Storytelling through Drawings: Evaluating Tangible Interfaces for Children

Cristina Sylla
University of Minho
Centre for Research
in Education (CIEd/UM)
Braga, Portugal
cristina.sylla@gmail.com

Pedro Branco
University of Minho
Dep. of Information Systems
Guimarães, Portugal
pbranco@dsi.uminho.pt

Clara Coutinho
University of Minho
Institute of Education and
Psychology
Braga, Portugal
ccoutinho@iep.uminho.pt

Maria Eduarda Coquet
University of Minho
Institute of Child Studies
Braga, Portugal
coquet@iec.uminho.pt

Abstract

This paper presents an ongoing study comparing the potential and the quality of the experiences provided by tangible versus traditional interfaces. The study was carried with two groups of kindergarten children using two interfaces that aim to motivate children to the practice of oral hygiene. Children's drawings were one of the methods used to assess their experience. We found differences quantitatively and qualitatively between the drawings of the children interacting with the tangible interface and the traditional interface. The drawings suggest that by interacting with the tangible interface children felt more actively involved with the task.

Keywords
Tangible Interfaces, Drawing, Children, Evaluation.

ACM Classification Keywords
H5. 2. User Interfaces: Evaluation / Methodology

Introduction
Vygotsky [16] sees drawing as a preliminary stage of writing, as long as children aren't prepared to express themselves through writing they use drawing to

express their feelings. Drawing allows children to represent their thoughts, feelings and interpretation of their lived or imagined experiences. Children draw everything that makes part of their experience, what is open to their perception; thus their drawings are the result from a profound connection between the moral and the psyche, what they draw has a preponderant weight in their mind [7].

Evaluating technology designed for children
Evaluating interactive technology for children began for about 10 years, one of the decisive works on usability testing with children was written by Hanna, Risden et al. [5]. The paper is a guide for the set up and planning of a lab-based evaluation session with children. In recent years there has been much interest in how children can evaluate interactive products; old methods have been adapted and there is a search for new methods of assessment that can provide helpful information [11]. Some of the methods that have been used with children are: peer tutoring [6] children teach their friends how to use the interface; think aloud [10] only possible to be carried with children as young as seven and eight, younger children may have difficulties verbalizing their thoughts [9,16]; the fun toolkit [13] a method for gathering children's opinions of technology, suitable only for children that can read; and the mission from mars method [4] better suited to evaluate early prototypes and tested with 10 and 11 years old children; and a new and more informal evaluation method drawing intervention (DI) [14, 15].

Storytelling through drawing as an evaluating method
Children's drawings are often used at kindergarten as a method to appraise the degree of what they have

learned after a particular activity, and it has shown to be useful and generally worthy of credibility [3]. Methods such as the Draw-a-Person test: QSS (Quantitative Scoring System) are widely used to assess children's cognitive development; the QSS test analyzes fourteen different aspects of the drawings, such as specific body parts and clothing, for various criteria, including presence or absence, detail, and proportion [12]. Studies have shown that children retain visual elements and details that they are able to draw; however, they may have greater difficulties if they have to describe these elements in spoken or written words [9, 8].

Games for Learning about Oral Hygiene
Motivated by the needs of kindergarten teachers that teach children about the importance of good oral hygiene we designed a tangible interface in which one can brush away virtual germs. A study was conducted to assess if the tangible interaction provides a more engaging and enriching experience than a traditional interface by conveying the same content. Therefore we developed in parallel a computer game consisting of a tooth with germs moving on its surface, that children can clean with a toothbrush (fig. 1) by handling the mouse.

figure 1. The computer game.

The tangible interface consists on a large physical tooth and a toothbrush both about 70cm. The virtual germs are projected on the tooth. Children interact by cleaning the germs with the toothbrush: they brush the tooth and the germs simply disappear with each pass of the brush (fig.2).

figure 2.   Child interacting with the interface.

The webcam tracks the toothbrush position making the germs disappear when in contact. In both interfaces when the tooth is cleaned, it turns into a pleasant face with a smile and a voice 'says': "I'm so fresh" (fig. 2) both interfaces have the same sound and graphics, (recorded and designed by and with the children).

User study
The Study was carried with two groups of children with an average age of 4 years; all children had a similar family background. The groups were from two different kindergartens[1] inserted within an upper middle class neighborhood and had no contact with each other. Group n. 1 (the target group), composed by 18

---

[1]   Kindergarten is used in the Portuguese context; other countries including the USA refer to it as preschool.

children, experienced the tangible interface. Group n. 2 (the control group), composed by 23 children, interacted with the computer game. In both groups every child interacted with the interface.
The tests were carried in two consecutive days. Group n. 1 (the target group) interacted individually with the tangible interface, which took about 30 minutes. Group n.2 (the control group) played the computer game individually, which took about 40 minutes.
After the interaction children asked to go in another room and draw what they had seen. Children weren't asked any kind of question and no suggestions were made. Parents were given questionnaires before the interaction to assess their child's willingness to brush the teeth and were also provided the same questionnaires two weeks after the interaction. We are still evaluating that data and do not report it here.

Evaluation parameters for the drawings
To evaluate the drawings we grouped the elements present into two groups: elements common to both interfaces (table A) and other elements (table B). Each of the elements was scored a point.
Occasionally there were difficulties interpreting some elements in the drawings; to prevent a false interpretation, children were asked individually what they had drawn and the annotations were added to the pictures.

A. Elements common to both interfaces:

Tooth	germs	brush	smiling face

B. Other elements:

Self drawing	computer	researcher
other persons	other elements	

Results

Total A	Average Child /A	Total B	Average Child /B	Total	average Child /A+B
57	2,6	5	0,39	62	3

figure 4. Results of the control group

Total A	Average Child /A	Total B	Average Child /B	Total	average Child /A+B
59	3	35	**1,9**	89	**4,9**

figure 5. Results of the target group

Comparing the numbers we recognize that both groups draw the elements common to both interfaces, the target group scored 3 points against 2,6 points from the control group (fig. 4,5). The significant differences between both groups concern the other elements; Children of the target group achieved an average score of 4,9 drawn elements against 3 points from the control group (fig.4, 5). In fact only 9 out of 23 children from the control group drew other elements while 17 out of 18 children from the target group drew them. This difference is statistically significant for p<0.05 (fig. 6).

	nº children	Mean Rank	Sum Rank	Mann-Whitney U Wilcoxon W
Control	23	26,72	614,50	75,500
Target	18	13,69	246,50	246,500

Z	Asymp. Sig.(2- tailed)
- 3,555	0,000

figure 6. Non-parametric Mann-Whitney U test for independent groups

A non-parametric Mann-Whitney U test for independent groups was chosen because the conditions for normal distribution of the high value of skewness weren't fully guaranteed.

figure 7. Picture drew by a child from the control group.
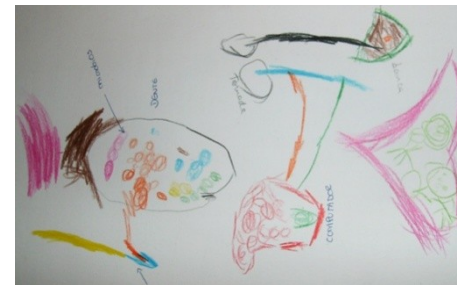

figure 8. Picture drew by a child from the target group.

Our interpretation of children's drawings was not only quantitative (number of elements represented), but also qualitative, related to the action itself. Looking at the children's drawings, we see that most of them represented not just a static situation but the various stages of the action, for instance, they draw the tooth with the germs and also the cleaned tooth on the same

sheet of paper. Other children even draw several images of the tooth showing the different stages of the action. This indicator suggests a high level of children's involvement with the experience [2].

Discussion
At this age children still think animistic, they believe that inanimate things are alive and have feelings, thus for them there is no clear boundary between objects and living beings [1]. Strictly realistic stories are against children's internal experiences [1] for a story to truly capture their attention it is necessary that it raises children's curiosity and stimulates their imagination. Both the tangible interface and the computer game convey a very simple story, with three moments: a tooth with germs, the cleaning of the tooth and the cleaned tooth; with the tooth being the main character. Children's drawings represent the story they have experienced, through them we can reconstruct what they have seen. Because they had different experiences, what they draw is also different.
As the results show, children from the control group drew mostly the tooth, the main character of the story (fig.7), which is what they have seen on the computer screen. Children from the target group drew not only the tooth and the germs, but also the surrounding scenery and the vast majority of them drew themselves holding the toothbrush. Their drawings are more detailed and complete. This suggests that the children interacting with the tangible interface felt part of the story, and an active character of the play, probably because they could touch the tooth and hold the brush in their hands, thus having a more physical experience. According to Zuckerman the handling of tangible interfaces stimulates sensory perception such as touch,

sight and hearing as well as promoting team work, communication and exchange of experiences [17].

Unlike the target group the control group simply handled the mouse; none of the children portrayed themselves, it is as if they were just mere observers. "For the construction (drawing) of forms the touch and the knowledge of the usefulness and functionality of objects is of paramount importance" [2].

Conclusions
The empirical study carried out allows two distinct but complementary conclusions. First it suggests that tangible interfaces have a greater potential to provide engaging and enriching experiences than conventional interfaces. Second, the method "storytelling through drawing" that we used to assess the impact of different interfaces in pre-literate children, seems to be an interesting path for further research in assessing children's experiences while interacting with the various interfaces. In future work new prototypes will be developed and its usability will be tested, extending the assessment method to other groups of children in order to verify its efficiency, stability and reliability.

Acknowledgements

References and Citations
[1] Bettelheim, B. *The Uses of Enchantment: The Meaning and Importance of Fairy Tales*, Knopf, New York, 1976.

[2] Coquet, M. E. *A narrativa Gráfica das Crianças dos 5 aos 10 Anos de Idade*, Universidade Técnica de Lisboa, Faculdade de Arquitectura, 1995.

[3] Coquet, M. E. *A Narrativa Gráfica como forma de Comunicação de Crianças e Adultos*, CESC – Universidade do Minho, Braga, 2000.

[4] Dindler, C., et al. Mission from Mars: a method for exploring user requirements for children in a narrative space, in *Proc. IDC*, ACM Press (2005), 40-47.

[5] Hanna, L., K. Risden, and K. Alexander. Guidelines for Usability Testing with Children. In *interactions* 4, 5, (1997).

[6] Höysniemi, J., P.Hämäläinen, and L.Turkki. Using Peer Tutoring in Evaluating the Usability of a Physically Interactive Computer Game. In *Interacting with Computers*, 15, 2, (2003), 203 - 225.

[7] Luquet, G., H. *Le Dessin Enfantin*. Éditions Delachaux & Niestlé, 1967 (1st. edit.1927).

[8] Magalhães, C. *Ler e Interpretar a Literacia das Imagens: um estudo de caso* - tese de Mestrado em Estudos da Criança, especialização em Comunicação Visual e Expressão Plástica, Universidade do Minho, 2006.

[9] Malkiewicz, J., Stember, M.L. Children's Drawings: A Different Window. In *Art & Aesthetics in Nursing.* Chinn, P.L., Watson, J. University of Colorado Health Sciences, New York National League for Nursing Press, 1994, 284.

[10] Markopoulos, P. and M. Bekker. Usability testing with children subjects: comparing Usability Testing methods. In *Proc. IDC*, (2002).

[11] Markopoulos, P., et al. *Evaluating Interactive Products for and with Children*. Morgan Kaufmann, San Francisco, 2008.

[12] Naglieri, J. A. *Draw a Person: A Quantitative Scoring System.* San Antonio: The Psychological Corporation, (1988).

[13] Read,J. C, MacFarlane, S. Using the Fun Toolkit and Other Survey Methods to Gather Opinions in Child Computer Interaction. In *Proc. IDC*. (2006).

[14] Xu, D., Read, J. C., Mazzone, E., MacFarlane, S. and Brown, M. Evaluation of Tangible User Interfaces (TUIs) for and with Children – Methods and Challenges. In *Human-Computer Interaction. Interaction Platforms and Techniques*, vol. 4551/2007, *Lecture Notes in Computer Science*. Springer, 2007, 1008-1017.

[15] Xu, D., Read, J. C., Sheehan, R. Search of Tangible Magic. In *22nd BCS British-HCI* (2008).

[16] Vygotsky, L. S. *Thought and Language*, Cambridge, MA: The M.I.T. Press, 1985.

[17] Zuckerman, O., Saeed, A.,& Resnick, M. Extending tangible Interfaces for Education: digital Montessori-inspired manipulatives. In *Proc. SIGCHI (CHI'05)* USA, ACM Press, 859-868.