

Digital and New Technologies: Research Tools and Questions

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Abstract

Children and young people's use of technology is an important topic for research. The research topic has grown in size and importance since the 1980s as people's use of technology has become much more widespread within and outside of school. In this chapter, we outline the way that new technologies are providing a range of research tools to gather data and information about children; we also consider the methods that are used to answer important questions about young people's use of technology. Lastly, we raise questions, particularly for psychologists, about their role in investigating technology and educational processes and look to future directions.

1. Introduction

Changes in technology, even small changes, have always been with us and in the lives of children; it also seems that these changes are accelerating in pace and involving younger and younger children. For example, there are widely circulated examples of infants swiping and tapping on iPads, while the availability of the Internet and the accessibility of digital information are significantly changing the working and non-working lives of all who use these systems. In this chapter, we first consider the use of iPads/tablets and other computer devices as ways to gather information about children and young people (e.g. as recording devices of their behaviours). This is similar to chapters in this book which are concerned with specific research techniques, such as eye tracking, where the technique provides a way of understanding psychological processes. Second, we consider more general issues about research methods and design in relation to major research questions about the use of technology. In this case technology is not simply a research tool, but a subject of inquiry. We use the term *research tools* when discussing the ways new technologies can be used to collect information and the term *methods* to refer to general paradigms that are used in investigations, such as experimental, participatory and so on.

Our subject matter concerns new technologies and digital technologies and we use these terms to refer to various kinds of hardware such as iPads, tablets, smartphones as well as desktop computers (PCs) and entertainment devices such as PlayStations. We use the term technological tools when considering interconnected networks or specific approaches, such as for example learning analytics and internet. Examples are often be drawn from our own work (simply because we know it best), and often concern issues related to the use of technology for educational purposes or in educational settings. We conclude by outlining new issues and new directions for research in this area.

2. Using Technological Tools to Gather Data and Information

In this section we outline the way that commonly available forms of digital technology can aid the collection of information from children and young people. We consider: simulations and games, eye-tracking, iPads, learning analytics, and the internet.

Before considering these tools it is useful to make some general points. Most children and young people are fascinated by technology and do not have the inhibition or concerns of some adults who may worry they will 'break' the device or fail to master a task. As a result, children are often eager to participate in investigations that make use of technology,

especially new and unfamiliar technology and may even feel disappointed if they do not take part. Although using technology has many advantages one has to be careful about the time and financial costs in setting up a computer based activity and the ease of collecting information about the activity. Furthermore, one needs to consider whether access the Internet is necessary for the research; many schools block this access because of concerns about children's access to unsuitable sites. It also is useful to bear in mind the possibility of theft or damage; often the researchers have to be prepared to bear these costs. However, in our experience such events are very rare, though with portable equipment such as iPads/tablets the purchase of protective covers can be helpful. Thus, there are a number of general issues that need to be worked out at an early stage of research planning.

2.1 Virtual worlds: Games and Simulations

Many investigations make use of the attractive and engaging properties of technology to collect information about cognitive processes. For example, standardised tests are now often presented on computer, which may be more motivating and provides gains in relation to the time taken to score the tests (for a more detailed discussion see chapter 4). Games, puzzles, and problems presented on digital devices often make the tasks more interesting and engaging.

In some cases, commercial games are used for research purposes. For example, a virtual car racing games have been used to investigate risk-taking in adolescents (Gardner & Sternberg, 2005). In this investigation, recordings of brain waves were obtained to locate regions of the brain that were associated with risk taking (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011). Although it cannot be assumed that the risk-taking seen in a virtual game exactly corresponds to the behaviour seen when driving, the simulation provided insights into risk-taking in competitive situations.

In other research projects, simulations are used as a less difficult and less dangerous way of obtaining information about behaviour. A good example is the use of virtual, interactive, simulations of walking round city streets to investigate the navigation abilities of children (Courbois, Blades, Sockeel, & Farran, 2013). This is less dangerous than carrying out research in 'real' streets, and provides standardised experience for all children without the need to construct a physical environment. Furthermore, keyboard responses can be automatically recorded to aid data collection. A 3D simulation of a Geology field trip based in the Lake District has been developed by Minocha (2015), using Unity 3D software. The interactions and the learning activities within the 3D environment are designed both to mirror the experience of a real field trip and to enhance it with additional functionality. This is very useful for students with limited mobility who cannot take part in real field trips and also for teachers who can complete risk assessment and take part in professional development training anytime and anywhere in the world.

These examples show how technology can engage children and also provide a way to look at responses in a safe environment which sometimes can be less costly to construct than similar activities in the physical world. There is evidence that virtual worlds provide a very good indication of children's responses to real world activities; an issue that always needs to be considered (Sheehy, Ferguson & Clough, 2010). Thus, new technologies have opened up new possibilities for research into a range of behaviours and thought processes.

2.2 Eye-tracking

Eye tracking makes it possible for tablets or computers to know where users are looking (see Chapter 2 for a detailed discussion). This is relevant to the development of websites and digital material (e.g. games), but also for measuring children's engagement. For example, Southgate, Senju and Csibra (2007) has used recordings of eye gaze to look at anticipatory in infancy and in this way provide a detailed record of events. Eye-tracking is a direct and powerful tool for revealing what information the brain is processing. For children with special needs, the technology can be used to generate a click or other command and supplement traditional communication mechanisms. As such, children with profound communication difficulties can control resources around them with gaze without the need for use of hands or speech.

2.3 iPads

In this section we outline the way that iPads (and comparable tablets) can be used in research. This section is more detailed than the others because of the comparatively less research with these new tools. iPads/tablets can be used as effective research tools for three main reasons: first, the devices contain several data collection tools embedded in one : camera, digital notepad, audio-recorder; second, they are portable and light-weight facilitating fieldwork and third, they are easy to access and intuitive to use. In addition, there are many applications (software programmes) facilitating data collection. For instance, researchers can use annotating apps, apps supporting representation of ideas (various mind-maps apps) or apps facilitating editing videos and audio files. iPads are intuitively designed and therefore easier to use than some of the older technologies for both the participant and the researcher. Moreover, unlike many other data collection tools (e.g. eye-trackers), iPads are commonplace in many classrooms and homes. As such, they are non-intrusive data collection tools. This makes iPads particularly suitable for studies that require children's focused attention and close manipulation of the device.

Our investigations of iPads have focussed on Our Story (OS hereafter; free from iTunes; see <http://www.open.ac.uk/creet/main/projects/our-story>) in educational settings. We have been involved in the design and development of this iPad/tablet app. The app enables the creation of narratives around digital photographs, and text and/or audio recording can be added to each photograph. The screen shots below illustrate some of the app's characteristics. The user interface shows that pictures can be dragged from the camera role at the top onto the storyline at the bottom. Text and/or sound can be added to the pictures in the storyline and it can be played, printed or sent to others. We describe two of our projects to illustrate how the OS app- and comparable tablet apps- can be used in research.

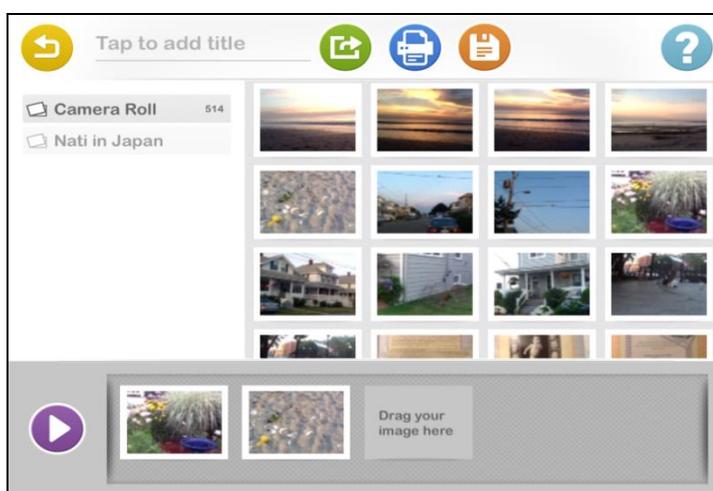


Figure 1. Screen Shot of a Page from Our Story

2.3.1 Using OS to Promote and Collect Information about Narrative Abilities.

We have used the OS app both as an intervention and a way of collecting information about children's progress. In one instance, we worked with an Early Years teacher who contacted us with the explicit intention of using the OS app to support the narrative development of children who were 3-5 years old in her pre-school. In the course of 6 months, the teacher used the app to motivate children in narrative and literacy activities, especially those children who lacked such engagement at home or could not fully participate in classroom group activities because of their limited oral language skills. The teacher used the app to display, in an attractive digital format, some of the children's favourite books. She, together with classroom assistants, encouraged children to narrate their own stories by taking their own photos and recording sounds to accompany them. A formal evaluation of the approach, comparing pre- and post-test activities found that as a result of the intervention, children produced more utterances in their digital stories and their narratives were also richer in detail than at the start of the study (Kucirkova, Messer & Sheehy, forthcoming). In this way technology was used as a way to provide early literacy related experiences and their digital (and other) narrative abilities before and after this experience were compared. The ease of use of the app enabled the research to be set up reasonably quickly, and the interest of the teacher in technology enabled a co-operative research project to take place.

2.3.2 Using Our Story for Participatory Research.

The use of the app can provide an impetus for more collaborative and participatory data collection. Punch (2002) explains that participatory research with children is different from research with adults given children's marginalized position in adult society. iPads and other similar novel technologies provide children with the opportunity to place themselves in a reverse role and showcase their expertise at managing new devices, which is often better than adults (Hutchison, Beschorner, & Schmidt-Crawford, 2012). In addition, several researchers have engaged in research where children's voices are not only respected but actively sought and where new technologies set the stage for learner-centered participatory research (Conole, Scanlon, Littleton, Kerawalla, & Mulholland, 2010). We found that participatory research with iPads meets several ethical criteria and best practice guidelines, including allowing children to collect, view, and interpret the data together with the researchers (Alderson, 2000).

In one projects undertaken with colleagues at The Open University, we encouraged 12 pre-schoolers from six different early years settings to use OS when retelling their experiences of specific story acting/storytelling activity delivered by a private theatre company. Pictures to scaffold children's retellings were taken by the researcher, while the children were involved in the storytelling/storyacting or by the children themselves. When asked how they liked the activity, the children recorded their answers using the microphone feature of the app or produced short captions to accompany the digital pictures. Without the need for prompting, the children helped us interpret the data in that they played the recorded sounds back to us and talked us through their storylines (Kucirkova, 2013). Such a participatory research approach was invaluable in ascertaining children's own perspectives on the activity and provided a window into children's personal story worlds. The data generated through children's retellings could be used as further evidence of the value of the technique for the theatre company, but was of great interest also to us, researchers, and the teachers. For example, the teachers were keen on using children's digital narratives as part of tracking their early literacy related development. We, as researchers, were intrigued by children's portrayal of self in these narratives and have further analysed the data for the evidence of children's novel self-representations in new media (Kucirkova, 2013). From this perspective, new technologies can provide easy- to- use methods for children to present their own viewpoints which are based

around photographs and speech, rather than being constrained by written text and paper-based materials.

2.4 Learning Analytics

Automatic recording of participants' responses is often possible with technological devices. This has provided an impetus to learning analytics with student responses collected to identify learning needs and provide tailored or customised support. In this case, the technologies used can range from smartphones to PCs. This has attracted the interest of researchers and educators in higher education, but is also relevant to educational organisations where there are large cohorts such as in secondary schools. However, as Clow (2013) describes learning analytics 'is a 'jackdaw' field of enquiry, picking up 'shiny' techniques, tools and methodologies, including web analytics (the analysis of logs of activity on the web), social network analysis, predictive modelling, natural language processing, and more' (p. 6). There have been concerns that this form of data collection has aspects of 'big brother' institutional scrutiny, although it also should be said that the purpose of such analytics is to be supportive.

The idea of using data collected via technology to support learning through individualised tutorials has had a relatively long history (Mandle & Lesgold, 1988). Still, this approach has not become widespread partly because of the cost of research and development to produce the software and also because agreed theories about learning processes are rare. The presence of many apps which are sold to parents on the basis of their learning and educational potential has transformed this situation. Although it should be admitted that few of the apps are grounded in psychological and educational principles, there is now a possibility for both teachers and parents to select apps that fit with the learning style they believe suitable to children (Chau, 2014).

In many ways the success of learning analytics has yet to be established as a research and education tool, we suspect the major factor governing success is the ease and ability to identify critical markers of a students' progress and the effectiveness of interventions that can be given when this is identified. Thus, the availability of information may be less important than the use made of the information that is collected. In our experience the sheer volume of the data that is collected and the difficulties of understanding the context of the responses can make it difficult to know what are the key events (e.g. an error in a calculation can be due to a range of factors). Thus, research using these data is likely to be helped by clear testable hypotheses which are based around theory or previous findings (Hirsh-Pasek et al., 2015).

2.5 Using the Internet as a Research Tool

The Internet also offers possibilities for both quantitative and qualitative research and for the use of existing research tools in new ways. Questionnaire surveys can be based on the Internet and specialist providers (e.g. Opinium; SurveyMonkey) are available to host these questionnaires and make the data analysis relatively simple. In addition, the Internet can be used to collect data from large populations of respondents when this is associated with sites which attract many users. For example, in our own work information has been collected about a range of topics as a result of the Open University's association with the BBC Child of Our Time Series. These have resulted in obtaining over 100,000 responses in some instances. In one study, we have investigated the relations between questionnaire answers about food preferences, television watching, and worries about appearance/weight in relation to enjoyment of exercise in young people (Wright, Messer, Oates & Myers, forthcoming). This involved participants answering a relatively large number of questions on the Internet, so it was possible for them to return to their answers if they took a break. The very large number of responses would not have been possible without both using the draw of a television

programme and automatically recorded responses. One additional feature that might have helped maintain interest was that participants could see their own response in relation to those of other participants; when the questionnaire had been completed the participants could opt to review their own responses and a summary of the responses from all the previous respondents. However, a large sample collected in this way has its own problems. For example, the population is going to be self-selected and care needs to be taken to exclude responses that are fraudulent from anonymous data collection. Issues of ethics need to be considered in what are for most investigators unusual circumstances (see also Chapter 15). In addition, with such large samples many statistical tests will reveal significant effects so more attention needs to be paid to effect size rather than significance, i.e. to the size of the effect rather than confidence in whether there is an effect). Furthermore, it should be remembered that online questionnaires are not always successful, especially when it is difficult to publicise their existence, and for some participants the ease and immediacy of paper based questionnaires is more likely to result in a response.

Chat rooms, Facebook, and other social media provide a basis for qualitative research into a whole range of topics about social processes. These Social Network Sites (SNS) now form an important aspect of the social worlds of many children and young people, with many hours/week being devoted to these sites. As Underwood & Farrington-Flint (2015) point out behaviour is different on SNS and face-to-face interactions; and the popularity of these sites indicates that they are addressing important psychological needs. Research about these processes often involves participant observations and ethnographic approaches. This type of research can provide valuable information about activities and processes that often are neglected, and provide insights into new and emerging ways that we communicate and present ourselves. However, not only can there be technical difficulties (Orthmann, 2000), there are important and difficult ethical issues about the disclosure of the researcher's identity and their participation in discussions (Convery & Cox, 2011; Hudson & Bruckman, 2004).

2.6 Summary

In general terms, the technological tools that we have discussed provide many advantages for research into cognitive processes, they can provide interesting tasks and with many of them, data can be collected automatically. Technological tools also can provide many advantages when trying to understand the opinions of participants: web-based questionnaires can result in a high number of respondents and the multimedia of iPads/tablets can provide a way to understand children's and young people's perspectives. Social processes can be recorded using digital technology and the technology itself provides new forms of social interaction.

3. Research Questions, Research Methods and New Technologies

Research which considers children's use of technology, by its very nature is likely to focus on the technology rather than the psychological processes associated with its use. In this section we consider three major questions that often are asked about new technologies and the research methods that can be used to answer these questions: 1) How are new technologies used? 2) Are new technologies harmful? 3) Can new technologies enhance learning and education?

3.1 How are new technologies used?

With new technologies, researchers often ask questions around the frequency and length of use as well as the competence levels of the users. In relation to schools, there also are questions about the introduction of new technology and identification of the barriers to introduction (see Flewitt, Messer & Kucirkova, 2014; Flewitt, Kucirkova & Messer, 2014).

Observations into the use of new technologies can be carried out in schools and homes. However, observational studies are usually costly in terms of researcher time, so that qualitative methods often are favoured to provide in depth information about a small number of participants. An example is the observations we carried out with two mother-child pairs into their use of the OS app (Kucirkova, Sheehy & Messer, 2014). Although the study was small in scale, it offered examples of the type of positive and rewarding social interaction that can occur between pre-school children and their mothers and raised interesting issues about the application of Vygotskian theory to new technology.

More generally interviews and questionnaires are used to collect information from larger samples. A particular issue that has generated recent interest are the claims of Prensky and others that today's generation of children, because they are growing up in a digital world, can be regarded as 'digital natives' and expert in these matters. However, these notions of expertise have been challenged. For example, Helsper & Enyon (2009) collected information from face-to-face interviews with over 2000 respondents who were age 14 years or above. They concluded that there were not 'unbridgeable differences' between young and older respondents, and on this basis provided an evidence-based challenge to the idea of 'digital natives'. This suggests that it should not be assumed that all children will be familiar with new technology, an important point when considering how they take part in the research.

When BBC computers were introduced into primary schools in the 1980s, one of us was involved in a survey of computer use in primary schools and this was followed up 2 years later with a comparable survey. The second survey showed that drill and practice activities (i.e. activities where similar tasks/questions are re-presented until success is achieved) continued to be the main use of the computers, although there were suggestions that the use of more innovative software might be increasing and this was related to training possibilities (Jackson, Fletcher & Messer, 1988). Although there appear to have been changes since then in the use of PCs with a greater emphasis on collaborative activities (Condie, Munro, Seagraves & Kenesson, 2006), there are indications that drill and practice activities are often used with iPads and tablets perhaps because of the changing nature of the interface (e.g. size and touch) as well as the availability of relevant software (Flewitt, Messer & Kucirkova, 2014).

In general terms, qualitative research can deliver findings which are relevant to understanding the interests and the perspectives of the participants, as well as understanding how participants construct and interpret their activities. For example, a qualitative description concerning the use of the Internet can provide more insights and detailed information than would be possible from a questionnaire survey. However, there are issues about whether the insights from these more detailed observations can be generalised more widely. In this case, a questionnaire-based survey might be more appropriate, even though as is generally accepted less detailed information can be obtained and the questions are more likely to be misinterpreted. Furthermore, we believe that both techniques provide useful information about the use of new technology and are complementary rather than opposition to each other.

3.2 Do New Technologies have Harmful Effects on Children and Young People?

The introduction of new technologies is often accompanied by concerns about the effects on children. However, experimental investigations of this issue are unlikely to be possible because of ethical concerns: random assignment to a potentially harmful experience is not acceptable. As a result, many investigations of this topic involve quasi-experimental research where one compares children who have a target experience with those who do not have or

have less of a target experience. These methods have been used to investigate the effects of gaming violence or Internet pornography (see Boyle & Hibberd, 2005). The matching of groups on relevant characteristics or the statistical adjustment of the influence of other variables (e.g. regression analysis) can help to control for the effects of confounds. Even so, these types of investigations cannot provide definitive answers because it is always possible to argue that certain children may like violent computer games and be more disposed to fights, rather than one leading to the other. In the case of concerns about computer (Underwood & Farrington-Flint, 2015) and Internet addiction (Cash, Rae & Winkler, 2012), this is again something that is difficult to address in both quantitative and qualitative research. Undoubtedly, there have been changes in the amount of time children spend on computer related activities. Yet, it is very difficult to make accurate comparisons with activities in previous generations or, for example, in the proportion of children who appear to isolate themselves from others (e.g. the 'book worms of previous generations). Thus, although the question of the effects of new technology on children are extremely important, obtaining objective answers is extremely difficult, and any conclusion is likely to come out of a body of research findings rather than a single definitive study.

3.3 Can Technology Enhance Learning and Education?

We devote more space to this question, partly because different perspectives about the methods that should be used when answering questions about causality, particularly between psychologists and educationalists. Many psychologists argue that experimental investigations, especially those that involve a randomised control design are the *gold standard* to determine causality. In contrast, many educationalists criticise this method and argue that it is difficult to carry out true randomisation without large and costly investigations involving large numbers of schools and classrooms. In addition, experimental conditions involving new technology are likely to be more motivating for teachers and children especially compared to a control condition of *learning as usual*, so the effect of new technology is confounded with the attitudes of teachers/children. Furthermore, questions are raised about whether findings can be generalised to other schools and children. In the next sections, we provide examples of methods used to investigate the effects of new technology on children's skills, and discuss some of their strengths and limitations.

3.3.1 Experimental Investigations.

An example from our own work provides an illustration of the reasons for carrying out experimental investigations, an evaluation of computer-based support for literacy abilities. There is good evidence from well-controlled investigations that a range of non-computer interventions, particularly those that concern phonological abilities, can be effective with children who have literacy difficulties (Hulme & Snowling, 2009). However, at least with English speaking children who are 'struggling readers', there is very little positive evidence about computer based interventions of positive effects and few randomised controlled trials. Cheung & Slavin (2013) in a review of this topic only identified 20 studies, and of these only 13 involved a randomised control investigation. Our investigation concerned the effectiveness of the Easyread tutorial system for children with literacy difficulties using a randomised controlled trial (Messer & Nash, in preparation). In this investigation, 78 children aged about 8 years were identified by their schools as needing support for reading were randomly assigned to an intervention condition and a waiting list control condition. Both groups continued to receive the support normally given by their school. The intervention group had short 10-15 minute sessions over 13 months. All children were given a pre-test that involved standardised assessments of reading and reading related abilities, and they also received a post-test of the same assessments when this phase of the study ended.

The findings indicated that the intervention group made significant gains in reading (decoding) and phonological awareness as predicted from the nature of the intervention and

they had reached a level of ability that would be expected for their age. Importantly, a waiting list control group was used, who did not show similar gains; these children received the intervention after the randomised controlled trial. This opportunity was important for ethical reasons and also helped with recruitment as parents often are reluctant for their children to take part in a study that is of no potential benefit. Furthermore, our experience indicated that special care needs to be taken when explaining the randomisation to parents and it is likely that there will be a higher drop-out rate from a waiting list control group.

The Easyread tutorial system contains a number of techniques designed to help the development of reading. This illustrates a dilemma, one can either put together what one believes is an effective collection of techniques, in which case the intervention is more likely to be effective, but one will not know which particular technique is effective. Alternatively, one can evaluate each technique on its own which allows for better understanding, but the research is likely to be more lengthy and costly. Another general issue is the experience of the control group and it is worth giving this some careful thought as it will influence the conclusions that can be drawn. A waiting list control group means the intervention is compared to what usually happens, and so whether it is more effective than the usual support. However, if there are resources it can be useful for the waiting list group to have an unrelated intervention (e.g. arithmetic) or some other experience to control for the possible effect of the motivating properties of receiving special attention.

3.3.2 Action research and Formative Experiments.

Another way to investigate and develop techniques to assist educational processes concerns action research. Action research has several definitions and meanings, we subscribe to the definition provided by Reason and Bradbury and the view that action research brings together several approaches which are participative, grounded in experience, and action-oriented (Reason & Bradbury, 2001). Reflection is a fundamental element of the approach, as it serves as a connecting point between action and research (Coughlan & Coughlan, 2002). In the research concerning the effectiveness of the OS app, we were keen on producing practical knowledge that would be of direct use and benefit to specific research organisations, community groups, and charities. Action research was very suitable for this objective given that it is oriented towards improvement and given that it invites research participants into the research process. Action researchers are not interested in developing robust theories that would deal with infinite possible scenarios, but rather in theories that work in specific contexts and circumstances. In developing such theories (Reinking, 2001), action researchers need to engage in reflection during several stages of the research process. Reflection is a useful tool for the researchers to learn about participants' views but also, in collaboration with the research participants, to 'contemplate what can be learned from the experiences (Lau, 1997, p. 52). Action research can employ a diverse range of study designs and methodologies (Cargo et al., 2008). In the next section, we describe the methodological approach adopted in our work.

An example concerns an exploratory investigation when we were interested in finding out about whether the OS app contributed to educational experiences in a holistic way. As a result different tools were used and a qualitative approach was adopted (Kucirkova, Messer, Critten & Harwood, 2014). This study involved OS being used in two schools by children with complex needs. In one school the whole of a small class of nine children used OS to construct a narrative about their visit to a spinney which related to the theme of the 'Great Outdoors' with sessions of about 30-45 minutes occurring every week for 7 weeks. In the second school one pupil used OS to relate an event where there was a successful achievement; these sessions occurred for about 45 minutes over 6 weeks. The main research tools that were used involved documenting what was done in the sessions, looking at whether the teaching aims for each

child had been achieved, and for the teachers to reflect on the process. In general terms, the aims were achieved, the app provided a focus for motivation and engagement, and the children expressed pleasure and pride in their achievements.

3.3.3 Formative experiments

Formative experiments are an effective methodology for research which aims to ascertain how instruction-related design might support specific outcomes as well as the conceptual development of the actual intervention (Lim, 2001). By definition, formative experiment implies a collaborative teacher-researcher investigation. In contrast to large-scale controlled experiments or in-depth case studies, formative experiments are concerned with scalable improvements and unlike traditional intervention research which often relies on “fix it approaches”, formative experiment is located in the perspective of multiple realities (Labbo & Reinking, 1999, page number needed).

David Reinking, the ‘father’ of design and formative experiments, wrote that ‘Formative experiments seek deep pedagogical understanding informed by iterative, data-driven modifications of a promising intervention aimed at achieving a valued pedagogical goal in authentic instructional contexts. The aim is to generate recommendations, not prescriptions, and pedagogical principles (humble theories) useful to practitioners, thus closing the gap between research and practice. This approach challenges the reductionism of conventional experiments and the observational passivity of naturalistic approaches’. As the quote suggests, formative experiments are very effective if researchers wish to, for example, develop a framework for school professional learning communities to reflect upon, reimagine, and redesign their communication with families about literacy and communication with families. Cooperation and collaboration with practitioners and ongoing mini-cycles of reflections are fundamental principles of such an approach. Also, when designing instruction for children, this usually takes the shape of working closely with the classroom teacher. Researchers who embed process-focused reflections into the design itself often do so with the aim of enabling the teachers to be both learner and designer and feel agency and ownership of the process.

In the example of qualitative research there were informal assessments of progress by experienced practitioners. Both the formative experiment and action research methodologies can be useful techniques for showing how children with complex needs engage in a story telling activity, mediated by a technological tool (the app) and by effectively embedding this approach in existing practice, the teaching aims were achieved as a result of this engagement. The findings are useful to practitioners and more generally in understanding the way that these types of app can be employed in a school setting. The research provided an exemplar of what could be done with a specific technological tool and the teaching aims that were achieved, with the aims of this research being very different from those traditionally identified by psychologists, particularly those using experimental designs. Thus, practical research about technology involves a consideration of what questions need to be answered and about the appropriate methods to answer these questions.

3.3.4 Summary

We hope these examples illustrate the way that different research tools and different research methods/approaches can be used to answer questions about new technologies. Psychologists and other researchers need to consider a range of methods and often there are both positives and negatives about any method that is chosen with each method providing different insights into the process. Research into the way that new technologies are used is relatively straightforward with decisions having to be made about the depth of questioning and the

size/breadth of the sample. In the case of the questions about the negative effects of new technology, these are difficult to definitely answer because ethical considerations mean that experimental investigations are not possible. In contrast, experimental investigations are possible into the positive effects of new technology, although there is debate about the usefulness of these and other methods. In relation to such debates we believe that quasi-experiments can often provide important insights into what effects might be occurring (and importantly what effects might not be occurring) and if sufficiently important experimental investigations can follow up the findings from quasi-experiments.

4. Future Directions

In terms of the tools that are used to study children's use of technology there undoubtedly will be developments. It is foreseeable that in the near future, the embedded camera in iPads and the possibility to track students' eyes and finger movements with the embedded camera, will become a favourite data collection tool in psychology research. Furthermore, more research funders may be prepared to support the development of state of the art research tools and assessments that can be used by individual researchers to collect data while at the same time contributing to large data bases of performance, a situation where everyone appears to gain (see <http://www.nihtoolbox.org/>). In addition, it seems likely that there will be greater integration between different methods of data collection, using the ever present camera on computers and tablets, integrating behavioural data and that about brain activity or eye movements are likely to become much more prevalent as the ease of use and cost of such are reduced. Where there is likely to be a large change in the research agenda is when voice recognition becomes reliable and commonplace, this will both transform children's (and researchers') use of technology and transform our ability to collect information about speech.

Another future direction that is likely to involve children, young people and adults is a more participatory research environment. Using the power of the Internet it seems likely that research may be directed not just by an isolate group of researchers in their ivory tower, but may become something that is supported, advised and participated in by a web-based community. We already have discussed the issue of children's voices and their ability to research issues that concern them, and the future is likely to involve more examples of participatory research. Thus, not only the research tools but the research methods seem likely to change in the future.

We suspect that in the near future there will be increasing interest in the coding and programming abilities of children. In England, a new part of the national curriculum specifies that all children aged five and up will have to learn to code. This policy change follows an emphasis in the United States on teaching children not just to use but also to create technologies. It is likely that Australia and other countries will soon follow the lead. This change is being accompanied by a surge of resources aimed at helping children code and engage in computational thinking, for example non-digital board games such as Robot Turtles or Google's visual, character-free programming language. Recently, Nesta, a UK innovation charity, analysed the attitudes of young people, parents, carers, and teachers towards digital making activities and showed that a great proportion of them are already making apps, games and even robots (<http://www.nesta.org.uk/project/digital-makers>), thus rebutting the concern that children only passively absorb information on the screens. The report also showed how digital meaning making can be a social activity, with several projects (e.g., Code Club, Young Rewired State centres) encouraging children to get together when creating their digital projects (Quinlan, 2015).

In thinking about future directions we, as researchers who are carrying out research in schools and children's homes, believe it is important to outline a topic which often is ignored, that is the way that research can contribute to promoting innovation and good practice in children's learning with technology. The recent impact of technology on our working and social lives has been profound. This contrasts with an education system in the UK that is concerned with the three Rs (reading, writing and arithmetic) and an assessment system that focuses on the knowledge of factual information, rather than on ways to equip the new generation of children to function effectively in the new digital age.

If one accepts these arguments then effective research which has impact should not simply be concerned with *augmentation* of the existing educational system by improving learning in the existing curriculum, but should also make arguments about *innovations* in both the learning experiences and learning objectives to take account of new social and employment opportunities. Clearly this is not an easy task. For one thing, psychologists (and other social scientists) usually lack the research tools to answer big questions, for example, a set of tools to assess the degree to which pupils are equipped to become effective citizens (Twining, 2012).

In the past, changes have often occurred because of innovative theories or case studies rather than the accumulation of research evidence. For example, Piagetian theory had a profound influence on UK primary education in the 1960s and resulted in an emphasis on discovery learning rather than formal teaching. A more recent question is whether the availability of information on the Internet will make classrooms and possibly teachers obsolete. One investigation that has been widely cited in this debate is Mitra's 'hole in the wall' study where children could access a computer and taught themselves advanced computer based and other skills with no support. Furthermore, in developing countries in particular, there are many projects that advocate or investigate the effects of teacher-less educational environments. The common rationale for why technology can replace teachers is that technology can provide one-to-one personalised teaching and necessary support in classrooms with few teachers and many children. There is also an implicit belief that children are capable of learning for themselves with very little adult support. Although the vision of a teacher-less school is often criticised (see useful blog by Harrison, 2014), the challenge facing researchers concerned with technology is what research methods can be used if they wish to support or transform existing systems. Furthermore, the presence of the National Curriculum in the UK and the concerns of many schools about their league positions in terms of conventional learning outcomes mean that there is a great reluctance to make changes that have associated risks.

5. Summary

Research related to technology cannot be neatly pigeon holed as based around a particular research tool or to one methodology. We have described technological tools that can be used for collecting information and data, with an emphasis on the novel uses of iPads and tablets, and have given examples of a range of methodologies that can be applied to three significant issues related to children's use of new technologies. In this way we hope to alert you to the diversity of tools and methods, and at the same time, link choices about these to a careful reflection by investigators about the question that the research is designed to address. We also hope to have alerted you to broader issues particularly when research about technology concerns educational processes.

Practical Tips

- Using new technologies as research tools might be time-consuming given that many need to be proof-tested. Do allow extra time for this in your research plan.

- Try to think of technologies not only as providing you with a wealth of data but also the added value of their use in a given context.
- Children sometimes know better than adults how new technologies work and involving them in the research process can bring interesting insights.
- There are different types of question that can be asked about digital technologies, think about the methods you need to use to answer your research question(s).

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