What is educational technology and how is it being used to support teaching and learning in the early years?

Christine Jack[a]* and Professor Steve Higgins[b]

[a]*School of Education, Durham University, Durham, United Kingdom;* [b]*School of Education, Durham University, Durham, United Kingdom*

Provide full correspondence details here including e-mail for the *corresponding author

Christine Jack, School of Education, Durham University, Leazes Road Durham DH1 1TA United Kingdom, c.l.jack@durham.ac.uk tel:07545569331 (corresponding author)

Author Biographies:

Christine Jack is a doctoral student at the School of Education, Durham University, her research interests include the use of educational technologies in early years education.

Steve Higgins is a professor at the School of Education, Durham University. His research interests include the area of effective use of information and communications technology (ICT) and digital technologies for learning in schools.

What is educational technology and how is it being used to support teaching and learning in the early years?

There are many digital technologies available to support teaching and learning. Historically the focus has tended to be on computers, but this has extended to include interactive whiteboards and tablets. As well as these technologies, which were originally designed for adults, there are devices specifically designed to support teaching and learning in the early years. These tend to be overlooked in the literature. This project aimed to find out if this reflected practice in early years settings.

Participants from twenty early years settings in the North East of England were asked about 'educational technologies'. This term was deliberately not defined, the aim was to find out what they thought it meant. They were asked about the technology they had, and how it was being used. This provided an opportunity to explore whether their use of technology fit with their beliefs about teaching and learning.

Findings suggest that technology is seen as more than computers and that technology is being used to support a broad range of activities in line with practitioners' pedagogical beliefs.

Key words: Early Years Education, Preschool, Educational Technology, ICT, Digital Technology

Early years and technology

> [Technology] has opened new ways of working that I have never seen before…

This quote, from one participant, reflects a position that has been seen many times over the last couple of decades: technology can make a significant, positive impact on teaching and learning (Couse and Chen 2010; Higgins, Xiao, and Katsipataki 2012). However, opposing views are seen just as frequently, in social media, websites, blogs, mainstream media and publications (Hall and Higgins 2002; Marsh 2005, 181).

Given such different opinions this research was designed to find out what is actually happening in early years settings. One key issue is the definition of educational technology, is there consistency between curriculum documentation, the literature and practitioners' understanding of the term?

Technology in the Early Years Curriculum

Even in 1990 (Rumbold), curriculum documentation in the UK referred to more than just computers, with references to toys and domestic technology. The Desirable Learning Outcomes (School Curriculum and Assessment Authority and Department for Education and Employment 1996) were less explicit, stating only that children should 'use technology, where appropriate, to support their learning'. There is, however, a reference to the Key Stage 1 curriculum for 5 to 7 year olds, which says that 'many everyday devices respond to signals and commands'. The Curriculum Guidance for the Foundation Stage (Qualifications and Curriculum Authority 2000) identifies a number of devices including: programmable toys, cameras, tape recorders, talking books, domestic technology and technology in the environment. This range of devices is also referred to in the 2008 and subsequent Statutory Frameworks as well as in in Development Matters (Department for Children Schools and Families 2008, 2012; Department for Education 2014; Early Education 2012). Curricular frameworks in the UK clearly identify a range of technologies, though this does not appear to be reflected in the contemporary literature.

What is educational technology?

A selection of literature from 1996 was reviewed and compared with an equivalent selection from 2016. These dates were chosen as 1996 was when the Desirable Outcomes for Children's Learning were published in England (School Curriculum and

Assessment Authority and Department for Education and Employment 1996). It also reflects a time before interactive whiteboards (IWBs) became prevalent in schools.

To be manageable, the search was limited to the Education Resources Information Centre (ERIC). The following Boolean string search was used: ("computer" OR "technology" OR "digital" OR "ICT") AND ("early years" OR "pre-school" OR "kindergarten" OR "young children") and the search was limited to peer reviewed journal articles. The search resulted in 44 articles from 1996. After reviewing the abstracts, 15 were excluded as they did not meet the criteria for this study. 240 articles were identified for 2016, 156 were excluded after review.

Studies which were excluded:

- did not focus on children or practitioners within early years settings,
- focused on assistive technology which supported individual students' needs but would not be described as educational for all pupils e.g. cochlear implants,
- focused on design and technology, science or medicine,
- used technology for data collection rather than as the focus of the research.

Twenty-eight of the twenty-nine articles from 1996 focused on using computers, or on software accessed through a computer. Even the remaining article, which evaluates the appropriateness of technology and its potential benefits, focuses mainly on computers (NAEYC 1996).

In 2016, there initially appeared to be a focus on a wider range of resources. Tablets and IWBs were now common. However, these were often used to access resources, software or apps that would previously have been used on a computer. Tablets and computers were mentioned most frequently. These, or resources accessed through them, are the focus in 62 of the 84 articles. Robots were the focus of seven

articles. In five, the focus was on technology or digital play, but it was unclear which technology was being used.

An initial look at the remaining ten suggested that they focused on more than computers, but a closer examination showed that this was not always the case. For example, even when the term used was 'digital technologies' or a list of technologies was given in the overview, the analysis often focused on computers or screen-based technologies (Ebbeck et al. 2016; Hsu 2016; Konca, Ozel, and Zelyurt 2016; Mangen 2016; Palaiologou 2016a; Preradović, Lešin, and Šagud 2016).

Only four explicitly looked at a broader range of technologies than this. Two focused on practitioner perceptions (Dong and Newman 2016; Palaiologou 2016b), one on technology and social interactions (Arnott 2016). The last one looked at technology use in settings. Its findings referred to how often technology was used and which curriculum areas it supported, but there were no references to what technology was actually being used for (Aldhafeeri, Palaiologou, and Folorunsho 2016). This finding is similar to that of Burnett (2010), while her search criteria allowed for the identification of studies using a wide range of technologies, all of the studies in her review were based on computer applications.

This was only a snapshot of the literature and literature can be found which has a broader focus, for example referring to how a range of technologies can be used to support authentic learning experiences (Garvis and Lemon 2015).

Defining educational technology

It is not possible to find a consistent definition of educational technology or a consensus on what terms to use. A quick review of literature on technology in the early years provides a long list including: digital technology, internet enabled technology, ICT, mobile technologies, digital tools, digital resources, digital artefacts, interactive devices,

information technology, digital literacy, learning technology and digital media. Sometimes these are accompanied by definitions, often not.

When a definition is given, it is often simply a list of the devices to which the article is referring (Ekici, 2016; McPake, Stephen, Plowman, Sime, & Downey, 2005; Stephen & Plowman, 2013). There is also evidence that definitions differ between researchers and practitioners (Plowman and Stephen 2005).

How educational technology is defined is important as practitioners' perceptions impact on how their practice. A narrow focus has been linked to a 'mechanistic approach' and a broader range as providing "scope for more imaginative, creative and collaborative activities" (Plowman, McPake, and Stephen 2012).

The case for moving away from a narrow definition of 'technology as computers' has been made many times (Plowman and Stephen 2005; Siraj-Blatchford and Siraj-Blatchford 2003). However, this review suggests that this is not reflected in the literature. The mentions of IWBs and tablets could be perceived as a broadening out of the devices used, or they could be seen as replacing or enhancing computers. They have additional functionality that make them easier for early years children to use. Even with the addition of tablets and IWBs, the range of devices the articles refer to is very limited when compared to the range of technology available.

The aim for this study was to give practitioners an opportunity to talk about the range of technologies they had access to and how they are being used. The definition of 'educational technologies' was deliberately left open to find out if practitioners' understanding was similar to the focus found in the literature.

Technology and early years pedagogy

Nearly all early years pedagogies are based on play and student-centred practices which favour exploratory learning (Roberts-Holmes 2012; Allen and Whalley 2010; Mertala

2017). Non statutory guidance in England identifies the characteristics of effective early learning as: playing and exploring, active learning and creating and thinking critically (Early Education 2012).

Even in 1991, it was possible to find examples of technology being used these types of open ended activities (Fields 1991), however, this did not appear to be typical (Yelland 2005). Until recently, there has been a perception that technology in schools has been used for 'drill and practice' activities, or to broadcast information using audio or video (Goodwin 2012; Wang et al. 2010; Murray and Olcese 2011), even now the majority of educational apps are based on 'drill and practice' principles (Papadakis and Kalogiannakis 2017).

If early years teachers prefer a flexible, active, exploratory approach to learning, this use of technology may be considered inappropriate (O'Hara 2008). Marcon (1999) found that children perform better in classrooms where there is a single and consistent pedagogical approach, technology use should match practitioners' beliefs.

There is a perception that early years practitioners may not be under the same academic pressures faced by teachers of older children and that their more child-centred approach, could provide an opportunity for them to lead the way in more appropriate and effective uses of technology (Brooker 2003; Mishra and Joseph 2012). However, even Brooker who is often cited as identifying this perception has said that curriculum guidance could be seen as 'an instruction to adults to replace children's own play agenda with adult-designed learning intentions' (Brooker 2011). Others, who accept that early years curricula are more flexible, suggest that technology is seen as an extension of the curriculum and not necessarily integrated with broader learning experiences (Edwards 2005).

Mertala (2017) found the use of technology was limited to more whole class instruction and drill and practice exercises. Other evidence suggests technology in preschool settings is usually interpreted as computers, used mainly during free play (Plowman and Stephen 2007). To address these issues in the existing research, and as a preparation for a further study, interviewees were asked about their teaching and learning philosophies and how these fit with their use of technology.

How is educational technology being used?

The snapshot of the literature from 1996 and 2016 suggests that there are a number of studies investigating specific technologies, usually individual devices or digital resources, and often with a focus on evaluating the efficacy of a particular resource. However, there is limited research that looks at how a broader range of technologies is being used. Where this does happen, the focus tends to be on the amount of time spent using a resource, or the area of the curriculum being supported, rather than how it is being used to support learning (Aldhafeeri, Palaiologou, and Folorunsho 2016).

Stephen and Plowman (2013) identified three kinds of learning associated with technologies:

- operational: how to use technology
- curricular knowledge and understanding: learning specific content
- developing positive learning dispositions: e.g. independence, confidence and persistence.

They suggested that children's home experiences were likely to support all these types of learning, but in educational settings the learning was more likely to be limited to basic operational skills, limited learning dispositions, e.g. taking turns, and some

content e.g. basic reading or number skills. Recent research suggests that technology is used infrequently in early years and is usually used for developing ICT skills, administrative tasks or for more didactic practices (Blackwell, Lauricella, and Wartella 2014; Kerckaert, Vanderlinde, and van Braak 2015).

There appears to be a disconnect between children's experience of technology at home and in educational settings (Aubrey and Dahl 2014; Palaiologou 2016a). The lack of integration of technology into early years teaching and learning is often attributed to teachers (Edwards 2013). In one study, practitioners did not see the value of using digital technology to support learning, so even when technology is available, it may not be used. Teachers can be sceptical and hesitant about its use (Aldhafeeri, Palaiologou, and Folorunsho 2016). However, this is not always the case, Mertala (2017, 1) found that the 'vast majority of early childhood educators feel positive about using ICT with children'.

Ertmer suggests that teacher beliefs are the 'final frontier' for introducing technology into schools, believing that barriers such as time, training, access to resources and support had been overcome (Ertmer 2005). Practitioner interviews allowed them to identify their beliefs about technology and how it was being used in their setting.

Interactions with technology

Research suggests that technology is more likely to have a positive effect when children use it alongside adults or more experienced peers (McCarrick and Li 2007). Of course, the need for adult support is not restricted to technology. Claxton and Carr (2004) recommend a potentiating environment, with 'frequent participation in shared activity'. It is not enough to make resources available, adults need to play an active role through explaining and modelling learning. While practitioners are familiar with supporting

young children's learning, this does not always happen when using technology. Plowman and Stephen suggest this may be because other activities take priority over technology and that practitioners have limited confidence with ICT (2007).

Research focusing on parents also suggests that adults interact with children differently when using technologies. The amount of talking can be affected by the use of electronic devices (Kucirkova et al. 2013; Sosa 2015).

The interviews in this study were designed to identify what kind of activities happened in practitioners' settings and the role of adults in this learning.

Methodology

The research questions are:

- How do early years practitioners define educational technologies?
- What educational technologies are available in early years settings and how are they being used?
- How does the use of educational technologies fit with practitioners' pedagogical beliefs?

Settings from six local authorities in the North East of England were visited between January and May 2015. They included eight individual settings: Local Authority (LA) nursery schools, a private nursery, LA primary schools and a free school. A focus group was also held with 12 practitioners from one Local Authority's Children's Centres. Semi-structured interviews were conducted and focused on teaching and learning philosophies, beliefs about technology and how technology is being used in the setting.

Most of the settings were known to the researcher through previous work. Other settings were identified through LA advisors. None of the interviewees had previously worked with the researcher. Almost all the settings took pupils from a range of socio-

economic backgrounds. Two catchment areas were described as deprived and one as affluent.

All interviews lasted between 30 – 60 minutes, they were recorded, transcribed and analysed using NVivo by QSR International. It is designed for qualitative researchers working with very rich text-based and/or multimedia information, where deep levels of analysis on small or large volumes of data are required. A series of codes based on descriptive categories relating to different technologies, teacher beliefs and pedagogical approaches were applied. A thematic analysis was also undertaken in relation to the research questions following the principles in Schreier (2014). The themes which emerged from this analysis have been used as headings when presenting the findings.

Ethical approval for the study was granted by the School of Education Ethics Committee, Durham University, UK. Participation in this study was voluntary, informed consent was gained from participants, with the right to withdraw at any point, and anonymity was guaranteed. Practitioners' consent for audio recording the interview was also obtained.

Findings

What are practitioners' pedagogical beliefs?

Almost all interviewees believed that the purpose of early years education was to support children to develop life skills. They thought education should focus on the whole child; on developing social skills, confidence and independence rather than how well they perform academic tasks. While all but two of the interviewees did refer to the need to prepare the children for school, they said this would be the purpose identified by the local authority or school leaders rather than being their own priority.

All practitioners talked about the need to provide time for exploratory, child-led, play-based activities. These were balanced with teacher-led, directed learning, and opportunities for children to practice what they had learned during free-choice time. Most interviewees talked about the importance of providing opportunities for children to reflect on their learning. All settings emphasised the need to develop links with parents and to provide opportunities for children to develop social skills.

For technology to fit in with the practitioners' beliefs about pedagogy, it would need to support this approach:

- Is it being used to support collaboration, links with parents and carers and to focus on children's interests?
- Does it provide opportunities for children to be in control and to spend time on creative activities?
- Is it supporting adults in their role as 'scaffolders' of children's learning?
- Does it support the development of positive learning dispositions?

What educational technology is available in early years settings?

Table 1 shows responses to the question 'what educational technology do you have?' This question was open ended and no prompts were given, so answers reflected the resources that interviewees most closely associate with the term 'educational technology'. Other resources may have been available and, even if an interviewee did not mention a technology, it does not necessarily mean they did not have it. The table does not show how often resources were used, what they were used for, or include information about the age or quality of the resources.

[Table 1 near here]

Discussions indicated that many of the resources were not being used regularly.

> We have an IWB here but, if I'm totally honest, we don't use it all the time.

> Programmable toys… but again we don't use those often.

Where technology was only available in a single setting, it was not included in the table. These resources were: Apple TV, calculators, an immersive room, light box, overhead projector, smart table, stop watches, torches, digital toys with lights and buzzers.

The amount of technology varied between settings. Schools tended to have more technology and it was used more often than in other settings. However, this may include older equipment that has been passed down to the early years. This is an area where there is little research (Bolstad 2004), it would be interesting to investigate whether this variation is apparent within a larger sample.

Not surprisingly, all practitioners mentioned computers, but they also talked about a range of other resources, which supports the view that the discussion of technology has now moved beyond 'just computers'. Resources include those designed specifically for young children e.g. metal detectors and audio recording devices. While some of these provide opportunities that have been available before in other ways, they are much more child friendly than devices used previously.

In an ideal world…

> …teachers may feel that their efforts are constrained by limited equipment, yet their reasons for wanting more computers may point to different goals and beliefs (Ertmer 1999, 57).

All interviewees were asked what educational technology they would like if there were no barriers to buying and using technology. The technology they identified, and the reasons they gave for wanting it, provided a useful indicator of their beliefs about how

technology can support teaching and learning.

Most talked about iPads and these were identified as desirable by all settings that did not already have them. Settings that had them wanted more. Software was also mentioned frequently. One interviewee thought the children had used the existing software extensively and needed to move on. Two people talked about needing software for their IWBs which were not being used effectively. One said they would love to have older software which was no longer available.

> I would like some of the old games … I loved them because they were very simple… it was linked to a story…I know things move on but it's a bit like stories, some of the old ones were still good ones.

Cameras were another popular choice, all the settings had at least one, but all wanted more, especially cameras children could use independently and safely. Some though this would allow them to get the children's perspective on their experiences in the setting.

> Cameras for the children, I like helmet cams, I would like a day in the nursery, little 'Joe Bob' what did you do, I'd like hat cams please, to see interactions.

Two interviewees said they would like access to an expert. Someone who knew about technology and could work with them to identify how it could be used appropriately. This reflected their view that they did not know enough about what technology was available, or how it could be used. Their comments suggested they did not have time to research what was available or keep up to date with new developments.

> My knowledge of technology isn't good, I think technology could make my job so much easier, but my barrier is that I don't know it exists.

> A technician… who's savvy and knowledgeable about the curriculum ...a very important person… someone to give guidance… who has got the time to research and source the better technology.

Some answers related to the convenience of having more resources allowing children to use them more often, so resources did not have to be borrowed or accessed elsewhere.

> We go [to the LA] to use their [green screen] but it would be good to have our own and not rely on someone else, and it costs money to get there.

> I would like sturdy equipment, like cameras, now they have to borrow the teachers' cameras that we use for observations, or they ask if we can take a picture of something for their learning journey, or they click the button. But if I had a class of 15, wow, you could have them all there and they could access it and just choose it, they can use it how they want.

Others talked about the value of using different interfaces, such as touch screens and voice-activated devices. These would make the technology easier for young children to use, though most people felt that children would still need to be familiar with a traditional keyboard and mouse.

How is technology being used?

Interviewees were asked to describe how they were using technology. Again, this was an open question and responses may have been different if they had been given a list of activities to choose from. While research in the past has focused on the use of technology by children (Bolstad 2004), all of the interviewees talked about how it was being used by both children and staff.

Technology being used by children

[Table 2 near here]

While in the past technology was often used for 'drill and practice' activities (Condie and Munro 2007), table 2 includes very few examples of this. Except for some of the games the children played, all the activities showed a more creative use of technology.

The activities cover the whole early years curriculum (Early Education 2012). They all support the development of Communication and Language. Most link to the area of Understanding the World, the area of the curriculum which covers technology. The Physical strand is mentioned least often. Literacy and Numeracy are also mentioned infrequently, though many of the activities could support these areas even if they are not the specific focus.

The themes which emerged from the analysis suggested that developing learning dispositions is a key goal. While this can mean different things to different people (Claxton 2007; Siraj-Blatchford et al. 2002), the respondents described: confidence, curiosity, cooperation, perseverance, resilience and reflection. These are could be seen as developing the reference to positive dispositions to learning identified by Stephen and Plowman (2013), mentioned above.

Interviewees highlighted the role of adults. Although there are times when children use technology independently, adult input is very important. Adults need to ensure children know how to use devices. The type of technology found at home is often more sophisticated than that found in early years settings (Plowman and Stephen 2013), so children may learn how to use devices here. Over time they are likely to come to the setting with more skills, meaning support for operational aspects could be reduced. This could allow more time for adults to support other types of learning.

The examples in table 2 suggest that there has been a change from those described in previous research (Plowman and Stephen 2005; Plowman, Stephen, and McPake 2008; Plowman and McPake 2013; Plowman and Stephen 2013; Stephen 2014) which included:

- little evidence of young children using the internet
- computers being mainly used for playing games during free play
- young children being more likely to do 'authentic' activities at home than in educational settings
- teaching being mainly focused on operational skills or turn taking
- technologies supporting cognitive development being limited to computer games and 'closed' activities
- the creative use of technology being mainly limited to drawing.

Interviewees were asked about the benefits children obtained from using technology. While some answers suggested children were using technology to learn operational skills or to do closed activities, the majority supported the claim that technology was being used in a much more open-ended way.

Technology being used by adults

All interviewees gave numerous examples of adults using technology to support pedagogy. Most used these as opportunities to model the use of technology to the children. Some, especially those concerned about children damaging expensive resources, expected adults to work away from the children. All settings used technology to collect evidence or record assessments; using cameras to document children's work was the most common use. Settings also used technology for planning, parental

engagement and communication.

Discussion

Interviewees talked about a broader range of technology than has been included in the literature reviewed as part of this research. This broad interpretation of 'educational technology' may have enabled them to focus more on how the technology could be used. 'Educational technology' has been seen as the broadest term and most appropriate when discussing the field as a whole (Reiser and Ely 1997), however, potential problems have been identified with making terms too broad or in discussing 'technology' as a whole. It has been suggested that this could mean that the wide range of activities it can support are less obvious (Burnett 2010), this is not the case here.

All practitioners in this study were able to discuss what they would use technology for, and what additional technology they would like. They indicated that they wanted child friendly devices that can be used independently and support their pupils' interests. They were all using technology to support their teaching and learning philosophies. Technology was used across the whole curriculum and to help children develop positive learning dispositions. All settings described how adults worked with children to use technology to support their learning. This contrasts with findings which suggest that settings prioritise developing operational skills and that open ended, exploratory activities are rarely observed (Plowman 2016).

This indicates that technology is more embedded in early years practice than some recent literature suggests, and practice has gone beyond the limited range of activities some may expect (Plowman and Stephen 2013; Blackwell, Lauricella, and Wartella 2014; Kerckaert, Vanderlinde, and van Braak 2015).

However, while all interviewees talked about a wide range of ways they use technology, it is unclear how much of this is actually happening. It is possible that the interesting activities practitioners plan may not match the children's experiences.

> We put out what we want them to use, but they very rarely do what we put out.

Details of how the technology was used was self-reported. When possible, the researcher toured the settings, which provided some additional evidence. However, it is possible that some interviewees may have been describing what they would like to happen, rather than current practice. Further research into the link between pedagogical beliefs and technological practice would be useful.

All practitioners, including the most reluctant, had positive attitudes towards technology.

> I am a technophobe, I will run away… [but] they gave me an iPad a year ago, I can't live without it, I cannot live without it … it has opened new ways of working that I have never seen before.

It appears that Ertmer's final frontier' of beliefs is not a barrier for these practitioners (Ertmer 2005) but early years settings may still be facing barriers that schools have already addressed. Their use of technology is hindered by extrinsic barriers: a lack of funds, time and confidence. Access to adequate training and support also remains a challenge.

Conclusion

Many debates are repeated in the literature over many years, this could lead to 'reifying existing approaches and resources rather than informing future possibilities' (Burnett 2010, 251). While research literature appears to focus mainly on computers or other screen-based technology, the practitioners in this study have a much broader

interpretation of the term ‘educational technologies’. This broader interpretation may be linked to the differences in practice reported in this research and that described in previous literature. The way these practitioners describe using educational technology focuses on teaching and learning rather than devices and clearly supports their personal pedagogical beliefs.

This study involved a small sample and investigated teachers’ beliefs and perceptions. It is not clear how generalisable this snapshot is. The interview questions were deliberately open ended, a large-scale survey approach may have produced a different result. Another possible focus for future is how all early years practitioners can be supported to use educational technology more effectively. Developing networks and collaborating with colleagues one of the best ways of showing how technology can be successfully integrated into the curriculum, but teachers often find it difficult to find time to do this (Shields and Behrman 2000).

References

Aldhafeeri, F, I Palaiologou, and A Folorunsho. 2016. "Integration of digital technologies into play-based pedagogy in Kuwaiti early childhood education: teachers' views, attitudes and aptitudes." *International Journal of Early Years Education*:1-19. doi: 10.1080/09669760.2016.1172477.

Allen, Shirley, and Mary E Whalley. 2010. *Supporting Pedagogy and Practice in Early Years Settings*: SAGE.

Arnott, L. 2016. "An ecological exploration of young children's digital play: framing children's social experiences with technologies in early childhood." *Early Years* 36 (3):271-88. doi: 10.1080/09575146.2016.1181049.

Aubrey, C, and S Dahl. 2014. "The confidence and competence in information and communication technologies of practitioners, parents and young children in the Early Years Foundation Stage." *Early Years: An International Research Journal* 34 (1):94-108. doi: 10.1080/09575146.2013.792789.

Blackwell, C. K, A. R Lauricella, and E Wartella. 2014. "Factors influencing digital technology use in early childhood education." *Computers & Education* 77 (0):82-90.

Bolstad, R. 2004. *The role and potential of ICT in early childhood education: A review of New Zealand and international literature*: Ministry of Education Wellington.

Brooker, L. 2003. "Integrating New Technologies in UK Classrooms Lessons for Teachers from Early Years Practitioners." *Childhood Education* 79 (5):261-7. doi: 10.1080/00094056.2003.10521210.

Brooker, L. 2011. "Taking children seriously: An alternative agenda for research?" *Journal of Early Childhood Research* 9 (2):137-49. doi: 10.1177/1476718X10387897.

Burnett, C. 2010. "Technology and literacy in early childhood educational settings: A review of research." *Journal of Early Childhood Literacy* 10 (3):247-70. doi: 10.1177/1468798410372154

Claxton, G. 2007. "Expanding young people's capacity to learn." *British journal of educational studies* 55 (2):115-34. doi: 10.1111/j.1467-8527.2007.00369.x.

Claxton, G, and M. Carr. 2004. "A framework for teaching learning: the dynamics of disposition." *Early Years* 24 (1).

Condie, R, and B Munro. 2007. "The impact of ICT in schools: Landscape review."

Couse, Leslie J., and Dora W. Chen. 2010. "A Tablet Computer for Young Children? Exploring Its Viability for Early Childhood Education." *Journal of Research on Technology in Education* 43 (1):75-98.

Department for Children Schools and Families. 2008. "Statutory Framework for the Early Years Foundation Stage: Setting the Standards for Learning, Development and Care for children from birth to five." In.

Department for Children Schools and Families. 2012. "Statutory Framework for the Early Years Foundation Stage: Setting the Standards for Learning, Development and Care for children from birth to five." In.

Department for Education. 2014. "Statutory Framework for the Early Years Foundation Stage: Setting the Standards for Learning, Development and Care for Children from Birth to Five." In.: Department for Education.

Dong, C, and L Newman. 2016. "Ready, steady … pause: integrating ICT into Shanghai preschools." *International Journal of Early Years Education* 24 (2):224-37. doi: 10.1080/09669760.2016.1144048.

Early Education. 2012. "Development matters in the early years foundation stage." In *London: Early Education*, 2013.
Ebbeck, M, Hoi Yin B Yim, Y Chan, and M Goh. 2016. "Singaporean Parents' Views of Their Young Children's Access and Use of Technological Devices." 44 (2):127-34.
Edwards, S. 2005. "The reasoning behind the scene: why do early childhood educators use computers in their classrooms?" *Australian Journal of Early Childhood* 30 (4):25-34.
Edwards, S. 2013. Getting beyond the ZPD: Further possibilities for strengthening early childhood education through cultural-historical analyses.
Ertmer, P A. 1999. "Addressing First- and Second-Order Barriers to Change: Strategies for Technology Integration." *Educational Technology Research and Development* 47 (4):47-61. doi: 10.2307/30221096.
Ertmer, P A. 2005. "Teacher Pedagogical Beliefs: The Final Frontier in our Quest for Technology Integration?" *Educational Technology Research and Development* 53 (4):25-39.
Fields, J. 1991. "Information technology in the early years classroom: A case study." *Early Child Development and Care* 69 (1):53-62. doi: 10.1080/0300443910690105.
Garvis, S, and N Lemon. 2015. *Understanding digital technologies and young children: an international perspective*: Routledge.
Goodwin, K. 2012. "Use of tablet technology in the classroom." *NSW Department of Education and Communities*.
Hall, E., and S Higgins. 2002. "Embedding Computer Technology in Developmentally Appropriate Practice: Engaging with early years professionals' beliefs and values." *Information technology in childhood education annual* 2002 (1):301-20.
Higgins, Steven, Z Xiao, and Maria Katsipataki. 2012. "The impact of digital technology on learning: A summary for the education endowment foundation." *Durham, UK: Education Endowment Foundation and Durham University*.
Hsu, P. 2016. "Examining Current Beliefs, Practices and Barriers About Technology Integration: A Case Study." *TechTrends* 60 (1):30-40. doi: 10.1007/s11528-015-0014-3.
Kerckaert, S, R Vanderlinde, and J van Braak. 2015. "The role of ICT in early childhood education: Scale development and research on ICT use and influencing factors." *European Early Childhood Education Research Journal* 23 (2):183-99. doi: 10.1080/1350293X.2015.1016804.
Konca, A. S., E Ozel, and H Zelyurt. 2016. "Attitudes of preschool teachers towards using information and communication technologies (ICT)." *International Journal of Research in Education and Science* 2 (1):10-5. doi: 10.21890/ijres.21816.
Kucirkova, N, D Messer, K Sheehy, and R Flewitt. 2013. "Sharing personalised stories on iPads: a close look at one parent–child interaction." *Literacy* 47 (3):115-22. doi: 10.1111/lit.12003.
Mangen, A. 2016. "What Hands May Tell Us about Reading and Writing." *Educational Theory* 66 (4):457-77.
Marcon, R.A. 1999. "Differential impact of preschool models on development and early learning of inner-city children: A three-cohort study." *Developmental Psychology* 35 (2):358.

Marsh, J. 2005. "Digikids: Young children, popular culture and media." In *Critical issues in early childhood education*, edited by Nicola Yelland, 181-96. Maidenhead: McGraw-Hill Education.
McCarrick, K., and X. Li. 2007. "Buried Treasure: The Impact of Computer Use on Young Children's Social, Cognitive, Language Development and Motivation." *AACE Journal* 15 (1):73.
Mertala, P. 2017. "Wag the dog – The nature and foundations of preschool educators' positive ICT pedagogical beliefs." *Computers in Human Behavior* 69:197-206.
Mishra, P. K., and A. Joseph. 2012. "Early Childhood Care & Education: An ICT Perspective." *Information Technologies and Learning Tools* 27 (1).
Murray, O. T., and N. R. Olcese. 2011. "Teaching and learning with iPads, ready or not?" *TechTrends* 55 (6):42-8.
NAEYC. 1996. "Technology and Young Children—Ages 3 through 8 A position statement of the National Association for the Education of Young Children." In.
O'Hara, M. 2008. "Young children, learning and ICT: a case study in the UK maintained sector." *Technology, Pedagogy and Education* 17 (1):29-40. doi: 10.1080/14759390701847443.
Palaiologou, I. 2016a. "Children under Five and Digital Technologies: Implications for Early Years Pedagogy." *European Early Childhood Education Research Journal* 24 (1):5-24. doi: 10.1080/1350293X.2014.929876.
Palaiologou, I. 2016b. "Teachers' dispositions towards the role of digital devices in play-based pedagogy in early childhood education." *Early Years*:1-17.
Papadakis, S, and M Kalogiannakis. 2017. "Mobile educational applications for children: what educators and parents need to know." *International Journal of Mobile Learning and Organisation* 11 (3):256-77.
Plowman, L. 2016. "Learning technology at home and preschool." *The Wiley Handbook of Learning Technology*:96-112.
Plowman, L, and J McPake. 2013. "Seven Myths About Young Children and Technology." *Childhood Education* 89 (1):27-33.
Plowman, L, J McPake, and C Stephen. 2012. "Extending opportunities for learning: the role of digital media in early education." *Contemporary debates in child development and education*:95-104.
Plowman, L, and C Stephen. 2005. "Children, play, and computers in pre-school education." *British Journal of Educational Technology* 36 (2):145-57. doi: 10.1111/j.1467-8535.2005.00449.x.
Plowman, L, and C Stephen. 2007. "Guided interaction in pre-school settings." *Journal of Computer Assisted Learning* 23 (1):14-26.
Plowman, L, and C Stephen. 2013. "Guided Interaction: Exploring how Adults can Support Children's Learning with Technology in Preschool Settings."
Plowman, L, C Stephen, and J McPake. 2008. "Supporting young children's learning with technology at home and in preschool." *Research Papers in Education* 25 (1):93-113. doi: 10.1080/02671520802584061.
Preradović, N. M., G Lešin, and M Šagud. 2016. "Investigating Parents' Attitudes towards Digital Technology Use in Early Childhood: A Case Study from Croatia." *Informatics in Education-An International Journal* (Vol15_1):127-46.
Qualifications and Curriculum Authority. 2000. "Curriculum guidance for the foundation stage." In.: QCA.
Reiser, R. A., and D. P. Ely. 1997. "The field of educational technology as reflected through its definitions." *Educational Technology Research and Development* 45 (3):63-72. doi: 10.1007/bf02299730.

Roberts-Holmes, G. 2012. "'It's the bread and butter of our practice': experiencing the Early Years Foundation Stage." *International Journal of Early Years Education* 20 (1):30-42.
Rumbold, A. . 1990. "Starting with Quality: Report of the Committee of Inquiry into the Educational Experiences Offered to Three and Four Year Olds." In.
School Curriculum and Assessment Authority, and Department for Education and Employment. 1996. "Nursery Education: Desirable Outcomes for Children's Learning on Entering Compulsory Education." In.
Schreier, M. 2014. "Qualitative content analysis." *The SAGE handbook of qualitative data analysis*:170-83.
Shields, M. K., and R. E. Behrman. 2000. "Children and Computer Technology: Analysis and Recommendations." *The Future of Children* 10 (2):4-30. doi: 10.2307/1602687.
Siraj-Blatchford, I, S Muttock, K Sylva, R Gilden, and D Bell. 2002. "Researching effective pedagogy in the early years."
Siraj-Blatchford, I, and J Siraj-Blatchford. 2003. *More than computers-information and communication technology in the early years*: British Association for Early Childhood Education (Early Education).
Sosa, A. V. 2015. "Association of the Type of Toy Used During Play With the Quantity and Quality of Parent-Infant Communication." *JAMA pediatrics*:1-6.
Stephen, C. 2014. "Young Children Thinking and Learning With and About Digital Technologies." In *Routledge International Handbook of Young Children's Thinking and Understanding*, edited by Robson S and Flannery Quinn S. London: Routledge,.
Stephen, C, and L Plowman. 2013. "Digital technologies, play and learning." *Early Childhood Folio* 17 (2):3-8.
Wang, F., M. B. Kinzie, P. McGuire, and E. Pan. 2010. "Applying Technology to Inquiry-Based Learning in Early Childhood Education." *Early Childhood Education Journal* 37 (5):381-9. doi: 10.1007/s10643-009-0364-6.
Yelland, N. 2005. "The Future Is Now: A Review of the Literature on the Use of Computers in Early Childhood Education (1994 - 2004)." *AACE Journal* 13 (3):201-32.

Tables

Table 1: What technology do settings have?

Setting Description (Age Range)	**LA School 1 2-5**	**LA School 2 3-5**	**LA School 3 3-5**	**LA School 4 3-5**	**Free School 4-5**	**LA Nursery 1 2-4**	**LA Nursery 2 2-4**	**Private Nursery 0-5**	**Children's Centres 0-5**
Cameras: video or still	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Computer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IWB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
iPads	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
Recording Device	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes
Programmable Toys	Yes	No	No	Yes	Yes	Yes	No	No	Yes
Audio Players	Yes	Yes	No	Yes	No	No	No	Yes	Yes
Remote Control Toys	Yes	Yes	No	No	No	No	No	No	Yes
Role Play	Yes	No	No	No	No	No	No	Yes	Yes
iPods	No	No	No	Yes	Yes	No	No	No	No
Metal Detectors	No	No	Yes	No	No	No	Yes	No	No
Musical	No	No	No	No	No	No	Yes	Yes	No
Phones	No	No	No	No	No	No	No	Yes	Yes
Visualiser	No	No	Yes	Yes	No	No	No	No	No
Walkie-talkies	No	No	No	No	No	No	No	Yes	Yes

Table 2 How are children using technology?

Activities	**Areas of Learning**	**Kind of Learning**	**Learning Dispositions**	**Adult Involvement**
Home / school projects: e.g. sending Teddy home with a **camera**	C&L UW	Operational Dispositions	Cooperation	Ongoing Support / Move to Independence
Searching the **Internet** for information to support their play	PSE C&L UW	Operational Dispositions Curriculum	Curiosity	Ongoing Support
Using **YouTube** to access songs and other stimulus materials	C&L UW	Dispositions Curriculum	Curiosity Reflection	Ongoing Support
Exploring cause and effect with **toys with buttons to press** and using this as a stimulus for language development	C&L UW	Operational Dispositions Curriculum	Cooperation Curiosity Perseverance	Ongoing Support / Move to Independence
Working on open ended language and number activities – **computer software**	C&L L M	Dispositions Curriculum	Perseverance Curiosity	Ongoing Support
Free play with **Bee Bots** e.g. creating mats for them to explore.	C&L UW EAD	Operational Dispositions Curriculum	Cooperation Curiosity	Ongoing Support /Move to Independence
Whole class or group role play including using **large screens and projectors** to support pretend play e.g. flying to the moon	C&L UW EAD	Dispositions Curriculum	Cooperation Curiosity	Ongoing Support / Move to Independence
Making movies and animations using **iPads**	C&L L UW EAD	Operational Dispositions Curriculum	Cooperation Perseverance	Ongoing Support
Drawing and printing pictures on **computers and iPads**	C&L EAD	Operational Dispositions Curriculum	Perseverance	Move to Independence
Copying dances, which children had found on **YouTube**	P C&L UW	Dispositions	Confidence	Ongoing Support
Using **iPads** to take photos when outside, using them as a tally instead if children writing numbers	PSE C&L M UW EAD	Operational Dispositions Curriculum	Independence	Move to Independence

Taking photos and videos to help children reflect and identify good learning, using **cameras** and **iPads**	C&L UW	Operational Dispositions	Reflection	Ongoing Support / Move to Independence
Recording messages using **easispeak microphones**	PSE C&L UW	Operational Dispositions	Cooperation Confidence Reflection	Ongoing Support / Move to Independence
Using **QR barcodes** to access appropriate websites independently	PSE C&L UW	Operational Dispositions	Independence	Move to Independence
Supporting children with Special Needs e.g. using music to calm down an autistic child, using an **audio player** or a **whiteboard** to enlarge books for a visually impaired child	PSE C&L	Dispositions Curriculum	Cooperation Independence Resilience	Ongoing Support / Move to Independence
Playing games / using **iPad apps** to support literacy or numeracy	C&L L M UW	Dispositions Curriculum	Independence	Move to Independence
Using **metal detectors** to support maths activities	C&L M UW	Dispositions Curriculum	Curiosity	Move to Independence
Listening to stories / songs using **storyphones / easi-ears headphones**	C&L UW	Operational Dispositions Curriculum	Cooperation	Move to Independence
Programming with **iPads**	C&L UW	Operational Dispositions Curriculum	Perseverance	Ongoing Support
Reading stories on **iPads**	C&L L UW	Dispositions Curriculum	Independence	Move to Independence

Key: PSE = Personal Social Emotional, P = Physical, C&L = Communication and Language, L = Literacy, M = Mathematics, UW = Understanding the World, EAD = Expressive Arts and Design

Table Captions

Table 1: What technology do settings have?

Table 2: How are children using technology?