Empowering caregivers in multisensory smart spaces for education and therapy

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Abstract

Interactive Smart Spaces (ISSs) are physical installations equipped with digitally enriched embedded devices that can sense the users' presence and actions and generate stimulation for multiple senses. Our research focuses on ISSs for education and rehabilitation. In these domains, there is a strong need of tuning and controlling the User Experience to address the specific needs of each user or user group, a process that, in principle, should be performed by caregivers and in real-time. Nowadays, several examples of ISSs exist but they do not provide control interfaces that are powerful for customization purposes yet simple enough for caregivers, who typically have a limited technological know-how.

Keywords

Smart space, User Experience Design, Caregivers Empowerment, Grafical User Interface,

1. Introduction

The increasing debate about personalized and multi-sensory educational processes, arisen in the literature in the latest years, pointed out the noteworthy potentialities that sensory and synesthetic experience can have in helping children, especially those with special educational needs, to improve their abilities. Most multi-sensory approaches take shape in dedicated spaces called "Interactive Smart Spaces" (ISSs) - rooms equipped with items that provide gentle stimulation of different senses while offering a non-threatening, relaxing, but also an educational, environment. An ISS is an inter-connected structure grounded on the theories of embodied cognition and sensory integration, on the development of cognitive skills such as mental imagery and implicit memory, reasoning and problem solving sometimes through the concept of "playful learning" [1, 2]. We developed the Magic Room (see Figures 1), an innovative, unconventional IoT enabled ISS, evolution of a previous work called P3S [5]. The Magic Room is a room-size interactive MSE that enables new forms of playful interventions for children. This installation has been designed to let children with NDD and more in general children with Special Education Needs in the school environment experience playful and learning activities improving their quality of life and inclusion in the society through playful learning experiences. The Magic Room has been designed to transform almost any room in a digitally semi-autonomous and affordable MSE if compared to commercially available solutions. Magic Room is easily extensible in quantity and category of smart appliances available in the environment, available stimuli that can be detected or provided by the system and experiences available to the children and caregiver in terms of content or mechanics of interaction.

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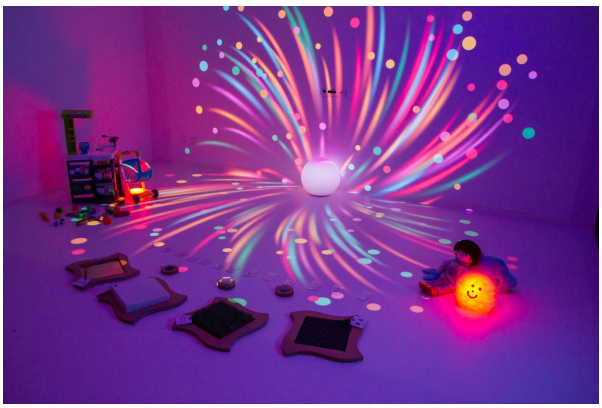

Figure 1: Magic Room

Several factors influence children with disability environment, one of the most important is the caregiver presence: a caregiver should promote autonomy (all activities that an individual does throughout a day that are necessary and/or meaningful to that person)[3]. Using interactive technologies such as ISS is considered an approach that does not replace current therapies, but can support caregivers in their work with children. Given the novelty of these technologies, caregivers have an even more important role as they are required to manage the children's experience in the ISS. The greater the understanding of the context where the child is inserted, the more caregivers are motivated. The total delegation of the system, instead, can cause pressure on the caregivers, who are therefore less motivated. To enable the caregivers to use the ISS, it is necessary to build an accessible and scalable tool that allows them to easily take advantage of all the possibilities that the technology offers. Usually, the absence of an easy to use and ecologic control is one of the most relevant causes that could lead to the non-use of the ISS, leaving an environment designed for social usage in need of high skilled technicians.

2. Related work

Researchers have already developed different solutions of multi-sensory environments, such as Snoezelen, MEDIATE, Lands of fog, and P3S. Snoezelen offers a relaxed atmosphere with pleasant surroundings, soothing sounds, captivating aromas, tactile experiences, massage and vibration, vibrosonic sensations, and gentle movement [4]. MEDIATE stimulates children through visual, tactile, and aural channels and allows them to express themselves through body movements, but does not support interaction with objects [5]. Lands of Fog is a full-body interaction system based on a projection on the floor where children can explore and discover unique characters, objects, and events [6]. In P3S (Playful Supervised Smart Spaces), smart objects are integrated with interactive multimedia content immersed in physical space, through light effects on a "luminous carpet "and animations (stories and games) projected on the wall and the floor [7].

MEDIATE [5],Snoezelen [4] and Lands of Fog [6] do not present any type of control interface, the system is independently managed. P3S [7] allow the caregiver a certain level of configuration and control. Most of these systems leave the educator in a pure observer role or acting on physical switches to change the state of the environment, and the children often explore the environment freely.

Figure 2: Caregivers' tablet interface

3. The Customization Tool

In close cooperation with 20 teachers from two primary schools in Milan and 10 psychologists from two local therapeutic centers, we did a workshop to define the user experience in the Magic Room. The co-design with the experts aimed at increasing user satisfaction by improving usability and ease of use provided in the interaction between the caregivers and the system. During the workshop, we wanted to understand their technology knowledge level and how they imagined children experience related to educational needs with particular attention with children's with special needs and, therefore, the identification of specific requirements to be addressed in the project.

We opted to design and develop a solution that allows teachers and therapists to use the room intuitively via tablet interface (see Figures 2). The system provides a set of customizable *Activities* each one devoted to a subset of specific purposes, among which the caregiver can choose and personalize. Activities can be organized in playlists, called *Experiences*. The system is mainly autonomous during its execution, letting the caregiver spend quality time with the pupils and not worrying about the system management: the educator is in charge only on deciding which game to play, to tailor it according to the situation and children, and then start it. However, we decided to let the caregiver the possibility to control the Activity in real-time and to manage the turn-taking. To perform all such tasks the caregivers' web interface is divided into three key moments (see Figures 3 and 4): *Create*, *Play* and *Live*.

In the Create, educators can customize the activities' parameters and save them for future reuse and or pack a set of those in an Experience in advance. In Play, they can select which Activities or Experiences to do in the session and eventually which player may participate. Additionally, before playing, the educator can modify the Activity's parameters to tailor them to the children's needs better. In Live, they can control the flow of the Activity during execution.

4. The Authoring Tool

The previously described Create allows to personalize some parameters such as level difficulty, enabled stimuli, themes, but it does not allow the structural modifications of Activities. Create can be considered as a *Customization Tool*, but we observed that in some situations, caregivers would obtain a wider expressiveness power. This increases the challenges because there is the need to find the appropriate trade-off between expressiveness and an intuitive interface. Observing the normal rou-

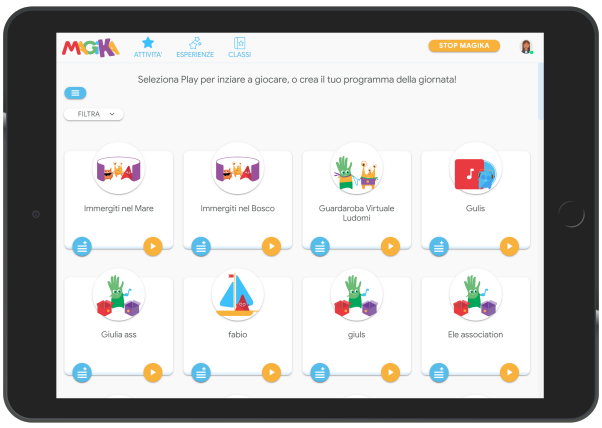

Figure 3: Customization tool (Play)

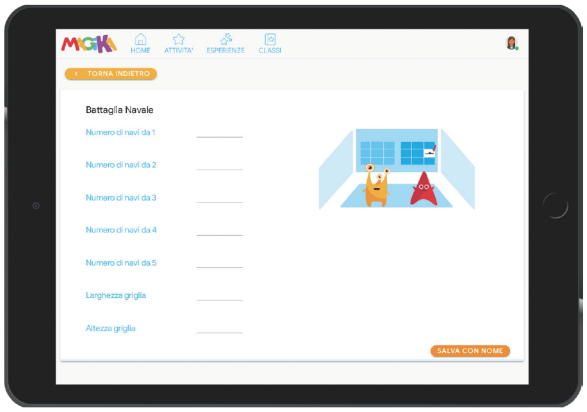

Figure 4: Customization tool (Create)

tine of caregiver, we had observed that storytelling is still widely used and that the amount of know story is huge (i.e., all caregivers can tell different stories to their pupils). For these reasons, we decide to design an *Authoring Tool* showed in Figure 5 to create stories benefiting of all the multi-sensory interactions and stimuli available in our Smart Space. The development of this tool required the conceptualization of the main aspects of a storytelling activity (Figure 6). It leads the design of the user interface and establishing a sound vocabulary for the caregivers.

The Magic Room is able to provide *Stimuli* and sense *Events* derived from user interaction and system triggers. A *Stimulus* is composed of a type and a set of parameters to personalize it (i.e., the light's color). Examples of stimulus are: showing multimedia content on the projectors in a specific position, turning on the bubble machine, controlling a LED in the fin of a smart dolphin. The stimulus can be combined in serial or parallel. A delay function is available to adjust the flow of the stimuli. An Event is described by the type of interaction required, the locus of the interaction (in terms of, possibly, both of position in the room or sensible area over a smart object), and a condition to be satisfied on the interaction.

A *Story* is composed by a sequence of *Scenes*. A Scene represents a relevant and self-contained moment of the storytelling. The Scene can be arranged accordingly to the traditional peculiarity of flows, including branches and loops: this enables interactive stories, with different paths and endings.

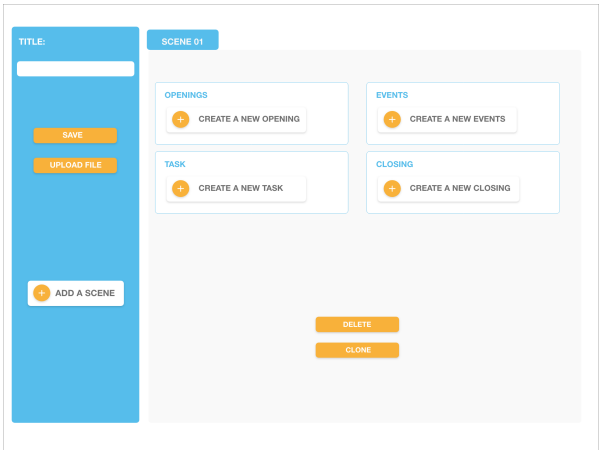

Figure 5: Authoring tool

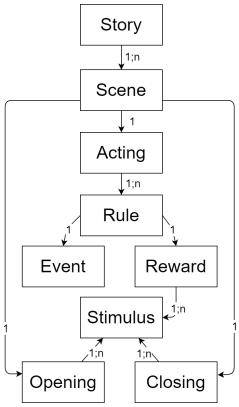

Figure 6: Model describing a storytelling Activity.

Each scene is composed of three steps: *Opening*, *Acting*, and *Closing*. Opening describes a set of Stimuli that introduce the Scene to the children. Acting is the central part of the Scene, and it is composed of *Rules*. A Rule consists of an Event and a Reward. When a Rule is triggered, the others are deactivated. A *Reward* is provided only at the completion of the corresponding Event before the Closing and is comprised of Stimuli. Finally, each Event is associated with a "flow instruction," which determines the next Scene. Closing, likewise Opening, describes final stimuli the children receive before the next Scene. Closings are independent of the triggered Event.

Based on this model, a graphical application has been implemented to support the authoring of stories for the Magic Room, without requiring any programming skills. Once the story has been defined, the system generates a machine-readable code for the activity engine, which can interpret and execute the story's specifications.

5. Conclusion and Future Work

The Authoring Tool described in this paper has been designed as an evolution of the previous generation of the Magic Room [7], in order to expand the expressive power of the newer environment. We

are now planning to perform a Usability study to assess the actual effectiveness of the tool with respect to the background and characteristics of the caregivers who need to configure the Magic Room.

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