The Design of Digital Tools for the Primary Writing Classroom

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Abstract: This paper describes the process by which a group of seven and eight year old children designed their own digital writing tools following their own study of digital pens, personal digital assistants and tablet PCs. Some of the children's thoughts about the three technologies are presented and how these were carried through into their own designs is explored. It was found that although the children were quite individual in their designs, their peers easily influenced them and their designs were limited by their abilities with the low-tech prototyping environments. The paper concludes with some ideas for further work and provides some guidelines for researchers wanting to carry out design activities with children.

Introduction

This work follows on from work by the authors that established that there is considerable scope for pen technology in the primary writing classroom (Read et al., 2004c), (Read et al., 2002b). Work to date by the authors has focused on the usability problems with pen devices and on determining the levels of accuracy that are needed for any associated recognition technology to be acceptable to the children (Read et al., 2002c).

The study that is reported in this paper was intended to inform future research directions for the design of digital writing tools in the writing classroom. It followed on from a study reported in Ed Media 2004 which compared the usability of a Toshiba® Tablet PC, a Dell® PDA and a Nokia® Digital Pen for writing (Read et al., 2004a). This earlier study reported on the use of the devices with children aged seven and eight in a year three primary school class, where they tried to use the devices in the same way that they would use pen and paper. In that instance, the devices were used in the classroom alongside all the other activity that was going on and their use of the objects was recorded using short video clips and notes taken by the research team.

This early study established that there were a range of problems with the three technologies; the tablet PC, although easy to use was heavy and it was sometimes difficult to see the screen, the PDAs were difficult for the children to write lengthy stories on as they were only able to see a few words at a time on the scrolling screen, and the digital

pens, although very easy to use were potentially ergonomically difficult for the children to use over any length of time due to them being very stout.

Designing Novel Technology

Each of these technologies, (the digital pen, the tablet PC and the personal digital assistant) was initially designed for use by adults. There are numerous different methodologies for product design (Barfield, 2004), (Dastbaz, 2002), (Shneiderman et al., 2004), but common to all are a set of key steps, generally identified to be;

- Identifying the requirements of the system
- Identifying the design issues
- Implementation
- Testing and Evaluation (Dastbaz, 2002)

These steps can be done sequentially (as in the Waterfall method (Dix et al., 1998)) or iteratively (as in prototyping methods such as Boehm's spiral method (Boehm, 1988)). Whatever method is used, in the first stage, (often referred to as requirements gathering), it is common to involve the prospective users by using interviews and observations to determine what is wanted and what is needed. In the second stage users are less likely to be involved with scenarios and task analysis being often used to investigate the tasks that a novel system needs to support. During design, published guidelines and principles can be used but it is also common to engage the prospective users by the deployment of iterative design using evolutionary prototyping and formative evaluations.

Involving Children in Product Development

Most of the hardware and software products that are intended for children are designed with very little input from children themselves. They are typically designed and built by adults who often have very little idea about what children want and need from interactive products. There is a growing body of research on developing interactive products for children and in examining the different levels of involvement that they can have during the system lifecycle (Druin, 1999), (Brouwer-Janse et al., 1997), (Bruckman et al., 2003). One useful contribution is the model of the different roles that children have in the design of technology as shown in Figure 1 (Druin, 2002). This model indicates (by the use of small and large circles) how the influence of the child on the final product increases as they become more involved in the earlier phases of the development lifecycle.

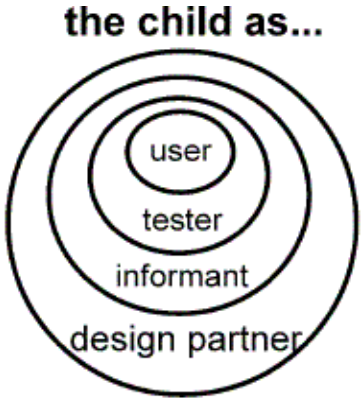

Figure 1: the roles of children in the design of new technology (Druin, 2002)

Working from the middle of the model towards the outside, when a child is simply a user he has no influence on the product development process, only meeting the product at the end of its development. When children are involved as testers, they sometimes are able to comment on prototypes as well as being able to try out finished products.

Children acting as informants have greater involvement in evaluations and in this instance there is a genuine wish by the product developer to establish with the children what is required, indicating that there may well be some

dialogue with the children. When children act as informants, they are essentially contributing their ides to the overall design of a product. The term was first used by (Scaife et al., 1997) in a paper that described the different levels of involvement of the children in participatory design and suggested that co-operative enquiry was generally difficult but children could participate in design activities as informants. In this, they are not doing the design themselves but are contributing. One of the authors of this paper has tested out some of the ideas proposed in the (Scaife et al., 1997) paper and has found that when children and adults work together, there are a range of forces, including skills, knowledge, environment and education that impact on the relationships and therefore affect the amount of each participants involvement in the activity (Read et al., 2002a). Another view of children as informants is that children are asked about what they want from a software product. Again, there are some special approaches including KidReporter, (Bekker et al., 2002), where children develop news stories (this assumes that children will focus on things that are important to them). More traditional approaches, such as interviews and questionnaires are often used both with adults and children (Antle, 2003), (Hanna et al., 1999) but there are few studies that look at how these compare, or how effective they are with children. One study that has looked at the efficacy of questionnaires and interviews for finding out what children wanted in software and hardware systems found that both of these methods resulted in the children taking a different emphasis but overall, the children were highly individual in their requirements whilst also being unable to articulate some of the things they wanted (Read et al., 2004b). This study also identified that with interviews, children were influenced by the researcher and with questionnaires administered in a group, and they were likely to collude with one another during completion. On, a positive note, it was reported that interviewing was a good way to gather up the children's vocabulary which could later be used in the design of the product.

To describe children as design partners, there needs to be a high level of involvement throughout the design phase of a product. The HCIL research team at Maryland USA have developed a special approach for this sort of work, termed co-operative enquiry; in which children and adults work together as design partners with all team members, young and old, being valued for their ideas and contributions (Druin et al., 1999), (Alborzi et al., 2000).

In the work reported in this paper, it is suggested that the children's participation was somewhere between informant and design partner.

The Research and Design Activity

Whilst observing the children using the digital technologies, it was clear that they had things to say about the design of these products. To further the research in this area, a research study was designed in two phases; In phase one, children would be able to use the technologies in a semi controlled experimental setting, and in phase two, they would design their own technologies, based on their own experiences.

Method

Twenty-four children aged seven and eight took part in the study, they were all recruited from a single class in a primary school in the UK. Consent was sought from the parents and the head teacher and every child in the class took part in both phases of the study. In phase one, children attended the research setting in groups of six. Two children were allocated to the digital pens, two to the tablet PCs and two to the PDAs. There were three adults participating in the research activity, with each adult supervising one of the three technologies. The actions of the children and the researchers were recorded using video cameras. The children began by commenting on how good they thought the activity was going to be, they then did writing tasks that the class teacher had set up for them, working on the tasks for around ten minutes, and then they rated the activity using the same rating scale that they had used at the start. During the writing activity, the children were not discouraged from talking and there was considerable dialogue, particularly between the children and the adult researchers.

Two days later, the researchers returned to the school for a design session with the same children. This took place in the school classroom where the children were initially divided in three main groups, according to the different technology they used in phase one. The children started working with large pieces of paper on which they wrote some first ideas for design. The early design ideas were discussed and then the children were given low –tech

prototyping materials (cardboard, paper, pens, paint, glue) and encouraged to construct their designs. At this point, some children formed their own new groups, others stayed in the groups they had been initially placed into, and some chose to work on their own. The activity was videoed by the researchers and by some of the children, and still photographs were taken of the processes and products.

Figure 2: Children writing down design ideas
and designing digital tools using low-tech prototyping

Results

During the evaluation of the three technologies (phase 1), the children were heard to comment on many of the short falls of the technology. One child commented that he was getting tired using the stylus of the PDA, another using the PDA said '*I can't remember what I have written*', and a third remarked '*this is stupid*!'. The children that used the tablet PCs were less vociferous, but it was observed that some adopted a strange working position whilst using the technology, both to see the screen, and to manipulate the stylus. Some of the children using the digital pen seemed to be a little dismayed at the simplicity of their technology and were seen casting envious glances at their peers with the 'better' technology.

Figure 3: Children's designs

When the children came to design their own technologies, the results were quite informative. Some children designed pen based technologies, some made devices that broadly resembled laptops, and some made smaller devices, more like personal digital assistants. The children formed themselves into single sex groups and there was some evidence to suggest that the girls spent more time on detail, whilst the boys added gimmicks. Two groups of boys designed devices that looked like pens but incorporated mobile phone technology and in one case an FM radio! Laptop – looking devices were made by both sexes, but those made by the boys were useable as games consoles as well as traditional work tools. Most of the girls tended to make smaller devices, either as tablets or as PDAs, and they made their products look attractive, focusing on functionality and minimalist design.

Discussion

The discussion that follows here is in two parts; first the design process is discussed and then the product of the process and its relative usefulness.

Lessons learned from designing with children
When the children came to design their own technologies, they had only been able to use one of the three technologies and so this will have limited their knowledge. Research by (Kafai et al., 1997) has shown that for children to participate in this sort of process effectively, they have to have information about what constitutes good design. This was certainly evident in this work, as it was seen that children were designing products that would (if implemented) be unusable and that had features that would be very difficult to use. There some concerns about the amount of involvement that the children had in the design process. Some children were seen to be very passive and their ideas were never progressed beyond the initial brainstorming stage, other children were seen to change their ideas once they noticed other children doing different things. The children all enjoyed making their digital products but it was not possible to determine how much of this enjoyment emanated from the novelty of the activity and the excitement of having the research team in, and how much was a result of intrinsic motivation. Involving children from the early phases of the design process is useful to get children's perspective of the technology and their interaction with it. Therefore, the low-tech prototypes they produced are helpful to support concept generation and to draw out possible requirements to implement in high-tech prototypes (Druin, 2002).

What the children's designs told us
With respect to the designs that the children ended up with, there were some very imaginative and entertaining ideas. (Druin et al., 1999) note that children notice '*what's cool, how easy things are to learn, what things look like*' and '*how much multimedia there is in a product*'. (Druin, 1999) concludes that children want interfaces that they can easily control; they want interfaces that '*respect*' them, those being interfaces that are not too simple. This was backed up by the findings of this study, which showed that children were keen to incorporate many extras in their products and that they were very concerned about the physical appearance of the artifacts that they made.

Research Questions from this study
From this study we were able to identify some research questions that are currently being followed up. The first of these is 'How can we assess the effectiveness of participatory design s3essions with children?' and the second is 'Can children design useful artifacts?'

Conclusions

This study has given us some ideas about what bit is that children find important in a writing tool. It has added to the research on participatory design with children and has highlighted some of the problems with this method, both for requirements gathering and for design.

This study is being followed up with an elongated study in the use of digital pens in the primary classroom and the children are currently assisting in the design of a digital writing tablet prototype. Future work is likely to focus on the usability of the associated software applications, these being the word processing software and the edit / upload tools.

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