Multitouch Displays to Support Preschool Children's Learning in Mathematics, Reading, Writing, Social Skills and the Arts

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ABSTRACT
In this proposal, we describe how multitouch displays can provide novel learning opportunities for preschool children in areas such as mathematics, reading, writing, social skills, and the arts.

Keywords
Multitouch, preschool, mathematics, reading, writing, arts, social skills.

INTRODUCTION

Multitouch systems have been around for a long time as documented by Bill Buxton in his website [1]. Multitouch displays that can be put together at reasonable costs and are responsive enough to support a wide variety of applications are much more recent. Jeff Han's demonstrations as well as his paper at UIST 2005 have sparked a new wave of interest in these technologies [2]. Although cost and availability may be a concern, the good news is that a growing community of academic researchers and enthusiasts are building their own low-cost multitouch displays. At the University of Iowa, we have built two vision-based multi-touch displays (about one meter wide), each for about 4000 USD, including the cost of a desktop computer with high-end graphics (more than half the cost), a projector, and a camera. Videos of our displays are available at http://vimeo.com/3548811 and http://vimeo.com/3546143. We expect that over the next couple of years, similar multitouch displays will be available commercially at comparable costs.

Given their potential availability, multitouch displays present a realistic opportunity to enhance preschool education. Multitouch displays can provide children more natural interactions than traditional desktop or laptop computers, supporting multiple simultaneous users, providing a large surface, and enabling children to interact with all their fingers. Sharlin et al. [3] in a review of tangible technologies tout the importance of input-output unification in the real world, which translates in computing as an advantage of direct manipulation and direct input devices. We expect that input-output unification will provide great advantages to children. Instead of interacting with a device and seeing changes on another device, an input-output unification approach means that children get to see the effect of their actions on the same device in which they provide input.

In the following sections, we discuss some ideas for activities that could be implemented with multitouch displays. The examples below are not intended to provide a comprehensive list of possible activities, but are meant as a way of exploring the potential of the technology. They assume a tabletop setup similar to that in Figure 1.

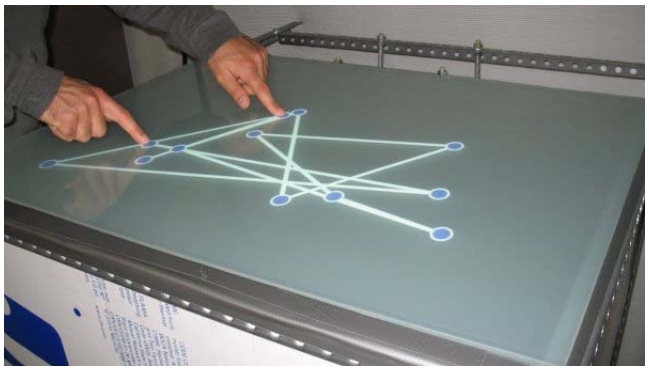

Figure 1. One of our multitouch displays at the University of Iowa.

MATHEMATICS

Geometry

Multitouch displays seem ideal to explore geometry. For example, one game could provide children with sets of lines and ask them to put together different shapes. For example, can they arrange three line segments to make a triangle?

Puzzles using simple geometric shapes could also be easily implemented, providing a virtually endless collection of puzzles by breaking up images of interest in different ways. By using a multitouch display, children would be able to manipulate the pieces in a way similar to how they would do it with physical puzzles. Similarly, games could be put together to encourage children to make shapes out of other shapes (e.g., make a rectangle out of two equal triangles).

Venn Diagrams

Multitouch displays could provide a variety of activities to learn about categorization through the use of Venn diagrams. Children could be provided with items to categorize, or they could use Venn diagrams to provide attributes to objects.

READING AND WRITING

Alphabet Play

In this game, the alphabet would be shown on the bottom of the screen. Children would be able to touch letters to hear their name and sound. Dragging letters to the center of the screen could be used to form phonemes and words. Phonemes could be sounded out through a synthesizer. With words (confirmed with a dictionary), besides sounding them out through a synthesizer, a Google strict filtering image search could be used to show children images related to the word they formed. This could provide great encouragement for learning how to write and spell words.

Writing Practice

Children could easily use the multitouch displays for practicing tracing letters using either their fingers or styli. The larger displays and the ability to show what the children see in an additional display could help teachers in providing extra feedback to children. In addition, the displays could provide interactive multimodal feedback to children. For example, sound and visual feedback could be used to tell children whether they are tracing letters correctly and what direction they need to follow.

SOCIAL SKILLS

Understanding Multi-Step Activities

An important skill for preschool children is learning to conduct multi-step activities. For example, when waking up from nap time, they may have to put away their linens, go to the bathroom, wash their hands, and sit at a table for snack time. To help children in these activities, a multitouch display could be used to display the steps of the activity, for example, showing pictures of the children completing each step. The children could then arrange them in the right order and see a slideshow of the steps. This application would be useful for helping children who have difficulty transitioning between activities and for teaching children about new activities they need to conduct, especially when joining a new classroom.

ART

Drawing and Collaborative Storytelling

Multitouch displays could provide an excellent medium for children to create visual stories collaboratively. This could begin by drawing scenes in collaboration and then putting them together in a story. It could also involve animation of existing graphics to tell a story. In this case, having a multitouch display helps significantly as it is a lot easier to coordinate multiple animated elements. This also encourages collaborative work.

Three Dimensional Design

Virtual clay applications, where children get to shape three dimensional objects with their hands could provide ways for children to create three dimensional objects of interest, such as characters for their stories. The advantages of using a digital medium include the ability to undo, edit, save and share creations. If this application were paired with a three-dimensional printer, then it could truly provide children with a novel way to create three dimensional items digitally that they could then see, touch and use in the physical world.

Music

Multitouch displays could provide the opportunity for children to play digital musical instruments together. It would be relatively easy to create custom instruments for the display and it would be relatively simple for the children to play them and explore musical concepts.

CONCLUSION

In this proposal, we presented our ideas on how multitouch displays may be used in preschools to provide further learning opportunities in a variety of areas. In particular, we believe input-output unification, the ability to collaborate, and to use all fingers to interact with the device will prove highly advantageous to preschool children, especially when compared to traditional interactions with desktop and laptop computers.

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Professional Preparation

American University	Computer Science	B.S., 1996
University of Maryland	Computer Science	M.S., 2000
University of Maryland	Computer Science	Ph.D., 2003

Honors and Awards

Member of Phi Beta Kappa Honor Society

Member of Upsilon Pi Epsilon Honor Society

Summa Cum Laude and University Honors, American University

Appointments

Assistant Professor, Department of Computer Science, University of Iowa, 2006-present

Computer Scientist, Statistical Research Division, US Census Bureau, 2003-2005

Selected Publications

Hourcade, J.P. (2008). Interaction Design and Children. *Foundations and Trends in Human–Computer Interaction, 1*(4), 277-392.

Hourcade, J.P., Perry, K.B. and Sharma, A. (2008). PointAssist: Helping Four Year Olds Point with Ease. *Proceedings of Interaction Design and Children 2008*.

Hourcade, J.P. and Berkel, T.R. (2008). Simple pen interaction performance of young and older adults using handheld computers. *Interacting with Computers, 20*(1), 166-183.

Hourcade, J.P., Crowther, M. and Hunt, L. (2007). Does mouse size affect study and evaluation results? A study comparing preschool children's performance with small and regular-sized mice. *Proceedings of Interaction Design and Children 2007* (IDC 2007). ACM Press: pp. 109-116.

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Synergistic Activities

1. Workshops Chair, *Interaction Design and Children 2008 Conference*. Chicago, Illinois, June of 2008.
2. Papers Co-Chair, *Interaction Design and Children 2005 Conference*. Boulder, Colorado, June of 2005.
3. Papers Chair, *Interaction Design and Children 2004 Conference*. College Park, Maryland, June of 2004.
4. Member of National Science Foundation Panels 2004-2005, 2007-2009.
5. Member of the Editorial Board of *Interacting with Computers*.
6. Article referee for *Interacting with Computers, Human Computer Interaction, International Journal of Human-Computer Studies*. Paper reviewer for *ACM Conference on Human Factors in Computing Systems* (CHI) 2003-2009, *Interaction Design and Children* (IDC) 2003-2009, User Interface Software and Technology (UIST) 2009, *Computer Supported Cooperative Work* (CSCW) 2008, *International Conference on Universal Access in Human-Computer Interaction* (UAHCI) 2005, *World Wide Web* (WWW) 2004.