



MINISTRY OF EDUCATION

Te Tāhuhu o te Mātauranga

The role and potential of ICT in early childhood education

A review of New Zealand and international literature



NEW ZEALAND COUNCIL FOR EDUCATIONAL RESEARCH

TE RŪNANGA O AOTEAROA MŌ TE RANGAHAU I TE MĀTAURANGA

WELLINGTON

2004

Prepared for:

Ministry of Education

Early Childhood Education

Tertiary, Curriculum, Teaching and Learning

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November 2004
ISBN Print 0-478-13236-0
Web 0-478-13237-9

Acknowledgements

We would like to thank the following people who contributed to the production of this review. From the Ministry of Education: Patricia Nally, Louise Alliston, Eliza Avery, Melissa Brewerton, Rachel Currie, Patricia Laurenson, Carol Moffat, and Lisa Oldridge. From the New Zealand Council for Educational Research: Linda Mitchell, Cathy Wylie, Christine Williams, Kristina Louis, Susan Tompkinson, Johanne McComish, Hilary Ferral, Diane Mara, and Shelley Carlyle. We are also grateful to all those from the early childhood education sector who provided references and suggested information sources for this review.

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Executive summary

This literature review was commissioned as part of the process of developing an ICT strategy for early childhood education in New Zealand. The review seeks to inform both the early childhood education sector and the Ministry of Education about the role and potential of ICT in early childhood education. It includes literature on children's and adults' use of ICT in early childhood education settings, and comments on the role of ICT with respect to teaching and learning, professional development and teacher education, sector capability, administration, infrastructure, and information management and communications. Data from NZCER's 2003 national survey of early childhood education services are used to develop a picture of current access to and use of ICT in New Zealand early childhood education.

What is ICT and why does it matter in early childhood education?

ICT can be defined as “anything which allows us to get information, to communicate with each other, or to have an effect on the environment using electronic or digital equipment”. In early childhood education (ECE), the term ICT could include computer hardware and software, digital cameras and video cameras, the Internet, telecommunication tools, programmable toys, and many other devices and resources.

The literature suggests at least three reasons why ICT matters in early childhood education. First, ICT already has an effect on the people and environments that surround young children's learning. Second, these technologies offer new opportunities to strengthen many aspects of early childhood education practice. Third, there is support and interest across the whole education sector for the development and integration of ICT into education policy, curriculum, and practice. However, there is a clear consensus in the literature that the introduction and use of ICT in early childhood education should be grounded in a clear understanding of the purposes, practices, and social context of early childhood education.

There is a growing recognition of the many different ways that ICT can contribute to, or transform, the activities, roles, and relationships experienced by children and adults in early childhood education settings. The literature indicates the importance of practitioners and other adults in early childhood education settings having guidance and opportunities to become capable, competent, and informed about the educational role and potential of ICT, and support to use ICT to strengthen many aspects of early childhood education practice.

What kind of research has been done on ICT in early childhood education?

Much of the available literature on ICT in early childhood education centres on the role and use of computers by young children. This is particularly true for most literature prior to about 1999.

However, in the last few years there has also been a growth in research and descriptive literature about the use of other kinds of ICT in early childhood education, including digital cameras, digital video, closed-circuit television, videoconferencing, programmable toys, robotics, and electronic musical instruments. There is also a growing focus on teachers using ICT *with* children, or on their own, as a tool to support and scaffold children's early childhood education experiences, to investigate and build learning experiences from children's interests, or to strengthen relationships between children, practitioners, and families. Case studies and exemplars of the use of ICT in early childhood education settings are becoming more and more common. These are often written by early childhood education practitioners, and provide recommendations, suggestions, or guidelines for other practitioners based on what the authors have learned in their own centres.

Key findings of the literature review

ICT and young children

Some authors have expressed the view that computer/ICT use is not appropriate for young children's cognitive, physical, social, and emotional development. However, there is no clear evidence to support this claim, and this view has increasingly been replaced by the view that, when used appropriately, ICT can be a useful tool for supporting young children's learning and development. Most authors note the need for practitioners to be aware of health and safety issues around children's use of ICT, and for these to be attended to in early childhood education centre ICT policies and practices. This includes: attention to children's physical and ergonomic safety; being mindful against children's exposure to inappropriate content (e.g. games or Internet-based material of a violent or sexual nature, or containing undesirable gender or cultural stereotypes); and protection of children's privacy (e.g. in online environments, or when information is published on the Internet).

Studies suggest that ICT use can provide a context for collaboration, co-operation, and positive learning experiences between children, or between children and adults. However, this will not necessarily happen of its own accord. Research indicates that practitioners must be conscious of the kinds of learning interactions they would like to occur in the context of ICT use (including between adults and children, or between children), and adopt pedagogical strategies to support these. Case studies show how ICT can be used to support aspects of learning, including language development and the development of mathematical thinking. ICT also provides unique opportunities for scaffolding and supporting learning for children with special learning needs, and children from culturally or linguistically diverse backgrounds. ICT provides a variety of ways for children to weave together words, pictures, and sounds, thereby providing a range of ways for children to communicate their ideas, thoughts, and feelings. Good software can allow children to engage in self-directed exploration, and can be tailored to children's individual needs, and assistive/adaptive ICTs can reduce barriers to participation for children with special physical or learning needs.

Using ICT to enhance the early childhood learning environment

Literature which explores how ICT can enhance the learning environment in early childhood education suggests that the value ICT can add to young children's learning environments depends on the choices practitioners make about which tools to select, and when and how to use these; and their understandings about how these tools can support children's learning, development, and play. To make these choices, practitioners need to be familiar with various tools and what they can do. They also need to be familiar with contemporary theories about learning and development, and recognise how these can be linked to the use of ICT. New kinds of practices may be needed, for example, to support young children to develop information and communication literacies necessary for learning in ICT-enriched environments.

Case studies show how early childhood education practitioners have used ICT to support a range of practices they believe to directly or indirectly support children's learning and development. These include: directly supporting and scaffolding children's use of ICT; using ICT to document and assess children's learning and activities; using ICT to reflect on children's and educators' interactions in the early childhood education setting; using ICT to build curricula from children's interests, ideas, and experiences; and using ICT to strengthen and support family involvement in children's learning.

Effective ICT professional development for early childhood educators

Without good guidance, examples, and support for their own professional learning, early childhood educators will make their own decisions about the nature and extent of ICT use in children's learning. These decisions are influenced by such factors as educators' own level of confidence with ICT, and their beliefs about learning and teaching in the early childhood years. Literature about ICT use in early childhood education settings, and studies of early childhood teachers and teachers-in-training learning to use ICT, suggest that effective professional development supports teachers to develop understandings of ICT that connect with their existing early childhood education philosophy and pedagogical views. Effective ICT professional development incorporates teachers' own aspirations, skills, knowledge, and understanding into the learning context. It provides opportunities for teachers to learn and explore new ways of working in their own early childhood education setting, and stimulates practitioners to reflect on their views and ideas about children's learning and development, and to analyse and question how things are done in early childhood education. Effective professional development emphasises collaborative knowledge-building, and practitioners sharing their situated learning experiences with ICT with one another. It provides support networks to help practitioners to be active researchers in their own early childhood education setting, and to access current research and expertise in ICT.

The use of ICT for administration and information management in early childhood education

Although computers and ICT are likely to be used in planning, administration, and information management in many early childhood education settings, there is little research which specifically investigates this aspect of ICT use in early childhood education. ICT also presents opportunities for sharing and exchange of information between different services and agencies involved in children's care and education, but it is difficult to locate examples of this in the literature.

Some relevant messages can be drawn from international literature about computerisation of systems for managing and sharing information about children who are looked after by social services. For example: the need for systems to make it easy to enter information and produce reports that save on administrative work; the need to establish common goals between ICT specialists, managers, and those who gather and input data; and the need to establish common data exchange standards to allow for data transfer between systems. Individual early childhood education centres may be using a variety of business and education administration packages. This may offer flexibility for individual centres to customise packages for their specific needs. However, it may also reduce the ease of communication and exchange of information between different systems and different locations.

ICT access and infrastructure in New Zealand early childhood education settings

Individual New Zealand studies of ICT use in early childhood education, and NZCER's 2003 national survey, indicate that current ICT use in early childhood education centres is variable. While some centres have begun to use ICT extensively to support children's learning, other centres report little or no use of ICT by children, or use of ICT to support children's learning.

Access to computers and other ICT varies between different kinds of centres. In general, kindergartens seem to be better-equipped and resourced than playcentres. Education and care centres seem to lie somewhere in between. There is insufficient data to comment on the adequacy of ICT access and resourcing in other kinds of early childhood education setting. Some New Zealand practitioners have identified a need for access to technical and advisory support in relation to ICT, particularly computer use.

One of the most common uses of ICT in New Zealand early childhood education settings relates to documentation of children's learning. Over half of the teachers surveyed by NZCER in 2003 reported they had access to a digital camera in their centre. Some early childhood education centres have used digital photography and other digital media to build up electronic or physical portfolios of children's learning for assessment purposes, and to share with children and their families. Just under half of centre managers surveyed by NZCER do not use a computer package for administrative purposes. Those who do use a range of educational and business packages.

Implications of the review findings and areas for further research

The findings of this review suggest that further development of ICT in New Zealand early childhood education should promote a view of ICT as a tool for enriching the teaching and learning environment in early childhood education. Since ICT development should be consistent with the purposes, practice, and social context of early childhood education, decisions about how to use this tool should be consistent with the principles, strands, and goals outlined in *Te Whāriki*.

Access to research evidence about workable approaches to using ICT for teaching and learning in early childhood settings would offer a valuable resource to practitioners. This review identified several areas in which further New Zealand research would contribute to the development and enhancement of ICT use in the early childhood education sector. In particular, research which explores both the *role* and the *learning benefits* of ICT use in New Zealand early childhood education settings would be useful. Some specific areas for further research include the following:

- How do early childhood educators in New Zealand make the transition from non-use or uncertain use of ICT (in their practice) to use of ICT to enrich the early childhood learning environment, and what kind(s) of support is needed for this process?
- In early childhood education settings where ICT is enriching the learning environment, how does this impact on or enhance children's learning and development, including:
 - cognitive learning (e.g. language development, mathematical thinking, or information literacy); and
 - learning which reflects the principles, goals, and strands of *Te Whāriki* (e.g. children's wellbeing, sense of belonging, opportunities to contribute to their learning environment and experiences, ability to communicate and express their views, ideas, and feelings, and active exploration of, and thinking and reasoning about, the natural, social, physical, and material worlds).
- What are New Zealand children's and families' views and experiences in relation to ICT in early childhood education? What are the relationships between children's home lives and experiences, and how might these interact with their experiences with ICT in the early childhood education setting?
- How could ICT be used in New Zealand early childhood education settings to provide additional learning support for New Zealand children from different cultural/language backgrounds? What existing tools and resources are available, and how can these be used? Do any new tools and resources need to be developed for New Zealand?
- How could ICT support planning and administration in early childhood education services, and information sharing between early childhood education centres, schools, and other agencies and organisations working in children's interests in New Zealand?

Glossary of terms

ICT information and communication technologies

Anything which allows us to get information, to communicate with each other, or to have an effect on the environment using electronic or digital equipment (in some literature known as *learning technologies* or simply *technology*).

Control technologies

Anything that has an embedded electronic or computerised control system and can be programmed.

Microworld

A computer-based simulation with opportunities for manipulation of content and practise of skills.

Listserve

A mailing list that allows a certain group of users to send email messages to a large number of people by sending the message to a single address.

1. Introduction

This literature review was commissioned as part of the process of developing an ICT strategy for early childhood education in New Zealand. The review seeks to inform both the early childhood education sector and the Ministry of Education about the role and potential of ICT in early childhood education.

Other recent international literature reviews of ICT in early childhood education have focused mainly on *children's* use of ICT in early childhood education (Stephen & Plowman, 2002). This review includes information about children's use of ICT, but takes a much broader view of the role and potential of ICT in the early childhood education sector. It includes literature on adult use of ICT in early childhood education settings. It comments on the role of ICT with respect to teaching and learning, professional development and teacher education, sector capability, administration, infrastructure, and information management and communications. It considers the role and potential of ICT in the context of an early childhood education community that includes children, practitioners, parents, and other people who have a role in supporting the early childhood education sector.

ICT can be defined as “anything which allows us to get information, to communicate with each other, or to have an effect on the environment using electronic or digital equipment”.

For details about the literature review methodology, including search strategies, see Appendix 1.

1.1 What is ICT?

ICT stands for “information and communication technologies”. This term is now widely used in educational research, policy, and practice. It replaces the older term, “IT”, or information technology, which was most often used in reference to computers and the Internet. In the past, the “information” dimension tended to predominate in the literature, and in people's thinking, about ICT. In recent years, the “communication” dimension of ICT has assumed an equal prominence. The term “ICT” encompasses much more than just computers. ICT can be defined as “anything which allows us to get information, to communicate with each other, or to have an effect on the environment using electronic or digital equipment” (Siraj-Blatchford & Siraj-Blatchford, 2003, p. 4). Some authors use the term *learning technologies*, while others simply describe it as *technology*.

In early childhood education (ECE), the term ICT could include the following types of hardware and software:

- computers (including desktop, laptop, and handheld computers);
- digital cameras and digital video cameras;
- creativity and communication software and tools;
- the Internet;
- telephones, fax machines, mobile telephones, tape recorders;
- interactive stories, simulated environments, and computer games;
- programmable toys and “control” technologies;
- videoconferencing technologies and closed-circuit television;
- data projectors, electronic whiteboards, and more.

1.2 Why does ICT matter in early childhood education?

The literature suggests at least three reasons why ICT matters in early childhood education. First, ICT already has an effect on the people and environments that surround young children’s learning. Second, these technologies offer new opportunities to strengthen many aspects of early childhood education practice. Third, there is support and interest across the whole education sector for the development and integration of ICT into education policy, curriculum, and practice. These three themes are explored further below.

ICT already affects the people and environments that surround young children’s learning

ICT is becoming a ubiquitous component of the physical and social worlds occupied by young children. It is an important part of the private and work lives of most people, including those who support young children’s learning and development, whether as parents, family members, caregivers, or early childhood educators. It is often argued in the literature that children’s early childhood education experiences should reflect and connect with their experiences in the wider world. Therefore, ICT matters in early childhood education, because it already has an effect on the people and the environments that surround young children’s learning and well-being. There is strong consensus across the literature that it is timely for the role and potential of ICT for the early childhood education sector to be critically examined, to guide future development and decision-making in this area.

ICT offers *new opportunities* to strengthen many aspects of early childhood education practice

The second reason that ICT matters in early childhood education relates to the opportunities and potential that these technologies offer the sector. These include:

- opportunities to support and enhance children’s learning and play experiences;

- opportunities to support and strengthen practitioners' professional learning and development; and
- opportunities to support and strengthen relationships and communication between early childhood centres, parents, and other people connected to the early childhood education setting.

Most of the literature about ICT in early childhood education strongly supports the view that technology on its own should never drive the process of ICT development in the sector (Downes & Fatouros, 1995). Rather, all planning for the introduction and use of ICT by children and adults in early childhood education should be grounded in a clear understanding of the purposes, practices, and social context of early childhood education (O'Hara, 2004; O'Rourke & Harrison, 2004; Sheridan & Pramling Samuelsson, 2003). Brooker (2003) has suggested that, at least in the UK, early childhood education may actually be leading the way in developing best practice in the use of ICT to support positive learning experiences for children. Compared with the school sector:

All planning for the introduction and use of ICT by children and adults in early childhood education should be grounded in a clear understanding of the purposes, practices, and social context of early childhood education.

...there is increasing evidence that some of the most exciting and appropriate uses of ICT are to be found in early years settings, where there is less pressure to meet strict targets and more opportunity to experiment with child-centred practice... (Brooker, 2003, p. 261).

This literature review will explore examples of such practice in New Zealand and overseas. It will also discuss the current extent of research evidence to support claims about the potential for ICT to strengthen various aspects of high-quality practice in early childhood education.

There is support for the development and integration of ICT into education policy, curriculum, and practice across the whole education sector

There is now a strong focus on the development of ICT policy, and integration of ICT in curriculum and practice across the whole education sector. ICT and "e-learning" have become important concepts in primary, secondary, and tertiary education. In most countries, policy and curriculum support for the development of ICT in the early childhood education sector have lagged behind that given to the school sector (O'Hara, 2004; Sheridan & Pramling Samuelsson, 2003; Stephen & Plowman, 2003). This situation is beginning to change. Some countries, like Scotland, have recently developed ICT strategies for the early childhood education sector (Learning and Teaching Scotland, 2003b). Researchers, academics, and practitioners in early childhood education have also published books, articles, and guidelines which provide information and guidance about ICT in early childhood, and aim to support early childhood education practitioners to make well-informed decisions and choices about ICT (Downes, Arthur, & Beecher, 2001; NAEYC, 1996; O'Hara, 2004; Siraj-Blatchford & Siraj-Blatchford, 2003).

The delayed attention to ICT in early childhood education presents some advantages for the sector. For example, the growth and development of ICT in the school sector has sometimes been driven by the desire to get more technology and technological infrastructure into schools, without sufficient attention given to the pedagogical purposes for introducing the technology, or the supporting conditions and resources that might enable the technologies to contribute towards better teaching and learning experiences. In many countries, heavy investments have been made in ICT for use by teachers and students but the purposes of these investments have not always been clear or made explicit (Higgins, 2003). While there is evidence from school-sector research that ICT *can* help pupils to learn and teachers to teach more effectively (Higgins, 2003), research has also uncovered many examples in which the widespread rollout of ICT into schools has done little to improve or transform teaching practice, or students' learning experiences in any meaningful way (Peck, Cuban, & Kirkpatrick, 2002; Reynolds, 2002). The evidence is clear that simply providing ICT equipment to schools or teachers will not necessarily make a difference; what makes the difference is the way in which this equipment and other resources are used (Higgins, 2003).

The early childhood education sector may find useful guidance from some of the school-sector ICT literature. For example, research into effective teacher professional development with respect to ICT (e.g. Ham, 2002), and the conditions that facilitate innovation in the use and integration of ICT in teaching and learning (e.g. Harris & Kington, 2002; Tubin, Mioduser, Nachmias, & Forkosh-Baruch, 2003; Zhao, Pugh, Sheldon, & Byers, 2002) Some of this research will be discussed in Section 6. However, it is also important to recognise the differences between the two sectors, and to recognise where there are limits for translating school-based research findings to early childhood education contexts. For example, within the school-sector ICT literature, there has been a strong focus on measuring the effects of linking the use of ICT in terms of assessments of student learning or achievement (Lewin, Scrimshaw, Harrison, Somekh, & McFarlane, 2000; Schacter, 1999). The concepts of "learning" and "achievement" are usually defined relative to the age level(s) of the students, and the learning goals and intentions that underpin specific instances of ICT use. These learning intentions are often connected with particular subject areas in the curriculum. By contrast, the New Zealand early childhood education curriculum does not align itself with traditional subject boundaries. Rather than specifying subject content areas, *Te Whāriki* emphasises five integrated learning strands: well-being; belonging; contribution; communication; and exploration. Assessment is holistic, viewing the child's learning as complex and contextual (Mutch, 2003). School-sector ICT research which focuses tightly on achievement and assessment of students' subject-specific learning may not transfer well to the early childhood education context. However, there may be some transferability of findings from research which looks at the role and potential of ICT to promote higher-order thinking, problem-solving, and creativity in school-age children.

...while some of the research findings about the use of ICT in the school sector will be helpful for guiding ICT development in the early childhood education sector, it is also important to recognise the differences between the two sectors.

Other areas featured in the school-sector ICT literature may have strong resonance within the ECE sector. For example, the role or potential for ICT to:

- support professional communities of learning among teachers (both within and between different schools);
- strengthen school-community relationships; or
- increase the involvement of parents, and other people outside schools, in students' school learning experiences.

The New Zealand school-sector ICT literature is notable for a strong focus in the areas listed above, in particular the notion that ICT can have a powerful role in supporting teachers' professional learning, and collaboration between staff and students within and between different schools. Findings from school-based research in these areas may be informative for the early childhood education sector.

1.3 What roles can ICT play in ECE?

There is a growing recognition of the many different ways that ICT can contribute to, or transform, the activities, roles, and relationships experienced by children and adults in early childhood education settings.

Table 1 shows some of the ways in which ICT can be part of early childhood education. These examples are derived from literature reviewed in this document.

Table 1 Possible roles for ICT in early childhood education

Roles for ICT	Some examples
Children using ICT in their play or learning (alone, with peers, or with adults).	<p>Children using computers to play games, listen to stories, or draw pictures.</p> <p>Children using ICT equipment in games or role-play activities.</p>
Children and practitioners using ICT together to scaffold children's learning.	Using the Internet to locate information or resources, sparked by children's interest in a particular topic or idea.
Children and practitioners using ICT together to document and reflect on children's learning, or to share children's learning with parents, or other practitioners.	<p>Taking digital photos, videos, or audio recordings of activities in the early childhood education setting and reviewing these together, or sharing them with parents.</p> <p>Practitioners and children using ICT to build portfolios of children's work, to use for evaluating progress in children's learning and development.</p>
Practitioners using ICT for planning, administration, and information management.	<p>Teachers developing individual learning plans for children, or using computer-based templates to plan or document children's learning (e.g. using learning stories templates, or inserting relevant concepts from <i>Te Whāriki</i> into children's learning records).</p> <p>Creating databases to keep track of important information about children and their families.</p>
Teachers or teachers-in-training learning to use ICT, or learning through ICT.	<p>Teachers-in-training learning to use ICT in their initial teacher education courses.</p> <p>Distance-learning teachers-in-training using ICT to learn to become early childhood teachers.</p> <p>Teachers-in-training learning to use technology with children in their practicum placements.</p> <p>Teachers using ICT to document and reflect on their practice, or using ICT as part of a professional development programme.</p>
Children and practitioners using ICT to communicate or exchange ideas or information with other practitioners, parents, or researchers.	<p>Using videoconferencing, online discussion communities, or email, to communicate with other practitioners, parents, or researchers, or to share news and information about what's happening in the early childhood education centre.</p> <p>Children and practitioners using telephones, email, or fax to keep in touch with parents who are not able to come to the early childhood education centre (e.g. parents who are at work during the day).</p> <p>Using telephones, email, or fax to keep in touch with children and their families in distant or rural communities (e.g. Correspondence School early childhood education programme).</p>

1.4 Developing ICT capability in the ECE sector

The literature supports two key ideas about the development of ICT capability in the early childhood education sector (e.g. see Brooker, 2003; Downes & Fatouros, 1995; O'Hara, 2004; Sheridan & Pramling Samuelsson, 2003; Siraj-Blatchford & Whitebread, 2003):

The first idea is about children, and the possibility that they can begin to develop ICT capability and “ICT literacy” as part of their early childhood education experiences. The second idea is that practitioners and other adults in early childhood education can be supported to develop ICT capability and “ICT literacy”. The literature suggests that practitioners need guidance, and opportunities to become capable, competent, and informed about the educational role and potential of ICT, and support to make the most of the opportunities that ICT presents for strengthening all aspects of early childhood education practice.

Supporting children’s ICT capability and ICT literacy

Information and communication technologies are becoming more embedded and ubiquitous in the environment around children. These technologies are having such a profound effect on all aspects of people’s lives that they are now becoming “taken-for-granted”:

Children today live in a communication-rich environment. The models of communication they encounter in their everyday lives include...a whole range of electronic and digital methods of communication...there are electronic forms of communication in the outdoor environment, in streets as cash machines or pedestrian crossings and in supermarkets and much more (Siraj-Blatchford & Siraj-Blatchford, 2003, p. 4).

It is highly likely that ICT will continue to be a significant presence in children’s learning environments throughout their schooling and into their adult lives. In order to be full and capable participants in their environments, authors like Siraj-Blatchford and Whitebread consider it important that young children begin to develop “technological literacy”. They define this as:

...a new form of literacy, but it is one that is increasingly considered to represent an essential curriculum entitlement in any broad and balanced curriculum for the twenty-first century (Siraj-Blatchford & Whitebread, 2003, p. 1).

The UK Foundation Stage¹ curriculum reflects this view. It states that as part of their early childhood education, children should find out about and identify the uses of everyday technology, and that children should have opportunities to use ICT to support their learning (Becta., 2004). Similarly, Swedish authors Sheridan and Pramling-Samuelsson argue that:

Just as it is every child’s right to become literate, he or she should have the right to become a skilful user of ICT. Children should...experience ICT as a tool with vast possibilities for communication and information retrieval/sharing (Sheridan & Pramling Samuelsson, 2003, p. 267).

¹ “Foundation Stage” refers to education for children aged between 3 and 5 years.

Downes and Fatuoros (1995) make the point that to be effective lifelong learners, children will need to be literate in the communication modes of their culture. They need to be able to make, and make sense of, “texts” (whether these be print-based, electronic, or image-based). For young children, this could mean developing skills in the use of images and sounds to convey information, ideas, and feelings. Multimedia ICT tools present many possibilities for doing this. Learners in the “information age” will also need to develop skills to organise and analyse information (Downes & Fatuoros, 1995). Recognising the way that ICT and other multimedia technologies shape this information is an important part of this process. However, learners will not only be consumers of information – they will also be producers and creators of information (Downes & Fatuoros, 1995). For young children, this could involve using electronic media to record information, ideas, and feelings about themselves, their activities, and their environments, to share these with others.

Supporting practitioners’ ICT capability and ICT literacy

The literature strongly supports the idea that ICT development in the early childhood education sector should be firmly grounded in existing knowledge about early childhood learning and development.

Te Whāriki’s socio-cultural approach to early childhood education emphasises the critical role of socially and culturally mediated learning, and of reciprocal and responsive relationships for children with people, places, and things. This suggests that an appropriate approach for developing ICT in early childhood education involves developing the ICT capabilities and “ICT literacy” of the significant people in young children’s lives, including early childhood educators, parents, and caregivers so that these people can make good decisions about the use of ICT with, or by, children. Many authors discuss the need for educators to have well-developed understandings of the role and potential of ICT for supporting young children’s learning, as well as practical skills in knowing how to make best use of the technology (e.g. O’Hara, 2004; O’Rourke & Harrison, 2004; Patterson, 2004; Siraj-Blatchford & Whitebread, 2003). At the same time, other studies signal that children’s experience (or lack of experience) with ICT at home is an important factor for educators to consider in planning for the use of ICT in early childhood education settings (Brooker & Siraj-Blatchford, 2002; Downes, 2002). Finally, case studies highlight a role for ICT in supporting parent involvement in their children’s learning (Lee, Hatherly, & Ramsey, 2002; Whalley & the Pen Green Centre Team, 2001).

The literature strongly supports the idea that ICT development in the early childhood education sector should be firmly grounded in existing knowledge about high-quality practice for supporting early childhood learning and development.

Studies from countries including Australia (Cooper, Farquhar, & McLean, 2001; Downes et al., 2001), Finland (Kankaanranta & Kangalasso, 2003), the UK (O’Hara, 2004), Scotland (Learning and Teaching Scotland, 2003a), and New Zealand (Bain, 2000) suggest that in many early childhood education settings, ICT use is minimal, and early childhood education practitioners are

uncertain about the value of ICT, or how it could contribute to their practice. There is evidence of variable interest, capability, and confidence in using ICT in early childhood education among early childhood educators. Similar findings in the school sector have often led to the portrayal of teachers as technophobic or technically incompetent. However:

Dawes (1999) points out that the reasons why ICT may not feature as expected...may have less to do with stereotypical views of practitioners as technically fearful, inept and incapable, but result instead from professional judgements about the appropriateness of ICT in educational settings (O'Hara, 2004, p. 17).

Other contextual factors to explain the lack of ICT use in early childhood education could include: teachers' limited training opportunities in the use of ICT; insufficient equipment or funds to buy equipment; absence of on-site technical support; or a lack of time to develop ICT-integrated teaching or learning activities (O'Hara, 2004). However, if more time, equipment, or training is to be provided to practitioners, this support must also acknowledge practitioners' views and beliefs about children's learning and development, and bring these to the foreground of ICT support and professional development provision for the sector.

Most of the recent literature on ICT in early childhood education adopts a "strengths" view of practitioners, which considers practitioners to be professionals with a critical role in decision-making and support for young children's experiences with ICT, who therefore need support to develop ICT capability and literacy. Developing practitioners' ICT capability and literacy does not mean simply providing them with the skills to use different forms of ICT. It also means providing opportunities for practitioners to learn more about:

- the *possibilities* that ICT offers for new ways of communicating, seeking, and handling information, and interacting with the environment and other people;
- what *research* says about the role and impact of ICT use for children's learning, play, and development; and
- *examples* of how other early childhood education settings have used ICT to support children's learning or play; or to strengthen relationships between children, practitioners, and families.

Developing practitioners' ICT capability and ICT literacy also means providing them with opportunities to identify how they could use ICT to support or extend practice in their own early childhood education setting (Downes & Fatouros, 1995).

1.5 The structure of this review

Section 2 comments on some general features of the literature about ICT in early childhood education. It discusses different kinds of research that have been carried out in this area, and considers the strengths and weaknesses of this research in terms of the direction and guidance it can provide for early childhood education practitioners.

Sections 3 to 6 review New Zealand and international literature about the use of ICT in early childhood education settings. Section 3 outlines the key issues arising from the literature about ICT and young children. It explores questions such as: Why use ICT with young children? What are the perceived risks or disadvantages of young children's use of ICT? Conversely, what are the perceived benefits and advantages of young children's use of ICT? Section 4 explores the literature on ICT and the early childhood practitioner and discusses frameworks for identifying "high-quality" practice in the use of ICT. This section describes case studies of practitioners learning to use computers and ICT in their early childhood education centres. Examples from the literature include: taking a thematic approach to ICT use in the early childhood classroom; the use of ICT to document, share, and reflect on children's learning; to support critical reflection by children, practitioners, and families; to build or strengthen networks between early childhood education centres.

Section 5 discusses strategies that have been used to help teachers and teachers-in-training learn to use ICT in early childhood education, and Section 6 reviews literature about the use of ICT for planning, information management, and administration.

Section 7 reports findings from NZCER's 2003 national survey which identify key issues for current ICT access and use in New Zealand early childhood education settings.

Finally, Section 8 summarises key themes from the international and New Zealand literature about the use of ICT in early childhood education. It also notes gaps in the literature and areas where evidence is unclear. Finally, it suggests implications for a national strategy for ICT in the early childhood education sector.

1.6 Summary of Section 1

- The term "ICT" encompasses much more than just computers. ICT can be defined as "anything which allows us to get information, to communicate with each other, or to have an effect on the environment using electronic or digital equipment".
- The literature suggests at least three reasons why ICT matters in early childhood education. First, ICT already has an effect on the people and environments that surround young children's learning. Second, these technologies offer new opportunities to strengthen many aspects of early childhood education practice. Third, there is support and interest across the whole education sector for the development and integration of ICT into education policy, curriculum, and practice.
- There is a growing recognition of the many different ways in which ICT can contribute to, or transform, the activities, roles, and relationships experienced by children and adults in early childhood education settings.
- Many authors argue that because ICT will be a significant part of children's current and future learning environments, it is important for them to begin to develop ICT capability and "ICT literacy", and that early childhood education experiences have a role to play in this respect.

- Practitioners and other adults in early childhood education settings need guidance, and opportunities to become capable, competent, and informed about the educational role and potential of ICT, and support to make the most of the opportunities that ICT presents for strengthening all aspects of early childhood education practice.
- A “strengths” model views practitioners as professionals with a critical role in decision-making and support for young children’s experiences with ICT.

2. Characteristics of the literature on ICT in early childhood education

This section comments on characteristics of the literature that was collected and synthesised in this review.

Much of the literature that is available centres on the role and use of computers by young children. This is particularly true for most literature prior to about 1999. However, in the last few years there has also been a growth in literature which documents or evaluates the use of other forms of digital technologies, including digital cameras, digital video, closed-circuit television, videoconferencing, programmable toys, robotics, and electronic musical instruments, in schools and early childhood education settings. There is also a growing focus on practitioners' use of ICT *with* children as a tool to support and scaffold children's early childhood education experiences, to investigate and build learning experiences from children's interests, or to strengthen relationships between children, practitioners, and families.

A 2002 Scottish literature review of ICT in early childhood education suggested that there was a "scarcity of good quality research findings on using ICT in educational settings for pre-school children" (Stephen & Plowman, 2002). This may be because ICT use in early childhood education is a relatively new phenomenon and there is generally a time lag of several years between the introduction of new technologies in education, and the publication of research which evaluates its impacts or effectiveness (Higgins, 2003). However, our search of the literature found that there is a current surge in research and writing on the use of ICT in early childhood education, including in New Zealand, and more research looks set to follow in the coming months and years.

2.1 Kinds of research on ICT in early childhood education

We have grouped the different kinds of research and descriptive literature that have been collected and analysed for this review into five categories, with some overlap. These are: (1) "effects" research; (2) investigations of children's behaviour and interactions around computers; (3) research into children's experiences of ICT in early childhood education settings and at home; (4) research about practitioners' professional learning in, or through, ICT; and (5) case studies or exemplars of innovative use of ICT in early childhood education settings. Literature in each of these categories has strengths and weaknesses in terms of the questions it

raises, and the information it provides, about the role and potential of computers and other forms of ICT for enriching early childhood education.

“Effects” research

“Effects” research evaluates the impact or effects of technology use for young children (e.g. Harris, 2001). This kind of research has been common in the literature since the 1980s, when computers first became widely used by children in schools and homes. “Effects” research includes studies that have sought to investigate both positive and negative outcomes from children’s use of computers. Typical research questions include: Does using computers have positive benefits for children’s learning or cognitive development? What effects does computer use have on children’s social behaviour? Can computer games promote aggressive behaviour in children?

Investigations of children’s behaviour and social interactions around computers

Many studies have explored young children’s behaviours and interactions with computers, and with other children and adults, around computers in early childhood education settings. Common areas that have been explored include: differences between boys’ and girls’ behaviour and attitudes around computer use (e.g. Fletcher-Flinn & Suddendorf, 1998); and the degree to which computer use can promote or inhibit collaboration between children, or comparisons of children’s behaviour around, or interest in, using computers, compared with other kinds of play and activity in early childhood education settings (e.g. Graham & Banks, 2000). Graham and Banks argue that research about what actually happens when computers are available to children in early childhood education settings is needed in order for practitioners to make good judgements about how, and when, to use computers with young children. In such studies, practitioners generally feature in a passive supervisory role. Research of this type often leads to recommendations about the roles that adults could or should play in order to support and scaffold children’s interactions. For example, guidance to help adults to create collaborative environments around the computer, to ensure that all children have adequate access and support to use the computer, and to ensure that children’s computer interactions are meaningful and have a learning purpose.

Research into children’s experiences of ICT in early childhood education settings and at home

For studies in the two categories of research above, the focus is directly on the child, the technology, and the interactions between them. These studies tend not to frame the investigation of children’s learning or behaviour around ICT within the context of children’s wider set of learning experiences and environments. However, some researchers have started to piece together a broader picture of young children’s access to, ICT in different environments including, but not

limited to, their early childhood centre. This includes research to find out about access to, and use of, ICT across different early childhood education settings (Bain, 2000; Brooker, 2003; Downes et al., 2001; Kankaanranta, 2001), or the relationships between children's ICT experiences at home and in early childhood education settings (Brooker & Siraj-Blatchford, 2002; Downes, 2002). These studies reflect an "ecological" view of young children's ICT experiences. They seek to investigate the interactions between factors in children's home backgrounds (including the interactions of ethnicity/culture and language, gender, and economic/social status) and their early experiences of ICT, and how these factors impact on the knowledge, skills, dispositions, and feelings children display around computers in their early childhood education settings. This type of research acknowledges that children in different locations or from different family backgrounds will have different experiences of childhood, and that when it comes to ICT, not all children will be starting from the same point. It acknowledges that children will have different levels of interest, confidence, and prior knowledge and skills when it comes to ICT use. It recognises that some children may have special learning needs, while others may be gifted or talented in some way, and that this must be taken into consideration when supporting young children's experiences with ICT (O'Hara, 2004).

Research on practitioners' professional learning in, or through, ICT

Some research focuses specifically on early childhood education practitioners' ICT learning. This includes research on early childhood teachers-in-training learning to use ICT in early childhood education settings (Laffey, 2003; Pollman, 2000); or learning through ICT (Katz, 2003). Research has also been done on the integration of ICT into distance education programmes for early childhood teachers-in-training (Higgins Hains, Conceicao-Runlee, Caro, & Marchel, 1999). The use of ICT for early childhood teachers' professional learning has also been studied (Haggerty, 1998; Jordan, 1999; Kankaanranta, 2001; O'Rourke & Harrison, 2004). These studies identify key features of effective ICT professional development for early childhood practitioners. For example, that practitioners' learning about ICT should be connected to their understandings about children's learning and development, and that exposure to examples of integrated ICT use in real early childhood education settings can help practitioners see ways to integrate ICT into their own practice.

Case studies and exemplars of the use of ICT in early childhood education settings

Case studies and exemplars of the use of ICT in early childhood education settings are becoming more and more common, particularly in publications aimed at practitioner audiences. Much of the recent New Zealand literature falls into this category (e.g. Jordan, 1999; Lee et al., 2002; Patterson, 2004; Wilson, Clarke, Maley-Shaw, & Kelly, 2003). These case studies may be the most useful kind of literature for early childhood education practitioners who seek to understand the role and potential of ICT for supporting and extending practice in their centre. Several early

childhood education websites also use case studies to showcase examples of “ICT in action” in real early childhood education settings, for example Early Years Online² (Scotland) and SOFWeb³ (Victoria, Australia).

These case studies are often written by early childhood education practitioners in collaboration with early childhood education researchers. They range from being mostly descriptive, to some which include research into the impacts and outcomes of the use of ICT for children, practitioners, and practice. Some case studies are associated with particular pilot projects or initiatives which aim to support innovation and development of high-quality practice in the use of ICT in early childhood education.

Case studies of ICT use in early childhood education encompass a wide range of technologies, used for a wide range of purposes, but generally include the following characteristics:

- they discuss *how* and *why* ICT was used, and what kind(s) of ICT, with reference to the particular learning goals or experiences that the centre was aiming to achieve;
- they discuss how the ICT use related to particular social, educational, or cultural features of the early childhood education centre;
- they discuss some of the outcomes or benefits of the ICT-related activities for children, for practitioners, or for the wider early childhood centre community (for example, including parents and families);
- they identify problems and challenges, and how these were addressed, and suggest the conditions that helped to support the development of high-quality practice in ICT use; and
- most case studies also provide recommendations, suggestions, or guidelines for other practitioners based on what the authors have learned in their own centre.

A comment about these categories of research

The five categories of research discussed in this section illustrate the broad range of approaches that have been used to investigate the role and potential of ICT in early childhood education. Over time, there has been a noticeable shift in the literature. The major trend has been a movement away from investigating children’s experiences or interaction with ICT in isolation from children’s wider set of learning experiences. This way of thinking is being replaced by the view that children’s interactions with ICT are socially and culturally embedded, and are best understood in reference to the wider set of learning experiences and environments in which children participate.

² <http://www.ltscotland.org.uk/earlyyears/casestudies.asp>

³ <http://www.sofweb.vic.edu.au/eys/eystech/>

2.2 Definitions of “early childhood” in the literature

There is some variation across countries in the ages of children considered to be in early childhood education. Some studies of ICT in early childhood use the term “young children” to refer to children up to 8 years old. In the United States and Canada, children start school at age 6. Nursery schools generally cater for children aged 3–5 years old, and kindergartens cater for children aged 4–5 years old. In England, Scotland, and Wales, children in nursery schools are normally aged between 3 and 5 years, and in Northern Ireland, between 2 and 4 years. In England and Wales, some schools have classes called “reception” classes for children who have not yet reached the compulsory school age (5 years old). Sweden has preschools for children aged 0–5 (förskola) and another preschool for 6-year-olds (föreskoleklass).

Unless otherwise specified, most literature reviewed in this document involves children aged 3 to 5 years old.

2.3 Summary of Section 2

- Much of the literature on ICT in ECE focuses on young children’s use of computers. However, there is a growing body of literature about the use of other digital technologies in early childhood education, including digital cameras, digital video, closed-circuit television, videoconferencing, programmable toys, robotics, and electronic musical instruments.
- Recent literature has explored the potential of ICT as a tool to support and scaffold children’s early childhood education experiences, to investigate and build learning experiences from children’s interests, or to strengthen relationships between children, practitioners, and families.
- Studies in this area include: (1) “effects” research; (2) investigations of children’s behaviour and interactions around computers; (3) research into children’s experiences of ICT in early childhood education settings and at home; (4) research about practitioners’ professional learning in, or through, ICT; and (5) case studies or exemplars of innovative use of ICT in early childhood education settings.
- Literature in each of these categories has strengths and weaknesses in terms of the questions it raises, and the information it provides, about the role and potential of computers and other forms of ICT for enriching early childhood education. Some research focuses mainly on children’s interactions with the technology. Other research views children’s interactions with the technology in a wider social context that includes practitioners, parents, and the early childhood education setting.
- Case studies and exemplars of the use of ICT in early childhood education settings are becoming more and more common, particularly in publications aimed at practitioner audiences. These are often written by early childhood education practitioners, and generally provide recommendations, suggestions, or guidelines for other practitioners.

3. ICT and young children: the key issues

This section outlines the key issues arising from the literature about ICT and young children. The following questions reflect some of these issues:

- Why use ICT with young children?
- What are the perceived risks or disadvantages of young children's use of ICT?
- What are the potential benefits and advantages of young children's use of ICT?

In their review of literature, Stephen and Plowman (2002) suggest there is a proliferation of literature which makes claims for both the benefits, and potential risks, of young children's use of ICT (mainly in terms of computers). However, Stephen and Plowman consider that "the evidence base for much of this writing is weak" and say that much of this literature relies on assertion rather than empirical study, or recycles a limited number of older studies.

This may be due to the fact that, other than "effects" or "observation of behaviour" studies, most research to investigate the value of young children's use of ICT is relatively new. Recent studies tend to view children's ICT use from a socio-cultural perspective. This approach acknowledges that children's interaction with ICT is embedded in a wider context of interactions with their total environment and other people, including their peers, and adults. As other authors have noted, the issue is sometimes presented as a simple question: Should children use computers or not? However, the general view from the literature is that more useful questions to ask are: What are appropriate and meaningful uses of technology with children? And how can educators take advantage of the power of these tools to enhance children's learning and development, while avoiding potential problems? (Van Scoter, Ellis, & Railsback, 2001).

3.1 Why use ICT with young children?

The foremost question in some people's minds in relation to young children and ICT is: Should ICT be used with young children at all? Can ICT constitute a danger to young children? What are the risks and hazards of children's ICT use? Conversely, are there benefits to be gained through young children's use of ICT, and are these sufficient to merit the integration of ICT into ECE practice? This section reviews commentary from the literature on these issues, and considers what research is available to support various claims about the benefits and drawbacks of young children's ICT use. Most of the literature focuses on ICT in terms of computer use.

Areas of concern about children's computer use

The increasing pervasiveness of ICT has led some parents, teachers, and children's advocates to question its relationship to the cognitive, emotional, social, and developmental needs of young children (Stephen & Plowman, 2003, p. 4). For the most part, debates around these issues have centred around young children's use of computers and computer games.

Specific areas of concern often raised in relation to children's computer use are:

- harmful physical effects of children's prolonged computer use;
- negative impacts on children's social development (for example, concerns that computer use will encourage anti-social behaviour, including isolation or aggressive behaviour);
- educational concerns that computer use can interfere with aspects of children's cognitive development;
- concerns about children's exposure to unsuitable content, for example, containing material of a sexual or violent nature, or containing inappropriate gender, cultural, or social stereotypes; and
- concerns that computer use may displace other important learning and play activities.

Some critics have argued that computer use is, at best, lacking in educational benefit for young children, and at worst, harmful to children's learning, health, or development. *Fool's Gold* (Cordes & Miller, 2000), a widely cited publication by the American Alliance for Childhood, represents the most conservative position on young children's computer use. Its authors called for an immediate moratorium on the further introduction of computers in early childhood and primary education, except for special cases of students with disabilities. *Fool's Gold* argues that computer use in early childhood education should be abandoned in favour of "the essentials of a healthy childhood", that is:

...most authors agree that ECE practitioners need to be aware of the debate about ICT use by young children, and the need to safeguard children's health and development particularly regarding the use of desktop computers.

...time for spontaneous, creative play; a curriculum rich in music and the arts; reading books aloud; storytelling and poetry; rhythm and movement; cooking, building things, and other handcrafts; and gardening and other hands-on experiences of nature and the physical world (Cordes & Miller, 2000, p. 98).

Many writers in early childhood education have criticised or rejected the *Fool's Gold* position. Some authors have characterised this position as representing a "death of childhood" thesis, based on a mixture of panic and nostalgia (Buckingham, 2000, cited in Stephen & Plowman, 2003). They point out that similar concerns about harmful cognitive, emotional, physical, and social effects on children have accompanied the emergence of every new technology from the advent of alphabetic print, to the proliferation of film, television, and video games (Linderoth, Lantz-Andersson, & Lindstrom, 2002; Luke, 1999). Siraj-Blatchford and Whitebread consider that "ideological" rejection of a role for ICT in early childhood education is founded on a belief that it encourages children to be passive recipients, that it is isolating, and that children cannot learn

from these kinds of experiences. However, evidence is available to support the converse of each of these ideas (Siraj-Blatchford & Whitebread, 2003). This is discussed further in Section 3.2.

While there is rarely clear evidence about the degree to which these concerns pose a risk to children, most authors agree that early childhood educators need to be aware of the debate about ICT use by young children, and the need to safeguard children's health and development (Stephen & Plowman, 2003), particularly regarding the use of desktop computers.

Physical health and safety concerns

Repetitive strain injury, eye fatigue, and postural effects of extended computer use are established hazards for adults. Although there are few studies of the health and safety effects of computer use for young children, most authors suggest a cautious approach and believe that practitioners and children need to become well informed about safe and appropriate ways to work with computers. In one preschool study, Graham and Banks (2000) observed children had to tilt their heads up to look at a computer screen, and raise their arms to use the mouse, and often assumed a "slouch" position when seated in front of the computer. Some children were also observed to move their noses very close to the computer screen. Siraj-Blatchford & Siraj-Blatchford assert that "general health awareness relating to ICT and computer use should form part of children's learning about ICT, and should certainly form part of any setting's health and safety policy" (Siraj-Blatchford and Siraj-Blatchford, 2003, p. 21). They recommend that children's use of computers should occur in relatively short spells, usually no more than 10 to 20 minutes for 3-year-olds, extending to no more than 40 minutes by the age of 8:

General health awareness relating to ICT and computer use should form part of children's learning about ICT, and should certainly form part of any setting's health and safety policy

It is important that, while learning about ICT in their world, children also learn how to manage their own space and select the right tools to use when sitting at a computer (Siraj-Blatchford & Siraj-Blatchford, 2003, p. 21).

In the same way that office workers are given clear guidance about posture, eye-level, foot rests, arm supports, and time to spend on computers, Siraj-Blatchford and Siraj-Blatchford suggest that children need to become responsible for ensuring they have a chair of the right height. Adults can help by ensuring that children have appropriate tools and workspaces, for example, including mice and keyboards that are the right size and design for children's bodies. However, newer, "child-sized" technologies, and alternative interface technologies such as touch-screens, modified keyboards, and hand-held computers must also be evaluated carefully, with consideration given to potentially adverse effects for children's health and safety.

Some technologies may not have adverse effects for children, but by the same token, may not be well matched to children's level of development, motor skills, or previous experiences. For example, in one study, young children had more success operating a computer using a mouse than a touch-screen. The authors of the study suggest that this may have been because the mouse was

physically easier for the children to operate, or it may have been because the children had more prior experience using a mouse than a touch-screen (Romeo, Edwards, McNamara, Walker, & Ziguras, 2003).

A less common concern in the literature on health and safety of ICT is whether or not the radiation emitted by wireless ICT technologies could have harmful health effects for adults and children. Wireless technologies (for example, cellphones and wireless computers) transmit information using radiofrequency (RF) or microwave signals.⁴ Although there is no specific research on the effects of wireless technologies on young children, there is a large body of international research that investigates the health effects of cellphones, cellsites,⁵ and other sources of radiofrequency radiation. While this is a contentious area, as yet there is no clear evidence that use of wireless technologies has harmful health effects, at least in the short term although few studies have looked at the impacts of RF on sub-populations which might be more susceptible to various environmental health hazards, such as children or pregnant women (The Royal Society of Canada, 1999). What is certain is that exposure to RF radiation via wireless computer technologies occurs at very low levels, approximately similar to cordless telephones. One test of exposure levels from wireless ICT equipment, carried out by the New Zealand National Radiation Laboratory in an industrial setting, found that exposures were very low. Exposure readings taken at different locations on the wireless network measured around half a percent or less of the acceptable exposure limit for devices transmitting at that frequency (Martin Gledhill, personal communication).⁶

Concerns about children's learning, cognitive, social, and emotional development

Some members of the early childhood education community have expressed concern about possible detrimental effects of computer use for children's learning, cognitive, social, or emotional development. These concerns are sometimes linked to unease that software developers may see young children, their parents, or early childhood education settings as lucrative markets for "educational" programs and games that might not deliver the educational benefits they promise.

Some early childhood education experts have expressed concern about "lapware", software designed for very young children (e.g. toddlers and infants) to use while sitting on the lap of

⁴ Television, radio, and radar also use RF to transmit information. These relatively low-energy forms of radiation are quite different to the ionising radiation that is produced by X-ray equipment or radioactive materials. For example, ionising radiation is known to cause damage to living tissues through changes to the chemical structures within cells. The primary known effect of radiofrequency radiation on tissues is a thermal effect – that is, exposure to microwave energy heats up water-based living tissues.

⁵ Cellular phone base stations.

⁶ Further information about radiation safety in New Zealand is available from the National Radiation Laboratory, <http://www.nrl.moh.govt.nz/ieindex.htm>

parents or caregivers (Elkind, 1998; Haugland, 2003; Wright, 2001). Elkind (1998) does not dismiss the potential value of ICT as a tool for young children, but suggests that writers of lapware “do not know child development and make no effort to learn even the basics of what research has to tell us about what children learn and when”.

Other concerns are that computer use might foster learning in a negative sense. For example, that solitary gameplay could lead to children’s isolation from social interaction in learning and play, or that violence in computer games could encourage aggressive behaviour. Some reviews of research on computer games conclude that the question of whether violent games promote aggressiveness cannot be answered at present (Griffiths, 2000, Sakamoto, 2000, cited in Linderoth et al., 2002), because the literature is relatively sparse and contradictory, and game design is evolving so quickly that many studies might be too old to be applicable to the kinds of games children are playing today. There are obvious ethical problems with trying to measure whether something might have negative effects for children. Whatever can be said about the difficulties of studying this area, Linderoth et al. conclude that “most researchers seem unanimous about the importance of continuing the research because even the existence of a vague connection between violent media and computer games should not be neglected” (Linderoth et al., 2002, p. 238). Commentators on the role of ICT in early childhood education generally suggest that it is practitioners’ responsibility to critically appraise the computer games used by children in their care to identify whether these might include or promote violence, as well as whether they promote undesirable gender or cultural stereotypes.

Not all computer games contain violence and many authors argue that the immersive, interactive environment of computer games can provide learning benefits which include the development of reasoning and problem-solving abilities, and skills in making inferences, and dealing with multiple sets and layers of information. These ideas will be discussed further in Section 3.2.

Concerns that ICT might displace other important learning and play activities

The *Fool’s Gold* authors take the view that children’s use of computers should be sidelined in favour of other kinds of learning and play activities. However, most authors suggest that computers can play a role in young children’s early childhood education experiences *alongside* many other kinds of activities – ICT should not be seen as a way of superseding or displacing these kinds of experiences. For example, ICT use should not be at the expense of outdoor or indoor experiences which promote development of gross motor skills through running, climbing, jumping, swinging, and using wheeled toys (Siraj-Blatchford & Siraj-Blatchford, 2003). Some authors express concerns that computer use is incompatible with open-ended, creative play and learning. This is most often the case when “computer use” is seen in terms of drill-and-practice software. However, other authors discuss ways in which ICT can contribute to children’s creative play and expression, not only through the selective and supported use of particular software applications, but also through using a range of different forms of ICT (for example, digital cameras, programmable toys, or walkie-talkies), both indoors and outdoors, for a range of different learning and play activities.

Do computers promote social isolation, or present opportunities for collaboration?

Some authors express concern that computers might encourage children to disengage from social interaction in favour of solitary play. Conversely, some studies suggest that computer use can provide a valuable context for collaboration, cooperation, and positive learning experiences between children, or between children and adults. For example, studies which indicate that young children prefer to play computer games with their friends than on their own (Linderoth et al., 2002), or that children show more interest in using computers when there is an adult available to support and scaffold their computer interactions (Graham & Banks, 2000).

Medvin, Reed, Behr, and Spargo (2003) suggest that the design of the classroom environment can encourage either isolation or integration. They describe a project in their American Head Start⁷ preschool which aimed to make the computer a “social centre” in their classroom. This approach was consistent with the preschool’s socio-cultural approach to learning, which emphasised peer interaction as a means of promoting social and cognitive development. Three rules were introduced to encourage social usage, sharing, and helping behaviour at the computer: the “find a friend” rule says that two or more children must be playing at the computer at all times. “Help a friend” encourages children to stay and help the child with the mouse, play the computer program by providing directions and information, by pointing, and by physically helping to guide the mouse. “Share the mouse” prompts children to pass the mouse to the friend next to them after they have played for a while.

Medvin et al. reported that although children initially needed help to follow the rules, they seemed to enjoy working at the computer together, and gradually needed less guidance from an adult. The computer became a “peer-led centre”:

Children spontaneously offered assistance to their friends in changing the game and exploring the programs. The children helped each other play new games as well. Some students had the same games at home and were able to assist their peers. At other times they simply problem solved until they found the solution (Medvin et al., 2003, p. 16).

A case study in another American kindergarten (Labbo, Sprague, Montero, & Font, 2000) shows how much planning and thought is required from practitioners to promote collaborative learning opportunities for children working at computers. Initially, the authors thought that children would be eager to serve as guides or collaborators with their peers. Instead, often they observed what they dubbed “mouse wars” at the computer. One child described by Labbo et al. was frequently observed to take the role of “mouse warrior”. Mouse wars seemed to relate to issues of power and control and consistently occurred when children wait in what Labbo calls the “me next” chair, a chair next to the computer where a child waits for his or her turn.

⁷ An early childhood programme for children from low-income families, including families from a range of cultural and language backgrounds.

Gradually, Labbo et al. started to suspect that the mouse wars could be occurring because the children did not have a common purpose, goal, or strategy for how to proceed while they were on the computer. They also noticed children engaging in “window-shopping” and non-strategic game play behaviour. These were all believed to be symptoms of the same underlying problem – the computer centre was not meaningfully integrated into any wider learning-related activities within the kindergarten. To address this concern, Labbo et al. went on to develop a number of strategies for better integrating the computer centre into the rest of the kindergarten activities. In particular, they sought to link instances of computer use to particular books, stories, or themes they were focusing on in the kindergarten at the time.

A widely-cited article by Davis and Shade (1994), entitled “Integrate, don’t isolate!”, makes the case that, regardless of the creative potential of any software used, the key to developing creative and rewarding learning experiences for children rests on the ability of practitioners to integrate computer-related activities into, and across, the curriculum. That is, computer use should not be seen as a stand-alone activity, but should be integrated into other planned and spontaneous learning and play activities within the early childhood education classroom. While this approach is widely endorsed in the literature, there is evidence to suggest that in many early childhood settings, children’s computer use *is* often a self-contained or free-choice learning or play activity (Learning and Teaching Scotland, 2003a). Many authors suggest that practitioners need to think about how to use computers and other ICT to enrich the early childhood learning environment, and need good guidance to help them do this.

3.2 How can ICT enrich the early childhood learning environment?

Critics of ICT use by young children tend to take the view that ICT encourages children to be passive recipients, that it is isolating, or that young children cannot learn effectively through these kinds of experiences (Siraj-Blatchford & Whitebread, 2003). In contrast, many other authors consider that ICT holds many potential benefits for young children, and that when used appropriately, ICT can:

- support children’s cognitive and emotional development, and the development of social and co-operative skills;
- assist in the emergence of early literacy and mathematical thinking;
- “level the playing field” for children with special learning needs;
- enhance and strengthen relationships between children and adults, or give adults new ways to gain insight into children’s thinking or their interests, thereby providing opportunities to better support and scaffold children’s learning; and
- facilitate the emergence of “new literacies” or “multiliteracies” in children (Hill & Broadhurst, 2001; Pastor & Kerns, 1997).

Patterson (2004, p. 25) describes this as using ICT to “enrich the learning environment”. Most supporters of ICT use by and with young children consider that the value of the technology hinges on the way it is used. Van Scoter and Boss (2002) point out that computers and other technologies add to, rather than replace, teachers’ complement of tools and activities:

New technologies offer teachers additional resources to use as they plan to meet a range of levels, learning styles, and the individual needs of students (Van Scoter & Boss, 2002, p.10).

Appropriate use of these tools in turn depends on the skill and knowledge of the practitioner, and the “developmental appropriateness” of the technologies (or applications of those technologies) for the children in question:

The use of ICT in the early years has the potential to enhance educational opportunities for young children. It can be applied in a developmentally appropriate manner to encourage purposeful and exploratory play. It can encourage discussion, creativity, problem solving, risk taking and flexible thinking, and this can all be achieved in a play-centred and responsive environment. However, all of this does demand that practitioners are well trained and skilled in the appropriate uses of ICT with young children (Siraj-Blatchford & Whitebread, 2003 , p.6).

Most supporters of ICT use by and with young children consider that the value of the technology hinges on the way it is used...computers and other technologies add to, rather than replace, teachers’ complement of tools and activities.

What is developmentally appropriate use of ICT with young children?

Developmental appropriateness forms a guiding principle in much of the literature on ICT in early childhood education. Two widely-cited sets of guidelines strongly emphasise developmental appropriateness: the DATEC (developmentally appropriate technology in early childhood) project in the UK (Siraj-Blatchford & Siraj-Blatchford, 2002; Siraj-Blatchford & Whitebread, 2003); and the American National Association for the Education of Young Children’s position statement on the use of technology with children aged 3 to 8 (NAEYC, 1996).

The term “developmental appropriateness” can be defined in a number of different ways, depending on what views or theories one holds about children’s learning and development. Children’s development is sometimes construed as a step-wise series of “stages” (Luke, 1999). In this view, activities or ways of thinking that require a more advanced stage of development than a child has achieved are considered not to be developmentally appropriate. O’Rourke and Harrison (2004) consider that strict developmentalist approaches sometimes focus on what children lack. Downes et al. (2001) suggest that renewed understandings of developmentally appropriate

practice take a stronger Vygotskian perspective,⁸ encouraging educators to plan experiences that challenge children within their “zone of proximal development” – the area of difference in performance between what a learner can accomplish unassisted and what they could accomplish with the assistance of a more knowledgeable or capable other.

Theoretical understandings about children’s development continue to be redefined over time (Clements, 2002; Luke, 1999). For example, Luke argues that:

...children’s cognitive, behavioural, and emotional development can no longer be assumed to fit unproblematically into traditional lock-step developmental stages. Today, children’s early literacy and play experiences are shaped increasingly by electronic media (Luke, 1999, p. 97).

In other words, Luke suggests that children’s early experiences with ICT and other media will impact on their development, and their experiences of childhood. Therefore, some of our ideas about development and what is developmentally appropriate for children will need to shift accordingly. To illustrate with one example: in the past, using a mouse to control a computer might have been considered incompatible with young children’s developmental abilities. However, children who have experienced using a computer at home might develop skill and expertise in controlling and manipulating the mouse at a younger age than children who have not. “Ecological” studies of young children’s experiences with ICT in early childhood education signal the need to view children’s development within a complex interplay of individual, biological, social, economic, and cultural factors, including attention to children’s experiences in their home and family lives.

DATEC’s eight general principles about what constitutes developmentally appropriate use of ICT provide a useful general framework for practitioners. These principles are listed in the table below.

⁸ Vygotsky viewed learning as socially constructed, where children learn what is necessary to participate within their society and culture through interactions with cultural tools that are mediated by peers and adults. In the 21st century these cultural tools include digital as well as paper-based communication and information tools, artefacts, and media (Downes et al., 2001, p. 4).

Table 2 **The DATEC project principles for developmental appropriateness of ICT**

DATEC offers eight general principles for determining the appropriateness of ICT applications to be used in the early years:

1. **Ensure an educational purpose**
 2. **Encourage collaboration**
 3. **Integrate with other aspects of the curriculum:** that is, if children are to understand ICT they need to see it used in a meaningful context, and for real purposes. This includes allowing for ICT to feature in children's play.
 4. **The child should be in control:** that is, the ICT application should not control the child's interaction through programmed learning or any other behaviourist device.
 5. **Choose applications that are transparent and intuitive.** The "drag and drop" facility on a computer screen is a good example.
 6. **Avoid applications that contain violence or stereotyping**
 7. **Be aware of health and safety issues**
 8. **Encourage the educational involvement of parents**
-

ICT and children's play

Play is considered an important dimension of early childhood education, as part of children's social, emotional, cognitive learning, and motor development. The literature supports several different ideas about the role and potential value of ICT in terms of children's play. Recall the idea discussed in the introduction that in early childhood, children should begin to learn *about* technology (that is, what it is, how it works, and the roles it plays in their own and other people's lives) as well as learning *through* technology. Play is seen to be an important aspect of both of these kinds of learning.

O'Hara (2004) describes a range of examples from English early childhood education settings of ICT featured in children's play, including socio-dramatic role play. It is important to note that O'Hara considers both functional and non-functional ICT to have a role in supporting children's learning "about" technology. The examples O'Hara describes include:

- an imaginative role-play about being "in the office", in which a child used a functional PC, photocopier, and printer;
- a spontaneous indoor/outdoor game which evolved when an adult introduced six children to a pair of walkie-talkies;
- a whole-class "karaoke concert" using a CD player, microphone, amplifier, video camera, and television monitor;

- an imaginative role play about going to the travel agent and booking an overseas holiday, then going on the aeroplane for the holiday. The “travel agent’s office” included a non-functioning PC and telephone, as well as catalogues and a globe. The “aeroplane” had a functioning PC in the cockpit, which displayed pictures of clouds as the plane “flew”. A tape player/listening station with several headphones served as the in-flight entertainment station in the “cabin”. A classroom helper had built a simple battery-operated “fasten seatbelt” sign that the “cabin staff” could switch on and off;
- a closed-circuit video camera and television monitor that were set up in a play area in an early childhood education classroom designated as a “sea-side café”; and
- a small group of children and a teacher sitting in a circle and learning how to operate a Pixie programmable vehicle, with each child having a turn to program the vehicle to travel across the carpet to another child.

O’Hara’s examples highlight some important themes about high-quality practice in ICT use with young children. These include: children using ICT in “realistic” and imaginative socio-dramatic role-play; children learning to use the correct vocabulary to describe different technologies and activities associated with them (for example, children talking about “typing”, “printing”, or “looking up flight times” using the computer); and children using different forms of ICT, both indoors and outdoors. Many of O’Hara’s examples show children being trusted and assisted to be in control of the technologies (for example, children being helped to operate a video camera, CD player, computer, or programmable toy themselves).

Computer games: play and learning

The actual or potential learning benefit of computer games for children is a widely-discussed area in the literature (Clements, 2002; Linderoth et al., 2002; Yelland, 2002). Verenikina, Harris, and Lysaght (2003) speculate that computer games might have a special or unique value for children’s play, and that if these are to become a significant part of children’s lives, then their developmental value should be examined. In their view:

Understanding the range of ways that computer games may or may not contribute to the child’s development will enable early childhood educators to make an informed decision when choosing particular software for their settings (Verenikina, Harris, & Lysaght, 2003, p. 7).

Verenikina et al. propose that early childhood educators could use classic and contemporary theories about the purpose and value of play to evaluate different games and applications. The table below suggests some questions that practitioners might use to do this, matched against different views and theories about play.

Table 3 **Questions for assessing the contribution of computer games to children’s play**
(adapted from Verenikina et al., 2003)

Theories about the purpose or value of play	Relevant questions for practitioners to assess software
General characteristics of play	
Play is a spontaneous, self-initiated, and self-regulated activity	• Does this computer game allow children to freely engage in play? Does it provide freedom of choice?
Children are actively involved in creating their play and are in control of it	• Does this computer game allow children to create their own scenarios, rules, and characters of the play?
Play includes a dimension of pretend	• Does this computer game enable children to act in an imaginary, “as if” situation?
Classical theories of play	
Play discharges natural energy of the body	• Does this computer game allow for discharge of natural energy? If so, in what sense?
Play alleviates boredom while the natural motor functions of the body are restored	• Does this computer game engage the interests of the child (with particular children in mind as this criterion is considered)?
Play restores energy that is expended in work	• Does this computer game allow for rest and relaxation in an enjoyable and engaging way?
Play affords opportunities to develop skills necessary for functioning as adults	• Does this computer game provide opportunities for developing adult skills?
Modern theories of play	
Play reduces anxiety by giving children a sense of control over their world and an acceptable way to express forbidden impulses	• Does this computer game enable children to gain a sense of control over events that they could not control in their lives, including traumatic experiences?
Play consolidates learning that has already taken place, while allowing the possibility of new learning in a relaxed atmosphere	• Does this computer game have the potential to consolidate existing learning? If so, what kind of learning? Does it have the potential to develop new concepts and skills? Does it engage the child in such approaches as problem-solving and self-discovery?
Play promotes the ability to comprehend multiple layers of meaning	• Does this computer game operate at literal and figurative levels of meaning? Does it enable children to reflect on the rules and means of communication?
Play promotes sense of self in terms of personal identity and social relations with others	• Does this computer game develop a sense of a child’s own identity? Does it develop a child’s sense of his/her own social identities in relation to others? If so, how?
Socio-cultural theories of play	
Play promotes abstract thought by separating meaning from objects and actions and using actions and objects in symbolic ways	• Does this computer game involve and develop use of symbolic meaning? If so, in what ways?
Play allows children to reach beyond their actual development in their cognition and self-regulation	• Does this computer game allow children to engage in their zone of proximal development and function above their everyday abilities in cognitive and socio-emotional areas?
In play, children achieve mental representations of social roles and the rules of society	• Does this computer game provide children with an opportunity to act out and explore the roles and rules of functioning in adult society? Does it allow for group work and collaboration?

Using ICT to support language development

Van Scoter and Boss (2002) discuss many ways in which ICT can make rich contributions to children’s literacy development, in the four interrelated areas of speaking, listening, reading, and writing. For example, “talking” word processors support young children’s experimentation as

they play with language. Word processors also offer possibilities for children to compose and write without needing to have mastered the production of letters by hand.

Computers in the classroom or early childhood education centre can contribute to a “print-rich” environment. Van Scoter and Boss suggest using computers and printers to help children make signs, banners, and other props for pretend play:

The props add interest and basic literacy skills to children’s play, and decisions involved in making them – what size, what colour, what words – give children more opportunities to use language. Making and displaying signs helps create an atmosphere that surrounds children with print that has meaning to them (Van Scoter & Boss, 2002, p. 15).

ICT also offers a variety of ways for children to weave together words and pictures. Van Scoter and Boss describe one class where teachers often send home digital photos of children’s activities and field trips. Working with children to put captions on these photos offers an opportunity to develop children’s written language skills, while photos with captions deliberately left off can promote children’s oral language skills, as children use their own words to describe what the photos show. In a Head Start kindergarten in Oregon, the latter strategy is considered particularly useful in homes where English is a second language, to support children’s oral language development in their native language. There are many ways in which ICT can support children’s storytelling. Even children who are not yet writing could dictate words to go with their pictures, or they could record their voices telling the story, or be videotaped as they tell the story and show the picture (Van Scoter & Boss, 2002).

There are New Zealand examples of ICT use to support language development in both English and Māori language in early childhood education centres. For example, several early childhood centres have used ICT to produce multimedia learning stories co-authored between children, educators, and sometimes, parents (Lee et al., 2002; Wilson et al., 2003). These are further discussed in Section 4. Ferguson and Mellow (2004) describe an early childhood e-learning resource, available online and as a CD ROM, which they developed to support young children’s development of te reo Māori.⁹ The resource includes a number of activities which use a mixture of images, recorded sounds, numbers, and written words and letters, and mouse-based drag-and-drop and roll-over interactions. The resource writers encourage adults to work through activities with children, and to read out positive reinforcement messages in English and Māori, and to allow children to control the mouse as much as possible. When the resource was trialled with eleven 4-year-old children at an early childhood education centre, the developers found children had some difficulties using the mouse, but that children’s average concentration span using the software was close to 30 minutes, much longer than the developers had expected.

⁹ The resource can be found at http://somatotype.net/Te_Reo

Using ICT to support mathematical thinking and problem-solving

Computers and other forms of ICT also have the capacity to support young children to develop mathematical thinking. Clements (2002) reviews research on young children's mathematical learning in conjunction with various forms of computer-mediated practice including the use of drill-and-practice mathematical software, and the exploration of shapes, patterns, and numerical relationships using general-purpose graphics programs, or specialised "computer manipulative" programs in which children are able to perform specific mathematical transformations on objects on screen. Clements concludes there is evidence that computers can assist even very young children to develop mathematical ideas, provided teachers are able to choose and use these tools in a way that scaffolds and extends young children's thinking, in particular, their higher-order thinking:

Unique advantages of computers for fostering higher-order thinking include: allowing children to create, change, save, and retrieve ideas; promoting reflection and engagement; connecting ideas from different areas, such as the mathematical and the artistic; providing situations with clear-cut variable means-end structure, some constraints, and feedback that students can interpret on their own; and so allowing children to interact, think, and play with ideas in significant ways (Clements, 2002, p. 167).

Particular software programs designed for early years learners may help. For example, Jones (2002) describes a Melbourne school which uses a software package that includes single key Logo. In this simplified version of Logo, new entrant learners are introduced to simple turtle geometry¹⁰ with a simplified set of keyboard commands, for example *f*, *b*, *l*, *r* for forward, backward, left, and right. Other programs enable young children to make and explore patterns and shapes.

Supporting children from diverse cultural or language backgrounds

ICT may provide unique opportunities for scaffolding and supporting children with special learning needs, or children from culturally or linguistically diverse backgrounds. Good software can allow children to engage in self-exploration and tailor the software to their individual needs in a way that traditional print-based material cannot necessarily match. For example, Castellani and Tsantis (2002) researched the way teachers used software in an ESOL summer school learning programme for 5–12-years-olds in the United States. The software offered opportunities to explore basic concepts such as colour, numbers, and shapes in children's native language, as well as offering the English language equivalent of these concepts, thereby providing teachers with opportunities to structure the learning environment in culturally inclusive ways. Brooker and Siraj-Blatchford (2002) studied the experiences of 3 and 4-year old children using a computer at an ethnically and linguistically mixed urban nursery school. They described computer use by

¹⁰ Turtle geometry involves an on-screen icon (the turtle) which can be programmed to move around the screen, leaving a trail line. By programming a series of turtle movements, users can draw lines, angles, and shapes on the screen.

bilingual children as “especially valuable”. Visual cues and animation embedded in the programs prompted ESOL children to use English words to talk about what they were doing (e.g. “Look! In the house go!”). The researchers regularly noted instances of language learning, and children repeating words and phrases in response to computer-spoken prompts. In addition:

The computer often provided a shared focus and experience for children who didn’t share the same spoken language, and this undoubtedly contributed towards the development of the very positive, collaborative, and language enriched multicultural learning environment that we observed (Brooker & Siraj-Blatchford, 2002, p. 269).

ICT can also be used as a way of bringing children’s home culture and experiences into the early childhood education centre. For example, Whalley et al. (2001) describe a UK early childhood centre where parents were able to borrow the centre’s video camera to film children’s experiences in the home. These could then be viewed and discussed between parents and early childhood educators, as a way of supporting parents’ involvement in their children’s learning.

Supporting children with special learning needs

Bray, Brown, and Green (2004) discuss opportunities that technology offers for supporting learners with a diverse range of special needs or characteristics, including ESOL learners, children identified as having learning disabilities, learners with physical or cognitive impairments, and children identified as gifted and talented. They divide technologies to support diverse learners into two broad categories: assistive/adaptive and learning support. Assistive/adaptive technologies make something physically accessible that would otherwise be inaccessible (for example, screen magnifiers, voice-recognition software, and modified mice or keyboards), while learning support technologies can assist learners through remediation, compensation, or extension. According to Haugen (1998), one special benefit of technology is the many ways in which it can “level the playing field for kids with special learning needs by supporting their efforts to communicate, explore, play independently, or cooperate with a peer”. Haugen cites several American studies in which children and toddlers with disabilities showed more active engagement, enjoyment, and social play during computer activities involving peers and adults than during similarly structured activities away from the computer.

Case studies in the literature support the idea that, when used well, technology can be a valuable tool for supporting children with a range of individual learning needs. For example, Labbo et al. (2000) describe strategies they used with computers in their kindergarten to assist children who were experiencing literacy difficulties. Five-year-old Joey struggled with many aspects of literacy, although he could decode words and read simple text. When using the kindergarten computer, Joey was observed to “window shop”, clicking silently from screen to screen. Joey’s teachers decided to try engaging him in highly focused activities on the computer using a “talking

book”.¹¹ The interactive features of the book allowed Joey to predict which words on the screen might rhyme, and then to check his prediction by clicking the mouse. Labbo’s field notes from observations of Joey and his teacher working on the computer illustrate how this approach helped Joey (see box).

Joey goes to click several times on the words *me* and *we* on the page. It’s as if he’s reaffirming and concentrating on how those words have the same ending sound. Joey clicks on the words *me*, *we*, and then he pauses with the cursor arrow over the word *the*... “wonder, does t-h-e- rhyme with me and we?” he asks.
“It depends on how you say it”, Ms Sprague responds. “Try it out and see.”
He clicks on *the* and sighs when it is pronounced “tha”. What is interesting is his recognition that the final *e* in a one-syllable word should have a long *e* sound. His interaction provided him with a moment of clarification. (Observational field notes, Labbo et al., 2000, p. 7)

3.3 Knowing when and how to use ICT with children

The literature suggests there is clear potential for using ICT, including computers, to enrich the early childhood learning environment:

Technology adds to the set of tools available for children to use and adapt, to feel at home with, to make part of their repertoire, and to help express themselves, verbally, visually, and emotionally. New technologies offer teachers additional resources to use as they plan to meet a range of levels, learning styles, and the individual needs of students (Van Scoter & Boss, 2002, p. 10).

As with any educational resource, the new technologies can be used well or badly (Siraj-Blatchford & Whitebread, 2003). The value that ICT can add to young children’s learning environments clearly depends on the choices that practitioners make about which tools to select and when and how to use these; and their understandings about how these tools can support children’s learning, development, participation, or play. The role of the early childhood education practitioner will be discussed further in the next section.

3.4 Summary of Section 3

- Some authors have expressed concern that computer use is not appropriate for young children. Common concerns centre around issues such as harmful physical effects of children’s prolonged computer use, negative impacts on children’s social development, concerns about children’s exposure to unsuitable content, and concerns that computer use may displace other important learning and play activities.

¹¹ An interactive digital version of a story that employs multimedia features such as animation, music, sound effects, highlighted text, and models fluent reading.

- Although there is rarely clear evidence about the degree to which these concerns pose a risk to children, most authors agree that ECE practitioners need to be aware of the debate about computer use by young children, and the need to safeguard children's health and development in planning for ICT use in early childhood settings.
- Studies suggest that computer use can provide a context for collaboration, co-operation, and positive learning experiences between children, or between children and adults. ICT can encourage purposeful and exploratory play. It can encourage discussion, creativity, problem solving, risk taking and flexible thinking, and this can all be achieved in a play-centred and responsive environment.
- Case studies show that ICT can be used to support early language development and early mathematics. ICT can provide unique opportunities for scaffolding and supporting children with special learning needs, and children from culturally or linguistically diverse backgrounds.
- The value that ICT can add to young children's learning environments strongly depends on the choices that practitioners make about which tools to select, and when and how to use these; and their understandings about how these tools can support children's learning, development, and play.

4. We have the technology, now what? Practitioners learning to use ICT in early childhood education settings

International and New Zealand literature suggests that the introduction of ICT in early childhood education can have many positive implications for early childhood education practitioners. When used well, the new technologies can provide powerful tools for strengthening and enhancing children's early childhood learning experiences, including relationships between practitioners, children, and parents. Using ICT with children can also stimulate practitioners to reflect on their views and ideas about children's learning and development, and to analyse and question how things are done in early childhood education (O'Rourke & Harrison, 2004). For this to occur, practitioners need good guidance, examples, and support for their own professional learning. They need to be well-informed about the potential and possibilities available from ICT, as well as being able to critically review different ICT hardware and software (Downes & Fatouros, 1995; O'Hara, 2004; Verenikina et al., 2003).

This section explores the literature on ICT and the early childhood practitioner. It describes case studies of practitioners learning to use computers and ICT in their early childhood education centres. Frameworks for identifying "high-quality" practice in the use of ICT are discussed.

4.1 The introduction of ICT in early childhood settings

Labbo et al. (2000) suggest that the introduction of computers may have an initially disruptive effect on the "ebb and flow" of life in early childhood settings:

Life in a kindergarten classroom is made up of an ebb and flow of routines, rituals, celebrations, circle time, play time, centre time, school schedules and timetabling, and the teacher's skilful orchestration of learning activities. When a computer centre is thrust into a smoothly running classroom, the natural rhythms of kindergarten life may be thrown out of whack temporarily, while the teacher and students figure out the role that the computer will play... (Labbo et al., 2000).

The situation of early childhood education practitioners grappling with the introduction of ICT into their centres, and learning how to make the best use of them with children, is a common theme in the literature.

In the absence of good guidance about how best to use computers and ICT with young children, staff tend to make their own decisions about the nature and extent of the involvement of technology-supported learning offered to children. These decisions are influenced by such factors as teachers' own level of confidence with computers, and their beliefs about learning and teaching in the early childhood years (Dockett, Perry, & Nanlohy, 1999). Most authors consider that children's ICT learning is significantly affected by teachers' pedagogical awareness, education, and ability to meet each child's interests and support, stimulate, and challenge their learning, through ICT, in the direction of their overall goals (Sheridan & Pramling Samuelsson, 2003). However, studies suggest that many practitioners lack awareness of the general issues around young children's ICT use (Bain, 2000), or do not see how ICT can be included in a curriculum focusing on play and creativity (Downes et al., 2001).

A 1999 survey of 58 New South Wales early childhood centres found that 31 percent of the centres had a computer available for children's use, but many staff indicated they never used computers with the children (Dockett et al., 1999). Stephen and Plowman (2003) describe the use of ICT in early childhood centres in Scotland as "a work in progress". Their research into ICT use in seven Scottish preschools (Learning and Teaching Scotland, 2003a) found that the computer use was often limited to children's "free-play" activities. Many practitioners were confident in the mechanics of ICT use, but most felt they did not have enough experience to feel confident about integrating ICT into teaching and learning activities. Although practitioners were enthusiastic about the value of ICT in their centre, there was overall a lack of developed pedagogy for integrating the computer into wider learning activities. The plea to the researchers to "come back in two years!" expressed practitioners' sense that, given time, they would move towards much better ICT-related practice in their centres.

4.2 Early childhood education practice with ICT

What kind of practice is it that early childhood educators like those in the Scottish study described above might be aiming towards? Is there some way of describing or evaluating the relative quality of practice around ICT in early childhood education? The term "best practice" rarely, if ever, appears in the ICT in early childhood education literature. However, a number of authors have drawn together research and theory about ICT use in early childhood to develop frameworks or guidelines for what might be considered to represent high-quality practice in the use of ICT in early childhood settings (Brooker, 2003; Downes et al., 2001; Sheridan & Pramling Samuelsson, 2003).

Terms like "best practice" and even "quality" are problematic in early childhood education, since they both carry a certain degree of subjectivity and personal judgement. For example, "best practice" suggests there is one universal standard of practice that works best for all people in all contexts. But Dahlberg, Moss, and Pence (1999) point out that what is "best" in the eyes of one

person or community is not necessarily best in the eyes of another. Similarly, “quality” in early childhood education:

...is a constructed concept, subjective in nature and based on values, beliefs, and interest, rather than on an objective and universal reality (Dahlberg et al., 1999, p. 5).

With these caveats noted, there are a number of useful guidelines which are helpful for thinking about features of practice that educators might aim towards with ICT use. These guidelines draw substance from their grounding in the experiences of early childhood educators (Brooker, 2003; Downes et al., 2001), or from theories about what constitutes “pedagogical” quality in early childhood education practice (Sheridan & Pramling Samuelsson, 2003). Measures of pedagogical quality in early childhood education could include assessments of: the way that educators interact with children to promote learning; the strength of relationships between children, educators, and families; and children’s perspectives on their early childhood education experiences; as well as physical and material resources available in an early childhood education setting.

Guidelines for judging the level or quality of ICT use in the early childhood education literature discuss physical and technical arrangements such as children’s access to computers and other ICT, the placement of computers in the room, the type of software that is available. They also highlight educational and social features of the learning environment, such as: the nature and quality of children’s interactions with, and in the context of, the computer; the role of adults in supporting and encouraging children’s ICT use; the degree to which ICT-related activities connect with other activities in the centre; and the practitioner’s broader learning goals. They also comment on how the children might “experience” ICT in their early childhood education setting.

Brooker (2003) suggests computer use could be classified along a continuum of three points, from “isolation” to “integration” to “immersion”. Similarly, Sheridan and Pramling-Samuelsson (2003) consider what ICT use in an early childhood setting would look like at three levels of quality: “low quality”; “good quality”; and “high quality”. Table 4 shows what these different levels of quality of ICT use might look like in an early childhood education setting.

At a *low level of quality* (isolation), children’s ICT use is self-contained and disconnected from other learning activities. The computer may be situated in a corner away from other play areas. Children seldom use the technology and teachers do not encourage its use. Teachers do not actively scaffold children’s learning while they are using ICT, other than to ensure children take turns, and have basic skills to use the ICT. At a *good level of quality* (integration), the computer is relocated into a more central position among other classroom activities. Computers and other ICT equipment, such as digital cameras, are available for children to use. Sitting together in front of a computer, children communicate, discuss strategies, solve problems, and have fun together while they use games and educational programs. Although teachers encourage and support children’s use of ICT, the technology is still not an integrated part of other activities in the preschool. At a *high level of quality* (immersion), children use computers and ICT equipment throughout the day as a multifunctional tool that is integrated with other activities and themes. Practitioners and children use computers to document children’s activities, make labels and signs as needed, and

send messages, and parents can access information about their children's learning or activities, or about early childhood education in general, while in the setting. The most important goal for the teacher is to help children experience the technology as a communication information tool with vast possibilities, and to give children the motivation to explore and create to the edge of their and the technology's limits, thereby helping children to become good communicators, information seekers, and evaluators of content.

Table 4 Levels of quality of ICT use in an early childhood education setting (adapted from Brooker, 2003 and Sheridan and Pramling Samuelsson, 2003)

	What this might look like in an early childhood education setting		
	Physical and technical arrangements	Role of children and adults	Scaffolding of children's learning
A low level of quality ("isolation")	<p>Only one computer is available for children to use, at the teacher's discretion.</p> <p>Only a few software programs are available, the software is unconnected with the current classroom themes and topics. The child operating the computer has his or her back to the other children and is not involved in their activities.</p>	<p>Children seldom use the computer, nor do teachers encourage its use.</p> <p>Teachers often take a controlling and instructing role, partly to ensure that all children have equal opportunities to use the computer.</p>	<p>Teachers stop engaging themselves once children are self-sufficient and have learned basic ICT skills.</p>
A good level of quality ("integration")	<p>The computer is relocated into a more central position among other classroom activities.</p> <p>Computers and other ICT equipment (such as digital cameras) are available for children to use.</p> <p>A range of software programs is available, including pedagogical programs, creativity/multimedia programs, and games.</p>	<p>Sitting together in front of a computer, children help each other, negotiate turn-taking, collaborate, and tutor each other. Children communicate, discuss strategies, solve problems, and have fun together while they use games and educational programs.</p> <p>Children develop different strategies while learning to handle the computer and/or different programs. They ask friends, experiment, guess, move the mouse aimlessly, use help functions, and explore by themselves or with friends.</p> <p>Teachers encourage children to send email, use the Internet for information, and write or illustrate, or lay down soundtracks and narration for their own stories on the computer.</p>	<p>The computer is still not an integrated part of other activities in the preschool. Its uses can be described as learning by doing various activities on the computer, compared to learning through the computer.</p>
A high level of quality ("immersion")	<p>Children use computers and ICT equipment throughout the day as a multifunctional tool that is integrated with other activities and themes.</p> <p>Children learn through the computer and from each other while using a variety of programs or creating their own.</p>	<p>Children explore new topics, are creative in their search for information, ask questions, and express their reflections and feeling.</p> <p>Practitioners and children use computers to document children's activities, make labels and signs as needed, and send messages.</p> <p>Parents can access information while in the setting.</p>	<p>Teachers interact with and guide the children.</p> <p>They create possibilities in which ICT can be used to support children in developing new experiences and to expand their world.</p>

The above frameworks for describing high-quality ICT practice prompt educators to consider ICT as a truly integrated *learning resource*. An Australian synthesis of research (Downes et al., 2001) provides six ideas about what would constitute effective learning environments for the use of “digital resources”.¹² These are as follows:

- First, the pedagogical approaches need to shape the use of digital resources. There should be continuity between philosophical and pedagogical approaches and digital resources in order to provide appropriate curriculum for young children. These include the recognition that children have different interests and different learning styles.
- Second, children’s use of digital technology needs to relate to specific learning goals or to have a particular focus. These can include a focus on processes such as critical thinking, problem solving, and learning to learn.
- Third, effective integration of digital resources into the learning environment is reflected in their timely, flexible, and varied use within the total learning environment. Digital resources need to be judiciously moved around and integrated within the play areas/learning centres of the environment.
- Fourth, using digital resources is a social activity.
- Fifth, digital resources need to support children’s self-directed learning experiences where they need to be able to investigate their own interests.
- Finally, digital resources should provide open-ended learning experiences. Children need depth in the resources; that is, many layers of meaning and complexity to explore rather than fixed or narrow resources.

4.3 Examples from practice

There are many case studies in the literature in which practitioners, faced with the introduction of computers and ICT in their centre, and believing that these can add value to their practice, through reflection and exploration, discover ways to make good use of these. These case studies illustrate how good use of ICT can emerge from a focus on the social context created by the use of the technology, rather than allowing the technology alone to drive the planning process (Downes & Fatouros, 1995). A range of examples are described next.

Using ICT to document, share, and reflect on children’s learning

When three computers were presented to their New York kindergarten, Pastor and Kerns (1997) brainstormed ways they could use these to support their goals of facilitating reading and writing literacy, without inhibiting children’s creativity. To accomplish this task:

¹² Downes et al. use the term “digital resource” to refer to a broad range of ICT hardware and software, including the Internet and Internet-based resources.

...we shifted our vision away from educational software and its limits and focused on hardware and its primary strengths: mass storage and speed. We also looked for software that would *assist* our goals rather than define them (Pastor & Kerns, 1997, p. 42).

This thinking led Pastor and Kerns to focus on using the computers to support children's digital photography. Children used digital cameras to photograph and write about field trips and other centre activities, produce class books, and share these experiences with their parents. At the end of the year the children helped to produce a slideshow of their year's experiences with text, soundtrack, and narration. The educators were "continually surprised" at the skills the children acquired:

They learned to use the camera, download the pictures to the computer, and use software to crop and alter their pictures...some children even learned to open files and start portfolios – advanced literacy that led to questions of ethical behaviour, integrity, honesty, and the importance of privacy (Pastor & Kerns, 1997, p. 43).

Pastor and Kerns tried to create and maintain an environment where all children had fair and equal access to materials. In spite of their careful planning, they met with some unanticipated problems and challenges, which they had to address during the year. For example, the initial placement of the computers at the front of the room was changed when it seemed to create a distraction to children working in other areas. Some children also appeared reluctant to use the computer because someone might be standing behind and watching. Finally, the computers were moved to a quiet corner where they created less disruption to the class environment. To address equitable use of the computers, the adults set out to ensure that all of the students had basic proficiency that enabled them to work on their own. For some children, this meant one-on-one sessions with practitioners to help them gain enough competence to overcome any initial fears they had about using the equipment.

In some New Zealand early childhood education centres, digital photography and video have been used to support and extend a "learning stories" (Carr, 2001) approach to the documentation and assessment of young children's learning. Through their participation in a professional development programme in which they were assisted to develop assessment documentation using the learning stories framework, teachers at Roskill South Kindergarten "have become skilled and passionate about using ICT" (Lee et al., 2002, p. 10). Teachers and children have used digital cameras, video, and software like iMovie to document and reflect on children's learning journeys, and to share these with parents. Images, video, and written comments can be compiled into individual portfolios for each child. Through these portfolios, children's learning is translated into a significant resource, thus strengthening the connections between children, families, and teachers. The ongoing multimedia documentation is also enabling teachers to listen more effectively to each child and access their interests and strengths (Lee et al., 2002, p. 13).

A group of Southland kindergartens that received a grant from the Community Trust of Southland to purchase a computer, digital camera, a printer, and software also picked up on the idea of using ICT to support the learning stories approach (Wilson et al., 2003). All other early childhood education centres in Southland which were open for more than 9 hours a week also received the

same ICT package. One condition of the grant was that the computers be situated in the play area and be accessible to children during all session times. To support each other in developing knowledge and experience to use the new equipment, the Southland kindergartens set up their own mini exemplar project involving eight kindergartens. Teachers in these kindergartens committed to explore the use of technology with a particular focus on learning stories. Cluster groups of 7–8 teachers each (involving teachers from all Southland kindergartens) were established at the same time so that teachers could develop networking opportunities and peer support for finding their way around the ICT equipment. This occurred alongside Ministry of Education professional development. Wilson et al.'s article describes how centres used the equipment to document and share children's learning stories with children and parents. One kindergarten developed a library of books and movies created by teachers and children using ICT "that children and parents can revisit time and again and reflect on the learning that took place" (Wilson et al., 2003, p. 43).

Using ICT to support critical reflection by children, practitioners, and families

Literature from New Zealand and overseas (including the articles described above) highlights the opportunities for the technology to promote and support critical reflection on the part of children and practitioners, and provide tools for practitioners to better scaffold children's thinking. Forman (1999) describes using digital video cameras as a "tool of the mind" for young children. Forman developed an approach to using a digital video camera in his kindergarten which he called "instant video revisiting" (IVR). Using this approach, video footage of activities and episodes in the kindergarten are reviewed, using the camera's fold-out screen, in the same place and context that is displayed in the episode on tape, (rather than being reviewed hours or days later in a different context). As a "tool of the mind" for the teacher, IVR gave insight into children's ideas and interests. As a "tool of the mind" for children, Forman "wanted to use the camera to bring into their consciousness the children's own high-level thinking in ordinary moments". Forman describes filming the children in the centre and then reviewing the footage with children, to discuss what they were thinking in those moments, and what they were doing. Forman also applied IVR as a way of helping children to see another child's perspective, for example, by reviewing an episode of conflict between themselves and another child, and helping children to see how they could solve problems in a different way.

Hong and Broderick (2003) describe using IVR in two preschool classrooms of children aged between 2.5 and 5 years old as "one of the most significant tools that we use to generate data to understand the children and to develop an emergent curriculum":

The advantage of IVR is that it provides the continuity for deepening a child's understanding of [an] experience. In this manner, the video frames serve as 'learning tools' for the children's construction of knowledge and the teachers' reflection of this learning (Hong & Broderick, 2003).

Hong and Broderick describe how IVR was used to help Ricardo, a 4-year-old child, develop an understanding that stories have a beginning, a middle, and an end. Ricardo had “written” his story as a sequence of drawings to make a “story map”. As Ricardo and the other children were developing their stories, the teachers challenged the children to think about where the “problems-to-be-solved” were introduced in their stories – that is, where the “middle” of the story was. Ricardo and a teacher acted out Ricardo’s story from his “story map” while another teacher videotaped their role play. Reviewing the video together, Ricardo identified three unresolved “problems” in his story. Ricardo realised his story had only got to the “middle” and that he needed to construct an “end” to resolve the problems that had been set up. Later, Ricardo and the teacher revisited the video footage again with the whole class, and the children discussed the ideas about the beginning, middle, and end of Ricardo’s story. This discussion allowed the children to scaffold one another’s understanding of story parts (Hong & Broderick, 2003).

Jordan (1999) discusses video cameras as just one of several technological tools practitioners can use to engage in co-construction and scaffolding of children’s thinking. Jordan worked in an action research project with four New Zealand early childhood education centres catering for children aged between 3 and 5 years old, to look at how the centres planned for support and scaffolding children’s thinking, and to deliver professional development to support teachers to develop processes and personal skills to do this better. Several different technologies were employed in this process. For example, practitioners used radio microphones, tape recorders, and video to record children’s dialogues, and their own conversations with children, as they engaged in their everyday activities in the centre:

The process of listening to their own dialogues with children was a powerful tool for change for the teachers. The teachers realised that they needed to provide more spaces for the children to talk. They also needed to listen to what the children were saying, to encourage children to listen to each other, and often, themselves, be silent (Jordan, 1999).

Teachers also realised they needed to do more to identify and build from children’s interests in their planning. Computers were used as a support in this process in three ways. First, the computer was used in conjunction with the video camera to print out still photos from the video recordings of children’s activities. Children could be involved in selecting which shots to print, and these became the focus for small-group discussion. Second, the computer was useful as a source of knowledge related to children’s interests (for example, from the Internet or encyclopedia CD ROMs loaded onto the computer). Finally, the computer was used as a support for recording teachers’ planning processes – for example, recording planning cycles for individual children, or referring to or transferring relevant material from an electronic version of *Te Whāriki* into each child’s planning records.

Video feedback has been used as a professional development tool for practitioners to research and critically evaluate their interactions with children. In one New Zealand study, Haggerty (1998) used video feedback over a 9-month period with practitioners in five early childhood education centres, to help practitioners to reflect on practice in their centres, and to consider these in relation to *Te Whāriki*. A Swedish intervention study (Pramling, 1996), involved staff from three early

childhood education centres, focused specifically on raising practitioners' awareness of the development and needs of very young children, (aged between 1 and 4). Practitioners were involved in a 1-week professional development programme about children's perceptual, emotional, cognitive, and social development. Practitioners were periodically videotaped over the next 18 months as they interacted with children in their early childhood education settings. They reviewed this footage to examine how their interactions with these children aligned with the understandings they were developing through their professional development programme. Pramling describes the video recordings and their analysis as "a very powerful educational tool" for the practitioners. Pramling found measurable changes to practice as a result of the project. Practitioners interacted much more with children by the end of the programme than they had at the beginning. They became more able to take the child's perspective and get the child to think, reflect, and verbalise, and allowed activities to be more child-led and less adult-led. There were also more instances where the children themselves were the initiators and extenders of conversations with adults.

At Pen Green centre in the UK, ICT featured in a strategy to help parents learn about the early childhood curriculum, and to engage with issues about child development. The centre ran a series of sessions for parents to learn about key concepts in child development, and a CD ROM was also available for parents to explore these key concepts on their own (Whalley et al., 2001).

Using ICT to build or strengthen networks between early childhood education centres

As well as providing tools for learning, reflection, and communication within an early childhood education setting, ICT creates opportunities for building or strengthening networks among the wider early childhood education community. These can include both face-to-face networks and networks that use ICT to support communication and sharing of information (for example, using email or videoconferencing technology).

Wilson et al. (2003) discuss the benefits of the collaborative network established amongst Southland kindergartens as they explored possibilities and practices for using ICT in their own kindergartens:

The opportunities for teachers to get together and problem solve, brainstorm and talk and discuss and discuss and talk were invaluable. What teachers were able to learn from each other was amazing (Wilson et al., 2003, p. 40).

An action-research project in Finland looked at 20 preschool and primary school teachers' evolving capabilities in the use of ICT as the teachers learned to construct digital (Internet-based) portfolios (Kankaanranta, 2001) to document and reflect the goals, practices, and daily life in their early childhood education centres. The point of putting portfolios on the Internet was to promote direct communication and collaboration amongst teachers at different centres. Kankaanranta (2001) reported that the teachers were eager to find possibilities for displaying and sharing their work and experiences with others, and were also interested in using ICT to build collaborative

bridges between different early childhood education settings, and between early childhood education settings and primary schools. This was their primary motivation for wanting to be part of the project. Kankaanranta does not report whether permission and security protocols were established regarding the publishing of information about children and their learning on the Internet. In New Zealand, principles for the collection, use, and disclosure of personal information about individuals are laid out in the 1993 Privacy Act, and original material created by individuals is also protected by the 1994 Copyright Act. The Ministry of Education has published a guideline for schools about online publication of student images and schoolwork which takes these two Acts into account (Ministry of Education, 2000).

Yost (2001) describes a project in which she and her kindergarten class in Pennsylvania established daily web-based videoconference interactions with a kindergarten class in Illinois. Yost and her Illinois colleague decided videoconferencing would be used to extend the classes' existing interest in weather reporting. Prior to the project, Yost felt that the children had some difficulty understanding concepts of time and distance, and the fact that not everyone experiences the same weather (or night and day) at the same time. In the build-up to the videoconference, Yost located a website with live webcams in different US states. Each day one child in the class would pick a state, and locate a webcam shot they liked. The page was left up for children to look at as a group, and then on and off during the morning. Over time the children were able to see that daytime and weather was different in other places. Finally, the two kindergarten classes used videoconferencing to exchange weather reports with one another, to ask each other questions, and get to know children at the other location. During the year, the classes shared many stories, answered many questions about each other, and even shared portions of special programmes each class was preparing. Yost felt that the videoconferencing and other Internet technologies provided an excellent opportunity for the children to construct new understandings of weather in ways not available to them without the technology.

Taking a thematic approach to ICT use in the early childhood classroom

Yost's example above illustrates ICT use embedded within a particular classroom "theme" (learning about the weather). In another American kindergarten, teachers linked the use of CD ROMs and other software loaded onto the classroom's computer centre directly to unit themes and literature that was read aloud during whole-group circle time (Labbo et al., 2000). Previously, computer activities had been largely disconnected to other classroom activities, and the teachers had identified problems with children's interactions with the software, and with each other, at the computers. Once teachers were aware of this problem they set out to make better links between the computers and the classroom activities, for example, to use the computers to extend on teachable moments and "spur-of-the-moment" ideas. For example, children became very interested in business cards when one parent sent their business card in as part of a unit on parents' jobs. The children learned how to use Kidpix design software, and with assistance from their teacher, were able to design their own business card for a job they would like to do.

Patterson (2004) suggests that in order to use computers and other ICT in such an “integrated” way, early childhood educators need to be familiar with contemporary learning theories and recognise how these can be linked to the use of ICT. Patterson carried out research in an Auckland early childhood education centre to look at how teachers and children, most aged between 3 and 5, used ICT over a 5-day period as they worked through Patterson’s “Starfish model” for integrating ICT into learning. The “Starfish model” is an information literacy approach developed specifically for early childhood educators to use a co-constructivist approach that integrates ICT as a natural part of the teaching and learning process. This model is based on the possible scenario of a child appearing at mat time with a starfish collected at the beach over the weekend. Using the “Starfish model”, the teacher establishes what the children already know, and then teachers and children progress through stages of an inquiry to find out and communicate their learning about starfish (or whatever topic the children wanted to explore). The model indicates how different forms of ICT like computers, software, the Internet, telephone, and video cameras, can be used (alongside conventional resources like books, drawings, paintings, and people) to support children’s search for information, and communication of their knowledge and ideas.

...in order to use computers and other ICT in an “integrated” way, early childhood educators need to be familiar with contemporary learning theories and recognise how these can be linked to the use of ICT.

Interestingly, Patterson observed that while teachers used ICTs such as audio players, video players and recorders, digital cameras, phones, and faxes “with confidence and in a seamless context”, they showed less confidence or knowledge about how to integrate the computer into children’s learning. Patterson noticed clear differences in children’s engagement with the computers whether they were working unassisted or with an adult:

...when children worked alone they chose more directive, tutor-type software and read-along stories. Sometimes when this type of software was loaded, teachers sat for a short time and assisted with operational concerns or tended to functional needs when passing by (Patterson, 2004, p. 28).

On the other hand, when teachers sat with children and worked with them, children tended to choose more interactive and information-type programs which encourage children to explore, think, and to make sense of material.

Observational data clearly showed that when teachers became involved they directly influenced the learning taking place. They supported problem-solving with children and were able to scaffold emerging interests and understandings (Patterson, 2004, p. 29). Patterson concludes that teachers’ practice needs to be informed by theory and research about how to operate within the “new learning environment” that ICT offers. In particular, they need to know about ways that they can use ICT to develop young children’s information and communication literacy.

4.4 Summary of Section 4

- Without good guidance, examples, and support for their own professional learning, staff will make their own decisions about the nature and extent of ICT use in children’s learning. These decisions are influenced by such factors as teachers’ own level of confidence with computers, and their beliefs about learning and teaching in the early childhood years.
- ICT can be used to support a wide range of practices in early childhood education, with an equally wide range of objectives. The literature does not support notion of a “best practice” model for ICT use in early childhood education, but frameworks for thinking about the quality of ICT in early childhood education settings are helpful for understanding what high-quality practice in the use of ICT might involve.
- These frameworks include considering the physical and technical features of the ICT learning environment, as well as the educational and social features of the learning environment. At a low level of quality (isolation), children have limited access to ICT, and teachers provide little support or scaffolding of children’s learning through ICT. At a high level of quality (immersion), children, supported by teachers, use ICT as a multifunctional tool that is integrated with other activities and themes.
- Case studies show how good use of ICT can emerge from a focus on the social context created by the use of the technology. For example, using ICT to: document, share, and reflect on children’s learning; support critical reflection by children, practitioners, and families; or build or strengthen networks between early childhood education centres. Practitioners can use ICT to support an emergent or constructivist curriculum based on children’s needs and interests.

5. Conditions for effective teacher ICT professional development

The previous section identified several factors that helped early childhood educators learn to develop high-quality use of ICT in their early childhood centres, including the opportunity to experiment and share their experiences with other early childhood educators. This section further discusses conditions for effective teacher ICT professional development.

5.1 Conditions for effective teacher professional development

There is a broad base of research from the school sector which indicates the underpinnings of successful teacher professional development in ICT (e.g. see Littlejohn, 2002; Owen & Lambert, 1996; Yocam & Wilmore, 1994). A synthesis of research indicates that successful approaches:

- involve teachers in setting the professional development and training agendas;
- take place in working classrooms;
- involve small-group collaborations between teachers;
- build on teachers' existing knowledge about curriculum and practice;
- are based on a specific project that teachers plan to implement in their own classroom;
- are linked to educational theory;
- provide time and opportunities to experiment and reflect on new experiences; and
- involve learning ICT skills on a "need to know" basis.

These features of effective ICT professional development share strong similarities with the characteristics of effective professional development recently identified as being linked to enhanced pedagogy and children's learning in early childhood education settings (Mitchell & Cubey, 2003). For example, Mitchell and Cubey found that effective professional development enables participants to investigate and challenge assumptions, change their educational practice, beliefs, understanding, and/or attitudes. It provides theoretical and content knowledge and information about alternative practices, and enables teachers to gain awareness of their own thinking, actions, and influence.

5.2 ICT professional development for early childhood educators

In many countries, access to ICT and ICT professional development for early childhood educators has lagged behind that of the school sector (O'Hara, 2004; Sheridan & Pramling Samuelsson, 2003). This situation is beginning to change as the number of ICT initiatives for early childhood education settings increases. As with some of the case studies described in Section 4, most literature about ICT professional development for early childhood educators stems from specific programmes, projects, and initiatives to introduce ICT into early childhood education centres. This literature indicates the features that make for effective professional development specifically for early childhood educators.

One large-scale example is an Australian professional development programme for early childhood educators that accompanied the implementation of the KidSmart Early Learning Program¹³ in Australia (O'Rourke & Harrison, 2004). In this programme, educators participated in a 2-day introductory workshop, designed to provide a space for educators to develop understandings of ICT that were connected to their existing early childhood education philosophy and pedagogical views. This meant beginning with what educators already confidently knew about the way children learn, then discussing what role ICT and multimedia could play in children's learning, and providing opportunities for the educators to learn about the new technology by playing, talking together, observing each other's work, and working in pairs. Many educators felt that the 2-day workshop had challenged them to see ICT use in a much broader context, but also felt they needed more time and support to begin to integrate ICT into their own centres. To facilitate this process, "research circles" comprising early childhood educators and the professional development providers were formed to explore issues that educators identified as being of concern or interest. These clusters:

...enabled educators to be active researchers in their own teaching situation and to share their ideas and experiences in a professional forum...the facilitation of the research circles provided early childhood educators with access to current research and expertise in ICT and assisted with the ongoing development of site-based action research and case study projects (O'Rourke & Harrison, 2004, p. 13).

In the first year of the programme, 192 educators developed action research case studies in their own centres to explore such issues as gender and ICT use, pedagogy, family involvement and attitudes, equity, appropriate software, and the impact of the computer on teaching strategies. Using this approach, educators in the first phase of the rollout identified areas for the development of additional professional development resources that have been made available to subsequent participants in the KidSmart program and other interested educators. The emphasis on

¹³ This is an initiative of IBM. The project aims to increase the access to technology particularly for children from economically disadvantaged backgrounds. By the end of 2003, the programme was to have donated more than 300 computers to early childhood centres around Australia (O'Rourke and Harrison, 2004).

collaborative knowledge-building, and practitioners sharing their situated learning experiences with ICT with one another, is echoed in other professional development initiatives described in Section 4 (Kankaanranta, 2001, Wilson et. al, 2003).

5.3 Learning to use ICT in early childhood initial teacher education

Studies of initial teacher education in ICT for early childhood teachers support the ideas that teacher learning about ICT should have a strong foundation in educational theory. This means embedding teachers' ICT learning in the context of their developing understanding about children's learning and development. In addition to having opportunities for good theoretical learning about ICT, studies suggest that teachers-in-training also need to see and experience meaningful uses of ICT in real early childhood education settings.

Laffey (2003) studied the perceptions and experiences of pre-service teachers at an American College of Education which infused high levels of technology use across its teacher education courses. The college of education programme drew from a socio-cultural, "apprenticeship" model of learning. The pre-service teachers were immersed in a technology-using environment in which there was ready access to, and high levels of support for, using advanced technology for multimedia and networking applications.

Using surveys, focus groups, and in-depth case studies of the pre-service teachers, Laffey investigated how the teachers came to view the potential use of ICT in their teaching. In-depth case studies with two pre-service teachers, Denise and Carrie, showed that pre-service teachers' field experience made a big difference in the development of their views about how ICT could be part of their relationship with children. For example, both Denise and Carrie had developed considerable ICT skills through their pre-service teacher education courses. However, Denise tended to see the role of computers in a classroom as a tool for typing, that comes between the students and the teacher. She felt her teacher education and field experiences had not prepared her to know what to do with computers in her teaching, or how to use them with children. On the other hand, Carrie's field experiences had included some rich examples of teacher- and student-computer use in the classroom. These experiences had helped her craft an image of her own future classroom as a place in which children may already know a lot about computers, and are excited about using computers, and in which the computers met the needs of children that she felt were critical. For example: bridging the inequalities between children from technology-rich and technology-poor home backgrounds, and giving children a good start in their educational journey.

Laffey (2003, p. 378) concludes that:

...field experiences, especially those that structure first-hand experience with children successfully using technology, are critical to [teachers] appropriating and overcoming resistance to using technology in teaching.

However, beyond their field experiences, Laffey considers that pre-service teachers also need help to plan for how to successfully implement and manage technology in their teaching, for example, by gaining knowledge from peers or working with computer teachers or media specialists in their school, taking continuing education courses, and having opportunities to talk about their field experiences and reflect on the use of technology with children, and the conditions that make it desirable and possible.

Literature suggests that there is likely to be greater integration of ICT in teaching and learning if teachers understand and know how to use ICT in ways which enhance the learning curriculum, and if they have opportunities to communicate ideas and information in new ways using technology (Yelland, Grieshaber, & Stokes, 2000). In order to provide such learning opportunities for teachers-in-training, Yelland et al. (2000) suggest that teacher educators need:

to become aware of the variety of ways in which ICT can complement and extend teaching and learning contexts in new and dynamic ways, rather than be used to perpetuate existing pedagogical strategies that need to be reconceptualised in the information age (p. 95).

Yelland et al. consider that ICT should permeate initial teacher education, and students should have opportunities to use a variety of ICTs to acquire new knowledge, and to interact and communicate with others. They cite courses delivered at Queensland University of Technology as examples.

Pollman (2000), a teacher educator at an American college of education, describes how she introduced technology into two initial early childhood teacher education courses she taught. Pollman's dual aims were first, to help the student teachers become familiar and confident using a range of digital technologies, and second, to help them develop a constructivist approach, in which children's ideas, theories, or questions are incorporated into curriculum planning. In one course, the student teachers were required to use at least two kinds of technology to observe, record, and reflect on children's conversations and activities while they were engaged in "meaningful experiences", and to present these through a panel of photographs and explanatory notes. This could be an area of children's intense interest, a problem the children were solving, or a theory or hypothesis they were building during their play. The student teachers could use conventional, digital, or video cameras, video printers, and computers for this project:

As a result of the assignment, pre-service teachers were able to see themselves as users of technology, ethnographic researchers, and co-constructors [with children] of knowledge (Pollman, 2000, p. 262).

Since the panels were displayed at the early childhood education centre, parents and visitors were also able to explore the meaning and value of children's thinking and exploration.

5.4 Summary of Section 5

- Effective professional development supports teachers to develop understandings of ICT that connect with their existing early childhood education philosophy and pedagogical views.
- Effective ICT professional development incorporates teachers' own aspirations, skills, knowledge, and understanding into the learning context. It provides opportunities for teachers to learn and explore new ways of working in their own early childhood education setting.
- ICT professional development should also stimulate practitioners to reflect on their views and ideas about children's learning and development, and to analyse and question how things are done in early childhood education.
- Features of effective ICT professional development align closely with features of professional development that are known to be effective for enhanced pedagogy and learning in early childhood education settings.
- Effective professional development emphasises collaborative knowledge-building, and practitioners sharing their situated learning experiences with ICT with one another. It provides support networks to help practitioners to be active researchers in their own early childhood education setting, and to access current research and expertise in ICT.

6. Using ICT to support planning, administration, and information management

Sections 3 and 4 have focused on the role of ICT in early childhood education with respect to teaching, learning, and communication between children, educators, and parents. This section considers the additional opportunities for using ICT to support planning, administration, and information management in early childhood education settings.

Today, computers have become a commonplace tool for planning and administration tasks in most kinds of organisations. Although this is likely to be the case in many early childhood education centres, there is less literature about the role and use of ICT for administration and information management in early childhood settings than there is about the pedagogical use of ICT. This may be due to what Bruce and Hogan (1998) call “the disappearance of technology”. This phenomenon occurs when technological tools become so embedded in everyday activity that they start to become invisible.

The main kinds of literature regarding the use of ICT for administration in early childhood education are:

- surveys which inquire about the extent and nature of computer use for administration and learning in early childhood education centres (e.g. Bain, 2000);
- case studies of early childhood education centres where ICT is used for planning, information management, and/or administration (Whalley et al., 2001); and
- reviews or commentaries about various software programs or packages that have been developed to assist with administrative tasks in early childhood education settings (Kalinowski, 1998).

ICT provides two major advantages for administration and information management. First, it provides a way to create and maintain electronic records and databases which are easy to update, amend, and transfer into many different formats. Second, networked and Internet technologies enable the electronic transfer of information between different locations. A few examples in the literature show how these capacities have been used in early childhood education settings.

6.1 Using ICT to create and maintain electronic records and databases within a centre

The notion of ICT use for planning and information management in early childhood education overlaps with some of the “pedagogical” uses of ICT discussed in the previous section. For example, the use of ICT to document, assess, and share children’s learning, can be considered to be part of planning and information management processes in early childhood education settings. The use of ICT to create and share children’s learning stories in some New Zealand early childhood education centres is a good example (Lee et al., 2002; Wilson et al., 2003).

Another example of computer-based information management is visible in literature about Pen Green centre in the UK. As part of an initiative to increase parental involvement in their children’s learning, practitioners and researchers wanted to find out more about the homes and families of the children in their centre (Whalley et al., 2001). The centre collected large amounts of information from parents via interviews and questionnaires and created a database to store this information. Later, staff worked with a researcher to analyse their data to better understand the home and family routines and circumstances of children and parents connected to their centre.

6.2 Sharing information between centres and other organisations and agencies

The *Strategic Plan for Early Childhood Education* (Ministry of Education, 2002) identifies co-ordination between early childhood services and other relevant services as an important aspect of strengthening the quality of early childhood education in New Zealand. Benefits of inter-service and inter-agency collaboration and sharing of information could include being able to identify children who are not participating in early childhood education and introduce them to services, and the collaborative development of resources or systems to enhance children’s transitions from home to early childhood education. The plan indicates the need to improve coherence and continuity of education for children from birth to 8 years of age. The collaborative relationships goal of the *Strategic Plan for Early Childhood Education* aligns with other government goals to integrate service delivery when a number of government agencies are involved (Advisory Group on the Review of the Centre, 2001).

This review found few references in the literature to the use of ICT for sharing of information between different sites and locations in early childhood education, or between government agencies and the early childhood education sector. However, there is some international literature which discusses the computerisation of systems for managing and sharing information between relevant parties involved in the care of children who are looked after by social services. For example, in 1996, a computerised version of a system called “Looking After Children” was introduced in England and Wales (Kerslake, 1998; Steyaert, 1997). The system includes a set of

forms for children of different age groups, and different aspects of children's care, a computer program, and a form for the annual return of statistical information to the Department of Health (Steyaert, 1997). Kerslake describes some difficulties with the implementation of the system, which replaced and extended an existing paper-based system. First was the variety of computer programs and database systems already used by the local authorities who were part of the Looking after Children system, most of which could not readily communicate with one another. Second, most of the database entry was completed by administrative staff. Social work staff, the main target group for the "Looking After Children" system, had little access to computer equipment and few incentives to develop the necessary skills to enter information electronically. The implementation team responsible for the system attempted to solve these difficulties by concentrating on three issues: systems targeting, implementation planning, and synchronicity.

- **Targeting** meant continuing to develop the system as one which not only met management needs for information, but also offered benefits to social workers by making it easy to enter information and produce reports that save on administrative work.
- **Implementation planning** meant establishing common goals between ICT specialists, managers, and those who gather and input data (in this case, social workers).
- **Synchronicity** meant working with central government to help identify a national minimum data set from items within the "Looking After Children" system, and then establishing common data exchange standards to allow for data transfer between systems.

This review found a small amount of literature that discussed specific educational administration programmes used in early childhood education centres. Kalinowski (1998) surveyed the use of childcare administrative software in American child care centres, and reviewed 20 child care administrative programs and nine popular business products. He found that there was no single "best" package, and that child care administrators considered the ability to easily customise their package as the most important feature of an ideal software package. Bain (2000) discusses several educational administration programs designed to meet New Zealand school or childcare centre needs. Bain considers that educational administration programs designed for New Zealand early childhood education settings should be directly related to the *Te Whāriki* curriculum, in the same way that some packages for schools are linked to the New Zealand curriculum and the Ministry of Education's accountability criteria for schools.

6.3 Summary of Section 6

- Although computers and ICT are likely to be used in planning, administration, and information management in many early childhood education settings, there is little research which specifically investigates this aspect of ICT use in early childhood education.
- The notion of ICT use for planning and information management in early childhood education overlaps with some of the “pedagogical” uses of ICT, for example, the use of ICT to document, assess, and share children’s learning.
- ICT provides opportunities for sharing and exchange of information between different services and agencies involved in children’s care and education, although it is difficult to locate examples of this in the early childhood education literature.
- Some relevant messages can be drawn from international literature about computerisation of systems for managing and sharing information about children who are looked after by social services. For example: the need for systems to make it easy to input data, and provide outputs that save on administrative work; the need to establish common goals between ICT specialists, managers, and those who gather and input data; and the need to establish common data exchange standards to allow for data transfer between systems.
- Individual early childhood education centres may be using a variety of business and education administration packages. This may offer flexibility for individual centres to customise packages for their specific needs. However, it may also reduce the ease of communication and exchange of information between different systems and different locations.

7. Current use of ICT in New Zealand early childhood education centres

The previous sections of this review have discussed the role and potential of ICT in early childhood education to strengthen various aspects of practice, and identified examples of high-quality use of ICT in early childhood education settings. One theme from the literature is that to cultivate high-quality practice in ICT use in early childhood education, it is important to connect with the existing situations, needs, and aspirations of educators, and to identify the issues for existing access and use of ICT, in the early childhood education setting.

This section reports findings from the NZCER 2003 national survey of early childhood education centres,¹⁴ which provide a recent national picture of current ICT provision and use in centres across New Zealand. Case studies of ICT use in New Zealand early childhood education settings reported in earlier sections of this review (e.g. see Bain, 2000; Haggerty, 1998; Jordan, 1999; Lee et al., 2002; Patterson, 2004; Wilson et al., 2003) suggest that some centres are beginning to use ICT for a range of purposes. These include: to document and share children's learning; to strengthen the involvement of families and whānau in children's learning; and to support planning, information management, and administration. To what extent are the experiences of these centres similar or different to those of other early childhood education centres? The data reported in this section looks at issues including staff access to ICT, children's use of ICT, the use of ICT to support teaching and learning, staff professional development, and the use of ICT for administration. This section also reports what teachers and managers thought would be the most important elements for a national early childhood education ICT strategy.

7.1 The survey sample

The survey was sent to 532 early childhood education centres, approximately 15 percent of all New Zealand early childhood education centres. The sample was selected to be representative of all the different types of early childhood education service in New Zealand except kōhanga reo. Each centre in the sample was sent one survey for management, and two surveys for teachers.¹⁵ Responses were received from around 50 percent of services, with highest response rates from kindergartens and lowest response rates from home-based services. The survey was completed by

¹⁴ A complete report will be released in late 2004.

¹⁵ Each centre was also sent surveys to be completed by parents and members of parents' committees (where applicable). However, parents were not asked questions about ICT.

242 early childhood managers or co-ordinators, and 402 early childhood teachers. Most respondents were from kindergartens, playcentres, or education and care centres, with around 10 percent from other types of service.

Table 5 **Survey responses by type of service**

Type of service	% of respondents	
	Managers (n= 242)	Teachers (n=402)
Kindergarten	32	39
Education and care centre	44	34
Playcentre	13	15
Other (including organised home-based care, hospital services, and pasifika ECE centres)	10	10

7.2 Access to ICT

Table 6 shows the availability of a range of ICT equipment in the centres. Teachers and managers both had similar levels of access to each of the different forms of ICT. Most managers and teachers had access to a computer in their centre (81 percent of managers, and 75 percent of teachers). According to responses from managers, 40 percent of services have one computer, 25 percent have two computers, 9 percent have three computers, and 7 percent have four or more computers. Over half the managers and teachers had email, Internet access, and digital cameras at their centre, and some have a range of other ICT peripherals including scanners, and video equipment.

It should be noted that playcentres have a significantly lower level of ICT access than other types of early childhood service. Only 9 percent of playcentre co-ordinators have access to a computer at their early childhood service, and most playcentres were unlikely to have email, Internet, digital cameras, or other ICT equipment at their centre. However, playcentre educators were as likely as other teachers to have a computer at home.

Table 6 **Managers' and teachers' access to ICT in the early childhood centre**

Types of ICT ¹⁶	% who have access to this in their early childhood centre	
	Managers (n= 242)	Teachers (n=402)
Computer	81	77
Email	64	52
Internet	59	50
Digital camera	53	54
Scanner	29	25
Video equipment	28	24
Data projector	6	6

Staff ratings of their ICT resourcing and access

Teachers were asked to rate the adequacy of various aspects of ICT availability/access in their centres, on a 5-point scale from “very poor/non-existent” to “very good” (see Table 7). Computer hardware, software, and consumables generally received higher ratings than access to technical support, Internet access, and access to other forms of ICT.

Table 7 **Teachers' ratings of their ICT resourcing and access**

Rating	% of teachers (n = 242)					
	Computer hardware	Software	Computer consumables	ICT technical support	Internet access	Other ICT (e.g. data projector, digital camera)
Very good	24	22	25	10	12	13
Good	23	23	25	17	17	19
Satisfactory	22	18	19	24	19	23
Poor	8	10	6	16	5	12
Very poor/non-existent	21	23	21	26	42	29
No response	2	4	4	7	6	4

Some differences were evident between different types of service. Playcentre educators gave consistently lower ratings of their centres' ICT provision and access than teachers in other kinds of early childhood education setting. For example, over 70 percent of playcentre educators rated their access to hardware, software, computer consumables, ICT technical support, Internet, and other technologies as “very poor/non-existent”. Conversely, 80 percent or more kindergarten teachers gave “satisfactory”, “good”, or “very good” ratings to their access to hardware, software, and computer consumables, and over 60 percent gave this rating to their access to ICT support, and other ICT equipment. Internet access was more variable. Although 65 percent of kindergarten teachers rated their Internet access as “satisfactory”, “good”, or “very good”, 31 percent said it

¹⁶ Other types of technology covered in the survey but not reported in this table include telephones, fax machines, photocopiers, televisions, VCRs and DVD players, and laminators.

was “very poor/non-existent”. Overall, 42 percent of teachers in the survey said their Internet access was “very poor/non-existent”.

In considering what was most important for a national ICT strategy for early childhood education, the element most commonly mentioned by staff was the need for more resources in this area (44 percent of managers and 40 percent of teachers mentioned some aspect of this). Important issues are the provision of ICT, suitable hardware and software for teachers and children, or the funding to buy it, and funding of more teacher time to spend on ICT use and development.

Operating systems and software

Managers were asked what operating system and software was used in the computers at their service. Most managers use Windows, most commonly Windows XP (33 percent), Windows 98 (32 percent), or Windows 2000 (26 percent). A further 6 percent mentioned other operating systems, mainly various other Windows systems such as Windows 95, Windows Millennium ME, etc. Seven percent use a Mac operating system.

Most managers have one or two software packages on the computer, but 30 percent reported three or more packages. The most common packages used are Excel (49 percent), Microsoft Office (48 percent), Word 2000 (38 percent), and Word 98 (25 percent). Seven percent have iMovie capability, most of whom are kindergarten managers (72 percent). Eleven percent mentioned various other software packages, mainly Microsoft Works packages. Also mentioned by one or two people were MS Publisher, Publisher 98, Digimax camera, iPhoto, Photoshop, KidsPix, Art Childcare, Corel Draw, iTunes, Encarta, ACE Payroll, MYOB Accounting and Payroll, Child’s Play, and Acrobat.

7.3 Children’s use of ICT

Children’s ICT use appears to vary considerably between individual early childhood services. Over half the teachers (52 percent) said that children do not use computers at their ECE service, but 41 percent specified two or more types of ICT use. When children do use computers, they work on pattern recognition (31 percent), alphabet recognition (30 percent), or other types of games (33 percent). Information about the specific games or software used by children was not collected, although 9 percent of teachers reported children’s use of graphics programs such as Kidpix. Smaller numbers (5–6 percent) reported children using the Internet to find information, using a computer to write a note or for role play, or using a fax machine to communicate with people outside the centre. Only 4 percent said children used cameras to take photos at home or at the centre, and only 2 percent reported children using email.

Children’s ICT use as reported by these teachers is relatively higher in kindergartens than other services. Kindergarten teachers were responsible for 50 percent of the ICT uses specified, and only 21 percent of the non-use responses. ICT use appears to be very limited in playcentres. The

52 playcentre educators reported only 10 instances of use, and 83 percent of them said that children do not use computers at their service.

7.4 Use of ICT to support children's learning

Teachers were asked how ICT was used to support children's learning. This included the direct question "How do you use ICT for supporting children's learning?", as well as questions about whether ICT was used in activities such as documenting or assessing children's learning.

Supporting children's learning

Most teachers (75 percent) identified more than one way they use ICT to support children's learning. Over half the teachers use ICT for creating portfolios/profile books (67 percent), documenting children's learning (63 percent), or developing resources (57 percent). Playcentre educators were more likely, and kindergarten teachers less likely, to say that they do not use ICT to support children's learning. Eighteen percent of teachers said they do not use ICT to support children's learning

It is difficult to identify the degree to which children themselves are involved in the use of ICT for the purposes described above. Smaller numbers said they used ICT to support children's learning by helping children to use ICT (31 percent), supervised children so they take fair turns (29 percent), used it for promoting social interactions (28 percent), or helped children to revisit and reflect on documentation of their previous work (26 percent). In all of these four areas, kindergarten teachers were particularly highly represented, and playcentre educators were underrepresented.

Documenting children's learning

The high percentage of teachers who reported having a digital camera in their centre aligns well with a finding that photography, either digital or conventional, is widely used as a means of gathering data about children's learning in New Zealand early childhood centres. Ninety percent of teachers reported doing this. Amongst other ICT-assisted methods of gathering data about children's learning, photography far outweighed the use of video recordings (13 percent) or audio recordings (4 percent).¹⁷

¹⁷ Other methods used to gather information about children's learning include conversations with children (90 percent), collecting examples of children's work (89 percent), discussion among teachers/educators (87 percent), and consultation with parents (86 percent).

7.5 Use of ICT to communicate with parents, caregivers, and whānau

Seventy-eight percent of respondents use ICT to produce newsletters, pamphlets, or notices. Fifty-five percent use it to make learning visible via documentation, and 24 percent record and document parents' or whānau views. Kindergarten teachers are more likely than teachers in other services to use ICT for these last two purposes. Fourteen percent of teachers do not use ICT to communicate with parents.

7.6 Staff use of ICT for their own learning

Table 8 shows the most common ways staff reported using ICT for their own learning. For both managers and teachers the most common learning uses reported are directly concerned with preparation for teaching, for example, finding information about a topic (61 percent), searching for teaching and learning resources (54 percent), and seeking new ideas and inspiration (40 percent).

More managers than teachers use computers to communicate with others in the sector (58 percent versus 40 percent respectively), and to find out about professional development opportunities such as courses, seminars, and conferences (35 percent versus 22 percent). More teachers than managers said they did *not* use a computer for their own learning (19 percent versus 7 percent).

Table 8 **Staff use of ICT for own learning**

	% of respondents		
	All staff (n=644)	Managers (n= 242)	Teachers (n=402)
Finding information about a topic	61	65	58
Searching for teaching and learning resources	54	52	52
Communicating with others in the sector	47	58	40
Seeking new ideas and inspiration	40	42	38
Finding out about professional development opportunities such as courses, seminars, and conferences	27	35	22
Don't use a computer for this purpose	14	7	19

Staff were asked how they would like to receive professional development (of any kind). Eighty-nine percent would like to receive professional development face-to-face. Twenty percent would like to use distance learning, 17 percent e-learning or using the Internet, and 4 percent video-conferencing.

7.7 Staff readiness and confidence to use ICT

Most staff did not indicate that a lack of knowledge or confidence to use ICT was a problem they encountered with ICT equipment or use. Between 20 and 32 percent of teachers and managers felt they had insufficient knowledge of how to use ICT equipment, a lack of confidence in using ICT equipment, or an insufficient knowledge of appropriate software. A smaller number of staff (11–12 percent) felt they had an insufficient knowledge of how to evaluate the usage of ICT and its role in ECE settings (*see* Table 9).

Table 9 **Problems with teachers’ and managers’ readiness to use ICT**

Problem	% of respondents		
	All staff (n=644)	Managers (n= 242)	Teachers (n=402)
Own lack of expertise with ICT	27	32	23
Insufficient knowledge of software	21	23	20
Lack of confidence using the equipment	21	20	22
Lack of knowledge of how to evaluate the role of ICT in early childhood settings	11	12	11

Eighteen percent of staff indicated that their budgets are insufficient to support the running costs of ICT equipment. Ten percent of managers, and 18 percent of teachers, said that their early childhood education service does not place a high priority on ICT usage.

7.8 Support and professional development

Managers were asked what ICT support was available to them. Fifty-five percent can get support from staff with ICT knowledge or expertise, 45 percent from parents or whānau, and 38 percent from a Helpdesk facility. Eight percent mentioned other types of support, mainly various courses and professional development opportunities (5 percent).

Thirty-two percent of managers and 20 percent of teachers said they had had some form of ICT skills professional development within the last 12 months. Thirty percent of managers and 23 percent of teachers said they intended to engage in professional development to upgrade their ICT skills in the coming 12 months.

Some staff commented in an open question that an ICT strategy for the early childhood education sector should provide for staff ICT professional development. Twenty-eight percent of staff said that initial and ongoing training should be provided for staff in ICT use, with some specifically mentioning the need for professional development relating specifically to the educational uses of ICT and software. For example:

Training for educators to use ICT with young children.

Relevant research material on the subject.

Supplying NZ based educational computer programs suitable for working with *Te Whāriki*.

7.9 Technical problems with ICT use

Some teachers and managers identified technical problems with ICT use, including problems with the functioning of the equipment (16 percent), lack of suitable hardware (15 percent), inadequate technical support (14 percent), or lack of Internet access (11 percent). These figures are low, but may indicate low levels of use of computers within some centres.

Table 10 **Technical problems with ICT use**

Problem	% of respondents		
	All staff (n=644)	Managers (n= 242)	Teachers (n=402)
Functioning of equipment	16	14	18
Lack of suitable hardware	15	10	17
Inadequate technical support	14	11	15
Lack of Internet access	11	7	13

Seventeen percent of staff noted that a national ICT strategy for early childhood education should provide for adequate and accessible technical support and information. Different methods for doing this were suggested, for example, telephone helplines, itinerant ICT tutors to visit centres, and providing a programme for one person from each centre to become their centre's ICT facilitator.

7.10 Use of ICT for administration

Forty-one percent of managers reported that they have an Early Childhood Management System in use at their ECE service. Forty-nine percent of managers do not have a system in use, and 10 percent did not answer this question. A range of different packages was reported. The most commonly used packages are APT Business Solutions Ltd (Ver. 5) (15 percent of all managers) and Skagerrak Software Ltd (FirstBase V3.Ob23) (11 percent). Very small numbers (less than 2 percent each) use the following packages – Kidiwinks, Child's Play, Sumner Software Childcare, MYOB, NZA Gold, Cash Manager, MUSAC, ACE Payroll, Auckland Kindergarten Association Rightstart, Wellington Free Kindergarten Association system, KIDS Database, Sollies Database, and self-developed systems.

APT Business Solutions Ltd (Ver. 5) is mainly used by education and care services, and Skagerrak Software Ltd (FirstBase V3.Ob23) is mainly used by kindergartens. No playcentre

managers reported using a management system. Education and care service managers were more likely than other groups to use a system.

Just under 10 percent of managers specifically commented on the need for an ICT strategy to include as one of its most important elements ICT uses for administrative, database, and record keeping purposes. A few managers said that a uniform system across their sector is an important issue.

7.11 Summary of Section 7

Of the 242 early childhood education managers and 402 early childhood education teachers surveyed by NZCER in 2003:

- Most early childhood education centre managers and teachers have access to a computer in their centre. Over half of managers and teachers have email, Internet access, and digital cameras at their centre, and some have a range of other ICT peripherals.
- Playcentre managers and teachers reported much lower levels of ICT access in their centres than other kinds of centre, particularly kindergartens. Kindergarten teachers gave higher ratings for their access to ICT hardware, software, and computer consumables than teachers at other kinds of centres. Education and care centres seem to fall somewhere in between.
- Internet access varies between centres. Overall, 42 percent of teachers surveyed said Internet access at their centre was very poor or non-existent.
- Children's ICT use appears to vary considerably between individual early childhood services. Over half the teachers (52 percent) said that children do not use computers at their ECE service. However, 41 percent specified two or more types of use. The most common reported uses are pattern recognition, alphabet recognition, or other types of games. Very small numbers of teachers reported children using graphics programs, using the Internet to find information, using a computer to write a note or for role play, or using fax or email to communicate with people outside the centre.
- Teachers reported using ICT to support children's learning in several ways, mainly related to documentation and assessment of children's learning, or the creation of resources. Ninety percent of teachers used photography (either digital or conventional) to gather information about children's learning. However, less than 30 percent mentioned use of ICT to help children to revisit and reflect on documentation of their previous work.
- Staff mainly use ICT to communicate with parents, caregivers, or whānau by producing newsletters, pamphlets, or notices. Just over half use ICT to make children's learning visible to parents or whānau through documentation, and just under 25 percent record and document parents' or whānau views.
- The most frequently named problems staff reported with ICT use related to their own expertise, knowledge, or confidence to use ICT, although the percentages of teachers who indicated these were problems was relatively low. These problems were generally more common than technical problems with equipment or access.
- Teachers and managers thought the most important elements for a national ICT strategy for early childhood education were: more resourcing for the provision of ICT; suitable hardware and software for teachers and children, or the funding to buy it; and funding of more teacher time to spend on ICT use and development. Some staff felt that the ICT strategy should provide for staff ICT professional development, including professional development relating specifically to the educational uses of ICT.
- Forty-one percent of managers use an Early Childhood Management System at their ECE services. Some managers specifically commented on the need for an ICT strategy to encompass ICT use for administrative, database, and record keeping purposes, and said that a uniform system across their sector is an important issue.

8. Discussion and conclusion

This section summarises key findings from this review of international and New Zealand literature about the use of ICT in early childhood education. It discusses the implications of these findings for future development in ICT in early childhood education, and identifies gaps in the literature and areas for further research.

Before reviewing the key findings from previous sections, it is worth noting the general finding that literature which explores the *potential* of ICT in early childhood education is more common than research which evaluates its *role* in early childhood education. This is consistent with other reviewers' findings (Stephen & Plowman, 2002). As noted in Section 2, this may be because ICT use in early childhood education is relatively new, and not necessarily widespread.

At least two key trends are evident in the literature over time. First, there has been a shift towards viewing the role of ICT in early childhood education within a socio-cultural context. Older studies tended to focus narrowly on the interactions between children and ICT, and sought to identify the effects, positive or negative, of computer use for children's learning and development. Recent literature tends to focus on the role of ICT as a tool for enriching the learning environment, for example, enabling educators to support and scaffold children's early childhood education experience, to investigate and build learning experiences from children's interests, or to strengthen relationships between children, educators, and families. Second, the kinds of ICT discussed in relation to early childhood education have broadened beyond just computers, to encompass a wide range of digital resources including digital cameras, programmable toys and devices, the Internet, email, and other information and telecommunication devices. These technologies offer a wide range of possibilities for people involved in early childhood education. Ongoing research will be needed to evaluate the impacts of these technologies for children's learning in early childhood education, as well as their impacts for early childhood education practice in general.

8.1 Key findings from the review

ICT and young children

A large proportion of the literature about ICT in early childhood education concerns questions about the positive and/or negative consequences of young children's use of ICT (mainly computers). Key findings from this review are as follows:

- Some authors have expressed the view that computer/ICT use is not appropriate for young children's cognitive, physical, social, and emotional development. However, there is no clear evidence to support this claim, and this view has increasingly been replaced by the view that, when used appropriately ICT can be a useful tool for supporting young children's learning and development.
- Most authors note the need to be aware of health and safety issues around children's use of ICT and for these to be part of early childhood education centre ICT policies and practices. This includes: attention to children's physical and ergonomic safety; being mindful against children's exposure to inappropriate content (e.g. games or Internet-based material of a violent or sexual nature, or containing undesirable gender or cultural stereotypes); and protection of children's privacy (e.g. in online environments, or when information is published on the Internet).
- Studies suggest that ICT use can provide a context for collaboration, co-operation, and positive learning experiences between children, or between children and adults. However, this will not necessarily happen just because the ICT is present in the early childhood education setting. Practitioners must be conscious of the kinds of learning interactions they would like to occur in the context of ICT use (including between adults and children, or between children), and adopt pedagogical strategies to support these.
- Case studies show that ICT can be used to support aspects of learning including language development and mathematical thinking, and can also provide unique opportunities for scaffolding and supporting learning for children with special learning needs, and children from diverse cultural or language backgrounds. ICT provides a variety of ways for children to weave together words, pictures, and sounds, thereby providing a range of ways for children to communicate their ideas, thoughts, and feelings. Good software can allow children to engage in self-directed exploration, and can be tailored to children's individual needs, and assistive/adaptive ICTs can reduce barriers to participation for children with special physical or learning needs.

Using ICT to enhance the early childhood learning environment

Literature which explores how ICT can enhance the learning environment in early childhood education highlights the following key findings:

- The value that ICT can add to young children's learning environments depends on the choices practitioners make about which tools to select, and when and how to use these; and their understandings about how these tools can support children's learning, development, and play.
- To make these choices, practitioners need to be familiar with various tools and what they can do. They also need to be familiar with contemporary theories about learning and development, and recognise how these can be linked to the use of ICT. New kinds of practices may be

needed, for example, to support young children to develop information and communication literacies necessary for learning in ICT-enriched environments.

- Case studies show how early childhood education practitioners have used ICT to support a range of practices they believe to directly or indirectly support children's learning and development. These include: directly supporting and scaffolding children's use of ICT; using ICT to document and assess children's learning and activities; using ICT to reflect on children's and educators' interactions in the early childhood education setting; using ICT to build curricula from children's interests, ideas, and experiences; and using ICT to strengthen and support family involvement in children's learning.
- Case studies of the integration of ICT into early childhood education practice are often written by practitioners, and provide recommendations and suggestions for other practitioners based on what they have learned. Seeing real examples of ICT-integrated practice in early childhood education settings appears to be important for supporting practitioners to develop understandings about how ICT can be part of their own practice.

Effective ICT professional development for early childhood educators

Without good guidance, examples, and support for their own professional learning, staff will make their own decisions about the nature and extent of ICT use in children's learning. These decisions are influenced by such factors as teachers' own level of confidence with ICT, and their beliefs about learning and teaching in the early childhood years. Literature about ICT use in early childhood education settings, and studies of teachers and teachers-in-training learning to use ICT, highlight these key findings about effective professional development for early childhood educators:

- Effective professional development supports teachers to develop understandings of ICT that connect with their existing early childhood education philosophy and pedagogical views.
- Effective ICT professional development incorporates teachers' own aspirations, skills, knowledge, and understanding into the learning context. It provides opportunities for teachers to learn and explore new ways of working in their own early childhood education setting.
- Effective ICT professional development stimulates practitioners to reflect on their views and ideas about children's learning and development, and to analyse and question how things are done in early childhood education.
- Effective professional development emphasises collaborative knowledge-building, and practitioners sharing their situated learning experiences with ICT with one another. It provides support networks to help practitioners to be active researchers in their own early childhood education setting, and to access current research and expertise in ICT.

The use of ICT for administration and information management in early childhood education

Although computers and ICT are likely to be used in planning, administration, and information management in many early childhood education settings, there is little research which specifically investigates this aspect of ICT use in early childhood education. Similarly, ICT provides opportunities for sharing and exchange of information between different services and agencies involved in children's care and education, but it is difficult to locate examples of this in the literature. However, key findings from the available literature include the following:

- The notion of ICT use for planning and information management in early childhood education overlaps with some “pedagogical” uses of ICT, for example, the use of ICT to document, assess, and share children's learning with children and their families.
- Some relevant messages can be drawn from international literature about computerisation of systems for managing and sharing information about children who are looked after by social services. For example: the need for systems to make it easy to enter information and produce reports that save on administrative work; the need to establish common goals between ICT specialists, managers, and those who gather and input data; and the need to establish common data exchange standards to allow for data transfer between systems.
- Individual early childhood education centres may be using a variety of business and education administration packages. This may offer flexibility for individual centres to customise packages for their specific needs. However, it may also reduce the ease of communication and exchange of information between different systems and different locations.

ICT access and infrastructure in New Zealand early childhood education settings

Individual New Zealand studies of ICT use in early childhood education, and NZCER's national survey of early childhood education services, indicate the following key findings:

- Current ICT use in early childhood education centres seems variable. While some centres have begun to use ICT extensively to support children's learning, other centres report little or no use of ICT by children, or use of ICT to support children's learning.
- Access to computers and other ICT varies between different kinds of centres. In general, kindergartens seem to be better-equipped and resourced than playcentres. Education and care centres seem to lie somewhere in between. There is insufficient data to comment on the adequacy of ICT access and resourcing in other kinds of early childhood education settings.
- Some New Zealand practitioners have identified a need for access to technical and advisory support in relation to ICT, particularly computer use.
- One of the most common uses of ICT in New Zealand early childhood education settings relates to documentation of children's learning. Over half of the teachers surveyed by NZCER in 2003 reported they had access to a digital camera in their centre.

- Some early childhood education centres have used digital photography and other digital media to build up electronic or physical portfolios of children's learning for assessment purposes, and to share with children and their families.
- Just under half of centre managers surveyed by NZCER do not use a computer package for administrative purposes. Those who do use a range of educational and business packages.

8.2 Implications of these findings for further development of ICT in New Zealand early childhood education

The findings of this review suggest that further development of ICT in New Zealand early childhood education should promote a view of ICT as a tool for enriching the teaching and learning environment in early childhood education. Decisions about how to use this tool should be consistent with the principles, strands, and goals outlined in *Te Whāriki*. Further ICT development within the sector could be connected to areas already valued within early childhood education in New Zealand, for example, the use of multimedia to document and share children's learning, strengthen relationships between educators and families, and forge stronger connections between the early childhood education setting and children's home and other learning environments.

Practitioners need to understand and make good use of ICT to support children's learning, to communicate with others, and for their own learning. Effective initial teacher education and ongoing teacher professional development should be considered as key tools for supporting the development of practitioners' understanding. Features known to be effective for professional development and teacher education offer a useful basis for identifying approaches to such professional support for ICT (Mitchell & Cubey, 2003).

Access to research evidence about workable approaches to using ICT for teaching and learning in early childhood settings would offer a valuable resource to practitioners. The literature indicates that practitioners find it useful to learn from other practitioners and share their own learning experiences with ICT in early childhood education. It may be useful for people involved in action research in early childhood education, including ICT, to share information about their research and its findings, and to publish research findings in accessible forms. Coordination of New Zealand research and dissemination of research within the sector could help to make research more accessible, and this could include processes to ensure that the information and evidence available to practitioners are relevant and of good quality.

The 2003 NZCER national survey of early childhood education services highlighted variable access to ICT between different early childhood education centres in New Zealand, and some practitioners expressed the need for access to technical and advisory support in relation to ICT. It would be useful for the sector to consider whether issues of ICT access need to be addressed, and if so, how. Investigation of how services have addressed problems of cost, access, or expertise, and what kinds of external support have helped, may be useful for informing services which currently have low levels of access to and use of ICT.

8.3 Areas for further New Zealand research

This section suggests areas where further New Zealand research could contribute to the development and enhancement of ICT in early childhood education.

Drawing together research on *role* and *learning benefits* of ICT use in New Zealand early childhood education settings

The first area for New Zealand research attention is research which looks at both the *role* and the *learning benefits* of ICT use in New Zealand early childhood education settings.

Currently, New Zealand and international research on the role and impacts of ICT in early childhood education tends to fall into one of three types. The first type of study focuses on identifying the role or impacts of ICT *for children's learning or development*. This can include studies in which ICT is introduced into children's learning environments specifically so that researchers can study their impacts or effects for the children's learning. These studies may investigate children's use of particular software or games, and assess specific aspects of children's learning which the software is intended to support (for example, language development, or development of mathematical thinking). These could be labelled "proof-of-concept" research. Syntheses of such studies (e.g. Clements, 2002) suggest that ICT *can* support children's learning in particular areas, when used or supported in particular ways. Although these studies may take place in early childhood education settings, they do not necessarily describe how (or whether) ICT fits in amongst the range of learning experiences and environments in the early childhood education setting.

The other two types of study focus more specifically on the role of ICT *in early childhood education settings*. This includes:

- (a) non-intervention studies to investigate how ICT is used or perceived by practitioners and children in "average" early childhood education settings (e.g. Bain, 2000; Fletcher-Flinn & Suddendorf, 1998; Graham & Banks, 2000; Learning and Teaching Scotland, 2003a, NZCER's 2003 national survey); and
- (b) case studies of innovative ICT use by early childhood education practitioners (e.g. Labbo et al., 2000; Lee et al., 2002; Pastor & Kerns, 1997; Pollman, 2000; Yost, 2001).

Studies of the first type generally find that although some practitioners may see a potential role for ICT to support children's learning, actual use of ICT with or by children is low, and most practitioners are uncertain about how to effectively integrate ICT into their teaching practice. Case studies of innovative practice usually describe the learning journeys of practitioners who have begun to integrate ICT into their early childhood education setting to support and enhance their learning and developmental goals for children. Often these practitioners have either worked in collaboration with a researcher, or their ICT use is connected with a professional development programme, or they have been provided with ICT as part of a specific programme (e.g. the

Kidsmart Early Learning Programme). In these case studies, educators are often stimulated by the use of ICT, with support from researchers or professional development staff, to question some of their existing ideas about children and their learning, and to identify new ways to support children's learning (e.g. Labbo et al., 2000; O'Rourke & Harrison, 2004; Wilson et al., 2003). This can include allowing children to take more responsibility and leadership in their learning and activities, or finding new ways to build learning experiences from children's ideas and interests.

Two areas for further New Zealand research are:

- (1) How do early childhood educators in New Zealand make the transition from non-use or uncertain use of ICT (in their practice), to using ICT to enrich the early childhood learning environment? What kind(s) of support is needed for this process? One approach which the literature suggests is effective is to establish cluster groups of practitioners, supported by researchers and professional development staff, to discuss, experiment, and research their own practice as they learn to use ICT in their early childhood education setting (O'Rourke & Harrison, 2004, Wilson et al, 2003). Is this approach possible/practical for all New Zealand early childhood education settings? Are there other approaches that would work for different kinds of early childhood education services?
- (2) In early childhood education settings where "ICT is enriching the learning environment", how does this enriched learning environment impact or enhance children's learning and development? Research in this area should include attention both to children's cognitive learning, and the learning goals and strands emphasised in *Te Whāriki*. That is, research to investigate how ICT use in these early childhood education settings supports both children's language development/mathematical thinking/information literacy *and* children's wellbeing, sense of belonging, opportunities to contribute to their learning environment and experiences, ability to communicate and express their views, ideas, and feelings, and active exploration of, and thinking and reasoning about, the natural, social, physical, and material worlds.

Children's and families' experiences of ICT in the early childhood education settings, and the role of ICT for connecting children's home and early childhood education setting experiences

Another area where further New Zealand research could focus is on children's and families' views and experiences in relation to ICT in early childhood education. Some international studies have looked at the relationships between children's home lives and experiences, and how this may interact with their experiences with ICT in the early childhood education setting (e.g. Brooker & Siraj-Blatchford, 2002; Downes, 2002). There is much anecdotal evidence to suggest that ICT can play a role in increasing parental involvement in children's learning in the early childhood education setting (including involvement in planning and assessment), and enhancing teachers' understanding of children's home experiences, activities, and learning (Lee et al., 2002; Whalley & the Pen Green Centre Team, 2001; Wilson et al., 2003). Further New Zealand research to

investigate the role and use of ICT in strengthening relationships between home and centre could demonstrate useful practical approaches and also raise any issues specific for the New Zealand context. Research in this area should include investigation of children's and families' perceptions and experiences, as well as those of practitioners.

Research is also needed to identify what differences in New Zealand children's home and family experiences might be significant for planning for the use of ICT in early childhood education settings. For example:

- How do children's different levels of experience with ICT at home impact on their experiences of ICT in the early childhood education setting? How might early childhood educators promote the use of ICT amongst all children? While there is some international literature in this area (Brooker & Siraj-Blatchford, 2002), research in a New Zealand context would be useful.
- How could ICT be used in New Zealand early childhood education settings to provide additional learning support for New Zealand children from different cultural/language backgrounds, or children with special learning needs? What existing tools and resources are available, and how can these be used? Do any new tools and resources need to be developed for New Zealand?
- How could ICT be used to provide greater links and continuity between children's home and family lives, and the early childhood education setting? For example, digital photography and other forms of multimedia could be used as a way of bringing elements of children's home experiences/cultural backgrounds into the early childhood education setting. Visual and audio recordings could be particularly helpful when English is not the main language spoken at home.

Research on the contribution of ICT to children's thinking and language use

Another area for New Zealand research is in how ICT use by children can contribute to children's thinking and language use. This could be designed as an intervention study aimed at developing children's use of ICT to communicate with others, and investigate and think about their experiences. Possible research questions are:

- What ICT tools, used in what ways, support various aspects of children's communication, thinking, and language use?
- What social contexts support this kind of learning with ICT?
- What kinds of adult support and scaffolding fosters and sustains effective learning with ICT for children?

Research about the use of ICT for administration and planning, and information sharing between early childhood education services and other agencies

There is little New Zealand research about the role or use of ICT for administration and information management in New Zealand early childhood education settings. Finally, there is little evidence about the use of ICT for sharing information between early childhood education services where the child attends more than one service or moves from one to another, between early childhood education services and schools, and between early childhood education services and agencies and organisations working in the child's interests (such as health organisations). Further investigation of ways to use ICT to strengthen information sharing across settings could provide useful information and understanding.

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Appendix 1: Literature review methodology

This literature review was commissioned in March 2004, and was completed in early September 2004. Sources used for the review include books, research reports, journal articles, and educational policy and curriculum documents. A number of New Zealand and international electronic library databases were searched using the list of keywords shown in Table 11. The full abstracts of search hits were examined, and books and articles that appeared relevant were retrieved. The search focused primarily on materials published within the last 5 years. The Ministry of Education also provided an annotated bibliography of books, chapters, and journal articles held in Ministry of Education libraries and several of these were retrieved for the review. The search strategy also included Internet searches.

Representatives from the early childhood education sector were also asked to provide assistance in locating New Zealand literature. A letter was distributed to sector representatives who attended a Ministry of Education consultation meeting on 25 March 2004.

Table 11 Electronic database searches for literature on ICT in early childhood education

Electronic databases searched	Keywords and search terms used
NZCER Library catalogue	(e-learning or ICT or information technology
INNZ (Index New Zealand)	information communication or computer(s) or laptop)
Te Puna (books held by NZ libraries)	AND
AEI (Australian Education Index)	(Early childhood or daycare or preschool(s) or
ERIC (U.S. database)	childcare or playcentre or kohanga reo or
OCLC (A collection of databases including ERIC and	language nest or kindergarten(s) or nursery
Electronic Collections Online)	school(s) or nursery class(es))
	Additional searches under subject headings:
	"Early Childhood Education" and ("Computer Uses in
	Education" or "Computer assisted teaching")

Appendix 2: Sources for further information

The sources below list some easily-accessible readings about ICT in early childhood education for those working in the early childhood education sector. For further readings, please consult the reference list for this review.

Some general key documents for early childhood education in New Zealand are listed in the last section of this appendix.

All weblinks were active at 25 August 2004.

ICT-related books and articles

New Zealand books and articles

Bain, J. (2000). Managing computers in teaching and administration in kindergartens. *Computers in NZ Schools*, 12 (1), 21–32.

Bain comments on the potential of ICT to contribute to early childhood education, and reports findings from a survey of ICT use in 15 Dunedin kindergartens.

Lee, W., Hatherly, A., & Ramsey, K. (2002). Using ICT to document children's learning. *Early Childhood Folio*, 6, 10–16.

The authors show how ICT can enhance learning stories and benefit children, families, teachers, and the early childhood curriculum. Examples from Roskill South Kindergarten are included. To order copies of Early Childhood Folio, contact New Zealand Council for Educational Research. Ph: (04) 802 1457 or email tanu.kapoor@nzcer.org.nz.

Patterson, M. (2004). How can ICT enrich the learning environment in early childhood centres? *Computers in NZ Schools*, 16 (1), 25–30.

Patterson describes a research project in an Auckland early childhood centre which investigated how ICT could enrich the learning environment, using the “Starfish Model”. This model was developed to provide scaffolding for early childhood teachers to take a co-constructivist approach to teaching. The approach integrates ICT as a natural part of the learning and teaching process to assist young children to develop information literacy skills.

Wilson, P., Clarke, M., Maley-Shaw, C., & Kelly, M. (2003). "Smile, you're on digital camera!" Collaboration between communities, children, and computers. *Early Education*, 33, 39–46.

The authors describe the learning experiences of teachers from Southland Kindergartens who received a grant from the Community Trust of Southland to purchase computers, printers, and digital cameras in 2002.

International books and articles

O'Hara, Mark. (2004). *ICT in the early years*. London: Continuum.

This easy-to-read book, published in the UK, demonstrates how ICT can be used to motivate, excite, and enthuse young children in their learning. O'Hara also addresses common concerns voiced by early childhood practitioners. Providing guidance on all aspects of teaching using ICT, this invaluable book demonstrates how ICT can be used to great effect in the early childhood classroom.

Stephen, C., & Plowman, L. (2003). ICT in pre-school settings: Benign addition or playroom revolution? *Early Childhood Folio*, 7, 33–38.

This article summarises findings from a 2002 Scottish review of literature about the use of ICT in early childhood education settings. Stephen and Plowman comment on pedagogical issues around supporting children's use of ICT, and make recommendations about the kinds of support and professional development needed to foster effective integration of ICT into early childhood education. To order copies of Early Childhood Folio, contact New Zealand Council for Educational Research. Ph: (04) 802 1457 or email tanu.kapoor@nzcer.org.nz.

Whalley, M. (2001). *Involving parents in their children's learning*. London: Sage Publications.

This book is essential reading for early years practitioners who wish to understand how to engage parents in their children's learning. It describes Pen Green Centre in the UK, which developed a range of strategies to develop collaborative relationships with

parents. ICT featured in these strategies, particularly parents' and teachers' use of video to analyse children's learning experiences at the centre and in their homes.

ICT-related websites

New Zealand

Ministry of Education: <http://www.minedu.govt.nz>

Select "Early Childhood" on the navigation bar on the left-hand side of the screen. The site includes a range of information and downloadable documents including Te Whāriki and the Strategic Plan for Early Childhood Education.

NetSafe, the website of the Internet Safety Group of New Zealand: <http://www.netsafe.org.nz>

NetSafe provides cybersafety education and information for all New Zealanders, including children, parents, schools, community organisations, and businesses.

International

BECTA ICT advice for teachers: <http://www.ictadvice.org.uk/index.php>

This British site provides ICT information and advice for teachers from Foundation stage to secondary school level. Select "Foundation curriculum" on the navigation bar on the right-hand side of the screen to find advice, ideas for activities, and case studies of ICT use in early childhood centres.

Developmentally Appropriate Technology in Education (DATEC):

<http://k1.ioe.ac.uk/cdl/DATEC/datecfm1.htm>

This website includes curriculum guidance and exemplars of the use of ICT in early childhood settings in the UK, Sweden, and Portugal.

EdNA online: <http://ictresearch.edna.edu.au/index.html>

This Australian research website lists research reports and articles related to ICT at all levels of schooling, including early childhood education.

The IBM KidSmart Early Learning program:

Australia: <http://www.ansn.org.au/projects/>

USA: <http://www.kidsmartearlylearning.org>

These two sites contain information about the IBM's KidSmart early learning programme. The programme aims to provide computers for early childhood centres which cater for children from economically disadvantaged backgrounds, and provides a programme of professional development for early childhood educators.

The IBM KidSmart Multimedia Guide to Computers and Early Learning:

Multimedia version: <http://www.ibm.com/ibm/ibmgives/edc/index.htm>

Text-only version: <http://www.ibm.com/ibm/ibmgives/edc/text/index.htm>

This site provides guidance and ideas about the use of ICT in early years. The site is structured around three themes: (1) Cognition and social learning: How can I use computers to support learning in my classroom? (2) Integrating technology: How can I make computers part of my regular programme? (3) Access and equity: How can I make sure that computers serve all my children? The multimedia version includes slideshows, video clips, and other multimedia resources.

The NCIP Early Childhood Library: <http://www2.edc.org/NCIP/library/ec/toc.htm>

This is a site provided by the US National Center to Improve Practice in Special Education through Technology Media, and Materials. It indexes resources and publications on the use of technology for preschool children with disabilities.

Other useful documents for early childhood education in New Zealand

Early childhood curriculum and strategy documents

Ministry of Education. (1996). *Te Whāriki mātauranga mō ngā mokopuna o Aotearoa*. Wellington: Learning Media.

Ministry of Education. (2002). *Pathways to the future: Ngā huarahi arataki. A 10-year strategic plan for early childhood education*. Wellington: Learning Media.

Research and practice

Biddulph, F., Biddulph, J., & Biddulph, C. (2003) *The complexity of community and family influences on children's achievement in New Zealand: Best evidence synthesis*. Wellington: Ministry of Education.

Carr, M. (2001). *Assessment in early childhood settings: Learning stories*. London: Paul Chapman Publishing.

Mitchell, L., & Cubey, P. (2003). *Characteristics of professional development linked to enhanced pedagogy and children's learning in early childhood settings: Best evidence synthesis*. Wellington: Ministry of Education.

Wylie, C. (2001). Early childhood education, an enduring legacy. *Early Childhood Folio*, 5, 3–5.

Wylie, C., & Thompson, J. (2003). The long-term contribution of early childhood education to children's performance – evidence from New Zealand. *International Journal of Early Years Education*, 11 (1), 69–78.