Little fingers on the tabletop: A usability evaluation in the Kindergarten

Evi Indriasari Mansor
University of Manchester
Evi.Mansor@postgrad.manchester.ac.uk

Antonella De Angeli
University of Manchester
Antonella.De-Angeli@mbs.ac.uk

Oscar De Bruijn
University of Manchester
Oscar.De-Bruijn@mbs.ac.uk

Abstract

This paper presents selected results from an experimental study designed to compare fantasy play in a virtual and physical setting. Twenty-two children (aged 3 and 4) played in same-sex dyads with a real wooden tree house and its virtual implementation on a DiamondTouch tabletop. The study evinced several problems in the interaction with the tabletop as children often struggled to drag the objects displayed on the surface. An error analysis is presented and results are used to propose guidelines for improving the use of DiamondTouch tabletops by young children.

1 Introduction

A large number of computer applications are available on the market offering a wide choice for children to play with. Children enjoy playing with computers, but current products do not necessarily encourage them to use their imagination. Yet, fantasy play is a fundamental component of children's development and has been found to have a number of social and cognitive benefits [1]. Fantasy play is a spontaneous activity where children give new meanings to objects while playing [1, 2]. For instance, a spoon can be transformed in a sword, or a brush can become an umbrella. Similarly, children can attribute social roles to themselves and others, as in 'I am going to be the doctor'.

A recent study suggested that technology has the potential to stimulate fantasy play when virtual and physical stimuli are combined [3]. Yet, little research has addressed how virtual objects relate to fantasy-play. Our research focuses on kindergarten children (3-4 years old), as this is the earliest stage when they start sharing and coordinating fantasies with peers. This user group is largely unexplored in interaction design, yet its importance has increased in recent years due to the diffusion of computers in houses and nurseries.

In our research we use the DiamondTouch table as interaction device, as it has the advantage of supporting collaboration, providing multiple cursors and dealing with simultaneous inputs. It also provides a large space for children to play with and an intuitive interaction style [4]. In this paper, we report some interaction issues with the use of the tabletop observed during user-research. We also propose guidelines to make the tabletop more accessible to young children.

2 Study

The experiment was designed to understand the similarities and differences between physical and virtual objects to elicit fantasy play in young children.

2.1 Participant and design

A total of 25 children (14 boys and 11 girls) were recruited from the Webster Primary School in Manchester. All children were between 3 and 4 years old (mean=44 months, SD=4.3 months). Parental permission was obtained for each child before participation. On the day of the study, one girl and one boy refused to participate and one boy was absent. Thus, the sample consisted of 6 dyads of boys and 5 dyads of girls. One of the girls was a special needs child. The nursery teacher selected the dyads by matching children based on their friendship.

The experiment was based on a *within-subjects* design. The children were asked to play in both *physical* and virtual *environments* in order to compare their performances in both conditions. In the *physical* environment, children played with a wooden tree house and a set of physical objects. In the *virtual* environment, a virtual tree house and virtual objects were displayed on the tabletop.

2.2 Apparatus

The wooden tree house was designed and built to provide a gender-neutral alternative to the Rochat's

978-1-4244-2898-4/08/$25.00

dollhouse [2]. It consisted of four open plan rooms attached to a tree base (Figure 1). The tree house was located on a coffee table (60cm x 60cm), together with a set of wooden objects. Following the experimental procedure proposed by [2, 5] these objects could be either *realistic* (e.g., dolls and suitable props for the house, such as a chair, and a TV) or *non-realistic* (small rocks, wooden sticks of different sizes and a set of wooden constructions).

Figure 1. The physical tree house

In the virtual environment, the children played with a virtual tree house, which closely resembled the physical one in appearance (Figure 2). The tree house was implemented in Macromedia Flash and displayed on the tabletop screen (60cm x 76cm).

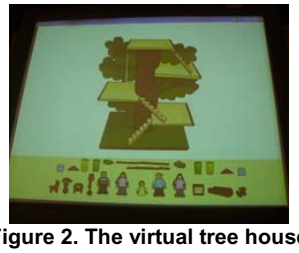

Figure 2. The virtual tree house

The tree house provided the same set of realistic and non-realistic objects as in the physical setting, but it also included some extra multimedia features, such as a few animations and sounds. For instance, the stone could be thrown and would bounce around the screen, the light switched on every time it was moved and the dolls waved or danced when moved. Objects could be moved around the space by dragging them with a finger.

In order to ensure maximum safety for the special population tested in this study, we had to build a robust iron frame moving the projector high, well above the children reach. The frame was also used to connect the Diamond Touch tabletop to a little coffee table. The mats were located on the floor and two children's chairs were provided (Figure 3). It was initially decided to invite the children to sit, to ensure that they would not move around the table thus leaving the mat.

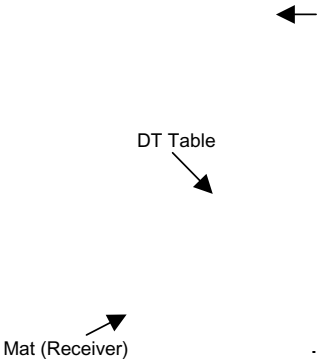

Figure 3. Tabletop setting

The virtual tree house was tested with a sample of 4 children, from 2 and half years old to 5 years old (accompanied by their parents) in the HCI lab. No particular, problems with the interaction emerged in the pilot studies and even the youngest child was capable of moving objects on the tabletop. Perhaps due to the small sample size involved, not all children being in the target age group and the lab environment influencing children to control their behaviour more, none of the problems experienced in the experiment were observed in the pilot study.

2.3 Procedure

The study was conducted during school time in a corner of a large schoolroom where dyads were transferred from their nursery class to the study location. The physical tree house and the tabletop were located next to each other. The order of presentation was counterbalanced among dyads. Privacy was ensured by a set of screens, yet the environment was often quite noisy. Two experimenters supervised the study; one interacted with the children, while the other operated the equipment. The children were already familiar with the main experimenter as she spent a few days in the kindergarten before the study.

At the beginning of the study, the experimenter explained the safety and important information such as the exit door and location of the toilet. Children had distinctive coloured paper wristbands to differentiate who was touching what. Each dyad played in the two different conditions for about 15 minutes each.

In the physical setting environment, children were given an introduction about the task by the experimenter before the dyad started their play session. In the virtual setting environment, there was a simple

training phase in which seven little balls were displayed on the screen and children were invited to drag them inside a box (Figure 4). Each ball produced a different sound when successfully moved into the box. This phase lasted the maximum of 6 minutes and ended earlier when there were signs of lost interest among the children. During the training phase, particular emphasis was given to inform the children of the need to keep both feet on the mat, touch the table with only one hand at the time, and control the body posture to avoid blocking the image projected on the table.

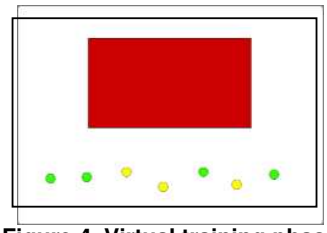

Figure 4. Virtual training phase

After the training phase, a cartoon spider introduced the virtual tree house: "*Hello, my name is dingle dangle. Here are five friends. They are moving into their new tree house. So, why don't you help them to decorate their new home with all these things."* The first 10 minutes of the study was videotaped for analysis purposes by using two cameras to ensure that all details were recorded. The activity on the tabletop was also recorded using Camtasia software. The children's names were replaced with a code. Only the codes were used in data analysis or in the presentation of the data.

At the end of the study, the researcher asked the children about their preferences and experiences. Each child was given a sticker as a token of appreciation. About a week later, the researcher interviewed each child individually in order to measure fantasy play predisposition.

3 Results

All children, except one boy who simply refused to, enjoyed playing with the physical tree house. They engaged with the physical toys and immersed themselves while playing. The virtual tree house, on the other hand, appeared to be much more problematic. Children did not show any surprise for the technological setting initially, as if they were already used to it. Soon, however, they started experiencing a number of difficulties in the interaction, which tended to frustrate them.

Training phase. The training phases lasted an average of 2.30 minutes during which, children only moved 2 balls on average. A strong individual difference was found with one child being capable of moving all the balls (N=7) and 6 children failing to move any of them. At the beginning of the training, children were very concentrated on the task. After a few unsuccessful attempts, some children lost interest in the game, yet they all wanted to play with the virtual tree house. We hoped that the more engaging environment would foster their motivation, and that practice would improve their performance.

Play phase. The following analysis concentrated on movement actions performed during play, e.g. every attempt made from a child to move one object from position x to position y. A total of 882 actions were collected. They were clustered in 3 categories (no movement, target fail and correct), by interpreting the children intention based on the interaction context and their verbal comments. *No-movement* included all unsuccessful actions where, despite the child intention, the object did not move from its initial location. *Target miss* included actions where the objects was moved to a wrong location. This could happen either because the children could not properly control the object trajectory or because they did not lift their finger at the end of the movement. *Correct* actions included all successful movements. Frequencies and percentages for all four categories are reported in Table 1.

Table 1. Moving actions

	Frequency	Percent
Virtual tree		
No movement	515	59 %
Target miss	58	6 %
Correct	309	35 %
Total	**882**	**100 %**

Even though children's performance improved with practice (not shown), the success rate was still very low (35%). The major problem for children was to initiate a movement, whereas precision did not appear to be a major issue. A strong individual difference was observed. The distribution of correct actions ranged from a minimum of 12% to a maximum of 75%. Interestingly, no correlation was found between object size and probability of success.

There were several reasons for unsuccessful actions; some of them were related to our specific application design, whereas others were more generally related to the interaction setting. In this paper, we mainly concentrate on general problems.

One of the main problems was that children very often tended to put two hands on the table and

constantly had to be reminded not to. The need not to touch the table at two points simultaneously was clearly an obscure constraint to them, and for some children the only solution was to ask them to put one hand on their back whilst playing.

Most children experienced some failures to make the target stick to their finger while dragging. Children found it difficult to point to the object with only one finger as in Figure 5 (b). Rather they tended to lean their forearm or other fingers on the surface to support their action as in Figure 5 (a). This incorrect posture seems to be afforded by the small size of children with respect to the table height. In the experimental setting children were initially invited to play seated, but asking them to stand up significantly improved interaction.

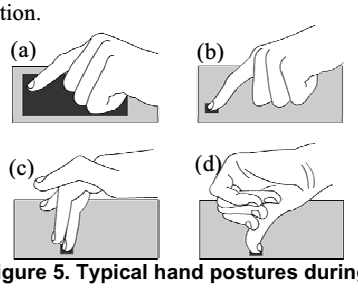

Figure 5. Typical hand postures during the interaction

Some very unusual hand gestures were spontaneously adopted by children in their attempts to move objects, as shown in Figure 5 (c and b). Children often used two fingers or their thumb, as if they wanted to better control the movement. In these cases, it appeared that the objects stuck more easily.

Another recurring problem was that children tended to relax on the chair while they were seated and did not put their feet on the mat in the correct position (Figure 6).

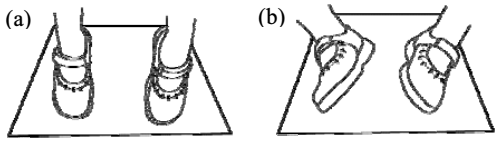

Figure 6. Typical feet position during the interaction

They often touched it only with their toes or with the corner of their feet. Children were perfectly aware that they had to touch the mat, but once again they easily forgot this requirement. Asking them to take their shoes off, and to stand up while playing strongly improved performance.

Other typical interaction problems were due to the fact that some children tended to suck their fingers, had difficulty reaching objects on the opposite side of the table, and sometimes tried to climb on the table to reach far away objects.

4 Conclusion

The study reveals that young children may experience several difficulties using a DiamondTouch tabletop device efficiently, but also that they are well motivated to do so. There seem to be two basic rules, which can be applied to maximize the success of the interaction: (a) Children should play while standing on the mat. (b) Children should be invited to take their shoes off before playing.

To be successful these rules should be incorporated into the game environment so that children will be less likely to move from their position. Inviting children to play while standing is not a panacea, as they tend to lean more on the table and block the projection of the image with their bodies. This is particularly serious in the case of girls with long and curly hair, which did end up on the table hiding most of the screen.

It is also instrumental that the tabletop structure is extremely solid as we witnessed several attempts to climb on the table in order to reach far away objects. Our research has now focused on the design of a new application, using the lessons learned in the study reported in this paper to make the tabletop more engaging and improve the children's experience with it.

5 Acknowledgements

We thank Webster Primary School and all the children who participated in this study. Also Adam Bogue, Alan Esenther and Chia Shen from MERL and Patrick Gunderson, Arnie Hamzah and Ezwa Ikram, the flash programmers who helped us with the flash scripting.

6 References

[1] Berk, L.E., *Child Development*. 7th ed., Pearson, Boston, 2006.

[2] P. Rochat, T. Striano, and M. Tomasello, "Social and object support for early symbolic play". *Developmental Science*, 2001, **4**: p. 442-445.

[3] J. Cassell, and K. Ryokai, "Making space for voice: technologies to support children's fantasy and storytelling." *Personal Ubiquitous Computing*, 2001, **5**(3): p. 169-190.

[4] R.J.W. Sluis, et al. "Read-It: five-to-seven-year-old children learn to read in a tabletop environment." in *Proceeding of the 2004 conference on Interaction design and children: building a community*. ACM Press, Maryland, 2004, p. 73-80.

[5] McLoyd, V.C., "The Effects of the Structure of Play Objects on the Pretend Play of Low-Income Preschool Children." *Child Development*, 1983, **54**(3): p. 626-635.