Designing the Reactive Playground: Benefits and Drawbacks of Adding Digital Technology to Outdoor Play Environments

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This paper discusses the benefits and drawbacks of integrating interactive technologies into playgrounds. Children thrive on the freedom these outdoor spaces provide. As more technologies materialize in the lives of children, we feel that researchers and designers must move forward with caution when proposing computationally enhanced playground equipment. We explored this problem space by prototyping an interactive pathway which we tested in an iterative, participatory process with twenty children age three to five enrolled in a preschool childcare center. This experience enables us to make initial design recommendations for *Reactive Playgrounds*. First, we believe it is critical to integrate technologies that will enhance children's current play activities. Second, these elements should support overlapping play patterns, for example encouraging children to connect fantasy play with physical activities. Third, special attention should be given to the type of feedback interactive elements provide so as to minimize purely goal-driven play and further encourage diverse play activities. Future research should refine these recommendations into design principles and propose more prototypes for testing the positive and negative impacts emerging technologies can have on the outdoor play of children in playgrounds.

Author Keywords
Education, Playground, Technology and Children, Outdoor Play.

INTRODUCTION

Digital technologies have entered almost all areas of children's lives including entertainment, museums, and toys. Until recently, playgrounds stayed technology-free. With the increasing availability of technologies for outdoor

Figure 1. Interactive pathway prototype on site.

interaction, we envision that digitally enhanced equipment will be incorporated into playgrounds in the near future [9]. In an effort to inform the HCI community about this emerging field, we designed interactive prototypes, conducted a field study, and put forth recommendations for the design of *Reactive Playgrounds*.

This paper briefly provides some historical and contextual background on playgrounds, describes an interactive prototype, and reports on an evaluation with 20 preschool children. Based on our investigations, the conclusion outlines the benefits and risks computational elements carry for children's playground activities and lists design recommendations for future work.

BACKGROUND

Open-Ended Play Outdoors

Playgrounds are special places because there are no predefined goals. In contrast to many other activities in a child's life, adults do not set the agenda in playgrounds. Here children define their own objectives, progress at their individual pace, and acquire social skills. The nature of the equipment and layout of playgrounds provides a framework within which children are able to continually challenge themselves through a variety of play activities.

Playground History and Context

The most familiar play installations we find in playgrounds today, such as swings and seesaws, originated for the amusement and physical training of the wealthy. Play was an adult activity among the upper classes with ample leisure time. The public play yard was designed in response to a lack of open space in urban settings depriving city children of physical activity outdoors [6]. Even though urban planners today consider playground spaces generic utilities which should be available to all city residents, designers have maintained an interest in truly playful and stimulating outdoor play spaces [1].

School traditions like Pestalozzi, Froebel also contributed significantly to current notions of appropriate playgrounds. The very notion of the kindergarten – the garden for children – implies a well-designed space that engages children on their terms [6]. During the 1970s, another tradition to design adventure playgrounds emerged where children design and build their own play environments [4,6,8]. Technologies are only recently being introduced to playgrounds while related work already exists in the art-world and in children and science museums. Many individual artists have designed interactive exhibits such as the outdoor play installation at the Museum of Science in Boston, MA [9].

THE PROTOTYPE: THE INTERACTIVE PATHWAY

In an attempt to capture the strength of time-tested playground installations and emerging, popular interactive exhibits, we designed a simple prototype for exploring the problem space of outdoor playgrounds in the digital era. The interactive pathway consists of two separate path sections. Each path section is composed of two wooden beams with a series of five pressure-sensitive mats attached to the wood at a distance that is approximately the length of a 4 year-old's gait. Each mat has a motor attached to the wood next to it. When a child steps on a mat the associated motor spins. When a child walks or runs through the pathway, the motors spin one-by-one accompanying the child on a short journey across the path (see Figure 1).

Technical Implementation

The prototype uses a mixture of custom-made and commercially available materials. A 20 MHz PIC16F876 microcontroller is mounted on a dedicated printed-circuit-board that handles power distribution, local processing, A/D conversion, and motor control. Two 12V batteries power the system. The pressure-sensitive pads are commercially available stair alarm pressure mats. The motors are part of LEGO Mindstorms. LEGO parts form the structure of the spinners.

PARTICIPATORY PROCESS AND EVALUATION

We worked with 20 three to five year-old boys and girls from international backgrounds enrolled in a university's on-campus preschool. We met with the same children in their classroom and on their enclosed playground.

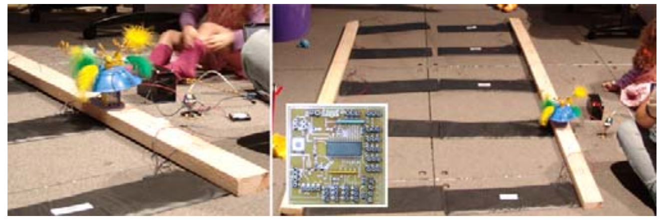

Figure 2. Technical implementation of pathway.

Throughout the process we documented via notes, video and photographs so that we could review our experiences later when developing design recommendations. We tried to understand the existing play in the playground and investigated what the children and teachers considered essential about the space and activities.

Phase 1: Observing Play

In order to gain a good understanding of the benefits and drawbacks of computational elements in the playground, we emphasized observation prior to implementing a prototype. In our summer-long study of the existing playground, both physical play and fantasy play were evident. For example, riding the tricycles while pretending to drive a bus, or trying to hold to the edge of the 'ship' (the slide) to prevent from falling into the 'water' (the woodchips on the ground).

Phase 2: Brainstorming

In the initial phase, participating children were invited to draw their playground in groups of three. We asked the children what they were drawing and what they did in that part of the playground. Since the children were young, the adult distinction between fantasy and reality was joyously blurred and many children drew objects in the playground, but from their own distinct perspective. Some children drew equipment and props from their playground while others drew items they imagined in their playground, they also described other places they played outside or simply things they had seen outside recently. The most popular item, the playground playhouse, was described through images and words as being a playhouse, a "magic-carpet" vehicle to other locations, and a place to make sand-soup. One girl, who loves flowers, drew a flower that she found growing beneath a bench.

Phase 3: First Play Activity Outdoors

After the initial stages of observation and discussion, we created a prototype to enhance the most basic playground activity – walking and running. We built the initial prototype of the interactive pathway and tested it in the preschool's playground. The prototype was easily transported by hand from one test site to another and proved to be robust. In small groups, the children investigated the new equipment, tinkered with the motors and LEGO spinners, and started to interact with the pathway in a traditional way, such as walking at different paces and some running.

Figure 3. From craft activity to design iteration.

Phase 4: Design Iteration

We decided to give the children an active part in the design of the new playground equipment. Using a selection of standard craft materials including glue, glitter, paper plates, pipe cleaners, bells, feathers the children designed their own spinners (see Figure 3).

Phase 5: Second Play Activity Outdoors

Returning the next day, we assembled the pathway with the new self-made spinners. We placed it in the same location in the playground where the children had played earlier. The children then played in same-gender pairs. Compared to the first activity, the larger self-made spinners attracted much more attention from the children. They inspected them and tried to find the ones they had made the previous day. The spinners promoted more diverse, unexpected play activities and increased running across the pathway.

OBSERVATIONS

Key Interactions

After initial hesitations to step on the pathway, all the children enjoyed the spinning elements, especially after they were redesigned to make a more significant visual and audio impact (the children attached small bells to their spinners). This aspect of the pathway was also the only one the children could truly articulate after the play activity.

In the second play session, we observed a rich set of play activities. Children started with the traditional types of physical play activities such as walking, running, skipping, jumping and standing on multiple steps at a time. The children also showed spontaneous collaboration, for example racing down the two lines of the pathway together, or running in circles through and around the pathway. When we arranged the two sections in a linear way, creating a long-and-narrow path, it further encouraged the running-based games.

Among the unexpected play activities we observed some interesting examples within the realm of physical play. For example, some children did more complex activities such as somersaults across the mats, lying down in order to trigger several mats simultaneously, or crawling across the pathway. While running and jumping, the children incorporated fantasy play into their physical activities. Two girls pretended the pathway was a train-track and choo-chooed while they ran through the pathway and around in circles. The children also used their favorite props from the playground, such as pushing a toy truck through the pathway, rolling a ball through, or throwing objects on the mats, to see if the spinners would be triggered.

Play Patterns

These interactions provide evidence for the many diverse play patterns children develop. We observed at least four styles: active play, fantasy play, exploring how things work, and game-building.

Physically active play as the name suggests involves walking, running, skipping, jumping, climbing, and more. During this type of play, children enjoy feeling their bodies move and often engage in repetitious behaviors with which they build physical competencies. This type of play, since it is externalized, is easy to recognize.

Fantasy play can be subtler because children imagine they are doing something beyond their physical actions. This fantasy can take the form of being in another place (such as imagining a play house is a portal to another world) or materials being something beyond what they are (such as making soup out of sand and water.) Often they speak or gesture to themselves. If they are playing with others, they may negotiate the fantasy (e.g., "you be the princess and I'll be the fairy.") Fantasy play may be the subtlest of all the categories.

Exploring how things work is characterized by carefully watching, tinkering, and experimenting with materials. This play is characterized by a combination of testing, often through physical manipulation, and observing objects in the physical world. In the case of our pathway, non-familiar causal connections intrigued some children, leading to experimentation with how the pressure-sensitive mats and motors worked.

Game building ranges from spontaneous development of simple games such as follow-the-leader to creating more complex games with changing rules such as hopscotch. These activities are often characterized by a mix of body motion and the creative act of designing the game rules.

A child at play rotates between these different styles and engages multiple styles at the same time. For instance, a child might be moving across monkey bars (physically active play) and at the same time talk to himself or herself about escaping alligators (fantasy play). These styles manifest themselves when children play in groups or alone.

Figure 4. Children engaging in multiple play activities on the prototype at the same time.

Reflections

Following the play activity we conducted interviews with the preschool teachers. They were excited about the project, and had precise observations about the interaction. One teacher emphasized the increased physical activity seen in the less active children. Another pointed out the high engagement level of the children and the exploratory nature of the activity. All teachers felt that the craft activity (letting the children design their own 'spinners') contributed to the children's engagement and were impressed by the idea of incorporating the children's creations into future playground equipment. When we asked about appropriate age groups, one teacher thought the prototype could also be appropriate for younger children (two to three years old) and might engage their natural curiosity in different ways than the older preschool children. Overall, the teachers were excited to see that the benefits of the interactive pathway outweighed the drawbacks, thereby acting as a natural extension to their school's playground without compromising the children's natural play patterns.

DESIGN RECOMMENDATIONS AND CONCLUSION

We believe it is critical to integrate technologies that will enhance children's current play activities [5,10] and contribute to the physical activity children enjoy in the playground. With digital technology, one can create so many different interactions and systems making it essential to consider what *not* to do in digitally-enhanced playgrounds. The best components will support a particular blend of physical sensation and activity with the fantasy that characterizes children's play. This combination might be in the form of delicate support of behavior, such as with our pathway, or displays that are ambient, not mapped too literally to particular behaviors. This can be a subtle distinction and an example may be helpful: For our pathway, we could have included a numerical display that indicated how fast the children ran. By doing this, the emphasis may have been to run competitively across the path, rather than to engage in a range of play activities which the simple spinners successfully encouraged.

Our field research enables us to propose an initial set of design recommendations for the *Reactive Playground*. First, a design should enhance rather than replace existing activities especially the physically active play which takes place in playgrounds. This integration allows children to approach a new technology from their vantage point.

Second, any device should enable multiple open-ended play patterns. This recommendation does not imply a lack of design constraints, but rather very specific ones which do not predetermine any one or two activities. In other words, slides are very specifically conceived to enable the physical activity of sliding down which does not stop children from using them as waterfalls or hiding spots and other elements in their play. This type of play benefits children significantly in many aspects of their development [7].

Third, careful attention must be paid to the types of responses technologies provide. In light of the previous recommendation, feedback should not reinforce simple, goal-driven play, but instead strengthen children's natural tendency to invent and create new play activities.

Finally, we believe that safety and robustness should continue to be a major consideration in developing further elements for outdoor use.

We believe our research presents an important question to the HCI community, which requires further attention by researchers and designers. Future explorations should expand on our early recommendations and lead to more detailed design principles.

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