EARLY EDUCATION SUPPORT

ICT in Pre-School: A 'Benign Addition'?

A review of the literature on ICT in pre-school settings

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1. INTRODUCTION

Learning and Teaching Scotland commissioned this literature review to inform their development of a national strategy for the provision and use of information and communications technology (ICT) in pre-school education in collaboration with the Scottish Executive Education Department.

The development of a national strategy 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 National Grid for Learning (NGfL) and ICT training for new and established schoolteachers are just two of the items on the ICT development agenda that witness to the primacy given to this issue in the school sector. ICT education is now firmly in place in the curricular guidelines for initial teacher education in Scotland and England. ICT is seen as having potential to improve the quality and standards of pupils' education in addition to supporting teachers in their everyday classroom roles and in their continuing training and development.

Parents, as well as policy-makers, place ICT high on their agenda for education. A survey in the USA found that 66 per cent of parents placed access to computers among their top priorities for education and 74 per cent of voters gave a higher priority to equipping every classroom with a computer than to improving school buildings or reducing class sizes (Milken Exchange and Hart, 1999). There is a widespread belief among educators and parents that children will require technological competencies to succeed in the workplace. Cuban (2001) argues that it is this belief and not research evidence that drives investment in computers for pre-school settings.

The pre-school curriculum in Scotland, *A Curriculum Framework for Children 3 to 5* (Scottish CCC, 1999), unlike the 5–14 school curriculum, does not make any specific reference to ICT. Within the curriculum area of knowledge and understanding of the world there is guidance that pre-school children should 'become aware of everyday uses of technology and use these appropriately'. However, the examples given are using scissors, waterproof clothing, a 'fridge, a bicycle. Nevertheless, informal observation of playrooms in the voluntary, private and public sectors suggests that computers are commonly present.

The National Curriculum for England (2000) has explicit aims for ICT skills at Key Stage 1 (that children should use ICT confidently and purposefully and be starting to use it to develop their ideas and record their creative work). Children in reception classes and nurseries are expected to be 'working towards' Key Stage 1. In the USA the National Association for the Education of Young Children (NAEYC) adopted a position statement in 1996 on Technology and Young Children (3–8), which endorsed the use of developmentally appropriate software for collaborative play, learning and creation.

Although many pre-school playrooms in Scotland may now contain a computer (used by children throughout the sessions offered in the setting) there is a lack of developed pedagogy for the use of ICT in these contexts. This is not a phenomenon restricted to ICT and pre-school education in Scotland, however. Mioiduser, Tur-Kaspa and Leitner

(2000) refer to the presence of technology in early childhood education as 'hardware reality' that has not yet become a technology-based learning reality. They go on to suggest that 'first hardware-based enthusiasm, then pedagogical reflection' is a recurrent pattern in the adoption of new technologies in education.

> The development of a national strategy for ICT in pre-school education represents an ideal opportunity for pedagogical reflection.

Our remit for this review was to examine the research evidence for the ways in which children and practitioners can make use of ICT for learning, both by supporting children's development and as a means of facilitating the work of practitioners. The focus of concern in the literature is predominantly with children's experiences and learning. While we searched for evidence about the way in which practitioners could use ICT to develop their practice and facilitate administration, only two sources made reference to this. Liang and Johnson (1999) describe ICT as a 'wonderful tool' for formative assessment, offering ways to store artefacts, pictures and narratives and Wright (2001) refers to ICT as having uses in professional development, lesson planning and for partnership work with parents. This review concentrates then, of necessity, on ICT and pre-school experiences from the perspective of the children. We look at the evidence in four specific areas:

- The Debate: should young children use ICT?
- The Media and ICT
- Provision of ICT in Early Education
- Learning with ICT.

Each section concludes with a summary of key issues for practice and policy on ICT use in pre-school settings.

Before looking at the evidence, we note the *scarcity of good quality research findings* on using ICT in educational settings for pre-school children. There is a proliferation of reports, articles and websites 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 by generalised discussion of the potential benefits, followed by cautions to use developmentally appropriate software and guidance about how to choose such software or how to begin using computers in the playroom (Haugen, 1998; Yelland, undated, among others). Some of the claims rely on assertion rather than empirical study while others draw on and recycle a limited number of older studies.

Along with Wartella, O'Keefe and Scantlin (2000), we suggest that 'there are far more questions than there are answers about what computer and video games and internet use mean to the social, intellectual and physical development of children today'. Most of the literature points to the use of ICT in pre-school settings as being what Cuban (2001) refers to as a 'benign addition'. In other words, computers have been brought into pre-school environments as a supplement to existing practices, and practitioners perpetuate existing ways of working while accommodating the new technologies.

ICT is often narrowly construed as consisting mainly of desktop computers but the range of technologies available now and in the near future provides opportunities for a more radical transformation of teaching and learning relationships and activities. If these changes are to be embraced, initiatives must be practitioner- and child-centred and tailored to individual ways of teaching and learning. Initiatives must be fully resourced in terms of technical support and training and especially in terms of time for practitioners to develop sufficient confidence with ICT that they can make judgements about when it is or is not appropriate. It is important that initiatives are not technology-driven.

2. THE DEBATE: 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 of America and the conservative view is exemplified by the Alliance for Childhood's stance. *Fool's Gold: A Critical Look at Computers in Childhood* (2000) 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 American Surgeon General on the hazards that computers pose to children. Further discussion of the *Fool's Gold* report can be found in Abbott *et al*. (2001).

In the UK, Buckingham (2000) characterises this position as adopting the 'death of childhood' thesis, which is fuelled by a combination of panic and nostalgia. This is opposed by those taking a position of believing that children are empowered by the new media, and that ICT can be used creatively and is central to their enculturation into the knowledge society and economy. However, opponents argue that such an approach risks positioning children as consumers and blurs the distinctions between work and play.

The main concerns centre on *protection 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, and in the USA the 1998 Children's Online Privacy Protection Act prevents the collection of personal information from children under the age of 13.

For older children, most of the protection issues focus on *exposure to unsuitable content* of either a sexual or violent nature. 'Effects' research tends to be associated with those who take the *Fool's Gold* position as it is usually enlisted to support agendas that promote regulation and censorship as a solution to the 'problem' of children's use of ICT, particularly games. It is a response to each generation's fears about new technologies, and similar research was conducted as a response to fears about television and its 'effect' on children.

The most commonly cited arguments for a link between violent content and aggressive behaviour are: (1) identification with the aggressive characters, (2) active participation and control over individual character's actions and (3) reinforcement and reward of aggressive behavioural choices (Wartella *et al*., 2000, p. 72). Although such concerns are not directly relevant to the use of ICT in pre-school settings they are relevant when we consider children's media environments in their entirety. 'Effects' research can be seen as denying any agency to the children concerned whereas research in the UK tends to be based on the premise that children are active viewers or users of technology. Children's use of the media needs to be analysed within a broader framework that encompasses social and cultural dimensions.

Other concerns focus on the *physical effects* of prolonged exposure to ICT, such as repetitive strain injuries, addiction and sedentary lifestyles. The BECTa information leaflet (2001) on keyboard skills in schools states that for children with years of typing ahead of them, using the keyboard with index fingers only is highly risky, 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, there is some evidence that ICT can *promote* health and positive behaviours with games that encourage children to manage conditions such as asthma and diabetes.

Underlying *educational concerns* is the belief that computers may damage young children's development. Healy (1998), for instance, claims that using computers before the age of 7 'subtracts from important developmental tasks'. Cuban (2001, p. 212) notes that early childhood researchers and policy-makers 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.

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. (See section 3.3 on the interface.)

Fomichova and Fomichov (2000) even go so far as to suggest that children in economically developed countries spend so many hours alone in front of the computer that a new non-nuclear family system of parents, child(ren) and computer has emerged. They refer to the computer as an 'intrusion' into the educational system, children's cognition and the family. However, Woodward and Gridina (2000) found that pre-school children spend an average of 27 minutes per day using computers at home, although use increases with age.

The US National School Boards Foundation (NSBF, 2000) commissioned research on a random sample of 1735 households including children between the ages of 2 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 and Nir, 2000) but it focused on families with children between 8 and 17. It 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.

There is a dearth of 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. (This issue of evidence for 'impact' on attainment is returned to below).

- Policy-makers must consider the debate around ICT use by young children when deciding on the future provision of technology in pre-school and its place in the curriculum.
- Practitioners should be aware of the debate about ICT use by young children and the need to safeguard children's health and development.
- Software available in pre-school settings must be free of violent, sexual or other content unsuitable for pre-school children. Practitioners should vet software with as much care as they vet other materials such as books and videos to be used in the playroom.
- Suitable safeguards must be in place if children are accessing the internet or using materials taken from internet sites.
- Careful observations and recording of children's ICT activities should be made to ensure that practitioners are aware of the extent and nature of each child's engagement with ICT.

3. THE MEDIA AND ICT

3.1 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 an erosion of boundaries between education and entertainment, and work and play in the home.

Numerous studies in the UK and USA (Kaiser Family Foundation, 1999; Marsh and Thompson, 2001; Turow and Nir, 2000) 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. Text messaging, internet chat rooms, websites and 'smart' toys are current manifestations of new media and this 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 e-mail, text message or telephone the presenters. Children appear to be relaxed about moving between media seamlessly and being exposed to what Kinder (1991) refers to as 'trans-media intertextuality' (namely 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 and Thompson (2001) analysed the consumption of media texts by 18 families in England and found that 3- and 4-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 with playing five computer games on PC or games console (owned by three-quarters of the families).

Playing games is the most common way children of all ages spend their time with computers, with boys spending considerably more time on this activity. Pre-school children are more likely to prefer educational games but this decreases for both boys and girls as they get older. Boys tend to prefer sports, action adventure and violent action games while girls generally prefer educational, puzzle and fantasy adventure games. This gender difference is not noted during the pre-school years but there is a lack of studies looking at patterns of use by gender or different ethnic groups for this age range. There is also a debate about whether games are a suitable medium for educational content (Kahn, 1999; Prensky, 2001).

Parents cite education as the main reason for buying a computer (NSBF, 2000; Sutherland *et al*., 2000). 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. Children are more likely to experience uninterrupted and extended periods of time at a computer when at home rather than at school and many parents

see a home computer as a way of making good this deficiency. Parents seem to tolerate computer games as contributing to greater familiarity with the use of computers, although there is an as yet undefined point at which the level of use becomes a source of anxiety.

Sutherland *et al*. (2000) suggest that the home has become a space for learning with technologies and that children will be entering formal education with a qualitatively different experience of ICT from their teachers. Buckingham and 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 and the commercial influences on young children. Although there is growing interest in using ICT to promote home–school links during the years of compulsory schooling, there is no research available on how this relates to pre-school settings.

A full acknowledgement of young children's media environments is unusual in pre-school or formal education. However, Marsh and Thompson (2001) describe how media boxes (similar in concept to 'story sacks') were developed as a literacy resource for use by parents and children in the home, drawing on environmental print, the media and popular culture. They had noted that the books children read at home are often not the type of books available in nurseries: they tend to be based on television shows or Disney films and are not part of the early years canon of picture books. The boxes did not include electronic artefacts or CD-ROMs but could be extended in this way.

3.2 Multimedia 'literacy'

The processes by which we create and share meanings with and through ICT are new literacies. There are many terms used to describe different aspects of these literacies (multimedia, network, interactive, ICT or digital literacy) but they tend to focus on operational aspects of using ICT. There is no detailed analysis of how children make meanings with interactive media and a conspicuous 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 they shape our strategies and there is some cross-fertilisation, the competences associated with traditional literacy may not be directly transferable to ICT and explicit guidance for children is needed, as it is for novice readers and writers.

Turbill (2001) focuses on the resistance to technology in teaching literacy in Australian kindergarten classrooms but 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. These are all findings that are familiar from countless studies of the use of ICT in schools. The only non-standard requirement was the need for more adult helpers to support and guide students as they interacted with the technology. Turbill emphasises the need for teachers to acknowledge the value of children becoming 'screen' and 'visually' literate through play with 'edutainment'

software, and Yelland (1999) also discusses the need for children to develop media literacy skills. (See section 5.2 for further discussion.)

Scottish pre-school curricular guidelines consider language and communication skills as one area of development but when literacy is considered there is a tendency to focus exclusively on print literacy – the reading and writing of linear, verbal text on paper. However this does not cohere with the recent shift of emphasis implied in the expansion of the term IT to ICT. *Communication* is now seen as a central component of ICT capability and clearly depends on both 'traditional' and 'new' literacies. The Queensland Literacy Strategy (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 and 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

Developing familiarity with 'new' literacies would be a welcome addition to the 'Communication and Language' area of the Curriculum Framework.

Practitioners and parents need advice on how children can be prepared for experiencing and learning some of these aspects of multimedia literacy during the early years. At the moment, we do not know 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 be particularly relevant to the design and use of multimedia 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.

3.3 The interface

There has recently been a proliferation of toys and other 'edutainment' products aimed at pre-school children and their families that display a new form of interface: one that is not televisual or text-based, does not use a desktop metaphor and does not rely on a keyboard or mouse input. Instead, these products exhibit a range of interface modalities: they are haptic (sensitive to touch), manipulative (three-dimensional) (Resnick *et al*., 1998) or anthropomorphic in the sense of simulating human characteristics such as movement or emotion (Strommen and 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. Interactive books such as LeapPad are, like traditional books, picture and text-based and freestanding but with the addition of audio and stylus input. There is also an expanding market for increasingly communicative digital toys, including dolls that 'learn' to walk and exhibit a range of emotions.

Such toys give rise to a range of concerns. How 'real' do children consider these toys to be? Do they attribute feelings and emotions to them? Is play too structured with these toys? Do they limit or develop children's imagination? But such products may also present an opportunity for the child's active learning and interaction with three-dimensional objects to take place through and with ICT. Many of the concerns about children's use of ICT are based on a concept of technology that is now out of date: ICT is seen as detrimental to the child's development due to its fixed, two-dimensional nature and it is assumed that young children cannot use ICT for creative and collaborative play. This range of toys and devices are part of the move towards pervasive or ubiquitous computing in which the technology is all about us but not necessarily visible as such.

Nevertheless, 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. Roschelle *et al*. (2000) suggest that ICT is likely to be most valuable in educational contexts when it reinforces one of the four principles of a constructivist approach: active learning, group participation, frequent interaction and feedback, and connections to real-world contexts. Partnerships of practitioners, parents and designers should ensure some degree of appropriateness and 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.

Twelve projects researching schools of the future for 4- to 8-year-olds were funded by the European Union under its Experimental School Environment programme (www.i3net.org/schools/). Projects included KidsLab on how to involve children as co-designers and KidStory on developing a collaborative storytelling environment. The

DATEC project (www.ioe.ac.uk/projects/datec) is a European survey of developments in the application of ICT to early years education (ages 0–8). DATEC's major product will be a multilingual internet site carrying guidance material for practitioners and policy-makers. Other examples are long-term research at MIT's Media Lab on 'Toys of Tomorrow' (www.media.mit.edu/toys/) and the Nordic Centre for Research on Toys and Educational Media (www.hh.se/ide/ncfl/).

New technologies may lead to new paradigms of learning that can promote discovery, curiosity, creativity, self-expression and pleasure in learning and that can encompass participation by practitioners, parents and children in different learning spaces. Nevertheless, the fact that such toys are 'interactive' does not necessarily mean that they are beneficial or educational.

3.4 Choosing products

Young children's introduction to software at home is often based on television programmes, animated films or games. As with their choice of books, these are unlikely to be the titles provided in the pre-school setting and there is a possibility of reinforcing the cultural differences between the two environments. Software designed for the domestic market often has higher production values but will not necessarily have been designed on pedagogic principles.

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.

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 integrates into pre-school activities. Legibility of the font is a particularly important issue and Sassoon (2001) has developed a family of typefaces, based on how children are taught handwriting and on what they find easiest to read. It uses long ascenders and descenders to give clarity, and the exit strokes help to lead into joined-up or cursive writing.

The Parents Information Network (www.pin.org.uk) provides some guidance and, to date, offers reviews of 78 titles for CD-ROMs and websites in the pre-school category. However, the evaluation criteria are not made explicit and many of the comments are very brief. The Teachers Evaluating Educational Multimedia site (www.teem.org.uk) 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 (besd.becta.org.uk/) lists more

than 300 titles for ages 2–5 but publishers provide the information and there are no reviews. Learning and Teaching Scotland has produced a catalogue specifically for ICT resources for the early years and appears to be a leader in this field.

Squeezing evaluations into the templates used by the guidance sites mentioned above 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 and Wright, 1997, p. 27) 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 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 very difficult because its use is very context-specific but guidance needs to be broad enough to be easy to apply and interpret.

Hardware considerations are mainly concerned with input devices and include overlay keyboards, trackerballs and proportionally sized mice, as well as mice that illuminate to confirm a click. There are reviews of such devices in professional magazines but, so far, less advice is available on the range of 'smart' and programmable toys. The marketing for these products makes unsubstantiated claims for 'interactive learning' and 'nurturing play', usually quoting unnamed child psychologists.

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, how information is presented, whether and how learning is assessed, and use of feedback. Unfortunately, this model is rarely made explicit and teachers do not have time to evaluate products in detail. A very recent study based in one Scottish local authority (Plowman *et al*., 2002) found that a lack of time to preview software was cited by 94 per cent of respondents as the main obstacle to use of ICT in Scottish schools.

- ICT use in pre-school should be viewed as part of a child's wider media experience.
- Practitioners should be aware of other media that children interact with (in and out of the pre-school setting) and seek ways to encourage children's 'media awareness' and appreciation of different genres and uses.
- The need for adults and children to develop the literacy skills required for effective ICT use should be recognised. Practitioners need opportunities to acquire screen literacy and navigation skills that they can share with children in the same way as they share book knowledge and language.
- Pre-school practitioners should observe and record children's developing ICT literacy in the same way as they monitor emerging 'print literacy'. Practitioners are well placed to engage in research into emerging ICT literacy but they may need the assistance of external researchers to carry out this work.

- Managers of provision will wish to develop ways of observing and recording children's developing ICT literacy and include this in the information transferred to primary school.
- Practitioners and those responsible for the provision of resources should be aware that ICT does not only encompass desktop computers, and the interface is not confined to a computer screen. They should be provided with opportunities to learn about the particular advantages offered by different design features.
- LT Scotland already offers advice on software choices. There is an evident need for this to continue and expand if practitioners are to make the most effective use of resources and become familiar with the particular criteria that apply to choosing software.

4. PROVISION FOR ICT IN EARLY EDUCATION

4.1 Current provision and practice

Among the expectations for children's developing knowledge and understanding of the world set out in *A Curriculum Framework for Children 3 to 5* is the suggestion that children should acquire an 'understanding of the everyday uses of technology and an ability to use these appropriately' (Scottish CCC, 1999). Many domestic products, toys, radio controlled equipment and recording devices incorporate aspects of ICT. Most pre-school playrooms will contain some of these items (for example, a tape player in a 'listening corner', a video player, digital clocks) but for most staff and parents it is the presence of a computer that indicates attention to ICT in the curriculum. Anecdotal evidence suggests that other programmable play objects, such as floor robots, are not part of the regular resources found in Scottish pre-school settings.

Although observations in pre-school playrooms suggest that a computer is commonly available for use during free play (particularly in public sector settings) a search for survey evidence about the provision of computers or programmable toys in pre-school settings in Scotland (or elsewhere in the UK) revealed no statistical evidence about *current usage or playroom availability*. This is perhaps not surprising, given the very diverse nature of pre-school provision and the under-developed state of research in the area, but does point to a need for a study of current practice. It will be necessary to consider where children and adults are now (as ICT users) before looking at ways of developing this further, especially if a deficit model of training for practitioners is to be avoided. The outcomes of a long history of in-service education and innovation that began by emphasising staff inadequacies in relation to a model of good practice held by 'experts' or 'decision-makers' are testimony to the ineffectiveness of such an approach (Stephen, Brown and Cope, 2001).

The literature suggests that that some *resistance to ICT* may be encountered from teachers and organisations (Turbill, 2001). Haugland (1999) cites evidence that suggests that parents are enthusiastic about computers having positive benefits on children's learning and refers to the NAEYC position statement that endorses the use of appropriate technology with young children. She goes on to contrast this with the situation of teachers who are still struggling with questions about the value of ICT and their own role in a computer-integrated classroom. On the other hand, a study of the current use of ICT by teachers in Scottish schools (Williams *et al*., 2000) suggested that two-thirds of primary teachers felt competent or very competent with ICT in classroom practice. They were much less confident about using ICT out of lessons but recent evidence from case studies of Scottish primary schools (Plowman *et al*., 2002) found that, although not all of the teachers used ICT in lessons, they all used ICT for preparation, administration or to develop their own ICT skills.

It is not possible to extrapolate confidently from this data gathered from primary school teachers to practitioners working in pre-school settings, particularly as staff members in nursery schools, classes and playgroups have diverse educational and training backgrounds. It does, however, seem safe to suggest that there will be staff members with perspectives on using ICT that range from the 'doubters' identified by Haugland to

the very confident teachers who responded to the survey by Williams *et al*. Any development programme offered to pre-school practitioners will have to address the needs of all staff if it is to avoid ICT being seen as the responsibility of one or two adults or the centre manager.

Suggestions for the development of schoolteachers' ICT skills and the enhanced use of ICT in schools can, arguably, be applied to the circumstances of pre-school practitioners. Williams *et al.* suggest that, in addition to appropriate training (in terms of skills, knowledge, relevance to educational goals and priorities) staff need ready access to ICT resources and ongoing support and advice to encourage progression beyond any formal training. Indeed, they argue that a supportive environment that encourages staff members to see ICT as integral to their existing goals is as important as any national initiative, and Plowman *et al*. found that primary schoolteachers prefer training to be delivered in-house by their ICT coordinator. Turbill (2001) reports the views of an early years teacher who felt guilty about not using the expensive resource of the classroom computer more often. The teacher was unconvinced of the value of computer-based instruction for the achievement of literacy goals and was therefore reluctant to let the children 'play with technology' in a time that she considered should be allocated to beginning reading instruction.

The forthcoming study by Plowman *et al*. indicates that word processing was the main *ICT activity* in lessons, followed by using drawing packages, searching for information on the web and using CD-ROMs. The main activities out of lessons (for example for lesson preparation) were word processing, e-mail and searching the web. It is also worth noting that three-quarters of teachers consider they do not have enough technical support and nearly three-quarters of primary schoolteachers have 'sometimes' or 'frequently' had to abandon or alter a lesson plan because of technical problems.

Selwyn and Bullon (2000) found that the younger primary school children tended to express unconditional preference for using the computer, regardless of the activity, while older children were more discriminating. Observations of the experience of 3- and 4-year-olds in all-day provision in eight case study settings in Scotland suggested that, while a computer was available in most (though not all) of the playrooms, this was not an activity 'frequently engaged' in any setting (Stephen *et al*., 2001). Available as a free-choice, rather than as an adult-led, activity it was one of many options competing for children's attention. Furthermore, the observations suggested that children's choices defined their experience of the curriculum on any one day. Some children engaged in a wide range of activities while others stuck to a narrow range, which might not include use of the computer. Selwyn and Bullon also point out that not all children will react the same way to opportunities to engage with technology, and Yost (1998, cited in Liang and Johnson, 1999) found that only four out of eight kindergarten children were drawn to the multimedia centre.

A study of 11 pre-school settings in Silicon Valley (Cuban, 2001) found that all but two of the kindergarten teachers offered computer activities as a free-choice activity (two teachers incorporated use of the computer into an interactive whole-group teaching activity). Typically the children were obliged neither to use the computer nor to produce any particular piece of work there. The computer was adopted as another

'centre' in the playroom, incorporated into the existing playroom practice rather than revolutionising practice. Cuban (2001, p. 59) goes on to argue that:

> *All of the teachers…except for those two, saw using computers as no more important a learning activity than playing with blocks and Lego… [T]he teachers' limited use of computers signalled ambivalence, even uncertainty, over the proper uses of technology for children.*

Although there is little evidence about the actual provision of computers and other educational technology in pre-school settings in the UK the literature does offer some advice on *provision*. Haugland (2000) and Shade (1996) both argue that computers should be placed in the playroom, not in a 'computer lab' or other set-aside area if they are to aid children's learning. Liang and Johnson (1999) refer positively to Yost's practice of taking a computer on a trolley around the different areas of the playroom so that it is not seen as isolated only in the technology area but can be integrated in areas around the setting. The ratio of computers to children is raised by a number of writers (for example, Liang and Johnson, 1999; Turbill, 2001). Typically five or six computers for a class of, say, 27–30 children is suggested, although many Scottish primary schools make use of a 'classroom in a box', a trolley containing enough laptop computers for classes to use one shared between two children.

4.2 Issues of equal access and inclusion

If ICT is offered as a learning resource in the playroom then issues of equitable access and inclusion apply to this learning opportunity as to any other. Concerns about gender, ethnicity, socio-economic differences and meeting special educational needs all raise questions about whether ICT provision is inclusive.

Studying children in primary school, Selwyn and Bullon (2000) found no significant differences between *boys and girls* in terms of the applications used on the computer. Shade (1996) and Haugland (1992) both suggest that there is no gender difference in the time spent engaged with a computer in the playroom among the younger children (4–5-year-olds) but that girls become less involved with computer activities as they get older. Satisfying ICT activities in pre-school may offer opportunities to establish boys and girls as confident users of computers as a tool for learning and communication.

While there may be no evidence of gender differences in ICT use in the playroom (and there is no literature on ethnicity) there is a body of evidence to suggest that there are *inequalities that arise from socio-economic differences* between families and home access to a computer. For instance, Haugland (2000) quotes a study in USA by the Milken Exchange which found that 80 per cent of children in households with an income of $75,000 or more had access to a computer at home while only 20 per cent of children living in households with an income of less than $30,000 had a home computer. In the UK, Facer *et al*. (2000) found that 70 per cent of children in SW England and Wales had a computer at home. In 2000, the Scottish Household Survey reported that 54 per cent of households with an annual income over £20,000 had access to the internet from home compared with 9 per cent of households with an income of less than £10,000.

Cuban (2001) concluded that the data suggested that having a computer at home added considerably to a child's competence and confidence with basic computer skills. Examples were given of adults seeking the assistance of a confident child when something had to be changed on the computer and of children who were unfamiliar with managing the technology allowing other children to assist them. It is possible that this offered opportunities for peer learning but, as young children are poor at offering explanations and instructions in a way that will allow others to follow them, it is likely that those who lacked expertise learned little in such an exchange (see, for example, Doherty-Sneddon and Kent, 1996). In the context of school-age children, Wellington (2001) argues that there can be large differences between pupils in the same class with regard to access to a computer at home. The teachers interviewed all expressed concern about this and felt that, while there are inequities in access to other resources at home too, the use of ICT can exaggerate these differences. Wellington's call for schools to audit the extent and nature of home use of ICT would seem to be relevant to pre-school practitioners.

Selwyn and Bullon (2000) suggest that, for many children, use of ICT in school was secondary to their engagement with technology outside formal education (for example, 73 per cent had access to a games machine at home and 64 per cent had access to a domestic computer). They go on to point out, however, that having a computer at home is not indicative of actual use. While most children regularly used their home computer, others had to compete for access there as they did in school. They suggest that children's access to ICT at home forms a distinctive part of their 'cultural capital'. Haugland (2000) concludes that it is necessary to offer a systematic induction programme in computer use to each child in the school setting in order to ensure that all children are helped to be users, not just those who are confident or have experience of a home computer.

ICT may have a *compensatory role*, however, as there is some evidence that the technology can offer specific assistance to children from disadvantaged backgrounds. An early study by Cohen (1993) suggested that the use of a voice synthesiser to augment specialised software contributed to 'impressive learning results and social development' among 3- to 6-year-old immigrant children learning French as a second language. Talley, Lancy and Lee (1997) offered opportunities to use CD-ROM storybooks during their free-choice time to 4-year-olds enrolled in a Head Start programme. Their results suggest that CD-ROM storybooks are a useful resource for increasing exposure to books and print for children who are not 'well-read-to' at home. They suggest (and the researchers caution that their study was limited) that electronic storybooks may go some way to providing 'at-risk' children with an immersion in the 'storybook culture' that other children experience at home, although Plowman (1998) suggests that poor screen design and gratuitous interactivity can detract from any benefits. The study points to the enduring advantages of a literacy-rich home environment, however, as the 'well-read-to' group were ahead of others on all pre-and post-test measures.

In the UK, Nicolson, Fawcett and Nicolson (2000) report that computer-assisted reading support can help children (6- and 8-year-olds) at risk of reading failure. They found that a computer-based literacy programme (assisting the teacher to provide tailored support appropriate for each child's attainment) was both educationally and economically effective. They note the significantly higher levels of enthusiasm observed

when the children were engaged with the computer presentation rather than the traditional approach. They argue that their results suggest that intervention in the child's first year at school is probably the most cost-effective way of avoiding reading failure. While it would be inappropriate to conclude on this evidence that even earlier intervention will be more beneficial it is an area of support for disadvantaged children that seems worthy of further investigation, if suitable software is available.

An Australian study has also suggested that computers can benefit 'at-risk' pre-school children enrolled in early intervention programmes. Elliott and Hall (1997) demonstrated that computer-based, teacher-guided contexts were an effective resource for learning mathematics. The authors stress that it was not the computer context alone that contributed to the children's attainment. They argue that improved performance is the result of teacher assistance with the development of the self-regulatory strategies necessary for effective learning and that such metacognitive processes are more likely to develop when children are motivated and engaged, as they are with computer-based tasks.

Although access to ICT as a resource may be the source of another socio-economic divide in education it does offer the prospect of bridging access gaps for children with *special educational needs*. Furthermore some innovations introduced to ease access to technology for children with specific needs have brought benefits to all children (for example Touch Windows, software that creates a spoken response and alternative keyboards). Not all ICT designed to assist children with special educational needs has to be 'high-tech', however. Haugen (1998) points to the benefits of 'low-tech' devices such as large button-like switches to control electrical appliances and simple communication devices that give children a voice by playing a recorded message when a picture is touched. Haugen goes on to cite a number of studies in the USA that demonstrate the benefit that pre-school children with special educational needs can derive from ICT. For example, a UCLA Intervention Program demonstrated that toddlers and pre-school children with disabilities showed more enjoyment, active engagement and social play during computer activities with peers and adults than in similarly structured activities away from the computer (Howard *et al*., 1996).

Technology appears to offer a basis for activities that are more motivating to deaf children than some conventional speech therapy techniques. For example, computer mediated early access to the hearing-environment was tentatively endorsed in a study by Walker and Rostron (1999). Software that required no traditional literacy skills allowed deaf children (5 years old) to be introduced to an acoustic environment that they could actively control and explore. The evidence indicated that children responded appropriately to aspects of the acoustic environment and were actively engaged.

Douglas (2001) offers case studies illustrating the use of different types of educational and access technology for children with visual impairment. He argues that this evidence suggests that ICT has a valuable role in allowing children with visual impairment to participate more fully in education and it is possible to conclude from his examples that, given age-appropriate adaptations, these benefits can be extended to pre-school children. While ICT may facilitate participation for children with a range of disabilities it is not an unproblematic resource. Douglas points to the need to consider carefully how technology is used in education and to ask questions about what pedagogical approach

to adopt in particular contexts for particular children. He suggests, too, that ergonomic aspects of computer use by visually impaired children require further study and that the use of complex technologies places demands on the skills of teachers. Perhaps most challenging, however, is his reference to ICT as a double-edged sword for children with disabilities. The rapid development of mainstream technology results in improved tools (for example, good quality speech-synthesis has become much cheaper in two years) but also challenges access technology to keep up.

- Pre-school practitioners and managers need two kinds of training:
  - formal instruction in the use of technology and the range of hardware and software resources available
  - opportunities to consider, as staff teams (and for individual professional development), ways in which they can use ICT in the context of their setting and the demands of practice there.
- In order to avoid a deficit, a model of training programmes should begin by encouraging practitioners to articulate their understanding of working with ICT and the way in which they currently use it in their practice.
- Practitioners should consider the degree to which ICT is integrated into plans for the playroom during free play and adult-led group time.
- There is a need to survey ICT use in Scottish pre-school settings (across the public, private and voluntary sectors) looking at the resources available, the plans that practitioners make for the use of ICT resources and the way in which children choose to engage with the computers and other technology available to them.
- Practitioners should be sensitive to the familiarity and confidence with ICT that children have acquired from home. There is a need to ensure that ICT is offered in an inclusive way, while recognising that children will make different decisions about the activities they choose to engage with.
- Staff teams will wish to consider the value of ICT as a way of offering compensatory experiences. There is a role for LT Scotland in offering advice about appropriate software for this and the way in which it can be most effectively used.
- The opportunities that ICT affords for children with special educational needs to participate more fully in the pre-school curriculum must be explored for each particular child. In addition, there is a need for all practitioners to be aware of the possibilities that ICT offers for enhancing participation and stimulating engagement if they are to be proactive in their planning for children.

5. LEARNING WITH ICT

5.1 ICT and learning in the early years

Views on *whether ICT enhances or facilitates learning* are polarised. Elkind (1996) argues that computer proficiency does not mean cognitive development, the latter requiring evidence of the development of an underlying concept. He points to the difference between knowing how to use the internet and learning something from it. Healy (1998) adopts a more negative stance towards the impact of computer use on young children's learning. She argues that use of computers is damaging to young children's development and, therefore, to their learning. She emphasises the need for human support and verbal interaction. Among the ways in which computer use is an inappropriate tool for learning for young children, Healy lists the failure of computers to offer intersensory experiences to enhance learning, the way in which graphics and special effects can distract attention and the 'concrete operations' phase of development that she claims characterises the cognitive development of children in the early years. She concludes that computers are an inappropriate educational resource for children below the age of about 7 years.

However, a report to the Teacher Training Agency (TTA) on a project exploring effective pedagogy using ICT in primary schools (carried out by a team led by Moseley, University of Newcastle, undated) suggested that computers can enhance teaching in three ways: presenting ideas dynamically (for example, changing word endings, zooming along a number line); providing feedback as children work; offering the capacity to present information in easily changed forms (for example, editing text). In pre-school, too, computer-based activities offer the opportunity for practitioners to use software to make a dynamic presentation, for example adding initial letters to form a word; to give feedback (for example, responses to a correct or incorrect answer); to word process a dictated story or annotate a drawing.

The effective use of these techniques depends on teachers identifying the specific objectives that ICT is being used to reach, matching the pedagogy with the purpose of the activity and having adequate ICT skills to achieve the specified objectives. Effective use of ICT in the playroom or classroom requires new ways of thinking about computers as tools for teaching and learning. Adding a computer as another 'centre' in the room or using it for drill and practice (using programmes that require little teacher involvement or knowledge of the software) does not maximise the opportunities that it affords for teaching and learning, as suggested by Cuban's (2001) use of the term a 'benign addition' to describe the use of computers in traditional early childhood programmes.

The particular *way in which practitioners use ICT* and interact with children as they engage in ICT activities has long been a matter of concern for some writers. Haugland (1999) advocates a 'hands off' approach, suggesting that children should be allowed to experiment with the computer and that adults should only intervene when the children appear frustrated. She suggests that 'a quick word or two, even from across the room, reminds children what they need to do next to reach their goal'. However she adds

that, because the teacher is observing what the child can do, he or she can expand the learner's computer experiences.

This approach appears to be in some contrast to that taken by other writers. As long ago as 1994 Schetz and Stremmel argued that, while the use of appropriate software is important, the role of the teacher is a greater concern. They advanced a theoretical framework of learning that was derived from Vygotsky (1978) and emphasised the role of social interaction in the learning process. In this framework the teacher has a key role in scaffolding learning within the child's 'zone of proximal development'. Adults acting as tutors can recruit children for activities using the computer and maintain their interest, assist them with task completion (for example, giving hints or directing children to the next part of the task), help children to identify why a response was incorrect, reduce children's frustration if they fail, and demonstrate solutions.

Davis and Shade (1999) argue strongly for teachers to abandon the use of computers in classrooms for drill and practice and turn their attention to ways in which ICT can be integrated into their practice. This concern for practitioners to be thoughtful, proactive users of ICT as a teaching and learning tool presents a challenge for pre-school staff who may have little knowledge of the possibilities of the software programmes available, lack confidence in the use of the hardware and have had little or no opportunity to develop ways of incorporating ICT into their practice. Anecdotal evidence suggests that all too often a computer is introduced into a playroom as a 'good thing' that will motivate children to get involved with some literacy or numeracy related activities without considering how this new tool fits with existing practice. For instance, in many playrooms supervising the computer is only part of a practitioner's role for the day and one to which she cannot give undivided attention, despite calls for adults to scaffold children's learning.

Haugland's 'hands off' approach to adults supervising children using computers in the playroom is predicated on two key assumptions: that the software they are using is developmentally appropriate and, secondly, that different modes of interaction with computers are appropriate at different ages. She suggests that 3- and 4-year-olds are developmentally ready to explore computers and need time to experiment and explore. Beyond this age range, as children enter formal education, Haugland argues for a combination of time to choose what to use the computer for and time for completing directed activities planned to meet the teacher's learning objectives. Other researchers are critical of an exploratory approach to computer use, which they argue leads to random-responding or mouse clicking to get some effect in the animation that is unrelated to learning, or 'window shopping' through programmes (Forman 1998; Labbo *et al*., 2000).

Observations in a kindergarten led Labbo *et al.* (2000) to conclude that a computer centre can be incorporated successfully into the patterns of playroom activities if the teacher finds ways to use the technology to meet children's learning needs. A prerequisite for such success is that the teacher is as familiar with the software content and features as she is with the children's favourite traditional literature. Three kinds of interactions were found to be most effective:

- brief targeted moments (for example, adult and child working together on a CD-ROM talking book and discussing rhyming words)

- spur-of-the-moment ideas (for example, children using the computer to help write a note or card, to follow up a conversation or part of pretend play)
- thematically linked activities that are planned to present key concepts in a variety of ways.

A number of researchers describe the way in which they consider that computers can be part of *play* activities. Liang and Johnson (1999) describe ways in which computers can be used in activities they label as investigative play, functional play, games with rules, pretend play and constructive play. They cite Silvern (1998) who urges that computers should be used for play and learning about 'microworlds' rather than practice or didactic interactions. However, Silvern goes on to point out that, while it is important to match the programmes with children's interests and abilities, it is also important to create a supportive atmosphere (emphasising the pleasure of performing rather than the production of an end product) if playfulness is to be encouraged. In addition, too much complexity or rigidity inhibits play (Frost, Shin and Jacobs, 1998). Plowman is currently engaged in ESRC-funded research to look at how children use 'smart' toys and the findings should contribute to this literature.

Yelland (undated) describes technological toys that she argues can be used for interactive play, for instance, a computer game using doll characters that can be programmed with particular characteristics. While there is clearly a view among some researchers that children can use ICT, particularly computers, in a playful way the papers that describe this offer little or no evidence of the child's perspective. It is possible to argue that this playfulness is an adult interpretation of informal learning activities that may appear more structured and less playful to a child. Liang and Johnson (1999) write about the need to consider what may be displaced when children play on the computer and that individual play styles and preferences should be respected. Both Cuban (2001) and Elkind (1996) stress the importance of the affective bond that builds between a young child and a teacher (a bond that does not evolve from interactions with a machine) and the nurturing nature of playrooms where practitioners' concerns go beyond the academic.

5.2 Learning across the curricular areas

If there is no clear evidence as to the way in which ICT facilitates learning and development in general for young children, the situation is no different when a search is made for literature that suggests how technology may be used to achieve particular curricular goals. Writing in 1992, Haugland offered evidence that children who had experience of computer use made developmental gains in non-verbal skills, structural knowledge, long-term memory, manual dexterity, verbal skills, problem solving, abstraction and conceptual skills. Fatouros (1995) offered a similarly positive picture of research findings linking developmental gains to computer use but the studies referred to were completed in the decade before 1995 and are not typical of later reports. There have been no similar wide-ranging gains reported in work carried out in the late 1990s and more recent studies offer evidence of progress in limited spheres only, for example progress with spelling. Alternatively, there are generalised claims about the positive impact of ICT without any evidence of measured impact being offered.

While some writers claim that using a computer can assist with fine *motor development,* Hohmann (1998) is clear that, except for the coordination involved in using a mouse, computers do not support the development of motor activities or motor skills development. He goes on to assert that, although touch typing is a motor skill that can be learned with the help of a computer, it is inappropriate for most children to begin this before they are about 7 or 8.

There are many references to ICT use facilitating communication between children, turntaking and collaborative problem solving (Clements *et al*., 1993; Fatouros, 1995) but despite the claims for *social development* there are few good, recent studies available to substantiate this for pre-school children in particular. Nevertheless, children can be observed sitting by others using a computer, talking together and sometimes enjoying an animation together. Some software has been designed specifically to support the development of cooperative learning (Denning and Smith, 1997) but there is little evidence of the success of this resource.

ICT offers many opportunities for children to gather information of the kind categorised as *knowledge and understanding of the world*. As pre-school children generally cannot read, only websites designed specifically for that age range are likely to be of value. The internet is nevertheless a rich resource for practitioners who have access to it and time to incorporate downloaded materials into playroom materials. On the other hand, CD-ROMS can offer 'virtual' experiences such as a trip to a zoo or another country that are beyond the child's immediate environment. Software has been designed to facilitate pre-school children's development of mathematical concepts, such as sorting, matching, shapes and patterning. *Millie's Math House* is a frequently quoted example of this genre.

The combination of drawing and art programmes with word processing and even the opportunity to add sound or music appears to offer opportunities for *expressive and aesthetic development*. However, measurement of 'impact' or attainment is especially difficult in this area of the curriculum. The need for children to value their own creativity (and to know that others recognise that too) is considered by Fomichova and Fomichov (2000) as a fundamental requirement before children are exposed to computers. They argue that this will allow children to use ICT as a creative tool rather than lose their creativity to the technology.

Language development and emerging literacy is the curricular area that is most commented on in the literature on ICT use. Lewin (2000) explored the effects of talking books software in UK primary classrooms (focusing on 5- and 6-year-olds). The findings of the study were complex because of interactions between learner preferences and reading abilities and the nature of the software. However, she concludes that electronic books can complement teaching in infant classrooms, having a positive effect on cognitive and affective outcomes. The mean gains on standardised reading tests were greater than might be expected during the one month that the study lasted. The nature of the gains made by children varied with their existing reading ability; for example, 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.

Similarly, Shilling (1997) found that the use of speech-synthesised feedback was likely to be most supportive when children already exhibited metalinguistic awareness and were beginning to recognise sound/symbol relationships, easily identified words and how words are constructed on and off the computer. Children who had not reached that stage were either unaffected by the speech-synthesised feedback or confused by it. Such evidence points again to the need for practitioners to be aware of the child's developmental stage and the nature of the learning activities (which may or may not include ICT) that will promote further development. As Mioduser *et al.* (2001) concluded:

> *Close observation of the child's performance followed by mindful pedagogical decision-making are of great importance.*

Two pilot studies designed to consider the efficacy of multimedia programmes for the training of reading and spelling are reported by van Daal and Reitsma (2000). In the first study they found that children (aged approximately 5 years) learned as much in up to 16 hours of independent computer practice as is normally attained in the first three months of formal reading instruction. In the second study they demonstrated that 'reading-disabled' students who had had computer practice were engaged in less off-task behaviour during computer sessions and classroom sessions. While the claims for children's reading attainment may be open to question (see Turbill, 2001, and below) the results of the second study illustrate the common belief (see, for example, Mioduser *et al*., 2001) that computer use is motivating and engaging for most children and can offer a way to break a cycle of failure to learn.

Although the children in her study were beyond pre-school age the findings of Matthew (1997) have interesting implications for younger children too. She found that, although there was no significant difference between reading comprehension when measured by open-ended questions, there was a difference when comprehension was measured by story re-telling. By that measure children who had read CD-ROM versions of the story had significantly higher comprehension scores. Matthew suggested that electronic books with multi-sensory effects supported a focus on meaning, rather than decoding, and could increase the motivation to read. She went on to point out, however, that teacher support and intervention was necessary for children learning to read electronic text just as it was for learning to read conventional print.

The way in which practitioners think about the process of learning to read will influence the value that they ascribe to ICT as a tool. Turbill (2001) found that if teachers adopted a 'cracking the code' approach to learning to read then there was no necessity for computer use, although she did feel that some programmes could offer worthwhile practice. Her observations suggest that children need adult support to engage with the literacy programmes and avoid the tendency to 'random-responding' mentioned above. Turbill 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. If viewed as an opportunity to develop concepts of screen, then time 'playing' on the computer can be construed by teachers in a more positive light. Turbill introduces the notion of considerate and inconsiderate software; the former support a focus on the storyline and print, while the latter offer visual animations that may distract children from the practitioner's intended goal for the activity.

ICT can support writing for young children as well as reading or pre-reading skills. Liang and Johnson (1999) suggest that some literacy behaviour is easier with technology, arguing that it is easier to type than to write. Moxley *et al.* (1997) studied 3- and 4-year-olds using the computer in a language activity that was self-selected. The children showed steady improvement in spelling (beginning with invented spelling) and storytelling. The researchers acknowledged that they were unable to tell how much of the children's attainment was due to the use of the computer but suggested that their data makes a case for moving writing into the pre-school curriculum.

- Policy-makers, managers of provision and practitioners need to consider the ways in which ICT can facilitate learning. There is a need to develop ways of using ICT in the playroom to maximise their potential to facilitate learning. The ways in which technology is to be used will have implications for staff deployment and practitioner interactions with children.
- Policy-makers, managers of provision and practitioners will have to develop a perspective on the use of ICT for playful purposes, beyond the evidently curriculum or learning outcome-orientated purposes.
- It is essential that practitioners have opportunities to consider the ways in which ICT can be used strategically to nurture development or the attainment of specific skills. It will take staff development time for staff teams to consider ways in which they can use ICT to achieve their goals for learning rather than view it as an additional experience *per se*.
- The evidence on the contribution that ICT has to make to each curricular area is not clear. However, it is apparent that practitioners should know about the kind of software that relates to work in each area and be confident about using it in a planned, targeted or spontaneous way. Staff will then be able to make appropriate decisions in their context and build a body of evidence about effectiveness that will support their practice.
- ICT has a contribution to make in the playroom as a way in which to motivate children and engage them in activity areas that they may otherwise reject. Using ICT in this way will be a valuable addition to practitioners' repertoires, although not necessarily an activity that they engage in as a routine option.
- There is a need to explore further the use of screen-based literacy software to support pre-school children's emerging literacy. The evidence suggests that this is most likely to be effective when part of a planned programme for literacy. Researchers and practitioners should find ways to explore further the ways in which ICT use can assist with particular aspects of emergent reading and writing in a way that accommodates children's learning styles and needs.
- It is clear that the pedagogical imperative should lie with the skilled practitioner who knows how a child likes to learn, when and with whom they like to learn and the stage that their learning has reached. While practitioners should be offered training about the use of ICT and have resources readily available, the decision about when and how to engage with ICT should rest with them.

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