Making Sense of Body and Space through Full-Body Interaction Design: A Case Study

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Abstract
Research based on the embodied cognition framework proposes the use of physicality and spatiality to promote learning. Nevertheless, methods to include children in the design of Full-Body Interaction Learning Environments often neglect to properly integrate the notion of body and space. In this paper, we describe a participatory design process in which we focused on how children can be encouraged to pay attention to their own body, to proxemics and to embodied constraints of the environment. We explored how this awareness may inform children's design choices for a Full-Body Interaction Learning Environment for public spaces. Our findings indicate that our approach promoted children's awareness towards bodily and spatial aspects of their proposals. Our work contributes to the reflection upon the use of bodystorming and theater-based techniques in two contexts: (1) in a simulated environment of the experience and (2) in physical spaces in situ.

Author Keywords
Full-Body Interaction; Learning; Children; Space; Participatory Design; Bodystorming.

ACM Classification Keywords
D.5.2 [User Interfaces]: Evaluation/methodology – Prototyping – User-centered design

Introduction

There has been a growing concern among designers of exhibits for public spaces that traditional exhibitions and communication media may often fail to promote a deeper understanding of the exhibition's themes. As a consequence, in the last decade a wide range of interactive technologies have been introduced to exhibition spaces to create new avenues of learning [1]. Building on this, the child-computer interaction community has explored the potential of Full-Body Interaction Learning Environments (FUBILEs) to foster students' skills towards collaboration [8], perspective-taking [11] and the understanding of abstract concepts [13], among others. Many of these studies arise from the embodied cognition framework and propose the use of physicality and spatiality to promote learning. However, little attention has been drawn on the exploitation of the full potential of the Full-Body Interaction paradigm. A number of studies in this field incorporate the notion of the body only on a functional level, and often disregard how sensorimotor functions can influence cognitive processes [9]. In other words, these studies do not consider how users' perception of their body and spatial aspects of the environment could impact how and what they learn. On the other hand, despite the long-standing tradition of participatory practices for interaction design [10], only a few studies involve children in the design process of FUBILEs [13]. One reason for this may be the difficulty in designing and developing prototypes at a full-body scale. To address these shortcomings, in this study we propose a Participatory Design (PD) approach which combines bodystorming techniques, physical theater practice and low-tech prototyping activities. Its goal is, on the one hand, to enable children to express design ideas through multiple modalities, such as crafting, oral expressions and body actions. On the other, we explore design techniques that promote bodily and spatial awareness and could help children to integrate those qualities in their design proposals. In particular, we aim at encouraging children to pay attention to (1) their subjective space [14], i.e. the space that surrounds their body and determines certain movements possibilities; (2) their proxemics [5], i.e. how they interact with each other and make use of space; and (3) embodied constraints [6], i.e. the configuration of space and objects within the environment and their impact on their interaction. In this paper, we explore how the awareness of these three aspects can inform children's design choices for a FUBILE.

Background

The potential of bodystorming is well documented within human-centered design research. Bodystorming is commonly used as a performance technique to involve physicality in the brainstorming process. Recent studies in the field of human-computer interaction developed bodystorming techniques derived from theater practices [7]. However, this approach has hardly been used with children [4]. In previous studies [12] we explored theater practice as warm-up activity to facilitate children in the design of games that incorporate the specific features of the Full-Body Interaction paradigm. Despite this bodily-based training, our results indicated that children tended to describe interaction design ideas related to device-based gestures (such as point, click, drag and drop) as opposed to using full-body movements. To overcome this shortcoming, we decided to incorporate the bodystorming technique in follow-up PD workshops [13]. The goal this time was to enable children to design specific body actions of a FUBILE aimed at supporting children's understanding around environmental issues of air-pollution. Therefore, we asked the children to think of gestures and movements which would show reciprocal relationships between specific game elements. Our findings showed that the children that employed the

Figure 1: The children take pictures of different spaces of the cultural center to draw their attention towards the physical space and its surroundings.

Figure 2: Children make their own puppets.

Figure 3: Children prototype the interactive experience.

bodystorming technique proposed a wider range of ideas. However, its use did not help them to focus on the specific design goals of the task. Moreover, we observed shortcomings when providing children with a printed version in DIN A4 format of the floor projection as a reference for the virtual learning environment. The representative model in small-scale did not allow children to explore their design ideas in accordance with the spatial relationships of the real-scale environment of the FUBILE.

These findings, on the one hand, pointed us towards the necessity of methods for the design of FUBILEs which are adapted to children's needs and capabilities. On the other hand, further research is required to deepen strategies to promote children's bodily and spatial awareness. Therefore, we hypothesized that the use of bodystorming techniques based on physical theater practice in combination with low-tech prototyping activities would offer children a playful way to explore bodily and spatial aspects of the experience. In addition, the outcomes of our previous studies motivated us to explore and compare children's spatial awareness during the performance of their design ideas in two contexts: (1) in a simulated environment of the experience in the workshop room and (2) in specific physical spaces of a culture center in situ.

The Case Study

Our work-in progress project aims at designing a learning environment which will allow users to explore the meaning of magic through an interactive experience based on Full-Body Interaction. The study we present describes the design process of a FUBILE which is planned to be displayed in the context of a theater event of Shakespeare's play *A Midsummer Night's Dream* in a culture center in Barcelona, Spain. The play describes the unstable balance between the worlds of magic and reality. The goal of the FUBILE is to contextualize the core concepts of the play; i.e. to facilitate users to better understand Shakespeare's interpretations around the differences between reality and illusion.

Methods and Procedure

The PD workshops were carried out on four consecutive weeks, one day per week in a culture center of Barcelona with a total of 12 children (girls = 4; boys = 8) between 10 and 12 years old. These workshops were coordinated with theater play activities that these children had signed up for as after school activities. Two theater teachers were present during our PD sessions and supported our research team in the activities. Each of the four sessions lasted for 90 minutes. During the first 45 minutes of every session, the teachers conducted warm-up exercises based on theater practice [2]. In the following 45 minutes, one researcher worked with the children on the design of the FUBILE. Our activities were built around Shakespeare's theater play *A Midsummer Night's Dream* that was being rehearsed in the theater workshops.

Exploring and signifying the space

On the first day, the workshop session focused on the exploration of children's interpretations and preferences towards the play. As mentioned above, the children had been working on it in the theater workshops. We first conducted an activity in which the children defined their favorite scenes of the play and wrote them down on post-its. The children were then separated into groups of four and provided with one camera per group. They were asked to take pictures of spaces in the culture center in which these scenes could be enacted (Figure 1). This is a common design technique [3] to gain insights into aspects that children find interesting and engaging in a particular environment. We used this technique to draw children's attention towards the physical space. Furthermore, we were interested to see which meanings the children would assign to different spaces. After the exercise, all groups came together and explained where

Figure 4: Children bodystorming in the workshop room

Instructions for The Machine technique
The exercise started with one child performing simple, repetitive movements of his/her choice related to the space and idea chosen by each team. The other children of the same team joined then in the exercise one after the other with a complementary movement.

Instructions for Slow-Motion technique
The groups were encouraged to alternate their performance of body actions between normal pace and very slow movements.

We asked each group to perform both exercises first in the workshop room, then in the space which they had represented in their small-scale models, and finally again in a group presentation in the workshop room.

they took the pictures and why they chose that particular physical space.

Definition of the learning topic for the FUBILE
In the second session, we asked the children to classify their own contributions (post-its and photos) from the previous session into three main topics of the theater play, namely: love, magic and dream. After that, we assigned each topic to one physical space of the workshop room. Through a bodily-based activity, we asked the children to position themselves in the space that represented the topic they liked the most. The majority of the children chose the theme "magic" as the core working topic for the design of the final FUBILE.

Using small-scale models of body and space
In the third session, we asked children to make flexible puppets [13] with different materials (Figure 2) such as straws, wooden sticks, wire, fabric in different colors, tape, glue, etc. After that, we showed them a map of the culture center. Each group selected one space and produced a small-scale model of it (Figure 3). They were instructed to represent only main features of each space such as spatial configuration of the walls and main elements such as columns, furniture, etc. We then asked them to tell us what concepts came to their minds when thinking about "magic". We gave the children time to think about how to represent one of those concepts related to "magic" with the puppets and the small-scale model. Finally, each team presented their proposals to the entire group. The brainstorming activity and group presentation were video and audio recorded.

Bodystorming in a simulated environment and in situ
In the fourth session, the children were introduced to different bodystorming activities based on physical theater practice (Figure 4), namely: *The Machine* and *Slow-Motion* techniques [2]. *The Machine* technique is commonly used as a group warm-up or exercise to prime children to work collaboratively. For the Slow-Motion technique, the children were instructed to enact specific body actions related to the narrative of their design proposal. (A detailed description of the procedure of the exercises can be found in the side bar of this page.) In both exercises, we particularly encouraged the children to incorporate the space which surrounded their bodies in their proposals. Each group was video recorded during their performance in the workshop room and in situ at the space they had chosen.

Results

Group A (girls = 1; boys = 3), that chose the courtyard of the culture center (Figure 5), designed a small-scale model of a vegetable garden with a scarecrow. During the performance of the bodystorming techniques in the workshop room, the children organized themselves in a circle and individually enacted different gardening actions such as hoeing, harvesting and watering. In contrast, in situ we observed that the children reinterpreted the use of space through the performance of the same gardening actions but this time in relation to their surroundings. For instance, one child incorporated real plants from the courtyard in his performance. During their enactment, three children used a stone bench which was situated outdoors. This suggests that working in a real setting drew children's attention onto the specific embodied constraints and helped them to incorporate those in their performance. The abstract performance of physical actions in the workshop room turned into a more natural and tangible experience in situ. Back in the workshop room, we observed a significant evolution from the children's first ideas to the final proposal with respect to the quality of actions that incorporated bodily and spatial features of the environment. In other words, in the final proposal the children imagined the physical objects they had used during their performance in situ and tended to perform the physical actions as if those objects were present in the workshop room.

Figure 5: Courtyard with trees, plants and benches.

Figure 6: Entrance area with chairs.

Figure 7: Lounge room with chairs and tables. The bar was situated in front of this area (not visible in this photo).

Group B (girls = 3; boys = 1) chose the entrance area (Figure 6) of the culture center. In their proposal they enacted a scene at the royal court between a narcissistic princess and her parents. During the bodystorming techniques in the workshop room, the children individually role-played the specific body actions of each character without paying attention to the enactments of their peers. They stood far away from each other and did not form any logical spatial configuration. In situ, the group performed similar body actions. However, this time they managed to focus on the relation of their body actions to each other. The two girls who represented the royal couple sat on chairs and looked at the girl who performed the princess. One girl (the king) made a pointing gesture towards "the princess". In response to this action, a boy (the wizard) stood in front of "the princess" and performed a body action as if he would put her on a spell. The girl dropped then on the floor. During the presentation in the workshop room, the children used two chairs for the performance of the narrative and tried to recreate the same action-reaction mechanics between each other as in situ. This example points out that the bodystorming techniques used facilitated the children to reflect upon interaction possibilities between each other and the space in which they performed their proposals.

Group C (boys = 4) selected the lounge room (Figure 7). In the group presentation the children enacted a scene in a restaurant for wizards. During the bodystorming techniques in the workshop room, the children performed different cooking actions such as stirring and chopping gestures. In situ, the children incorporated in their performance a bar which was located in the lounge room. Furthermore, two children proposed to perform a collaborative task such as washing and arranging the food. This example confirmed that the bodystorming techniques in situ helped children to think about interaction ideas between each other. Furthermore, it shows how children's ideas were influenced by physical objects and the spatial configuration of their surroundings. However, during the group presentation in the workshop room, the children did not manage to focus on the activity and performed a narrative unrelated to their previous ideas.

Discussion

From the analysis, we have seen that our PD approach is effective in promoting children's awareness towards bodily and spatial aspects of their proposals. Through the different proposed activities, the children paid more attention to their subjective space, their proxemics and to the specific embodied constraints and affordances of the environment. This helped them to think about initial ideas of the content, body actions and interaction between different users for the design of a FUBILE. Furthermore, our findings illustrate the differences between the enactment of body actions "out of context" and in situ. In all three cases, we observed that when the children enacted body actions in situ, that the quality of their performances was positively influenced by physical objects and the specific spatial configuration of each environment. In addition, the experience in situ primed the children in *Group A* and *B* in their interaction behavior and facilitated them to incorporate proxemics and certain aspects of the embodied constraints in the final group presentation without having the real environment physically present. Hence, we encourage linking the design of FUBILEs and Full-Body Interaction to the physical world in which they will be situated.

Questions remain about how we can translate children's interaction design ideas to the technology used in Full-Body Interaction. Our study showed that certain ideas and body actions cannot always directly be incorporated in the design of a functional prototype. However, further considerations should investigate design methods which bridge the gap between bodystorming in situ and how

children can be allowed to translate those ideas to large-scale prototypes for FUBILEs.

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