Young Children Thinking and Learning With and About Digital Technologies

Introduction

The consequences of children's engagement with digital technologies in educational settings and at home has become a source of intense and often polarised debate. The purpose of this chapter is not to 'take sides' or evaluate the outcomes of play with technologies but to consider the nature of the evidence available about the kind of thinking and learning supported when young children play with digital technologies and the contextual features which make a difference to these experiences. The chapter begins by considering the educational potential claimed for incorporating technologies into young children's play then moves on to consider the kind of thinking and learning afforded by play with digital technologies. This is followed by a discussion of the support from adults which children need to sustain positive encounters with technology and finally a review of the children's perspectives on playing with technologies.

The term digital technology is used here to cover a wide range of digital and interactive resources. Digital technology is typically taken to mean desk-top computers and laptops but young children are increasingly interacting with tablet computers, mobile phones and e-readers. As well as keyboard and mouse or touch screen interfaces there are motion-sensitive technologies such as the Wii and games consoles manipulated through a range of hand-held controls. Digital cameras and leisure technologies such as television and DVDs are commonplace features of educational and home settings, along with toys that simulate appliances such as cash registers and microwaves. By the time they begin formal education children may already have experienced conversations with distant family members via Skype, been helped to compose emails or to shop on-line and own devices such as responsive globes and toy lap-tops marketed as educational resources. Although our evidence suggests that playing with technologies and technological toys does not dominate the lives of young children in the ways in which those who express concerns about the negative implications fear (Plowman et al, 2010a) these resources are an everyday and popular reality in the homes, classrooms and playrooms of children in the developed world. As Kalaš (2010, p 16) suggests 'it is not necessary any more to prove that ICT matters in early childhood education. New digital technologies have entered every aspect of our reality, including families and lives of young people'.

Children's engagement with computer mediated activities in particular (and other forms of technology in general) is typically referred to by practitioners and parents as 'playing with the computer'. But defining play or digital play is difficult (Stephen and Plowman, forthcoming) and claims about children learning as they play often fail to take account of the players' perspectives on the playfulness or otherwise of the activity. In this chapter the focus is on 'what is played', what is learned and the social circumstances which influence children's encounters with technologies. I will draw on the international academic literature and especially on a series of studies carried out and published jointly with colleagues at the University of Stirling over a period of ten years. Our work focused on the technological play experiences of children aged 3-5 years which we researched in their preschool settings and in their homes. Our methods and analysis were framed by our socio-cultural understanding of learning and an ecocultural perspective which was concerned with the practices of technological play and the ways in which context shapes experience. We began by looking at encounters with technology in the preschool playroom (*Interplay* and other studies, Stephen and Plowman, 2008; Plowman et al, 2010b) then extended our interest to children's

everyday experiences with digital technologies at home through two projects *Entering e-Society: Young Children's development of e-literacy* and *Young Children Learning with Toys and Technology at Home* (e.g. Plowman et al, 2010b; Plowman et al, 2012).

Educational possibilities and playing with technologies

Children are typically introduced to educational technologies because their parents or educational practitioners are keen that they should develop early familiarity with the ways of interacting with information which will be a feature of their educational and work experience or because the adults consider that the technologies offer ways of adding fun, speeding up or ensuring learning. Marketing materials suggest that resources such as the LeapPad TAG reading scheme support children to become enthusiastic readers and the integrated television and on-line shows and games provided by media companies such as CBeebies are 'sold' as educational and entertaining. However, there is little developed understanding about how such digital experiences can and do support children's learning.

The gap between claims about the promise for educational development which technologies can bring and evidence of positive outcomes and change in educational practices has become an enduring feature of the debate over the introduction of new technologies at home and in schools. Writing in 1980 Papert saw computers as offering the potential to extend thinking and generate new knowledge but thirteen years later Cuban (1993) commented on the lack of change in the ways in which technologies are employed to support learning. Into the 21st century Yelland et al (2008) were arguing for a shift to new pedagogic practices to capitalise on the ways in which technologies allow adults and children to engage with and share multimodal ways of knowing. But, as Bolstad (2004, p 71) concluded 'literature about the *potential* of ICT in early childhood education is more common than research which evaluates its *role* in early childhood education' (original italics). Furthermore, reviewing the nature of the technological games and resources on offer and that research evidence which does exist about the outcomes for young children's learning of play with technologies leads away from clear expectations of positive outcomes to a more conditional and nuanced evaluation of potential.

The tentative nature of our understanding about young children's encounters with digital resources is evident in recent evaluation studies. For instance, Couse and Chen (2010) concluded that while tablet computers were a 'viable tool' for three- to six-years olds to use in an early childhood setting it was the way in which teachers employed the technology which was important. Spurred on by the proliferation of computer games, the associations claimed between playing computer games and the development of higher cognitive processes in adults and claims that computer play is a qualitatively different form of play, Verenikina et al (2010) explored the affordances and limitations evident when children aged from 5-8 years old played computer games at home and in their classroom. They argue that that the influence of play with digital technologies can be found in on- and off-screen activities but that key design attributes must be present if the games are to support higher order thinking and enhance development. Bergen et al (2010) carried out one of the few studies of children aged under 36 months engaging with technologically-enhanced toys. They suggest that there is some evidence these toys can facilitate exploration, practice and social play and expressions of humour.

Others such as Burnett (2010) and Zevenbergen (2007) make a case for educational research to take account of the influence of children's technological experiences beyond their classrooms and playrooms. There is evidence too that children's social interactions with peers in the playroom influences their engagement with technologies. Ljung- Djarf (2008) has demonstrated that specific roles and relationships emerge as children engaged with each other and technological resources and Arnott (2013) has extended this analysis to show how children's social status and role influences their agency during play with technologies in preschool. In these circumstances it would seem naïve to seek a direct relationship between children's play with digital technologies, whether games on a computer or using an interactive toy cash register and scanner, and specific impacts on cognitive development.

Thinking with digital technologies

Engaging with digital technologies involves children in many of the same cognitive operations which they encounter with traditional toys at home and in their educational settings. They match, sort, categorise and count. They practise phonics skills and other literacy competencies as they navigate menus and screen displays, watch films and listen to audio-stories. While taking photographs with digital cameras can be part of a larger activity involving communication and reminiscence and toys that simulate technologies can be incorporated into imaginative play, computer games are more likely to focus on comparing quantities, sequencing and identifying shapes and rhymes. Although these activities are presented in a playful way with accompanying animations most rely on children applying and rehearsing knowledge and concepts already within their repertoire.

Few of the technological games are open-ended. Most reward the right answer with praise and congratulatory animations but incorrect responses are usually met not with a diagnostic response but with the giving of the correct answer without explanation after several failed attempts. So while access to digital technologies at home and in educational settings does extend the range of options available to children, when considered in terms of the cognitive nature of 'what is played' the scene appears little different from that of a learning environment without technologies. In addition, the closed design of many technological games seems to be at odds with contemporary curricular goals such as creativity and collaborative working and, as Vangsnes et al (2012) have pointed out, there is sometimes conflict between the powerful gaming orientation of some computer activities and the educator's desire to promote higher-order thinking and problem –solving through discussion and cognitive challenge. Roberts-Holmes (2013) found evidence that playing computer games in an educational setting was more likely to be associated with behaviour indicating joint attention than shared cognitive challenge.

In our playroom-based study the creative use of technologies was restricted to the use of drawing packages, some of which were nearer to traditional 'colouring in' activities developing fine motor skills, than a medium for novel creation and self-expression. However, Marsh (2010) points to the growing numbers of examples of children in early years settings being involved in digital media projects such as making 'documentaries' or animated films. She suggests that such activities give young children opportunities to develop transferrable skills such as problem-solving, negotiation and risk-taking. Edwards (2011) has written about the way in which children's cultural interpretations blend aspects of their experience of virtual and real world play at home. There was limited evidence of children's play incorporating technological and traditional forms in the homes

included in our studies. For instance, we observed Larry using the internet to find and print images of characters which he then used as he acted out narratives and we noted Jasmine building imaginative scenarios with her technological puppy. On the other hand, Kelly preferred to have her similarly interactive puppy switched off when it was included in her pretend play. However, Marsh (2010) has reported examples of slightly older children (5-7 year olds) playing with characters, negotiating plots and enjoying games with rules during on-line play in virtual worlds, just as they did in traditional play.

Learning with technologies

In the course of *Interplay* (Stephen and Plowman, 2008), the practitioners reported evidence of three kinds of developmental change associated with engaging with technologies. Firstly, they observed that children became competent users of technological resources, reflecting both cognitive development and growing physical skill. The second area of development was in curricular knowledge and understanding; requiring the effective storage, integration and categorising of new knowledge and practising the application of newly developed understandings and skills to varied circumstances. There were also examples of children acquiring specific knowledge or using newly acquired understanding across the curriculum areas. For instance, adding an understanding of the conventions of interviewing when using a video camera to their developing language and communication skills, developing their competence with matching and sorting across a variety of dimensions and enhancing their capacity to link spoken and written language and act upon aspects of a narrative. The third area of change, by far the most frequently noted, was the development of positive learning dispositions. Children grew in confidence, independence, and willingness to persist in the face of initial challenge. The dominance of references to children developing positive learning dispositions may in part be a reflection of the practitioners' goals. Nevertheless, these changes were an unexpected and welcome outcome of playing with technologies, suggesting that play with technological resources engaged children's emotional and social subjectivities, as well as the more obvious elements of mathematical and language learning typically present in the design of the resources.

When we studied children's engagement with technologies at home we found the same mix of possible learning outcomes as in educational settings (Plowman et al, 2010a). Children developed operational skills, becoming competent with manual on-screen controls, acquired early e-literacy skills, such as the use of menus, icons and scrolling through pages, in parallel with traditional literacy capacities. Many of the games which children had access to at home on a games console, toy lap-top or 'real' computer were ostensibly targeted at developing literacy and numeracy (indeed this was often the reason why parents purchased the resources) but at home there were also enhanced opportunities to extend knowledge in specific areas of enduring interest such as athletics for one boy with a keen interest in sport and the natural history of a favourite animal kept as a pet by another child's family. However, there was an additional area of new knowledge which was possible at home. Here children learned to take part in local cultural practices concerned with sustaining family relationships (for instance, reviewing and exchanging digital photographs, interacting via Skype and webcams) and family leisure and purchasing practices such as playing games with siblings on the Wii, watching DVDs, making choices during on-line shopping.

Sustaining play with technologies

The power of technologies, and of screen-based resources in particular, to engage children in a wide range of activities designed to support development is oft cited and on occasions in our research we did observed children intensely engaged with digital technologies, for instance, exploring 'what if' or 'what next' options with a practitioner through a programme to explore space science, competing enthusiastically to gain points or collect targets, advising peers to choose particular responses and viewing peer-produced photographs and videos with friends. However, a closer look at children's play with technologies in educational settings suggested that children often became frustrated when they could not achieve their goals or reach the end point of a game with only the technological feedback supplied by the programme (Plowman & Stephen, 2005, Stephen & Plowman, 2008). We observed children abandoning the computer for other traditional activities in their richly-resourced playrooms because they could not understand or comply with the instructions for the game, became 'lost' in layers of choices, were unable to cope with the cognitive demands of the tasks, lacked operational skills or were distracted by peers. These encounters with computers and other digital resources appeared unsatisfactory rather than motivating and unlikely to promote the kind of intense engagement which Kalantzis et al (2005) describe as critical for learning.

The evidence which we gathered during *Interplay* made it clear that, while the design and affordances of the material resource and individual children's interests and willingness to explore or take risks were important mediating factors, it was sensitive and responsive interactions with practitioners which made a critical difference to sustaining children's engagement with technologies and thus to the play, thinking and learning associated with the activity. We identified a range of practitioner actions which were a necessary addition to the interactions with technologies if children were to engage in ways that were positive and rewarding. We conceptualised these pedagogic actions as *guided interaction*, a repertoire of proximal and distal scaffolding activities which make a difference to children's thinking and learning with technologies (Stephen and Plowman, 2008). In the distal domain the activities which practitioners plan for groups and individuals, the resources they offer, the ways in which activities are presented in the playroom and the manner in which staff are deployed in order to facilitate interaction with children all make a difference to engagement with technologies and to the thinking and learning facilitated. Proximal guided interaction happens in direct interactions with the children. Effective proximal pedagogic support is multi-modal, enacted through gesture, expression and touch as well as the spoken word. It happens when adults are able to observe children as they encounter digital technologies, diagnose their difficulties or note the opportunities for extending play and then act in a finely-tuned way to sustain the kind of interest and engagement that is associated with learning in action.

In their own homes children's encounters with technology are supported by distal and proximal guided interaction as they are in educational settings. The evidence gathered in our study *Toys and Technology* (Stephen et al, 2013) suggested that parents offered proximal support which mirrored the range of interactions observed in playroom practices. Like the preschool practitioners their actions were multimodal. The children's encounters were sustained by verbal instructions and gestures, physical guidance for hands and larger movements, praise, explanations and monitoring. Only one form of guided interaction was noted more often at home than in educational settings; when playing competitive games with resources such as the Wii or a games console young children needed more support at home than in preschool to cope with negative emotions arising as they compete with others. Yet, despite the common repertoire of proximal guided interactions enacted by parents, the data suggested that children's everyday experience of playing with technologies was

different in each family context. We identified four dimensions of this distal family context that make a difference to children's engagement with digital technologies:

- family perspectives on technology as an effective educational too, influencing children's access to technologies and encouragement to engage with particular kinds of resources
- parental perspectives on appropriate ways of supporting learning, making a difference to children's opportunities to explore and their understanding of the potential and affordances of resources
- family interactions and practices, sibling interactions and demands on parents' time, defining when children engage with technologies, who shares in these activities and the alternatives on offer at home
- children's preferences and characteristics, influencing what play activity is chosen and the style of interaction with technologies. (Stephen et al, 2013)

Thinking about technologies: preferences and judgments

The children's preferences, interests and judgments about play with the technologies at their disposal made a crucial difference to their experiences, particularly at home where there was more scope for following individual likes and dislikes and less concern for 'balance' across activities, although it should be noted that all of the families in our studies were keen to ensure that their children played indoors and out of doors and experienced a variety of types of play. In the literature and in interviews with parents the impression is given that children are happy to engage with any technology and readily become competent users. However, when we explored the children's perspectives directly through structured activities and conversations and analysis of video observations a more differentiated picture emerged (Stephen et al, 2008).

We found no evidence of play with technologies dominating the lives of 3- to 5-year olds (Stephen, 2011) and, although there was a gender difference between the kinds of technological resources which girls and boys favoured or were given, there was no difference in the proportion of the abundant of toys owned by girls or boys which were technological. Typically children said that they enjoyed traditional activities, particularly swimming, playing in the garden and riding bikes, and were happy to watch television and DVDS and play games on the computer or games console. While many children achieved a balance between traditional and technological play some had no interest in gaining operational skills and were content to rely on parents and older siblings while a few were not interested in engaging at all with new technologies, despite the enthusiasm of family members and ample resources at home.

For some children particular technological resources, especially those owned by older siblings, were high status items which they were keen to play with even if their level of operational skills and conceptual understanding limited their participation. However, in general children were discriminating users of technology who knew what they liked to use and what they were good at and who made more selective evaluations of resources than their parents recognised. Children differentiated between games they found frustrating and failed to succeed at and those which they enjoyed and with which they were successful. The young players talked about some activities being boring, too hard or too long or simply not having interesting content. Although we have no way of assessing the accuracy of their judgement it was interesting to find that children could identify

games they were good at and resources they could use alone and others with which they struggled. The 3-5-year olds had readily articulated expectations about age appropriate games and resources. They were more likely to suggest that another child would need help with operational features of a resource than to draw attention to ways of engaging with the substantive activity. For instance, we saw Arden seek help with operating the controls on a games console although later he seemed unaware of the goal of the game he was involved with and unsure about the meaning of the scores given. It is also possible that in some cases young children found it easier to complete an activity by dragging and clicking using a cursor and mouse than to control a pencil or manipulate small tools or objects such as jigsaw pieces and touch screen interfaces offer enhanced ways of interacting with technologies which afford a degree of manoeuvrability not necessarily available in 'concrete' objects. These findings about the ways in which children discriminate between technological play activities suggest that adult characterisations of preschool children as 'digital natives' may overstate the children's feelings of competence and overlook the differences in the ways in which individuals experience particular technologies or interfaces.

Summary

Contrary to the popular rhetoric about the educational promise of play with technologies the research evidence suggests a more conditional and nuanced picture. It is clear that not all technological play resources offer the same opportunities for learning and that some kinds of thinking and aspects of development are more likely to be promoted by play with technologies than others. Nevertheless, play with technologies can support the development of operational skills, extend knowledge and understanding and enhance dispositions positively associated with learning. But if children are to have the kind of sustained encounters with technologies which are likely to support thinking and learning they need more than interactions with the hardware and software; they need scaffolding interactions with the adults who educate and care for them. And the contexts for play with technologies which families and educators create, coupled with the preferences and interests of individuals, make a difference to children's experience and expectations of digital media. In the light of this multiplicity of conditions the outcomes of play with technologies are inevitably uncertain.

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