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Embedding educational technologies in early years education

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This survey of 335 practitioners builds on research which challenged the view that educational technologies are rarely used in early years settings. Previous research tends to focus on individual devices. This research looks at the range of devices being used and, instead of investigating how often they are used, considers how they support pedagogical practice. Findings support the view that early years practitioners are accessing a wider range of technologies and that these technologies are being used in more pedagogically appropriate ways than has previously been reported. Educational technologies appear to be increasingly embedded within early years education. Overall, attitudes towards educational technology are positive. Beliefs, however, are more likely to be linked to the social rationale, that children need access to technology because they are surrounded by it in everyday life, than the pedagogical rationale, that technology enhances learning. It may be necessary to review documentation to ensure that policy and practice focus more specifically on learning and teaching.

Keywords: early years education; educational technology; ICT; practitioner attitudes; rationales

Introduction

Although technology is seen to have a positive impact on learning in the early years (Vaughan and Beers 2017), research typically suggests that many settings rarely use it (Blackwell, Lauricella, and Wartella 2014). An earlier study (Jack & Higgins 2018) challenged this view, suggesting that while barriers to the use of educational technology still exist, digital devices are being used for a range of activities that is much broader than some earlier literature suggests.

The term 'educational technology' is being defined more broadly than what was done previously, referring to more than just computers, interactive whiteboards (IWBs) and tablets with a more inclusive view of digital devices.

This research builds on a small-scale, exploratory study involving interviews with 20 early years practitioners who work in the Early Years Foundation Stage (EYFS) (Jack & Higgins 2018), which in England refers to the stage between birth and 5 years old (Standards and Testing Agency 2017). The phase of the research described here aims to show whether these findings could be replicated on a larger scale.

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This study used a questionnaire to ask: what technology is available in early years settings, how often is it being used and what is it being used for? It explored how extrinsic and intrinsic barriers are influencing practitioners' use of technology.

Sections of the questionnaire draw on recent studies in the United States (Blackwell, Lauricella, and Wartella 2014; Blackwell *et al*. 2013, 2015; Wartella *et al*. 2010, 2013). While direct comparisons of all the data are not possible, some useful conclusions can be drawn.

Blackwell *et al*. (2013) identified a number of limitations in their research. Some, such as the use of self-reports, are shared by this study. One, the need to consider how technology is being used, is addressed here. In addition to finding out what technology is available, this research looks at how practitioners are using the technology they have. Rather than simply asking which areas of the curriculum are being supported, respondents were asked about the types of activities children were experiencing and whether adults were working with them to extend their experience beyond basic exploration.

What is educational technology?

There is limited information about what educational technology early years practitioners have access to, as research is often limited to small-scale, qualitative studies (Plowman 2016). Whilst these studies are often essential to understand the use of technology in context, it is difficult to get an accurate picture of what is happening more widely.

Technology is defined differently by different authors (Ekici 2016). A small-scale review of the literature (Jack & Higgins 2018) showed that the usual focus is computers, IWBs and/or tablets. (Jack & Higgins 2018) found that most of the interviewees had a much broader view of technology. Most commonly, they talked about computers, cameras, IWBs, tablets, recording devices, programmable toys, remote control toys, metal detectors, musical instruments, phones, walkie-talkies, the Internet and microscopes. All settings had at least five different types of devices.

Why is technology being used?

While educational technology is often described as a 'game changer', likely to result in a new approach to teaching and learning (Selwyn 2016), this is not the only way of viewing technology in education. An in-depth review of this area is beyond the scope of this article, but it is useful to consider four rationales identified by Hawkridge (1990):

- Social – computers are everywhere in society, schools need to prepare children for this life.
- Vocational – children need to learn about computers as they need them for their future careers.
- Pedagogical – computers support teaching and learning.
- Catalytic – computers are catalysts, enabling change in education.

If, as previously mentioned, technology can have a positive impact on learning in the early years (Vaughan and Beers 2017), simply having technology is not enough.

Practitioners need to consider how the technology is used (Higgins, Xiao, and Katsipataki 2012). A practitioner who has a social rationale will have a reason to have technology in their setting, but a pedagogical rationale may be needed for the technology to support teaching and learning.

What is technology being used for?

Much of the reviewed research consisted of evaluations of the efficacy of a specific resource or device; it rarely considered a range of technologies. Where this happened, it looked at the type of technology settings have, the amount of time spent using the different devices or the area of the curriculum which is being supported. There is little evidence of how educational technologies are being used to support teaching and learning (Aldhafeeri, Palaiologou, and Folorunsho 2016; Kerckaert, Vanderlinde, and van Braak 2015).

The interviewees reported that their technology was being used across the curriculum and supported child-led, active, exploratory approaches to learning (Jack & Higgins 2018). Again, this is different from previous work which suggested a more restricted use of technology, often limited to the use of computers during free play, or a focus on operational skills or turn taking (Plowman and McPake 2013; Plowman and Stephen 2005, 2013; Plowman, Stephen, and McPake 2008; Stephen 2014).

Barriers

The literature highlights a range of barriers that can limit the use of technology in schools. These can be divided into extrinsic (lack of equipment, training and technical support) and intrinsic barriers (attitudes and beliefs) (Ertmer 1999). Research suggests that most extrinsic barriers have been tackled in schools (Ertmer 2005); however, technology use is still not as widespread as some would like. Intrinsic beliefs are described by Ertmer (2005) as the 'final frontier'. The interviews (Jack & Higgins 2018) suggest that, for the interviewees, attitudes are not a barrier to the use of technology. The survey was used to find out if this was true for a larger sample.

Early years pedagogy and the role of the adult

Ertmer (2005) identified the need to examine the relationship between teachers' pedagogical beliefs and their use of technology. Early years education is different from other phases of education, with a stronger focus on socio-emotional skills alongside academic skills. Good learning is seen as active and independent (Mertala 2017). This is not always seen to be conducive to working with technology, which some people see as a potential threat, taking time away from other, more important, activities and disrupting learning (Ljung-Djärf, Åberg-Bengtsson, and Ottosson 2005).

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). If children use technology on their own, they may not use it in the most efficient way (Preradović, Lešin, and Boras 2017). There is a need for adults to scaffold and model appropriate use (Neumann and Neumann 2014). The survey aimed to find out whether this kind of support was being given.

Methodology

The research questions addressed by this study are the following:

- What educational technologies are available in early years settings and how are they being used?
- What barriers influence the implementation of technology in early years settings?
- What are early years practitioners' attitudes towards educational technology?

Data collection

Two surveys were adapted for this study: the survey described by Blackwell *et al*. (2013), which was also referred to in other studies (Blackwell, Lauricella, and Wartella 2014; Blackwell *et al*. 2015; Wartella *et al*. 2010, 2013) focused on technology, and Kim's survey (2005), which focused on pedagogical beliefs and practices. Given the rapidly changing technological landscape, changes were made to ensure the final survey included up-to-date devices and questions were added to ask how technologies were used. The adapted survey was shared with seven experts from local authorities and schools who provided feedback on the items and functionality. The research was reviewed and approved by the ethics sub-committee at Durham University.

A convenience sampling method was used to identify participants. The survey was sent to existing contacts, early years advisors and schools identified through Internet searches. Most communication was performed through email or social media and the survey was available online. This may have created a bias in the sample, resulting in more responses from people who are comfortable using technology (Tymms 2012). Paper versions were available on request and posted to a small number of settings. As completion required a significant time commitment, an incentive of entry into a draw for a £30 voucher was offered.

Sample and respondents

Of the 335 responses, 50.7% came from early years settings within schools, 27.2% came from private nurseries and 10.4% were from childminders. The rest of the responses were from preschools or playgroups (4.2%), Local Authority (LA) nursery schools (3.6%), other nurseries (1.8%) and children's centres (0.9%). About 1.2% respondents did not mention where they were from.

Of the respondents who came from schools, 75.6% worked in LA schools, 18.5% worked in academies that are publicly funded independent schools, 5.4% worked in independent schools that charge fees and 0.6% worked in free schools that are funded by the government but are not run by the local council, thus giving them more control than LA schools (Gov.uk 2018). This is representative of the types of schools in the UK.

The majority of respondents (96.4%) came from England, 1.8% from Scotland, 0.9% from Northern Ireland, 0.3% from Wales and 0.6% (two respondents) came from outside of the UK. Most of the respondents were teachers (48.3%) or head teachers/managers (37.2%).

Findings

What technology do they have and how often is it used?

Figure 1 shows that all respondents had access to at least one device, with some even having 20 or more devices.

Not all devices were working, though less than 5% of most types of devices were broken. Those that were over 5% are shown in Table 1. The most common broken devices were metal detectors (14.29%) and walkie-talkies (18.40%). In most cases, the respondents wanted broken devices to be fixed.

Blackwell *et al.* (2013) described technology use as universal if 75% of respondents could access it and non-universal if fewer than 30% had access to it. This definition was used to analyse the responses to this survey, as shown in Table 2, where some comparisons can be made.

Eight technologies can be classified as universal: Internet access, role play, digital cameras, audio players, laptops, programmable toys, tablets and desktops.

The availability of desktops, laptops and digital cameras is similar to the findings of Blackwell *et al.* (2013) study, but the number of televisions is very different (79% in the Blackwell study and only 37% in this study). Similarly, there is a significant difference when it comes to tablets. In the Blackwell *et al.* (2013) study, only 28% had access to tablets, while in this study a universal access was noted, with 79% having access.
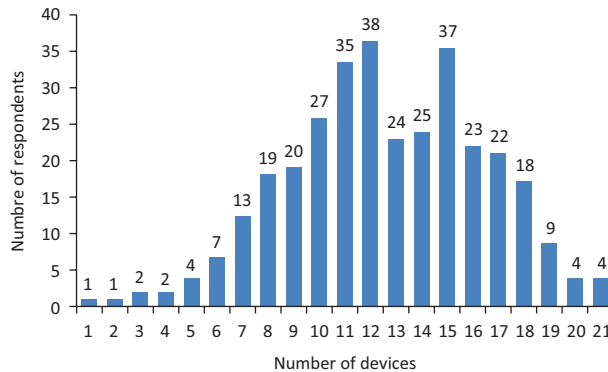

Figure 1. How many devices do respondents have access to?

Table 1. What percentage of each device was broken?

	Broken – needs fixing (%)	Broken – not needed (%)	Total broken (%)
Visualiser	2.70	2.70	5.41
Music	4.59	1.53	6.12
Audio recorder	5.98	0.54	6.52
TV	2.56	5.13	7.69
Remote controlled car	7.77	0.97	8.74
Video player	3.64	5.45	9.09
Metal detector	7.14	7.14	14.29
Walkie-talkie	16.00	2.40	18.40

Table 2. Percentages of universal and non-universal technology use.

		All	Childminder	Setting	*Blackwell et al. (2013)*
Universal – over 75%	Internet access	96.3	97.0	96.3	–
	Role play	92.5	91.4	92.6	–
	Digital camera	91.0	94.1	90.6	*92*
	Audio player	82.9	77.4	83.5	*21 (iPods/MP3)*
	Laptops	82.3	90.9	81.3	*See desktops*
	Programmable toys	81.5	62.5	83.6	–
	Tablets	79.3	78.8	79.3	*28*
	Desktops	78.0	48.3	81.1	*83 (laptop/desktop)*
	Remote control cars	64.6	68.8	64.1	–
	Audio recorder	62.6	44.8	64.5	–
	IWB	62.4	3.8	67.9	–
	Music	61.1	82.4	58.5	–
	Video camera	60.1	66.7	59.4	–
	Radio	50.6	78.1	47.6	–
	Mobile phone	45.9	97.1	39.9	–
	Walkie-talkie	39.3	45.5	38.6	–
	Video player	37.9	53.6	36.3	*79 (TV/DVD)*
	TV	37.0	88.2	30.9	*See video player*
	Microscope	33.0	40.6	32.1	–
	Gaming devices	30.6	71.0	25.9	*15 (iPod Touch)*
Non- universal – less than 30%	Visualiser	24.7	3.3	27.1	–
	Metal detector	18.5	16.1	18.8	–
	eReader	13.1	35.5	10.6	*15*

IWB, interactive whiteboard.

Table 2 shows that there are important differences between settings and childminders. For childminders, there are additonal universal technologies: music, radio, mobile phones and TV. They are also much more likely to have gaming devices. Most of these technologies could be described as 'home technology'. Childminders are, understandably, much less likely to have IWBs.

Frequency of technology use was measured in a similar way to the Blackwell *et al.* (2013) study: a dichotomous variable was created indicating (1) access and (0) no access. A second variable was created for respondents who had access to the technology. This was converted to a continuous variable using a six-point scale for frequency. As this research had a six-point scale compared to the seven-point scale used by Blackwell *et al.* (2013), it was adjusted accordingly. Never was converted to (0), occasionally (0.5), monthly (1), weekly (4), 2–4 times a week (14) and daily (30).

Figure 2 shows how often devices are being used. Perhaps not surprisingly, universal technology tends to be used most often, though this is not always the case. Programmable toys are universal but are used less often than some devices accessible by fewer respondents, for example, music and radio. Where there is access to IWBs, they are used more often than some universal devices.
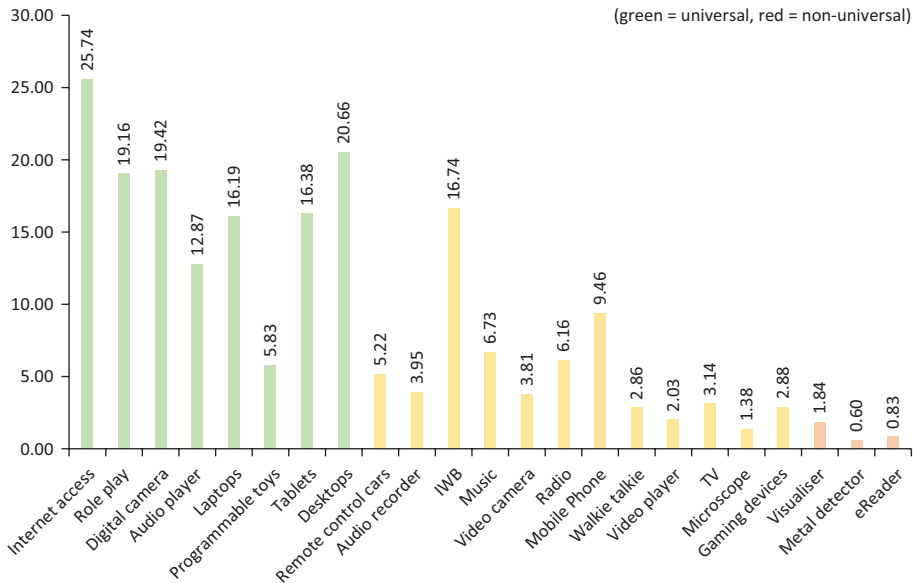
Figure 2. How often is each device being used?

Only 3% of respondents have no access to computers (defined as laptops, desktops or tablets). Of those who have access, they all use them at least occasionally. This could indicate a significant increase. In the 2013 study, 55% of in-home care providers and 59% of classroom teachers reported having access to computers, while 34% and 35% of practitioners, respectively, reported never using a computer with young children (Blackwell *et al.* 2013).

Over 30% of practitioners did not use certain technologies even when they were accessible. This was the case for visualisers, metal detectors and eReaders. However, this does not necessarily mean that they were not considered valuable. About 46.1% of settings that did not have metal detectors said that they would like to have them; for eReaders, it was 30.0% and for visualisers it was 29.4%.

Respondents who did not have access to a resource were able to indicate if they thought it was 'not appropriate' for their children. Not everyone agreed about appropriateness. Seventy-one per cent of respondents who did not have a TV in their setting stated that it would not be appropriate to have one; however, a small number of respondents (5%) indicated that they wanted a TV. For gaming devices, 74% of respondents stated that they were inappropriate, while 9% wanted one. For microscopes, 38% stated they were not appropriate, while 48% wanted them; for metal detectors, it was 39% and 44%, respectively. Of those respondents who had these devices, some were using them every day. These differences may indicate different understandings of how these devices can support learning.

Childminders identified more technology as being 'not appropriate'. The most striking difference was with mobile phones: 87% of practitioners working in settings identified these as not appropriate, while no childminders thought this. About 97% of childminders mentioned having mobile phones compared to 46% of practitioners in early years settings.

How is technology being used?

How are children using technology?

When asked if children are more likely to select activities that involve educational technology, most of the respondents (55%) said there would be no difference. Of those who stated that there would be a difference, over four times as many (36%) thought children would be more likely to choose technology compared to those who thought they would be less likely to do so (8%).

When asked if children spend more time on activities using technology, rather than activities involving other resources, most of the respondents (50%) said there was no difference. Of those who stated that there would be a difference, over four times as many (41%) thought children spend more time on activities using technology compared to those who thought they would spend less time on them (9%).

Table 3 shows how often children are reported as using technology for different activities. Listen to stories/music, practice literacy or numeracy, stimulus material, open-ended programs and celebrate achievements all have a modal value of 1: they are being used daily. Other activities have a mode of 5 and are used only occasionally. However, the means suggest that there may be less of a difference overall, with all activities happening regularly.

Respondents who were not using technology in a particular way were able to indicate whether they thought it was 'not appropriate' or something they may want to do in future (see Table 4). Again, there is a lack of consistency for some devices. For example, most users of technology said that they used it to support pupils to search for information at least occasionally, but 84% of those who were not doing this stated that it was an inappropriate thing to do so. About 65% of those who were not using technology to support children with special educational needs stated that this was inappropriate.

How are adults using technology?

Table 5 shows how adults are using technology, with all activities except communicating with children happening at least weekly. Childminders tend to spend more time

Table 3. Respondents response to how technology is being used by children?

	N	Mean	Mode
Listen to stories/music	319	2.06	1
Practice literacy or numeracy	283	2.17	1
Stimulus material	287	2.29	1
Open-ended programs	274	2.56	1
Celebrate achievements	245	2.67	1
Taking photos	301	2.85	5
Search for information	243	3.04	5
Support SEN	229	3.05	5
Supporting reflection	225	3.12	5
Show how to use	251	3.58	5
Take videos	207	3.77	5

SEN, Special Educational Needs.
Note: 1 = daily, 2 = 2–4 × a week, 3 = weekly, 4 = monthly, 5 = occasionally.

Table 4. If respondent indicates they do not use technology in this way would they want to or is it 'not appropriate'?

	N	N Do not use	% Do not use	N Would like to	% Would like to	NA	% NA
Listen to stories/music	319	11	3.3	7	63.6	4	36.4
Practice literacy or numeracy	283	45	13.7	19	42.2	26	57.8
Stimulus material	287	37	11.4	12	32.4	25	67.6
Open-ended programs	274	52	19.0	22	42.3	30	57.7
Celebrate achievements	245	74	23.2	38	51.4	36	48.6
Taking photos	301	29	8.79	17	58.6	12	41.4
Search for information	243	82	25.2	13	15.9	69	84.1
Support SEN	229	82	26.4	29	35.4	53	64.6
Supporting reflection	225	94	29.5	38	40.4	56	59.6
Show how to use	251	69	21.6	28	40.6	41	59.4
Take videos	207	110	34.7	51	46.0	59	53.6

NA, not appropriate; SEN, Special Educational Needs.

Table 5. Respondents' response to how technology is being used by adults?

	N	Mean	Mode
Recording observations	325	1.92	1
Find	330	2.02	1
Planning	329	2.07	1
Assessment	319	2.23	1
Communication with colleagues	322	2.31	1
Displays	323	2.56	1
Professional development	323	2.86	1
Communication with multiple parents	324	3.01	1
Communication with individual parents	321	3.11	1
Publishing children's work	320	3.32	1
Communication with children	314	5.01	6

Note: 1 = daily, 2 = 2–4 × a week, 3 = weekly, 4 = monthly, 5 = occasionally, 6 = never.

on communicating with parents, either in groups or individually, while practitioners in settings spend more time on communicating with colleagues, using technology to create displays and for digital publishing of children's work.

Other uses of technology identified by the respondents included using electronic learning journals for assessment, recording achievements and parental engagement.

Which areas of the curriculum are being supported by educational technologies?

In England, early years provision has to follow the Statutory Framework for the Early Years Foundation Stage (Department for Education 2012). This document identifies three characteristics of effective teaching and learning:

- Playing and exploring
- Active learning
- Creating and thinking critically

There are three prime areas:

- Communication and language
- Physical development
- Personal, social and emotional development

and four specific areas:

- Literacy
- Mathematics
- Understanding the world
- Expressive arts and design

In the most recent curriculum documentation for England, educational technology is mentioned only in the 'Understanding the World' section. The Early Learning Goal states: 'children recognise that a range of technology is used in places such as homes and schools. They select and use technology for particular purposes' (Department for Education 2012).

There is no mention of technology supporting teaching and learning across the curriculum, though the exemplification materials contain an explanatory note: 'The child chooses the technological opportunities around him or herself as a tool to enhance and extend his or her learning' (Standards and Testing Agency 2012).

In previous curriculum documentation, the role of technology to support learning across the curriculum was more explicit. For example, the Desirable Learning Outcomes (School Curriculum and Assessment Authority and Department for Education and Employment 1996) stated that children should 'use technology, where appropriate, to support their learning'.

Although the curriculum handbook does not mention the use of technology to support learning, respondents indicated that technologies are regularly being used to support all three characteristics of effective teaching and learning. It is used regularly across the areas of learning and development, though slightly less in expressive arts and design, personal, social and emotional, and physical development.

Role of adults

Table 6 shows that adults are regularly working alongside children and providing them with support when using technology, though it is not possible to say what this

Table 6. Respondents' response to how technology is being used with children in their setting, how often is it used in this way?

	N	Mean	Mode
Child initiated – with adult support	333	2.31	2
Child initiated – no adult support	330	2.32	2
Adult initiated – large groups/whole class	323	2.34	2
Adult initiated – one or two children	330	2.43	3
Adult initiated – small groups	331	2.49	3

Note: 1 = extensively, 2 = regularly, 3 = occasionally, 4 = not used.

consists of. It appears that adults are more likely to support child-initiated activities than those the adult initiated themselves.

Barriers

About 46.3% of practitioners in settings reported having had enough training, while this dropped to 25.7% for childminders. About 26.7% of practitioners in settings and 54.3% of childminders had not had any training, while 75.9% and 54.3%, respectively, wanted more training.

Figure 3 shows the type of training respondents had previously accessed, and what they would like in the future. Responses suggest that access to information about how other settings use technology, and time to explore, would be the most useful form of future training. Training in basic skills and technical skills appears to be the least desirable.

Practitioner confidence was high, with 97.9% reporting confidence in using technology for personal use, and 94.5% were confident in using it to support children's learning.

Factors that were identified as encouraging practitioners to use technology were curriculum requirements, children's ability to use educational technologies, personal ability to use educational technologies, personal confidence and the amount of equipment available. Only one factor, the amount of finance available, appeared to discourage the use of technology.

What are their attitudes towards technology?

The majority of respondents (61.6%) felt that the amount of technology their children had access to was almost right. Of those that felt the amount should be changed, 33.9% thought their children needed more access, while 4.5% thought they needed less access.
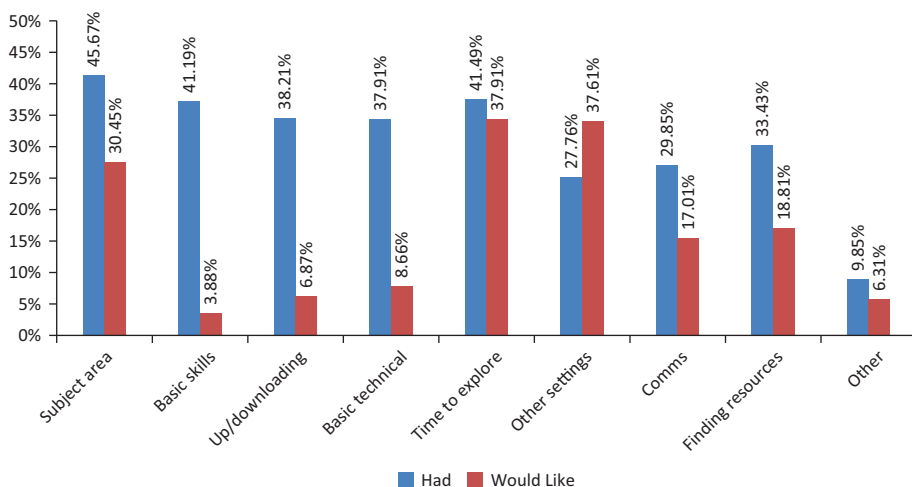

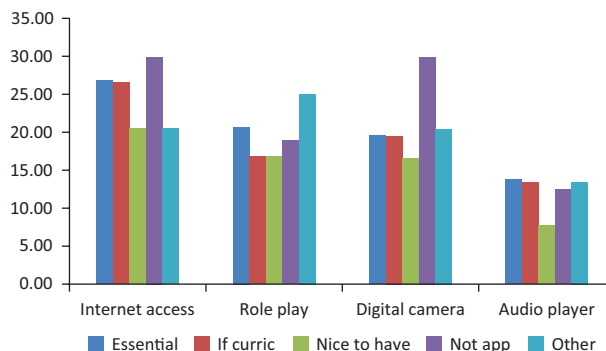Figure 3. What sort of training have you had?

Figure 4. How often is a device used (depending on attitude)?

Most of the respondents (45.8%) stated that children should be introduced to technology when they are 3 or 4 years old. Of the respondents, 34.4% stated that children should be younger, 3.9% said they should be 5 years old or older, while 0.6% stated it was not appropriate to use technology in the early years. Not everyone felt this was an easy question to answer, with 15.3% of respondents suggesting that the answer would depend on the circumstances.

Of the respondents, 52.0% thought technology was essential in the early years, 28.7% thought that it was necessary to support the curriculum, 15.4% thought that it was nice to have and 1.2% thought that it was not appropriate. It might have been expected that respondents who describe technology in the early years as 'not appropriate' would use it less often than other groups. However, for most devices, it was the group that describes technology as 'nice to have' that uses it least often. An example of this is shown in Figure 4.

The respondents were asked to explain their attitude towards educational technologies. Most of this data will be reviewed in a future paper, but an initial analysis showed that many respondents referred to one of Hawkridge's (1990) rationales in their explanations. Of the 194 respondents who did this, the majority of comments (56.7%) referred to the social rationale, 41.2% referred to the pedagogical rationale and 2.1% referred to the vocational rationale. No one referred to the catalytic rationale.

Discussion

These findings support the view that early years practitioners are accessing a wider range of technologies than has previously been reported. However, while respondents were reminded that a device may have more than one function, they did not always appear to understand the range of functions some devices have. For example, of the 256 respondents who said they had access to one or more tablets, 10.6% said they did not have a digital camera, 43.4% said they had no video camera and 38.7% said they had no access to an audio recorder, yet all of these are standard functions of most tablets. This may indicate a limited use of multifunctional devices. For some devices, there were differing views about whether they are appropriate to use in the early years. This could be because of a lack of knowledge about what is possible.

The biggest difference between childminders and settings when looking at whether devices were appropriate or not concerned mobile phones. This is likely to be a result

of systems and resources that are available in different kinds of settings. In more formal settings, other staff may be responsible for contacting parents, while child-minders are more likely to need the immediate communication that mobile phones offer. A second reason is likely to be eSafety. Schools tend to have policies in place restricting the use of mobile phones on school premises.

Technology is being used across the curriculum and responses suggest that children are using it in open and exploratory ways, supporting the usual pedagogical approach found in early years. This indicates that there has been a move away from simply using technology in free play, or to teach children how to operate devices. It is worth noting that while a significant proportion of respondents had received training on how to operate devices in the past, few wanted such training in the future. Plowman (2016) suggests that operational approaches are the least appropriate way to use technology; this research indicates that there appears to be a shift away from this approach for both children and practitioners.

Adults appear to be working alongside children and scaffolding their use of technology, suggesting that it is used in more interesting and appropriate ways than the drill and practice of the past (Wang *et al*. 2010). Given the self-reported nature of the study, it is not possible to know if what is being reported is happening in practice, as is the case in the original study (Blackwell *et al*. 2013). It is possible that respondents could have misinterpreted some questions. One respondent, who indicated they used technology across the curriculum, added a note saying, 'we use technology to support them, rather than them using it individually'. In some settings, the adults may be using the technology more than the children and the survey may not fully capture this distinction.

Respondents were asked if they would be willing for the researcher to visit them to see what was happening in practice. Due to the scope of the research, it was only possible to visit a small number of local practitioners. All those visited were using technology in age-appropriate ways that supported the early years curriculum. As this group was self-selecting, it could be possible that there was a bias towards practitioners with a more positive approach to using technology.

Implications for research and practice

It is important to recognise that comparisons are being made between research conducted in the UK and earlier research conducted in the United States. The international picture is diverse. Research conducted in Kuwait, for example, found that digital cameras were not being used (Aldhafeeri, Palaiologou, and Folorunsho 2016). For the respondents in this research, who were mainly English, they are one of the most common devices. Comparisons should be treated with caution and it would be useful to repeat the study across the UK to see if the findings are replicated. Follow-up research with a larger random or representative sample and supported by observations would be valuable in this regard.

The findings suggest that technology is physically embedded in early years education and being used in more pedagogically appropriate ways than it was in the past. Attitudes towards technology are generally positive and it is being used even when practitioners' own beliefs may be more negative. A range of educational technologies are physically embedded across the respondents' settings and there are indications that they are becoming culturally embedded too.

This raises an interesting question: what comes first — the technology or the belief? Has the physical presence of the technology resulted in practitioners' beliefs, and the ways that they use the technology, becoming more positive? Or are beliefs leading to an increased physical embedding of educational technologies?

While attitudes appear to be more positive, and educational technologies are being used in more educationally appropriate ways, this does not necessarily mean that they are having a positive impact on learning. Most of the respondents stated that they believed it was important to use technology because children were surrounded by it in society. Fewer respondents suggested that it was because of its pedagogical value. Future research should address this issue more explicitly and explore whether the embedding of educational technologies in early years education results in a move towards a more pedagogical rationale.

This article refers to the second phase of a longer study; phase 3 examines how technology is being used in practice. This is linked to a more in-depth evaluation of the pedagogical rationale and other key theoretical frameworks that look at how practitioners can implement technology within their settings. The Technological Pedagogical Content Knowledge (TPACK) model is used to examine how the use of technology can be integrated with the practitioners' pedagogical beliefs (Voogt *et al.* 2013). Substitution, Augmentation, Modification, Redefinition (SAMR) is a hierarchical model that suggests that there are different levels of technology use (Puentedura 2006). Technology can be used as an alternative way of doing existing activities, or it can be used to redefine activities; it can allow children to access activities that would previously have been impossible (Hockly 2012). These frameworks will allow practitioners' practice to be examined more critically.

The pedagogical rationale is not explicit in the Statutory Framework handbook in England. It is possible that for educational technologies to have more of an impact on teaching and learning, curriculum documentation should address this. However, recently proposed changes to the early years curriculum appear to be going in the other direction, with references to technology being removed (Department for Education 2018a, 2018b).

Conclusion

This article has challenged the view that technology is being used in very limited ways in early childhood education. Technology appears to be more physically and culturally embedded than it was previously, but the self-reporting nature of this research means further research is needed into how it is being used in practice.

The final phase of the research described in this article examined how technology is being used to enhance teaching and learning. It looked at the pedagogical rationale in more detail and used key theoretical frameworks, including SAMR and TPACK, to critique how technology is being implemented in early years settings. Findings from this phase will be published in later articles (Jack, 2019).

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