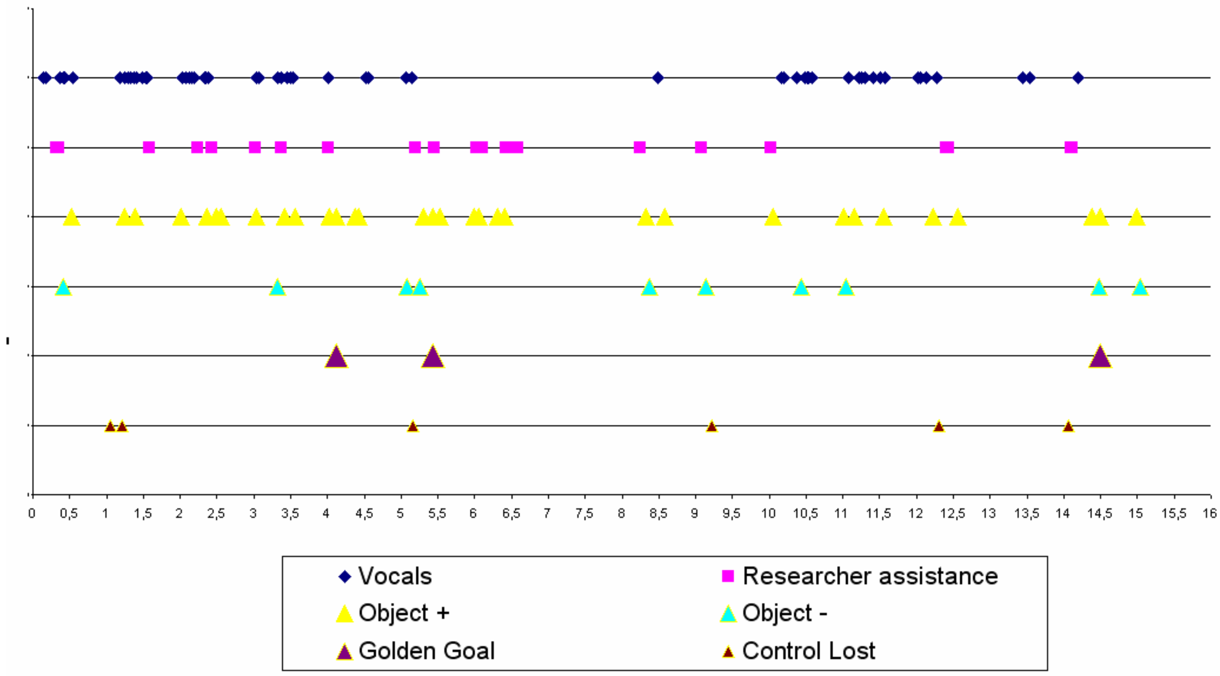

Image 5: LED-ME test timeline

The graphic in image 4 shows the timeline of the session and the relevant events of the test.

The base line represents the time length of the test; the upper lines represent the identified variables in the box. The first represents the moments when Philip "called" for the radar waves, allowing the disclosure of eventual preys. Below this line is the researcher assistance, anytime that Philip was having a hard time in controlling his object or in required situations so that the game could go on. Object lines represent when the abortion of good (+) and bad (-) shapes occurred. The visible gap between 6½ and 8 minutes was due to a sudden malfunction of Camspace® in recognizing the yellow ball. This short break was used to change the game environment from "Feluides" to "Harenes". At last, we also signaled the moments when Philip seamed disoriented in controlling his object. The golden goal was reached roughly after 4 minutes playing the game. The general behavior of Philip during the game was very interested and cooperative. He did not show difficulties in understanding the simple game dynamics. The control of the object was not perfect, although the need for assistance has decreased along the test. On the other hand we were able to notice that Philip could follow simple instructions to get objects located up, or down in the game environment.

6. Discussion

We consider that the results obtained with this test are very encouraging, both in regards to the implementation of the design guidelines and the hardware configuration to support it. Philip, our Client, was able to understand the game play context and to have fun with it, despite his personal limitations. The hardware/software combination worked, although some adjustments can be done to improve the camera set to recognize movement.

Philip followed all the test session with interest and wonder. In fact his fair level of playfulness was a powerful ally to facilitate his involvement and commitment in the ludic activity; this is confirmed by his early use of the vocal technique allowing object localization. Allow us to remember that this child never played a videogame before. The realization of the design guidelines previously presented to the development team resulted in a game with potential for adaptation to an audience with limitations, although with little to add in terms of innovation for a general audience. The game could improve significantly by reinventing the objects and environments with a more attractive and actual design, which can basically be done without affecting the program setup.

Just by allowing simple ludic moments that require the mobilization of basic competences (like communication, interpretation and motricity), this game enabled a friendly context for their development, and can be best integrated in global context of the activities taking place in MSE. We did not measure the use and mobilization of any specific competences and a single test would not be representative to draw any conclusions about their development. However simply by exercising these competences one can assume that, in principle, they are being trained.

From the game characteristics we highlight the game reaction to the sound produced by the player as one of its stronger features, because this allows a quick association between cause and effect. The configuration of the difficulty level is also very useful, because it allows a better adaptation of the game to different users. Globally, the selected hardware configuration is also a positive feature, allowing the use of other possible games based on mouse movement. Camspace® revealed itself an adequate and accessible solution, although a safety margin of distance from the webcam must be respected to work in perfection. In fact we noticed in the test a few gaps, lasting for one or two seconds that caused sudden losses of control, but rather easy to compensate. This safety distance rule between the object and the webcam might constraint the necessary hardware installation, because the webcam must be connected to the PC; otherwise it could be lighten by the use of a wireless web cam.

7. Conclusion

The design problem in short was to create a computer game, suitable to support a ludic context and the performance of general play skills, considering the usage of accessible technological solutions and the adaptability to different contexts of implementation, within the reality of MSE. The LED-ME project achieved this challenge and opened new and accessible opportunities for participation in computer-mediated ludic activities inside MSE. The design guidelines grounded the functionality and the implementation needs. This hardware/software combination also allows other computer games to be played inside MSE, as long as they are considered adequate and useful for intervention.

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