Designing for Children
- With focus on 'Play + Learn'

Designing Inclusive & Playful Technologies for Pre-School Children

First Author: Wendy Keay-Bright, Reader in Inclusive Design, Cardiff School of Art and Design
University of Wales Institute, Cardiff, CF5 2YB, wkbright@uwic.ac.uk
Second Author: Adam Martin, Senior Lecturer, Newport School of Art, Media & Design,
University of Wales, Newport, NP18 3QT, Adam.martin@newport.ac.uk

Abstract: This paper reports on an investigation into the potential of everyday technologies to foster playful experiences for young children prior to their formal education. The aim is to consider how best to design age appropriate experiences that are desirable and useful within pre-school settings, and to assist practitioners in experimenting with technologies in the early years school curriculum. This phase of the study focuses on observations of the real-time, non-digital play of young children in a pre-school playgroup and the subsequent introduction of group activities with affordable, non-specialist devices such as ReacTickles, Wii remote and microphone. The study captures the vital inspiration phase of design research. By utilizing observation and interview as an analytical framework to help practitioners to articulate the nuances of playful interaction, the designers have been able to draw early conclusions that provide the guiding principles for future design.

Keywords: play, inspiration, technologies, inclusive, interaction, pre-school

1. Introduction
Play is explicitly acknowledged in Article 31 of The United Nations Convention on the Rights of the Child, which states that:

- *Parties recognize the right of the child to rest and leisure, to engage in play and recreational activities appropriate to the age of the child and to participate freely in cultural life and the arts.*

- *Parties shall respect and promote the right of the child to participate fully in cultural and artistic life and shall encourage the provision of appropriate and*

equal opportunities for cultural, artistic, recreational and leisure activities.

The study was conducted in a pre-school playgroup with practitioner experts in education and inclusion. The motivation arose from a desire to design age appropriate technologies that support autotelic play; particularly the sense of immersion and flow achieved through concentration, repetition and imitation within early years learning settings (Csikszentmihalyi, 1991; Keay-Bright, 2007a). Autotelic play is valued as a non-formal learning experience, which encompasses *"ludic activities motivated by curiosity, exploration, play and aesthetics rather than externally defined tasks"* (Petersson, 2006, p40). Research has shown that autotelic play enhances a child's sense of agency and self worth, which can advance skills in more formal areas as a child develops, particularly creativity and social interaction (Petersson, 2008). Furthermore, the study also needed to consider how to empower practitioners to use technologies creatively in their own contexts.

Whilst certain developmental play theories have informed this study (Rubin, 1989; Piaget, 1951; Vygotsky, 1962), the goal was to gain inspiration from the real-life interactions of children and the adults responsible for their well-being, and to determine methods of encouraging practitioners to articulate their observations and ideas. The analytical framework focused on gathering qualitative data through interview, observation and video analysis. The data was used to inspire, enrich and inform design, as well to consider the usefulness and desirability of prototypes, from the end-user perspective (Kouprie & Sleeswijk Visser, 2009; Keay-Bright, 2007b, Battarbee & Koskinen, 2005).

The phase of the study reported in this paper uses Rubin's Play Observation Scales (1989) to assist in analyzing play experiences. Informed by early observations, the researchers discuss how a software interface designed for autistic children, ReacTickles, together with certain non-specialist technologies, such as the Nintendo Wii and a microphone, can support developmentally appropriate play, without making unnecessary demands on practitioner time (Keay-Bright, 2009). The findings from this initial phase of the study demonstrate the need for designers to strike a balance between creating technologies that are functionally interesting, without becoming cognitively overwhelming, and those that provide the opportunity for children to deepen interaction on their own terms, which is key to achieving the sense of flow and immersion so readily discovered in real-world interaction.

2. Design for children: the context for this study

This study involved collaboration with two external partners, Autism Cymru and Mudiad Ysgolian Meithrin. Autism Cymru is Wales National Charity for Autism and Mudiad Ysgolion Meithrin (MYM) is a voluntary organization that offers early years services and nursery provision for children under three years old through the medium of Welsh. Autism Cymru works closely with MYM in the delivery of training to celebrate diversity and promote inclusion. Both organizations support practitioners in delivering the Foundation Phase curriculum for 3-7 year olds in Wales.

Within the curriculum little use is made of sensory engagement with technology. Planning for physical development, including fine motor skills and an awareness of space, height and distance, is positively encouraged as a means to support play. However, the kinesthetic, and spatial/visual properties of technology are not featured as important for playful interaction. Play with technology tends to be instructional—biased towards learning goals and the acquisition of skills—flow and immersion can only be achieved if the child is able to focus on a predetermined task. For very young children this type of activity is developmentally inappropriate, cognitively overwhelming and inhibits personal exploration.

2.1 The setting for the study

The preschool playgroup included approximately 22 children, who regularly attend for either full- or half-day sessions. The atmosphere in room is busy, noisy, happy and relaxed. The space is designed to support clusters of activity and to accommodate the variety of playful explorations associated with children of pre-school age (2-3 years).

3. Methods

The approach undertaken by the researchers describes a feature of participatory design, whereby knowledge and experience of a situation and its potential for interaction is gained through close and regular contact with end users (Kensing, & Blomberg, 1998). Input from end-users and those who support them, not only serves as a validation process but also provides vital inspiration for designers that cannot be achieved through empirical processes that fail to acknowledge individuality (Kouprie & Sleeswijk Visser, 2009; Keay-Bright, 2007b, Battarbee & Koskinen, 2005).

Described here are three observational sessions undertaken with playgroup children and practitioners over a period of one month. Each session was guided by the practitioner and lasted around 20-25 minutes. The researchers focused the first observation session on non-digital interaction with the toys, objects, environment and other people. Whilst these interactions were clearly not augmented through technology they provided sufficient baseline information to enable the researchers to experiment with certain scenarios in which technology could be introduced during subsequent sessions. Other ecological information, for example: the risks to be assessed for installation, level of instruction required, location and scale of equipment, as well as need for children to freely to move around and ultimately share technologies, supported the researchers proposal to introduce non-specialist technologies such as the Wii controller, microphone and the ReacTickles software. The researchers conducted short interviews with practitioners in which they established that the sessions would involve small groups, maximum 10 children.

Later sessions will involve the use of Nintendo Wii remotes, inexpensive game controllers used to interact with gestural based console games. For example in the Wii golf game the physical action of swinging the controller like a golf club makes the onscreen character mirror the same action within the game. This ability to of the controller to mirror the physical activity of the real world-on screen could be used to further enhance the ReacTickles experience. The Wii controller when connected to a computer via Bluetooth can be used as an alternative to a desktop mouse and provides additional access to motion sensors and an infrared point-tracking camera. This makes the Wii controller an attractive device with which to develop unique gesture-based interactions. It is intended to modify the dancing squares ReacTickle to respond to the physical motion of the Wii controller as a child is manipulating it. By introducing further controllers up to four children could interact physically with the onscreen objects, creating opportunities for collaborative and social play.

One of the underlying principals of the study is to develop playful experiences that are available to practitioners with limited technical and financial resources. Therefore complex equipment setup, expensive cameras and specialist software are not appropriate for this target group of pre-school practitioners. Given these constraints it is still possible to use off-the-shelf webcams and the ubiquitous Adobe Flash player software to create interesting applications. The Flash software for example provides a simple method for detecting the activity level occurring in a webcam image. This could be used to create new ReacTickles that respond to varying levels of motion, much like the volume level of a

microphone. Using more sophisticated techniques such as edge detection and difference-images between frames it is possible to develop ReacTickles that respond to more specific movements and silhouettes of the children. However an initial test of the software found that the limited setup time of around 10 minutes and positioning of the projector and camera was prohibitive.

Further sessions will be used to assess the feasibility of applying these techniques in the pre-school environment. As further prototypes are developed and refined it should be possible to provide the pre-school with examples to use on a more regular basis with their own computing equipment. This would provide an opportunity to assess the longer-term impact of using this technology within the pre-school environment and give the staff more opportunity to develop their own play activities based around the software.

3.1 Gathering data

In contrast to research that relies on empirical data to assess the role of play in cognitive development, this study favored qualitative and discovery-led methods as a means to discover the totality of play situations. Practitioners were invited to participate in the design of the study in order to optimize the understanding of play patterns through their knowledge of individual children and to assist the researchers in appreciating the ecological and social contexts for play. Although none of the practitioners had experience with using technology with their young charges, they were happy with the proposals to introduce the non-specialist devices. It was proposed that relevant data should be captured using video recording, transcriptions of observations, open-ended interview techniques and photography, these being the least time consuming for practitioners and non-invasive for children. Hand held-video was used in the early observations in order to focus on interactive play, particularly to look for instances of functional and autotelic play. Although this method is frequently avoided as it can draw unwanted attention to the camera and thus bias responses, in this particular setting the children showed little interest in the camera and played naturally.

Rubin's Play Observation Scales - POS (1989) were used as a general guide for the analysis of video footage. Observations and interviews were employed far more generally as a free-form method of capturing ideas for the implementation of technologies and as inspiration for design (Keay-Bright, 2009).

4. Playful Technology Interfaces

4.1 ReacTickles Software, microphone, and Wii remote control

The ReacTickles software is an example of simple, playful interaction design that was originally created for children with autism spectrum conditions (ASC). ReacTickles encourage the child to play with technology in a functional way, by manipulating physical properties, for example mouse, keyboard, switch, joystick, touch screen or if using a microphone, ReacTickles are sound activated. A dynamic visual response is rendered immediately visible wherever the output is projected —monitor, wall, whiteboard—that introduces the concept of space and proximity, pressure and movement through the behavior of primitive shapes and colors, Figure 1. The challenge for the child is to bring the projected surface to life by touching, smoothing, dragging, shaking, stretching or sound and to explore and maintain the interaction through repetition.
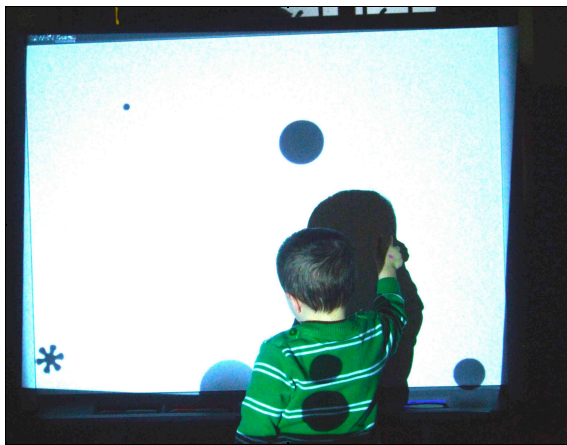

Figure.1 Play with ReacTickles at the interactive whiteboard

4.2 Embodied Interaction

ReacTickles and the other technologies described in this paper foster embodied interaction, which means that familiarity, ease of understanding, and engagement are gained from repetitive physical action and information in the environment rather than instruction. Dourish presents a perspective of embodiment as the "*property of our engagement with the world that makes it meaningful*" (2001, p126). When we act in an embodied way we are motivated by bodily instincts and our innate ability to interpret information in the environment through our senses (Heideggger, 1996). Conversely, when we interact in the virtual worlds of desktop computers, we become disembodied receivers of information and rely on cognitive, rather than physical processing. When information is presented with no physical constituents, successful interaction relies on instruction rather than intuition (Norman, 2005).

5. Discussion

5.1 Non-digital Play

The cognitive play behaviors of children were consistent with Piaget's (1962) and Smilansky's (1968) classification as: (a) functional — repetitious and sensorimotor with and without objects; (b) constructive — manipulative, with a desire to create something; (c) dramatic — creating an imaginary situation through the contextualization of objects in the environment; (d) games-with-rules — accepting prearranged routines. These four categories of play are understood to develop simultaneously and are related to the social context of play (solitary, parallel and group play).

Children were generally content to engage in functional solitary play with little desire for collaboration from peers or staff unless there was a specific purpose, for example requesting. When playing with toys, children became immersed when parts of the toy invited further interaction. Other children appeared content to watch the play of peers for short periods of time when they were at a close focal length; however, they rarely joined in unless the practitioner organized the activity. Group play was centered on making things and singing.

5.2 Play with Technology

Practitioner intervention made significant impact on optimizing the sessions where technology was introduced. The first two ReacTickles sessions used the microphone and keyboard and interactive whiteboard; these were conducted as small group activities. When the technology was introduced to the first group, children were happy to randomly explore without assistance and to play alongside each other in parallel, for example manually investigating a keyboard to make patterns, and jumping up and down in front of the projector to make shadows. However the playfulness of the session increased dramatically when the practitioner introduced games-with-rules, for example singing and using instruments. By far the most engaging ReacTickle, that held the children's attention was a square that simply wobbles when there is no interaction. When interaction occurs though sound or touch the square splits into twelve smaller squares which appear to dance; the greater the input volume or pressure the further the individual squares move. As interaction decreases so does the momentum of movement until the square reforms as one. With practitioner support the children practiced a song that required them to understand the Welsh words for "quiet" and "noisy". When the practitioner drew their attention to the movement and acceleration of the projected image they quickly grasped that they were in control and maintained the interaction. Those children who had

observed the first group of children quickly mastered the situation and used the technology to manage their own performances as soon as the formal session ended, without the need for instruction.

Intervention from the practitioner clearly assisted the children in the gaining confidence to playfully interact within the environment. High relevant to this, the practitioner immediately felt able to organize an activity without assistance from the researchers, having witnessed a demonstration of the software and some impromptu interaction from children, Figure 2. Thus the playfulness arose as a mutually enjoyable experience and acceptance of the technology was established. As a direct consequence, further ideas flourished, most notably the practitioners could articulate ways in which the technologies could be used to augment existing play strategies.

Figure.2 The technology set up in the playgroup

6. Results

The overarching aim of the study is to consider how best to design age appropriate technologies that are desirable and useful within pre-school settings, and to assist practitioners in experimenting with technologies in the early years school curriculum. Our findings from the first stages of this study reported in this paper suggest that designers need to:

(1)   Take care to ensure that hardware is easy to install and to avoid the need for technical support.

(2)   Gain the confidence and interest of practitioner as the key to optimizing interaction.

(3)   Use one interaction modality (for example, sound or touch) to correspond with

one output response.

(4)   Encourage repetitious and recursive actions to enable the child to observe his own action.

These design guidelines have been defined in relation to the ecological and social contexts in which play arises and is understood.

6. Conclusions

The limited conclusions of the study have enabled the researchers to meet the goal of finding inspiration by observing participants — children and practitioners — in authentic settings and gaining the confidence to extend the study by introducing new technologies and prototypes to the playgroup. Promoting collaboration between the researchers and practitioners has been highly motivating for all concerned, which has directly impacted on the children's enjoyment of the sessions to date. As regards the introduction of technology into the early years curriculum, early findings indicate that when children are able to playfully interact with guidance from a motivated practitioner, autotelic play, non-formal learning and pre-verbal forms of social interaction, such as concentration and turn-taking, improve. Determining a mode of playfulness with technology where input is action-driven without overwhelming the child with complex adaptations, sophisticated imagery, metaphors and semantics has the potential to include all children and ultimately offer a positive introduction to their future uses of Information Communication Technologies.

References

Csikszentmihalyi, M. (1991) *Flow: The Psychology of Optimal Experience*. Harper-Collins, New York.

Petersson, E. (2006) Non-formal Learning through Ludic Engagement within Interactive Environments. Malmö Högskola, Sweden [Online PDF]. Available at

<http://dspace.mah.se:8080/bitstream/2043/7970/1/EPHelaboken.pdf> [Accessed 1 November 2009]

Petersson, E. (2007) Ludic Engagement Designs for All In: *Digital Creativity* Vol. 19, No.3, p. 141-

Rubin, K. H. (1989). The Play Observation Scale (POS). Waterloo: University of Waterloo.

Piaget, J. (1962). Play, dreams and imitation in childhood. New York: Norton.

Vygotsky, L. (1962). *Thought and Language*. Cambridge, MA: Harvard University Press.

Kouprie, M., Sleeswijk Visser, F (2009) Bringing the everyday life of people into design. ... A framework for empathy in design: stepping into and out of the user's life. Journal of Engineering Design 20(5) 437-448

Keay-Bright, W. (2007b) 'The Reactive Colours project: demonstrating participatory and collaborative design methods for the creation of software for autistic children'*, Design Principles and Practices: An International Journal*, Volume 1, Issue 2, pp.7-16

Battarbee, K. and Koskinen, I., (2005). Co-experience: user experience as interaction. *CoDesign*, 1 (1), 5–18.

Healy, J. (1998) Failure to connect: how computers affect our children's minds. New York: Simon & Shuster

Keay-Bright, W. (2009). ReacTickles: playful interaction with information communication technologies. *International Journal of Arts and Technology , 2* (1-2), 133 - 151.

Keay-Bright, W. (2007a) 'Can computers create relaxation? Designing Reactickles software with children on the autistic spectrum', *CoDesign*, 3, (2)   97 – 110.

Kensing, F., & Blomberg, J.,1998. Participatory Design: Issues and Concerns In Computer Supported Cooperative Work, Vol. 7, pp. 167–185.

Keay-Bright, W. (2007b) 'The Reactive Colours project: demonstrating participatory and collaborative design methods for the creation of software for autistic children', *Design Principles and Practices: An International Journal*, Volume 1, Issue 2, pp.7-16

Dourish, P. (2001) *Where the Action Is: The Foundations of Embodied Interaction*, Cambridge, Massachusetts: MIT Press

Heidegger, M. (1996) *Being and Time*, Albany, New York, State University of New York Press

Norman, D. (2005). Emotional Design: Why we love (or hate) everyday things. New York, Basic Books.

Smilansky, S. (1968). The effects of sociodramatic play on disadvantaged preschool children. New York: Wiley.