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A 'benign addition'? Research on ICT and pre-school children

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Abstract This paper reviews the international research evidence on the ways in which information and communication technologies (ICT) are used in both formal and informal pre-school settings. The review addresses the debate over the value and desirability of young children using computers and computational toys; the relationship of these technologies to a media environment which encompasses television, video, books and magazines; the literacies involved in using these media; and interface design and interactivity.

Keywords: Implementation; Interface; ICT; Literacy; Literature review; Media; Multimedia; Policy; Pre-school

Introduction

This paper reviews the international research evidence on the ways in which information and communication technologies (ICT) are used in pre-school settings. 'Pre-school settings' in the UK are defined as provision by the public, private and voluntary sectors for children up to the age of five but the term as used here has been extended to include domestic settings and so encompasses formal and informal learning environments. Given government initiatives in different countries to introduce ICT at progressively earlier stages of education, there is a lively debate by parents and practitioners on the desirability of such policies. So far, however, an overview of research in this area has been lacking.

Although the focus is on children aged 3–5 years, studies of children up to the age of about eight are included if there is little research available that is specific to the pre-school years. Most of the literature points to the use of ICT in pre-school settings as being what Cuban (2001; p. 67) refers to as a 'benign addition'. In other words, ICT has been brought into educational environments as a useful supplement to existing resources. Its use does not transform practice, however, and pre-school practitioners tend to perpetuate existing ways of working whilst accommodating the new technologies. They are not alone in this, as school teachers also continue with their existing teaching styles rather than use the introduction of new technologies as an opportunity to examine and transform existing practice (Becker & Riel, 2000).

ICT is often narrowly construed as consisting mainly of desktop computers. However, the range of technologies available now and in the near future provides opportunities for a more radical transformation of teaching and learning relationships

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and activities than desktop computers alone would provide. The British Educational Communications and Technology Agency lists a number of products available to young children that incorporate some aspect of ICT. This includes activity centres, musical keyboards, tape recorders, programmable and radio-controlled toys as well as everyday items such as remote controls, telephones, fax machines, televisions and computers (BECTA, 2001).

This range of toys and devices is part of the move towards pervasive or ubiquitous computing in which the technology blends into the environment and is not necessarily visible. In order to accommodate such developments a broad definition of ICT for the purposes of this review has been adopted (although most of the literature currently focuses on ICT defined as computers) and most of the research considered has been published in the last five years. An attempt has been made to avoid a technocentric approach to the discussion of ICT and pre-school children by placing this topic within a social and cultural framework.

The review addresses the following areas:

- the debate over the value and desirability of young children using computers and computational toys
- the relationship of these technologies to a media environment which encompasses television, video, books and magazines
- the literacies involved in using these media
- interface design and interactivity.

There is a scarcity of good quality research findings on using ICT with pre-school children. There has been a proliferation of reports, articles and web sites that make claims for the benefits to be derived from children using computers but the evidence base for much of this writing is weak. Many articles can be characterised as providing generalised discussion of the potential benefits, followed by cautions to use developmentally appropriate software. Some of the claims rely on assertion rather than empirical study.

Context

The interest in ICT in pre-school settings comes at a time when there is widespread (though not unequivocal) support for the value of computers in educational settings and a political commitment to the creation of a knowledge economy. The school starting age across European countries ranges from 4 to 7 (Sharp, 2002) and there appears to be an increasing desire to prepare children of all ages for what is seen as an increasingly complex and technological world. In the UK, ICT is seen by the government and colleagues as having potential to improve the quality and standards of pupils' education in addition to supporting teachers in their everyday classroom roles. However, there is contested evidence that can point to a direct link between the use of ICT and attainment, regardless of users' ages, and it is unlikely that such a link will be any easier to identify in the pre-school years.

The pre-school curriculum in Scotland does not currently make any specific reference to ICT other than general guidance that pre-school children should 'become aware of everyday uses of technology and use these appropriately'. The pre-school curriculum is currently under consultation and the revised version is likely to include references to ICT. Elsewhere, whether the curriculum documents refer to ICT is likely to depend on when they originated. In England, for instance, the foundation stage was introduced in September 2000 as the two-year period before children

attend school. There are a number of references to ICT in the guidance documents and one aim of the foundation stage curriculum is that children should '*find out about and identify the uses of everyday technology and use information and communications technology and programmable toys to support their learning*' (QCA, 2000).

There is explicit reference made to ICT in the Portugese curriculum guidelines. In the section on 'Expression and Communication' ICT is seen as part of the '*new languages present in children's everyday lives*', as well as an information tool, and is included in the remit of media education (Folque, 2001). Samuelsson (2001) cites Sweden's only references to ICT in the pre-school curriculum as the use of various materials and technologies in building and designing and a statement that '*Multimedia and information technology can be used in the pre-school both in the development and application of creative processes*'. There are a number of development projects using ICT in Danish pre-school settings but, as compulsory education for Danish children starts in the year in which they reach 7, the pre-school years encompass ages at which children in some other European countries would be at school. In the USA, the National Association for the Education of Young Children adopted a position statement in 1996 on Technology and Young Children (NAEYC, 1996) which endorsed the use of developmentally appropriate software for collaborative play, learning and creation.

Should young children use ICT?

The increasing pervasiveness of ICT has led to parents, teachers and children's advocates questioning its relationship to the cognitive, emotional, social and developmental needs of young children. At its extremes, the debate has become polarised between those who consider computers to be detrimental to health and learning and those for whom computers can make a key contribution to children's social and intellectual development.

So far, the debate has found strongest expression in the United States and the Alliance for Childhood exemplifies the conservative view in *Fool's Gold: A Critical Look at Computers in Childhood* (Cordes & Miller, 2000). This report calls for an immediate moratorium on the further introduction of computers in early childhood, except for special cases of students with disabilities. It also recommends a refocusing on 'the essentials of a healthy childhood' (such as play, reading books and 'hands-on experiences of nature and the physical world') and calls for a report by the Surgeon General on the hazards computers pose to children.

In other contexts, Buckingham (2000) describes positions such as this as adopting a 'death of childhood' thesis in which it is believed that childhood has been lost as a result of changes in modern society. Fuelled by a combination of panic and nostalgia, this has been a continuing anxiety over the last several decades but has found new expression in fears focussed on children's use of ICT (Valentine & Holloway, 2001). Those who believe that children are empowered by the new media and that ICT can be used creatively oppose this view. This is not a clear-cut issue, however. Some commentators are broadly supportive of educational and leisure applications of ICT for children but have some reservations about the ways in which government policy makes ICT central to its aims of training children for the knowledge economy.

There does not appear currently to be any clear evidence on the deleterious effects of exposure to ICT. 'Effects' research tends to be associated with those who take the

Fool's Gold position as it is usually enlisted to support an agenda that promotes regulation and censorship as a solution to the 'problem' of children's use of ICT, particularly games. Such approaches are a response to each generation's fears about new technologies and similar research was conducted as a response to fears about television and its impact on children. 'Effects' research has been criticised as identifying children as passive viewers and denying any agency to the children concerned. An alternative approach is based on the premise that children are active viewers or users of technology and that children's use of the media should be analysed within a framework that encompasses social and cultural dimensions.

The most widespread concerns centre on protection and there is broad consensus on issues such as online privacy and the commercial intentions of many websites. Henke (1999) found that children up to the age of nine have difficulty distinguishing advertising on websites. This has been confirmed by a study of children aged six to 12 using sites specifically designed for children and three mainstream sites designed for adults (Amazon, Weather.com and Yahoo!). The study found that children often click on website advertisements because they are unable to distinguish between content and advertising and the authors call for adults to acquaint children with the realities of Internet advertising (Gilutz & Nielsen, 2002).

The US National School Boards Foundation (NSBF, 2000) commissioned research on a random sample of 1735 households including children between the ages of two and 17. The main finding was that children and parents view the Internet as a positive force in children's lives, although concerns were expressed about children encountering pornography, undesirable adults and violent or hate content.

The Annenberg Public Policy Centre has also commissioned research on children's and families' use of the Internet (Turow & Nir, 2000) but they focussed on families with children between 8 and 17. They found that 'all but a small proportion of parents feel that the online world holds strong educational possibilities' but parents are '*evenly divided on whether the Web will harm young minds.*' A key concern voiced in this study is children being enticed to disclose information about themselves and their families to commercial interests, although the 1998 Children's Online Privacy Protection Act prevents the collection of personal information from children under the age of 13 in the United States.

For older children, most of the protection issues focus on exposure to unsuitable content of a sexual, counter-cultural or violent nature. The most commonly cited arguments for a link between violent content and aggressive behaviour are summarised by Wartella *et al.* (2000; p. 72) as: (i) identification with the aggressive characters; (ii) active participation and control over individual character's actions and (iii) reinforcement and reward of aggressive behavioural choices. Although such concerns are not central to the use of ICT in pre-school settings they are more relevant when children's media environments in their entirety, including at home are considered.

Other concerns focus on the physical effects of prolonged exposure to ICT, such as repetitive strain injuries, addiction and sedentary lifestyles. The BECTA (2001) leaflet on keyboard skills in schools states that using the keyboard with index fingers only is highly risky for children with years of typing ahead of them, especially when there may be added strain from playing games on home computers. Research on the possible addictive nature of the Internet and computer games has so far been limited to older children. However, ICT has been used to promote health and positive

behaviours with games that encourage children to manage conditions such as asthma and diabetes (see http://www.starbright.org).

The belief that computers may damage young children's development underlies educational concerns. Healy (1998), for instance, claims that the early years are a 'busy time for the brain' and using computers before the age of seven subtracts from important developmental tasks. She states that learning to use computers uses up cognitive resources that could be applied to other types of learning. However, a review of developments in neuroscience and their implications for research on learning (Blakemore & Frith, 2000) concludes that while it is true that pre-school children have brains that undergo substantial and rapid changes '*this increased flexibility remains throughout adolescence, at least in some brain areas*' (p. 10).

They comment that educators often cite scientific research on brain development when arguing for particular educational practices but that neuroscience cannot yet resolve these issues. In terms of children's development, the use of ICT by pre-school children appears to have no more evidence for or against it than there is evidence for the early introduction of the study of languages, mathematics or music, or even the optimal time to start formal teaching.

Cuban (2001; p. 212) also notes that early childhood researchers and policymakers habitually cite brain research on infants and young children to support or rebut positions on the 'critical period' of intellectual development but most neuroscientists are reluctant to apply their findings to pre-school settings. Papert (1996; p. 98) refers to the question 'At what age should children use computers?' as analogous to asking when children should use crayons or dolls. He considers the question to be inappropriate because it implies that computers have only one use. A more useful question, according to van Scoter *et al.* (2001), is *What are appropriate and meaningful uses of technology with children?* The predominant view is that, as a screen-based medium, activities at the computer are not as effective as manipulatives in developing understanding and skills in the early years (Yelland, 1999) and that, as children learn through their bodies, computers are not developmentally appropriate (Haughland, 2000). These concerns are predicated on the use of desktop computers and have less currency as ICT becomes embedded in a range of everyday objects and uses wireless technologies.

The media environment

In an age of media convergence, it is important to consider the entirety of children's experiences of their media environment rather than discrete elements of it. This convergence is not simply technological. There is also an erosion of boundaries between education and entertainment and, particularly for this age range, between sites of learning and play.

Numerous studies in the UK and United States (e.g. Kaiser Family Foundation, 1999; Turow & Nir, 2000; Marsh & Thompson, 2001) indicate that children are immersed in the media. A few years ago CD-ROMs and video games were the main supplements to 'traditional' media such as books, magazines and televisions in the home. The new media are currently manifested in text messaging, Internet chat rooms, websites and 'smart' toys and will soon encompass interactive television and other applications of broadband technologies.

The distinctions between media are becoming blurred as, for instance, Saturday morning television shows feature an associated website and children are asked to

email a text message or telephone the presenters. Children appear to be relaxed about moving between media seamlessly in this way and being exposed to what Kinder (1991) refers to as '*trans*-media intertextuality' (i.e. television, film or videogame spin-offs such as clothing, confectionery, lunch boxes, toys and magazines). In such scenarios, the technology itself may be less important than media content, types of interactivity, the context and the purpose.

Marsh & Thompson (2001) analysed the consumption of media texts by 18 families in England and found that three- and four-year-old children watch television far more than engaging in any other leisure pursuit. Over a four-week period children watched more than 50 television or video programmes compared to playing five computer games on a PC or games console (owned by three-quarters of the families). Young children's introduction to software at home is often based on television programmes, animated films or games. As with parent's choice of books, these are unlikely to be the titles provided in a formal pre-school setting, although Marsh and Thompson (*op. cit.*) found that '*computer games may be an important factor in orientating children toward printed texts*'. Woodward & Gridina (2000) found that pre-school children spend an average of 27 minutes per day using computers at home, although use increased with age.

Playing games is the most common way children of all ages spend their time with computers, with boys spending more time on this activity (Casas, 2001; Facer *et al*. 2001). Jessen (1997) reports gender differences in how children use computers in kindergartens as early as ages 3–4 but Downes (2002) reports that gender differences were not as marked as in earlier published research. She notes that girls preferred education and strategy games whereas boys preferred combat and sport games. Anecdotal evidence from a recent study of pre-school settings suggests that pre-school children are more likely to prefer educational games and this gender difference is not noted by practitioners during the pre-school years. However, with some exceptions (Brooker & Siraj-Blatchford, 2002), there is a lack of studies looking at patterns of use by gender or by different ethnic or socio-economic groups for this age range.

Parents cite education as the main reason for buying a computer (NSBF, 2000; Sutherland *et al*., 2000) and they seem to tolerate computer games as contributing to greater familiarity with the use of computers, although there is an undefined point at which the level of use becomes a source of anxiety. They are keen for their children to take advantage of what they perceive to be the educational benefits of using ICT and the level of parents' desires for children to become familiar with computers seems to be a predictor of increased use. There is a widespread belief among educators and parents that children will require technological competences to succeed in school and then in the workplace (DfES, 2002). Such is the potency of this belief that Cuban (2001) argues that it, not research evidence, drives investment in computers for pre-school settings.

Children are more likely to experience uninterrupted and extended periods of time at a computer when at home rather than at school. Many parents see a home computer as a way of making good this deficiency and so the home has, for some families, become a space for learning with technologies. Buckingham & Scanlon (2001) refer to the growing 'curricularisation' of learning in the home, as exemplified by the proliferation of broadly educational magazines aimed at the pre-school market. Although there is increasing interest in using ICT to promote home-school links

during the years of compulsory schooling, there is no reported research available on how this relates to pre-school settings.

Literacy and ICT

The processes by which meanings are created and shared with and through ICT are new literacy practices. There are many terms used to describe different aspects of these literacies (multimedia, interactive, ICT or digital literacy) but they tend to focus on operational aspects of using ICT. There is little detailed analysis of how children make meanings with interactive media and, with some exceptions (Snyder *et al*., 2002), a lack of evidence about what actually happens in social, cognitive and affective domains.

The use of the term 'literacy' in the context of ICT presupposes some analogy with the literacy associated with writing and reading and it is widely assumed that the reading skills acquired from exposure to traditional media can be transferred, even though the presented 'text' is mediated by a computer. Although influential, and there is some cross-fertilisation, the competences associated with traditional literacy may not be directly transferable to ICT and explicit guidance for children may be needed, as it is for novice readers and writers.

Language development and emerging literacy is the curricular area that is most frequently studied in relation to ICT in the early years (see Matthew, 1997; Moxeley *et al*., 1997; Shilling, 1997; Mioiduser *et al*., 2000; Nicholson *et al*. 2000; van Daal & Reitsma, 2000). Lewin (2000), for example, explored the effects of talking books software in UK primary schools (focusing on 5- and 6-year-olds) and found that electronic books can complement teaching in infant classrooms, having a positive effect on cognitive and affective outcomes. The basic software version (without additional coaching procedures) was successful in improving sight recognition of key words for lower reading ability children while the enhanced software (with additional coaching and hints) was more effective for those who had already acquired some sight vocabulary. This type of study tends to focus on using ICT as a tool to improve traditional literacy rather than analyse how children's literacies adapt, or not, to the demands made by computer-mediated tutoring.

Turbill (2001) focuses on the resistance to technology in teaching literacy in Australian kindergarten classrooms. She concludes that technology could play a much greater role if there were more computers, more support, more time for familiarisation with content and more appropriate software — findings that are familiar from countless studies of the use of ICT in schools. She argues that just as children need to develop concepts of print to read so too they need to develop 'concepts of screen' if they are to become 'screen' and 'visually' literate. Yelland (1999) and Snyder (2002) also discuss new literacies in terms of understanding diverse media.

The recent shift of emphasis in the expansion of the term IT to I*C*T indicates that *communication* is now seen as a central component of ICT capability and clearly depends on both 'traditional' and 'new' literacies. The Queensland Literacy Strategy (Queensland, 2000) encapsulates this broader definition of literacy as 'the flexible and sustainable mastery of a repertoire of practices with the texts of traditional and new communication technologies via spoken language, print and multimedia'. The new literacies encompass competences associated with reading and writing in combination with those related to the computer mediation of information. Although

not all of these competences are appropriate in the context of emergent literacies, they constitute a combination of any or all of the following (Plowman, 1998):

- interpreting the computer's interface, including familiarity with screen conventions and how to map icons onto user actions and screen events
- navigating the text, including understanding different representations of space and the structure of multimedia documents
- knowing how to 'read' texts with contiguous media components
- locating and retrieving appropriate information
- having the ability to produce multimedia texts
- understanding the provisionality of texts
- understanding shifts in relationships between reading and writing
- differentiating between texts in terms of their provenance and verifiability
- having the sensorimotor skills necessary for computer interaction.

At the moment, it is not clear if the operational aspects of interaction *hinder* literacy development because cognitive resources required for interaction with the computer become unavailable for reading and writing on screen. An awareness of cognitive load (Kirschner, 2002) may therefore be particularly relevant to the design and use of software for the early years. An alternative hypothesis is that the explicit interaction required to access and navigate the screen-based texts means that children are more aware of the processes involved and this *enhances* the development of literacy.

Interface and interactivity

Equipment produced for adults often has inappropriate physical and cognitive ergonomics for children, particularly for pre-schoolers, and yet children are expected to adapt to products that have not been designed with them in mind. This is clearly the case with the standard desktop PC and keyboard. Design for young children is not simply a matter of scaling down the hardware, however, as pre-school users are not scaled-down adults but have specific requirements of equipment, such as robustness and mobility.

Hardware considerations are mainly concerned with input devices and include overlay keyboards and trackerballs. Mice need to be larger to make them appropriate for young children's hands and those that illuminate to confirm a click can help young children by making interaction visible. Adult technologies tend to be designed for individual users whereas pre-school children learn and play collaboratively — with their peers, but also with siblings and adults.

A range of products that can be described as ICT in the introduction to this paper have been indicated. If ICT is defined strictly in terms of *information* and *communication* technologies then not all of these products exhibit the functionality to fulfil these requirements. Many of the toys used in nurseries or at home are electronic but the level of information or communication created by flashing lights or the production of sounds such as animal noises is fairly minimal by adults' standards. Play is central to the development of the pre-school child and, through exploration and discovery, such toys can serve to familiarise children with a concept of operational interactivity in which pushing a button or picture produces a response. Nevertheless, the fact that such toys are 'interactive' does not necessarily mean that they are educational.

Generally, play is seen as an embodied and physical activity (dressing up, sand and water play, tumbling and climbing) rather than a digital one and, as said earlier,

ICT is seen as having explicitly educational rather than play value in pre-school settings. However, this distinction between digital and embodied play can be eroded by the new generation of technologies with tangible (i.e. touchable) interfaces. Many of the concerns about children's use of ICT outlined earlier are based on a concept of technology that is now out of date. Seen as detrimental to children's development due to its fixed, screen-based nature it is assumed that young children cannot use ICT for creative and collaborative play or engage all of their senses.

The conventional reliance on screen-based text and graphics presents a barrier to interaction for pre-school children that could be overcome by products designed with tangible interfaces. As Ullmer & Ishii (2001) comment, '*the screen has cultivated a predominantly visual paradigm of human–computer interaction*'. The tangible applications they describe include the physical manipulation of building models for urban planning and MediaBlocks, which enable online media to be edited using a sequence rack modelled on the tile racks used in Scrabble™.

These examples are for adult use but there are important implications for designing technology for pre-school settings. In particular, tangibility is well suited to the constructionist approach to education advocated by Papert and colleagues (Kafai & Resnick, 1996). Not yet at the stage of commercial development, researchers are producing programming environments which physically manipulate computationally augmented objects (Montemayor *et al*., 2002). These have evolved from Papert's programmable floor turtles, as has the curlybot (Frei *et al*., 2000), a new class of computational toy aimed at children over four. The curlybot is a two-wheeled toy that can record its movement through a path chosen by a child and then play back the movement until stopped. A pen can be attached to make visualisation of the created pattern easier. There are also imaginative uses of tangible interfaces to contrast with the 'talking books' approach to developing literacy described earlier. These include *Sam*, an embodied conversational agent (Ryokai *et al*., 2003), and a 'magic carpet' (Stanton *et al*., 2001), although both projects worked with children aged five or over.

Some of the issues relating to interactivity and interface were explored in 12 projects researching schools of the future for 4- to 8-year-olds funded by the European Union under its Experimental School Environment programme. Projects included KidsLab on how to involve children as codesigners and KidStory on developing a collaborative storytelling environment. The DATEC project, funded by the same initiative, aimed to develop agreements regarding the constitution of an ICT curriculum for young children throughout Europe and involved a survey of developments in the application of ICT to early years education. Its findings were used to inform the KidSmart Early Learning Programme (Siraj-Blatchford & Siraj-Blatchford, 2001) which established computer centres in a number of disadvantaged areas. Other examples of research can be found at MIT's Media Laboratory on 'Toys of Tomorrow' and the Nordic Centre for Research on Toys and Educational Media.

Recently, there has been a proliferation of toys and other 'edutainment' products aimed at pre-school children and their families that combine opportunities for digital and manual play through new forms of physical artefacts with tangible interfaces. These products use familiar forms, such as toys, dolls or construction bricks, but they are computationally enhanced. They are not televisual or text-based, do not use a desktop metaphor and do not rely on a keyboard or mouse input (see Luckin *et al*., 2003, for an example). Instead, these products exhibit a range of interface modalities and they can be manipulative (Resnick *et al*., 1998) or anthropomorphic in the sense

of simulating human characteristics such as movement or emotion (Strommen & Alexander, 1999).

These toys are not tethered by cables in the same way as personal computers and so are portable. They can be wearable or cuddly and range from soft toys that communicate with the computer by radio transmitter to robotic pets. Papert (1996) speculates that an infant's computer will look like the stuffed toys which are familiar and the baby will use it by 'hitting it, touching it, gurgling or yelling at it, watching what it does and hearing the sounds it makes'.

There is also an expanding market for increasingly communicative toys, including dolls that 'learn' to walk and exhibit a range of emotions. These toys prompt questions such as (i) whether children consider these toys to be 'real' and attribute feelings and emotions to them (ii) whether play is too structured and (iii) whether they limit children's imagination. The toys may present an opportunity for the child to explore and develop concepts of social relationships but the marketing for these products currently makes unsubstantiated claims for 'interactive learning' and 'nurturing play', usually quoting nameless child psychologists.

Anecdotal evidence suggests that currently there is not widespread use of the Internet by very young children. Gilutz & Nielsen (2002) found that most of the problems encountered by children using the web suffered from the same classic design faults as sites used by adults and that children were incapable of overcoming many usability problems. In addition to the problems of a screen–based interface described above, extensive text is particularly problematic for pre-school novice or nonreaders.

Their study did not encompass children below the age of six but a key design problem for this age group is that text cannot be relied upon to convey instructions or content. From this perspective, CD-ROMs are often more suitable for very young children. Not only is it easier to incorporate voice instructions and narrative but the fixed boundaries of the CD-ROM's content mean that children do not face straying into unsuitable sites. Where text is used, legibility of the font is an important design issue and Sassoon (2001) has developed a family of typefaces for the screen, based on how children are taught handwriting and on what they find easiest to read.

The quality of design of such products is clearly at the heart of their suitability for purpose and how attractive they are to children. If anything, the consequences of poor design are more serious for this age group than others but design tends to be market driven. The domestic market is more lucrative than the educational market and different design criteria are likely to be used, especially as these products tend to be heavily promoted on television. Partnerships of practitioners, parents, children and designers should ensure some improvements. Druin (1999) has taken the principles of participatory design to involve children as active partners in the design of technology for their own use, although the children concerned have been aged 7–11. More recently, she has produced a useful overview of the roles that children can play in the technology design process, categorising these roles as user, tester, informant and design partner (Druin, 2002).

In the same way that the design of adult's products is inappropriate for pre-school children, so is the evaluation process. Usability problems with software tend to be easier to identify for this age range inasmuch as very young children do not have the range of work-around strategies from which older users can draw if they are confronted by difficulty. If pre-school children do not understand an icon or

instruction they will tend to click randomly and excessively, often until the screen freezes.

However, usability is a fairly limited concept in this context and methods need to be developed or adapted that can illuminate fun, enjoyment, learnability and age-appropriateness. Hanna *et al*. (1997) comment that conducting usability testing with pre-school children requires extensive adaptation because children have a low attention span, want to please adult researchers and have problems articulating their likes and dislikes. Kersten-Tsikalkina & Bekker (2001) investigated the suitability of two evaluation methods that had originally been developed for adults and found that they revealed some useful expressions of fun and frustration, although the children concerned were aged 9–11.

Such evaluation methods are generally used to inform the design of the technology, but parents and practitioners also need to be able to draw on evaluations that can be used to inform purchase decisions and choosing appropriate activities. The advice currently available is limited in its value because, whilst usually aware of pedagogical issues, it does not necessarily take cognisance of the full range of factors that can affect the use of ICT in pre-school settings.

Conclusions

The NAEYC (1996) position statement on technology and young children advises that teachers must choose developmentally appropriate software but also states that *choosing appropriate software is similar to choosing appropriate books*. This is misguided because it overlooks the role of computer mediation of content and does not fully acknowledge the range of interaction patterns afforded by different types of software. However, the statement emphasises the importance of adults participating in activities at the computer as well as encouraging children to use computers on their own or with peers.

As with much of the research reported here, resources which provide advice on ICT for pre-school children tend to focus on software for standard PCs rather than technologies such as computational toys or handheld devices. Parents and practitioners may find it more difficult to make judgements about choosing educational software for this age range than for older children. Many of the criteria will be the same as for choosing any educational software but it is also important to take into account reading age, whether adult assistance is required and how well it supports collaborative activities.

At the end of this paper, are listed some websites that provide guidance. These are intended to be resources for parents and practitioners but it is also useful for researchers to be aware of what is on the market and the evaluation criteria used. In the UK, the *Parents Information Network* provides some guidance and, to date, offers reviews of 78 titles for CD-ROMs and websites in the 0–2 and 3–5 categories. However, the evaluation criteria are not made explicit and many of the comments are very brief. The *Teachers Evaluating Educational Multimedia* site does not have a specific category for pre-school or early years and, although some titles indicate they are appropriate for use in nurseries, it is not possible to search by this term. The *BECTA Educational Software Database* lists more than 350 titles for ages 2–4 but this is a catalogue resource: publishers provide the information and there are no reviews. The *Early Connections* site provides some guidance on choosing age-appropriate software with links to evaluation sites and the *Children's Software and*

New Media Revue provides comprehensive listing (over 1200 on a search by 'pre-school') but is only available on subscription. A five-point scale from 'dud' to 'outstanding' is used for reviews.

Squeezing evaluations into the templates used by the guidance sites mentioned here can be misleading as they are typically one practitioner's account of how they used the software with one group of children. Browsing through the materials does not necessarily reveal the problems because, without authentic activities, the software design leads users, so masking navigational and other design problems.

However, complex rating charts such as the Haugland/Shade Developmental Software Scale (Haugland & Wright, 1997) are also problematic. This one provides over 40 categories to be assessed and then reduces the findings to a score out of 10. This complexity is unlikely to be suitable for practitioners or parents conducting their own evaluation but neither are they likely to find a score out of 10 very revealing when they make purchase decisions. Deciding on useful criteria for educational software is difficult because its use is so context-specific but guidance needs to be broad enough to be easy to apply and interpret.

The fundamental design problem for educational applications is the lack of an explicit pedagogical model to underpin use. All design has a model or models of the teaching and learning process implicit in it, manifested by how the learner is conceptualised, whether and how content is presented, whether and how learning is assessed, the role of feedback and whether it encourages collaborative use (Plowman, 1999). Unfortunately, this model is rarely made explicit and parents and practitioners do not have time to evaluate products in detail.

Although it is now commonly accepted that children learn through play (e.g. Sutton-Smith, 1979), there is some uncertainty about how this manifests itself in the design of ICT for this age-range. Parents favour educational applications, even for children in this age-range, but some of the so-called educational software is quite dreary in terms of appearance and content. Operational interactivity, such as knowing where to click, can present barriers and it may be that the future lies with the new concepts of interface described earlier.

New technologies may lead to new concepts of play and learning in which ICT is much more than the 'benign addition' referred to by Cuban (op. cit.), especially as new ways are found of conceptualising ICT so that the term does not simply denote standard computers. These shifts in thinking may lead to technologies that can encompass participation by practitioners, parents and children in different learning spaces and promote discovery, delight, curiosity, creativity, self-expression and pleasure in learning.

Research in this area has an important role to play in investigating with greater rigour the complexities of arguments for and against young children's uses of ICT and, if appropriate, using that information to develop technologies specifically for pre-school children. Instead of the current situation in which very young children have to adapt to inappropriate technologies in pre-school settings, what could be referred to as a 'malign addition', it is possible that adults too can benefit from these developments in unexpected ways.

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ICT in Pre-school: A "benign Addition"? is available from Learning and Teaching Scotland (http://www.LTScotland.com), price £3.75.

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