Digital Media in a Special Educational Needs Classroom:

A Study

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I, Keir Simon Ayodele Williams, confirm that the research included within this thesis is my own work or that where it has been carried out in collaboration with, or supported by others, that this is duly acknowledged below and my contribution indicated. Previously published material is also acknowledged below.

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Abstract

This thesis presents a series of design-led case studies concerned with the use of digital technology and the practice of interaction design for children within the context of UK special educational needs classrooms. It explores the use and development of accessible digital systems to support groups of students who have a range of special educational needs. Working with groups of mixed ability students has found to be the most typical situation for teaching in the participant schools and is a rich but underexplored area of concern for interaction design research. This thesis presents detailed accounts and grounded analysis of four embedded, design-led, case studies in two UK special needs schools. It makes three main contributions to the community of researchers, designers and educational practitioners who are concerned with the use of digital technology with children and more specifically working within the field of interaction design for children with special educational needs. These contributions are: A set of design guidelines developed through an analysis of the detailed and thorough accounts of four embedded design-led research projects in two special needs school in the UK. A discussion of the development of the research approach taken in this thesis. A set of design personas of teaching staff interaction designers are likely to encounter when working in a UK special needs school.

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1 Introduction

1.1 Motivation and aims

This dissertation is about the use of technology in education and the practice of interaction design for children. It studies how interaction designers negotiate and design interfaces and software for use within the context of a special educational needs (SEN) school. It is concerned with the impact and development of accessible digital systems to support students with special education needs and their teachers to use digital media in their learning activities. It focuses on the social complexities of designing in this context and the use of digital media to support students and teachers to share their ideas and achievements with others of significance to them.

Children and young adults with special educational needs require specialist support to mitigate the negative aspects of their impairments and negative social attitudes if they are to participate fully in education and wider society. Meeting the needs of individuals within an institution such as a school for children with special educational needs requires an intricate mix of teaching practices, tools, attitudes, specialist medical and physiological staff and wider pastoral care.

Media and arts technologies including specialised interface designs, digital music and video software are transforming who has access to creative activities and the quality of their experience. The main purpose of this dissertation is to provide the reader with insights into the impact of digital media on communication and learning in a SEN classroom through the development of novel interfaces and software for using digital media in the classroom. The main aim of this research is to develop and document an understanding of technologically mediated teaching activities using digital media. This then provides the means to develop design guidelines to help other designers and researchers in this field understand the intricacies of working in this specific setting. This is achieved through a set of four descriptive, design-led case studies with two partner schools and an analysis of relevant literature and practice.

A special educational needs school as a site for research provides a rich environment for understanding how interaction designers work with children with widely varying needs and within an institution that has its own constraints and requirements. There is a growing set of literature on the design of interactive systems for children with SEN, the focus of which has been on specific diagnoses of impairment, which make up a small minority of students (Benton & Johnson, 2015; Bruce et al., 2013). The research in this dissertation focuses on mixed ability SEN classroom settings within which students present a broad range of abilities, impairments and needs.

There is a focus in the field of interaction design for children on the use of design methods that involve children in the research and design of interactive systems. Within this literature there are two subtly different approaches to participatory design that inform this study (Read, Fitton, & Horton, 2014). The first takes the perspective that children are active agents in the adoption of technology and so their involvement in the design and research process provides invaluable insights into their needs, interest and abilities which in turn leads to a better understanding of their interactions with technology and thus more effective design (Druin, 2002) (Frauenberger, Good, Keay-Bright, & Pain, 2012b). The second aim is subtly different and originates from the Scandinavian inception of participatory design (PD). This inception of PD is used in order to help children realise they can have a direct choice in the development and use of technologies that affect their lives. This approach is concerned more with giving children the tools and opportunities for making decisions, than with the development of more effective designs, though this can be a result of applying these participatory design methods (Larsen & Hedvall, 2012). These methodologies are discussed in detail

in the literature review chapter of this thesis and are then used to inform and reflect on the approaches to design-led research used in the four case studies.

Chapter - 8 Discussion at the end of this dissertation results in a set of qualitative design guidelines and a discussion of the theoretical and methodological approaches to design in this context. These discussions are framed using four design-led case studies that also highlight the practical processes of conducting research in this dynamic context.

In summary, this research project aims to:

- Consider the role of digital media in the context of a mixed ability special educational classroom context.
- Identify a set of key issues that can inform the development of future novel designs.
- Create a set of novel designs that are informed by the theoretical and practical insights developed through the case studies.
- Develop a set of design guidelines to support researchers and designers working in this field.
- Ensure that the research conducted in this project forms part of a reciprocal relationship with the school and the people working within it.

1.2 Contributions of this thesis

This thesis makes three main contributions to the community of researchers, designers and educational practitioners who are concerned with the use of digital technology with children and more specifically working within the field of interaction design for children with special educational needs. These contributions are:

1. A set of key insights and guidelines for the interaction design community on the design and use of digital media to support students and teacher in a mixed ability special needs educational context. The guidelines where developed through an iterative, grounded analysis of the empirical evidence gathered and analysed in the four main studies of this thesis. **The key insights and guidelines are presented in** 8.3 - Digital media in a mixed ability SEN classroom: key concepts and guidelines

2. A discussion of the of the research approaches taken in the four main studies in this thesis: **This discussion is presented in:** 8.4 - Reflections on Approach

3. A set of design personas developed in *Chapter 4 – The scented school*, that sets out for three key members of staff interaction designers are likely to encounter when working in a UK special needs school: their role in the school, their priorities for the use of interactive technologies in their work, their role in the interaction design process and the challenges for designers and researchers in this context. **These personas can be found in:** 4.5 - *Personas*

1.3 Organisation of the thesis

Chapter 2 – Position, begins by setting out and discussing the methodological positions and methods of inquiry that are used to conduct the four design-led research studies in this thesis. In *Chapter 3 - Background and literature review*, I situate the theoretical and empirical work conducted within this thesis within relevant fields of study.

The first study discussed in *Chapter 4 – The scented school* provides a research case study that details the processes and challenges of designing and using interactive digital tools in a special educational needs school from the perspective of four key staff members. Through an extended visual arts project I embedded myself within a UK special needs school as a means to collect a range of rich, empirical evidence. This evidence is analysed in an iterative, grounded analysis resulting in three theoretical categories: *Accessing Education*, *Classroom Management* and *Reflections on Approach* that are discussed and result in a set of insights and personas for those in the interaction design community working within the context of a SEN school. This study provides us with a high level understanding of the role and involvement of staff in the interaction design processes in the school.

The next study, detailed in *Chapter 5 – My photos, your photos* continues the thesis research by moving to a mid-level view of an interaction design process in a SEN school. This is done by considering the social role of digital media in a mixed ability classroom context through the use of a design-led workshop series. The study consists of five design-led workshops which were first analysed as a team with the resulting design considerations used to inform the design of a photo-sorting console for students and teaching staff. I then conduct an individual, grounded analysis of the empirical evidence from the workshop series and design process which results in three theoretical categories: *Digital Media and Representation, Classroom Management* and *Reflections on Approach*, which are discussed and lead to insights for the interaction design community.

Through an embedded design-led and experiential research approach, *Chapter 6 – This year I have…*, builds on the findings around digital media and representation and classroom management presented in *Chapter 5 – My photos, your photos*, by introducing a set of photo-sorting console prototypes through a series of workshops. These provide a means for students to self-advocate in 'real world' presentations of their achievements in a UK SEN school. This study was conducted within a mixed ability special needs classroom. This chapter contains a descriptive case study and a grounded analysis of the empirical evidence which results in three qualitative categories: *Designing for Self-Advocacy*, *Design Concerns* and *Reflections on Approach*. These categories are discussed in detail an in relation to wider literature.

The final study *Chapter 7 – Sounds and stories,* turns from introducing new novel digital systems to support students to focus on how interaction designers can support existing classroom practices in the design and use of digital media and interface design in a mixed ability SEN classroom. This is considered, through an embedded and inductive research approach to the research. Through a grounded analysis of the empirical evidence the study results in the discussion of two conceptual categories: *Existing Classroom Practices* and *Reflections on Approach*, and a set of qualitative design insights for those in the interaction design community working in mixed ability special needs classroom contexts.

Chapter 8: Discussion, provides an overview of the content in this thesis to place the subsequent discussion in context. It presents a series of key insights and a resulting set of guidelines for the interaction design community on the use and design of systems for using digital media in a mixed ability special educational needs classroom. This discussion is based on a grounded analysis of all the evidence gathered in the four studies of this thesis and is illustrated as a final conceptual map at the start of the section. Each key insight and guideline links to concrete examples and detailed literature in the main body of the thesis. The chapter then turns to a reflection on the methodological approach and methods used throughout the studies in this thesis. It finishes by detailing the specific contributions to wider research and design discourses and sets out avenues for future research and design work based on this thesis.

1.4 Previous work

Figure 1 - Screenshot of student's digital story (originally projected on wrap-around digital projection space)

In 2009/2010 I conducted a study at Delmore School that is the main site for the studies in this thesis, during a six-month placement as part of the Media and Arts Technology Doctoral Training Centre program. This study considered how students and teachers used readily available digital media and presentation software to create and present stories using sound, video and performance in the school's digital sensory room. During the project I worked in the school as a teaching assistant and lead artist on a digital storytelling project that formed the basis of the research study.

The study consisted of a three-month digital storytelling project with two form groups of students aged 13-16 with a range of physical, cognitive and emotional impairments. During this project I worked with students and staff including the school's interaction designer to develop the arts project whilst simultaneously making observational notes and conducting interviews with staff. An analysis of these observations and interviews resulted in some tentative insights about the use of digital media in a SEN school. Whilst the insights that resulted from this study were interesting, the rigour of the qualitative methods used and the subjective assessment of the observational data were questionable. The following are presented here not as rigorously formed insights but rather to show the reader how this study informs the in depth studies presented in this thesis.

- Digital technology in combination with effective teaching practice can provide scaffolding for students to devise and perform their ideas to their peers.
- Ill-designed and poorly used digital technologies for working with digital media can have a detrimental effect on self-esteem and engagement for students.

This initial study provided an area of focus for subsequent research for this thesis - the design of interfaces for using digital media in the context of a special educational needs classroom. It also provided an opportunity to build a strong relationship with the school enabling subsequent study to occur. It did lead however to some key insights on how to approach research of this kind for the researcher which motivated this PhD thesis. Firstly, that spending an extended amount of time in the school was important for developing a rich understanding of the context, and secondly, that there was the potential for digital media to support teachers and students during learning and creative activities in the school.

2 Position

> We should never lose sight of the fact that children and teachers in classrooms are conscious, sentient, and purposive human beings, so no scientific explanation of human behaviour could ever be complete. (Berliner, 2002)

The aims of this PhD are to observe, participate, interpret, analyse, and reflect the social phenomena and the practices that occur when designing and using interactive digital media systems in a specialist school for children with special educational needs. The adoption and dissemination of practice in the second, third and fourth studies of this thesis allow us to see in what ways we can put to work that which has been learnt in the other areas of this thesis, within the real world context of a special educational needs classroom.

This chapter starts from first principles to explain the epistemological position, the methodology, and the methods of inquiry that this thesis adopts as the basis for this PhD study. It goes on to discuss why these are relevant to the social context and research aims of the PhD study. It concludes by discussing some key pragmatic issues about the relationship with the research partner that are essential in realising the goals for the research.

2.1 Epistemology

This PhD study is empirical and phenomenological. It starts out from phenomena and builds upwards from them. To study phenomena is not to find out 'what they really are' but to abstract purposefully and selectively from aspects of the empirical evidence and observations to allow interpretation, analysis, and explanation. In this case the phenomena are social interactions.

The aim here is not to put forward a hypothesis, and then see whether it can be falsified or not against evidence of significant cases or a number of cases. It is to interpret an abstracted, 'pure-type' or 'ideal-type' representation of a single complex 'case' (Weber & Shils, 1949, p. 90).

This position is not put forward as the only one suitable for researching the subject of this thesis; interaction design in a special educational needs classroom. It is put forward as being the most suitable for developing an understanding of the complex and unexpected social actions that occur and arise from the interactions of technology and multiple participants over time within a SEN classroom.

Following Charmaz (Charmaz, 2006, p. 10) this position allows us to critically consider the processes that construct the phenomena being studied over time and allows for unforeseen and unforeseeable consequences of those processes to be included within our analysis. In the remainder of this chapter the methodological position and subsequent methods of inquiry that arise from this position are discussed in relation to the subject under study.

2.2 Methodology

The methodology that is adopted here for studying those social interactions, following Max Weber, is an 'interpretive understanding of social action and interaction':

> Sociology … is a science concerning itself with the *interpretive understanding of social action* and thereby with a *causal explanation* of its course and consequences. We shall speak of action in so far as the acting individual attaches a *subjective meaning* to his behavior – be it overt or covert, omission or acquiescence. Action is "social" in so far as its subjective meaning *takes account of the behavior of others and is thereby oriented in its course*.
>
> (Weber, Roth, & Wittich, 1979, p. 4 vol. 1)

Social action takes place within social structures or institutions, and also helps to shape those structures. Institutions are themselves 'meaningful'; they give meaning to and set out expectations and rules, and forms of authority and accountability. They also provide a context within which people can innovate and find new ways to interact.

Social institutions are fields, within which people find a 'place'. Their places are not firmly fixed and their fields can change. Social institutions are not closed. The institutions present their face to the world outside. People are, and must be, involved in and engage in a multiplex of relations with actors within and outside of the institutions. The researcher must engage, to some respects, in a 'methodological closure' i.e. to set boundaries to the phenomena that are to be studied and that can be taken account of.

Social actions have meanings; social institutions have structures; they both have consequences. The researcher must be concerned to ask: what are the consequences, intended and unintended, *of* and *for* forms of social action and interaction and social institutions?

The engagement of the researcher in the social situation, as researcher and as participant in the institution's activities, has consequences for people's actions and interactions and in the ways in which they present themselves to the researcher.

Kathy Charmaz in her guide to grounded theory (GT) as a form of qualitative analysis contends that qualitative research considers the processes that construct the phenomena being studied as they occur over time. This, she argues allows researchers to consider how events develop and also how the interactions between processes connect with one another. The complexity of a social situation lies not simply in the amount of intersecting processes, but in the fact that these processes may be contingent to one another so that the outcomes of their interactions may give rise to unforeseen and unforeseeable consequences. (Charmaz, 2006, p. 10)

This thesis does not seek to build a theoretical framework that would be applicable in multiple contexts, rather it looks to develop a set of concepts that can support a detailed and useful account of the phenomena under study. The approach taken in the four studies presented in later chapters do not strictly follow any one methodology but rather use the appropriate tools and ways of thinking about the phenomena under study offered by grounded theory and a range of participatory design methods to build a coherent and useful account of those phenomena.

2.3 Method

The methods of inquiry used in this thesis (observation, conversation, interview, social interaction, participation, and reflection) arise from the methodology (interpretive understanding of social action and interaction). They are chosen for and are appropriate to this study; they are not put forward as a general method for sociological inquiry or design research or indeed as a prescriptive method for pursuing interaction design in a special needs context. The methods of inquiry and methodological approaches used in the studies of this thesis are discussed in detail in *3.6 - Participatory methods in design research and 3.7 - Grounded theory.*

Researchers must adopt flexibility in their research methods. Employing a rigidly structured method of data collection forces researchers to impose ideas of what they expect to find in the situation before they have started their research. This narrows the line of enquiry, places an emphasis on the researcher's view, which may be based on other research, and excludes the views of participants that may be at odds with the researcher. If social situations are contingent on the interaction of multiple processes over time then the researcher must be careful when making assumptions as to what they will observe in a situation.

A study of social phenomena does not begin from nowhere. The researcher should start their investigations with an open-ended vision. Through engagement in the social setting researchers can narrow their inquiry in an iterative fashion. Collecting and interpreting information and the processes that are revealed in doing so refocuses the researcher's questions and directs him or her to look for different information and ask different questions in the research field. An emergent theory is formed based on the information collected, the interactions of researchers and those whom they are studying and their stance towards their research.

2.4 A non-determinist approach to interaction design in schools

Underpinning research into the use of technology in education are assumptions that are made about the people and places that are being studied and the relationships between them. They affect the way the research is conducted and the knowledge that is produced. We don't always see these because they operate 'behind our backs'.

As is demonstrated in the literature review, there is a tendency in research on the development and use of technology in education to start from what we want to achieve

rather than where we are. This approach closes down possibilities and our ability to take a critical perspective on the interactions of technologies within educational practice. Where research asks the question 'how do we achieve a pre-defined outcome by using technology', we do not consider that the introduction of a technology will become part of a complex set of interactions between people and place. This means not only can the outcome not be pre-defined but also that the problem itself may change.

Problems arise in research concerned with the use of digital technologies in educational practice when technologies are placed at the centre of the relationship between children and teachers. This is based on an essentialist reading of children as sharing common traits that technology can impact upon and with. Teachers are cast as operators who deliver the solutions offered by the technology to the children. There is a far more nuanced relationship between teacher, technology and child that should be understood as there are a variety of ways in which teachers, children and technologies interact within a fluctuating institutional context.

The research process takes place within a context. We need to understand the context in which the technologies emerge and how they are affected by and affect that context. The research process may itself reveal unanticipated aspects of the context, and have unanticipated effects on and be affected by that context. The researcher must recognise that any technical intervention that is introduced interacts within a complex social environment populated by individuals and groups of people with a range of abilities and experiences.

A researcher's position should be one of critical engagement with design, building and evaluation of technology and the context in which it interacts and emerges. If we always believe that the technology we introduce will have an overall pre-determined effect then we are left to find ways in which the context must be changed to enable that technology to have the desired impact. This is the wrong way around. The researcher must acknowledge the personal, social and political context. The design/uses of a piece of technology start from that understanding of the interpersonal dynamics and social realities, and the limitations of any intervention within it. That is not to say that technologies cannot offer alternative practices within education but those changes will not come about through the technical qualities of a technology but through a complex realignment of people, place and institution that it may or may not play a part in.

2.5 An embedded, longitudinal approach

2.5.1 Embedded

An important theme in the approach to research proposed in this thesis is the importance of spending extended periods of time embedded in the school in order to gain an understanding of the context in which their future design interventions will be situated. The aim is that this understanding will be formed spanning three levels. From the lower level of specific students and staff and their interactions in the classroom, through the middle of this particular institution and its functionality, up to the higher level of how technologies can be designed and used for the special educational needs (SEN) classroom context in general.

The desired outcomes are that having developed this understanding and forged strong relationships within the institution, the researcher will be able to design interventions that can address the gathered requirements comprehensively and rigorously. Additionally, gaining extended access to design partners may help to generate more detailed and flexible evaluation frameworks for use when assessing the efficacy of any interventions that are made.

Developing and maintaining routine is important for most children, but is especially important for children with special educational needs. Routine helps children with special educational needs to understand what is required of them, supports them in developing confidence in their and other's abilities and provides a way to structure their lives. Children with Autistic spectrum disorder for example will often react negatively to disruptions in their normal routine. Maintaining routine and order is also an important aspect of teacher's professional practice when working with children with special educational needs. Taking an embedded approach to research helps to mitigate any disruption by embedding the researcher as part of the participant's daily routine.

Finally, conducting design research in this way could result in a lasting legacy with which the participants involved can gain more sustained use and development of the designs or frameworks beyond the initial scope of the project.

Conducting research in a special needs school requires the researcher to negotiate with a wide range of people and institutions with differing responsibilities and sometimes competing agendas.

2.5.2 Longitudinal

The research conducted at the two partner schools was carried out over an extended period of time spent in the schools. This longitudinal approach has several important benefits for the goals of the research as a methodological approach. The main aim of spending an extended period of time in each school is to develop an understanding of the personalities and abilities of young people and staff within the school in order that any interpretation of the empirical evidence is done based on sensitivity to the participants and the context in which they work.

This longitudinal approach also allows the researcher to consider the impact of technology over the duration of the study. Instead of visiting the context at the point of evaluation of a technology the researcher works within the context over the duration of the technology's development ensuring that the researcher can draw on their knowledge of participants' attitudes to technologies and the research itself that would be difficult in a much shorter evaluation period. This approach also allows the researcher to constantly assess the success and impact of different methods used in the studies and to refine or change those methods depending on how the pragmatic restraints of the context affect them.

Working in this extended way helps the researcher to develop a tacit knowledge of how well methods and interventions are working or not in the studies. It is hard to quantify this tacit knowledge but it is essential for the researcher to create insightful analyses of their empirical evidence. Spending time with people enables you to develop meaningful relationships and most importantly trust with your participants. By building these relationships you are more likely to increase access to your participants and lead to more informal discussions and observations that might not be possible in a shorter study.

2.5.3 Context

Working with and conducting research with any group of young people requires discretion, patience and hard work amongst other skills. When working within a SEN school context we must always remember the sensitive and vulnerable nature of the context and participants under study. This may be an obvious point for those with experience of working in this field. It is nevertheless an important observation because it means the researcher must attend to the diverse and nuanced behavioural traits of the participants and consider how our approach to research might affect those

behaviours. It is very difficult to gain the depth of knowledge that staff in the school; including teaching, pastoral and management staff, have of the students they work with. Thus it is vital that the experience and expertise of those professionals are taken into account.

2.5.4 Managing relationships

The management of relationships with the range of partners during the research project requires an ongoing process of clear communication between researcher and partners. It is essential that contact be maintained all the way through the different stages of the research project. Negotiating the initial access to the school is a long and arduous task. Maintaining access regularly enough is equally important. This means keeping in touch with key staff members and updating them on the progress of the research. They can then pass this information on to others such as students, parents and other teaching staff who might be involved in the project. If there is a stage when the researcher is away from the school for some weeks for example, care should be taken to communicate this to all the students and staff that are involved. This is not simply a case of being polite but helps to keep the project in the minds of the participants as the project can easily be forgotten or loose importance within the multiple demands and activities within the school. Maintaining a dialogue with the research partners throughout the research study is imperative to planning and carrying out a successful research study in this context. This negotiation should include: the roles of participants, the resources that will be used and required and the potential outcomes for both the researcher and the research partner.

2.5.5 Reciprocity

As researchers we should take on tasks that distinguish us from being mere observers in the school. During my research at the two schools that are the subjects of this thesis, I worked as; a teaching assistant, supported after school clubs with movement classes and A/V instruction, acted as a technical consultant for teaching staff on the procurement and use of new equipment and instigated and ran term length arts projects within the school. By carrying out these supportive tasks I was able to show a commitment not only to my own research aims but also to the school and the participants in the research.

As a researcher and artist I have a wide range of skills that can support the schools, their staff and most importantly the students. For this research project I considered

how I could apply my skills beyond the scope of our research aims to support my partner schools.

Supporting the school beyond the roles demanded by the research was both an ethical and pragmatic choice. The school and its participants are research *partners.* By participating in my research they offered their time, resources and potentially their reputations. As a researcher I then have an ethical imperative to offer something in return.

My decision to support the school as a teaching assistant, artist and technical consultant was also pragmatic. The different roles I took on allowed me to develop trust between myself, staff and students. It enabled me to gain wider access to the school and its facilities than I would have received visiting only for short periods. The reciprocal approach I took meant I could spend extended periods of time with participants getting to know their behaviours and start to consider their ever changing relationships with each other and the school as an institution. This in turn helped me to develop a more nuanced understanding of the context and participants under study. It also allowed me to maintain a relationship with the school and provides the potential for further, post-doctoral research.

2.6 Ethics

There are many important and necessary safeguards in place to ensure that research involving children with special needs goes through a detailed ethical approval process. Working with such potentially vulnerable members of society places ethical demands on how, when and why research is conducted. Issues of disclosure, child protection and informed consent are of particular importance.

For each study in this thesis ethical approval was sought and approved by the ethics committee at Queen Mary, University of London, in consultation with the headmaster and participating staff from the partner schools. The inductive, embedded and longitudinal approach taken in all four studies meant that the university ethics committee had to agree to a flexible and extended timeframe for each study. This required careful planning and a detailed explanation in my submission to reassure the committee about their reservations of approving an adaptable schedule for the studies. I obtained two separate Criminal Record Bureau (CRB) checks for the two schools that I worked in because at the time anyone spending extended periods of time with children or vulnerable people was required to have a separate CRB check for each place

they worked in. The lengthy application process and financial cost for this had to be factored into the planning of the study design.

The four ethics committee applications I submitted all shared important ethical considerations; disclosure, equal access and informed consent.

Disclosure: Issues of disclosure are central to ethical practice in research and are of particular concern when dealing with vulnerable participants. One of the main concerns for the studies in this thesis was the production, storage and distribution of images, video and other digital media. I used the participating schools' policy on media storage and distribution as a basis for my own. I kept all data on an encrypted hard drive that only members of the research team could access and view. In the second study I was required to edit out and permanently delete any images or video of one particular student onsite at the end of each session as disclosure of their location would put them at risk. I kept all data from the project on an encrypted drive and ensured that I conformed to the data protection policies of the University and partner schools.

Equal Access: In a special educational needs context it would be unethical to withhold educational activities from children that may benefit them or to introduce interventions that would negatively impact their social and educational development. In all four studies no students or their guardians declined to participate in the research but provision had to be made to ensure that any student who wished to withdraw did not miss out on any teaching or opportunities their classmates were offered.

Informed Consent: Every participant in my research was required to give informed consent. This included all of the teaching staff, children and the institutional consent on behalf of the partner schools. In order for it to be informed consent every participant was provided with information about the study and their part in the study in a manner in which they could understand. I created two different information sheets for each study; one for parents and teaching staff and another for the participating children. The children's' information sheet used symbols and simplified language to explain their part in the study. This was checked and approved by the schools' deputy head. I also spent time during classroom sessions explaining to students what the study was and what part they played in it.

As my university ethics committee explained to me, children under 16 and those with special educational needs could not give informed consent and so consent had to be sought from their parents and legal guardians. I felt that it was still important to explain

and gain verbal consent from all of the child participants to ensure they were aware of what they were doing and being part of. I received signed consent from every person involved in all four research studies.

Planning, writing and receiving ethical approval for the research studies in this thesis was a lengthy and difficult task. Considering how the research process affects the way in which children with special educational needs and those that support them conduct their lives is of paramount importance in the planning and running of research in this field.

2.6.1 Anonymising Data

The names of the partner schools, the participants and organisations associated with the research other than Queen Mary University have been anonymised. I have chosen to give all participants and organisations in this thesis names as I felt codes such as STU01 would detract from the flow of the writing. The names have been anonymised in accordance with the terms of the university ethics board that oversees the research conducted in this thesis and the photographic and child protection policies of the schools involved.

3 Background and literature review

3.1 Introduction

This chapter situates the empirical and theoretical work conducted during this research project within the relevant fields of research. The chapter is divided into five main sections. The first section discusses the terminology and discourses around the use of the term 'children with special educational needs' (SEN) and the 'special schools' that some children with SEN in the UK attend. These two terms are used to describe the participants of this research project and the institutional context in which it was conducted. Through the literature I show that the terms are based within statutory and institutional discourses and defines a population of children with a vast array of impairments, abilities and experiences. By looking briefly at the social model of disability I will show that the term 'children with SEN' is an oversimplification relying as much on socio-political dynamics as medical diagnosis. In light of this discussion I present potential challenges for conducting research with children with SEN and within the institutional constraints of special schools in the UK.

In the second section I survey literature from multiple research disciplines on the impact of Information and Communications Technologies (ICTs) within special educational needs contexts. The section begins by discussing the areas of social and

educational development that ICTs can support. It then turns to look at how we approach the design and research of the impact of ICTs in schools by looking at the relationship between the educational computer industry and governments. Through the work of Neil Selwyn I consider an approach to developing and studying the impact of ICTs in education that starts by considering the social implications of designing and introducing technologies into educational contexts and recognising that engrained political and economic problems cannot be solved purely through the introduction of technology. The role of teachers in the introduction of technology in schools is considered through a brief survey of contemporary and historical sources. It presents two conflicting positions; one, that teachers' 'old-fashioned' attitudes are blocking the potential revolution in education that technology offers, and another, that sees teachers' choices around when and how to use technology as being embedded in a matrix of practical and pedagogical constraints.

Within the literature on interaction design and children (IDC) self-advocacy is identified as being an area that can be supported through the design and introduction of interactive technologies and the research processes that are used to develop them. In the third section I discuss what is meant by self-advocacy for children with SEN and set out the complex matrix of opportunities, skills, tools and knowledge that are required for children with SEN to self-advocate. It concludes by considering literature on how the complex power relationship between children and adults affects research that seeks to include children's experiences within the research process.

In the fourth section I explore research and design methodologies that enable people to participate in the design of technologies that directly impact on their lives. It starts by discussing the historical roots and underlying socio-political motivations of several design methodologies including participatory design, universal design and inclusive design. It then turns to literature that calls for a continuous questioning of the motivations of researchers and institutions in using participatory design methods. In the concluding part of the section I look at the methodological issues around the use of participatory design methods with children and discuss specific research projects that make use of participatory methodologies to design technologies for children with special educational needs.

As has been set out in the *Position* chapter, this research project takes a non-determinist approach and uses a range of methods to collect and analyse the empirical evidence in the four studies and discussion that make up this thesis. In this final section

I discuss the histories of and reflect on the research and design methodologies that are used in this thesis.

3.2 Children with special educational needs (SEN)

This chapter begins with a brief discussion of the term 'children with special educational needs' and the special needs schools that many children in the UK attend. I discuss these in order to set out the population and setting for the research in this thesis.

The term special educational needs is a statutory and institutional term that is used to define a specific population of children in the UK. I will show that the term covers a wide variation of impairments and by presenting the social model of disability I contend that the term is dependent on socio-economic factors as much as medical diagnosis. The section concludes by discussing the challenges for research that this population and setting present.

3.2.1 Children with SEN within the UK education system

Locating a single definition of what constitutes a student with special educational needs is difficult as it covers such a vast range of needs and impairments. Every year since the 2008 *Special Educational Needs Information Act*[1] the Secretary of State in the UK has been obliged to publish information about children with special educational needs in the UK and their educational provision. The main information is published in an annual report covering the socio-economic characteristics, legal definitions, attainment and educational progression of children with special educational needs in the UK. This report alongside the *Special Educational Needs Code of Practice* (Department for EducationDepartment of Health, 2015) are used here to inform legal definitions and statistical information relating to children with special educational needs in the UK. The UK government currently defines a student as having special educational needs if they:

[1] Available here: http://www.legislation.gov.uk/ukpga/2008/11/introduction

> a) Have significantly greater difficulty in learning than the majority of children of the same age.
>
> b) Have a disability that prevents or hinders them from making use of educational facilities of a kind generally provided for children of the same age in schools in the area.
>
> c) Are under compulsory school age and fall within the definition at (a) or (b) above or would so do if special educational provision was not made for them.
>
> (Brook, 2012, p. 4)

This is a broad definition and encompasses a wide range of children and young adults with a vast array of physical and cognitive difficulties. These impairments include sensory impairments, behavioural difficulties, autism of varying degrees, and physical and cognitive impairments. These categories are further complicated as they include participants with multiple disabilities. The impairments a student may have might last for only a limited time – due to illness or social factors for example, but can also persist so that children may identify as having special educational needs into adulthood. The personality, class, race and other social aspects that the students inhabit will affect how their specific impairment will impact on their learning and social interactions with others.

Students in the UK who show signs of having special educational needs are given an assessment by a multi-disciplinary team of educational and psychological experts in collaboration with the student and their parents/guardians. If deemed necessary, a formal document called a 'Statement of special educational needs' is drawn up detailing the child's learning difficulties and the support that the student should then receive. This statement is reviewed at least annually and monitored throughout the year by professionals and parents.

Children with statements of special educational needs make up around 2.1% of school children aged 5-18 in the UK. Boys are 2.5 times more likely than girls in primary school and 3 times more likely in secondary school to have statements of special education needs. Students with special educational needs are more likely to come from economically disadvantaged backgrounds (Brook, 2012).

The types of needs that are covered in the legal definition in official government policy documents demonstrates the breadth of needs experienced by children with special educational needs:

> Specific learning difficulty, moderate learning difficulty, severe learning difficulty, profound and multiple learning difficulties, behavioural, emotional and social difficulty, speech, language and communication needs, hearing impairment, visual impairment, multi-sensory impairment, physical difficulty, autistic spectrum disorder, other difficulty/disability (Brook, 2012, p. 12).

The most prevalent primary needs for children with statements of special educational needs are the autistic spectrum disorder followed by moderate learning difficulties with multi-sensory impairments as the least likely (Brook, 2012, pp. 8-10).

Within this thesis the term 'typically developing' is used to describe children who are not receiving support for special educational needs. This term is used in place of *normal,* as this would denote that children with special educational needs are in some way *abnormal.* Whilst the term 'typical' is somewhat problematic it is used widely in literature as a non-derogatory term to contrast with 'special educational needs*'.*

This section has discussed the statutory and institutional definitions of the term SEN. I will now look at the educational provision for children defined as having SEN in the UK.

3.2.2 UK Schools for students with special educational needs.

The majority of students with statements of special educational needs in the UK are taught within mainstream schools but with additional provision for their needs provided in school and through external specialist agencies. Were deemed appropriate, students with statements of special educational needs are taught within specialist schools. These specialist schools will be the focus of the case studies in this thesis. The Department for Education defines a special school as:

> Special school – a school that is just for pupils with statements of special educational needs. (M. Walker, 2010, p. 133)

A special school is an institution that serves multiple roles for its staff, students and wider society. It functions within shifting political, financial and ethical pressures that define and constrain the objectives and agendas that it works towards. Whilst this is true of mainstream schools these ethical, financial and political pressures are

particularly acute in special educational needs due to reasons that include the costs of specialist equipment and staff and the vulnerability of students.

Odom et al. also point out that the remit of a special school extends beyond the classroom into a much broader set of contexts that include assessment, healthcare and social services in the home, social and vocational settings (Odom, Brantlinger, & Gersten, 2005, p. 139).

As with children with special educational needs, there are great variations in the experiences, qualities and pedagogical standpoints of staff that teach and support them. Although there are national teaching standards and policy that define what teaching methods are appropriate, staff in these settings hold their own viewpoints and respond to the circumstances of students, individually and as interactive groups, in different ways.

Special schools follow the national curriculum as far as is possible for the children they work with but adapt that curriculum depending on the needs and abilities of their students. The wide range of needs, impairments and complex social backgrounds of students with special educational needs means that schools have to contend with and support a huge array of adaptations in their approaches. The resources, the approaches to teaching and management of special educational schools, and their settings are not consistent throughout the UK. The type of teaching and care approach children receive in specialist schools is dependent on the resources, the social demographics of their students, the ethos of the school, the management/ leadership of their head teachers, budgets of local educational authorities and the individual professional practice of its teachers.

This variation in pedagogical and care provision for children with special educational needs in specialist schools is reflected in students who attend them. Children and young people exist within social and institutional contexts that are as complex as those inhabited by adults (Christensen, 2004, p. 170). Within a classroom in a special school, children and young people will have a range of abilities, impairments, learning styles and social/economic backgrounds, all of which fluctuate over time. Children learn and develop over their time in a school. This can be in terms of behaviour, physical capabilities, learning and their abilities to interact socially with others. These changes can happen over days, weeks, months and years and are not necessarily positive. Classes in special schools are typically made up of a mix of students with different

abilities. Some classes may deliberately be made up of students with similar needs and diagnoses but each individual will have a range of experiences, needs and learning styles and every student has a personality distinct from those around them.

3.2.3 The social model of disability

Definitions of a person as 'disabled' or 'normal' are constructed through social, cultural and economic factors (Auslander, 2008; L. Davis, 1995; Goodley & Moore, 2000; Guha, Druin, & Fails, 2008; Liu, Cornish, & Clegg, 2007; Oliver & Barnes, 2002; Sandahl & Auslander, 2005). There is a model of disability that is referred to as the British or social model of disability. It distinguishes between disability as a social construction, and cognitive, bodily, or sensory impairment. A digital text-to-speech device may be used to meet a need dictated by impairment. Social conventions, physical barriers, and curricula, which limit a person's ability to participate in life and work, constitute a disability (Finkelstein, 2007; Oliver, 1997; Swain, 2004). The physiology of a student that means they require an alternative interface to a mouse and keyboard in order to create a digital animation is an impairment. The social discrimination and stigma they face, as a disabled artist is a disability.

In distinguishing between impairment and disability the model allows us to focus on and to address a person's abilities by considering the barriers and disabilities created by social, cultural and economic factors external to the person. In using this model, caution should be taken that the impairments of a person are not ignored to their detriment.

The terms that are used to describe the specific needs of children with SEN such as autistic spectrum, multiple and complex need, visually impaired, are socially constructed rather than absolute. Each term represents a range of impairments and abilities but is dependent on the context and cultural positions of those who use them. The term SEN is useful as a general term to describe a population of students and is used in statutory and institutionally contexts. The generality of the term hides the fact that each student has a range of needs, abilities and impairments that are specific to that individual and that the disabilities they contend with can be due as much to external social/economic factors as their individual impairment. The approach and provision that a school and its staff offer students and the attitudes of the society in which they interact are all important factors in working to negate the impairment and disabilities that students with special educational needs face.

There is no singular definition of what constitutes a child or young adult with special educational needs. The term special educational needs describes a wide range of individuals with differing abilities, needs and ways of interacting with the world who receive an equally differing range of support and care. Special educational needs (SEN) is used throughout this study as a broad term to describe the participant population but is done so with the acknowledgement that the term special educational needs does not define an individual.

3.2.4 Challenges in special education research

Conducting research in special education schools presents difficult challenges for the researcher. These difficulties arise from the qualities of the participants, the educational context in which the research is conducted and the social processes that dictate them both.

Variability of participants and setting

One of the most challenging aspects of this research is the variability of the participants in special education. As I have discussed the term 'special educational needs' covers a vast array of physical and cognitive difficulties. These include sensory impairments, behavioural difficulties, autism of varying degrees and physical impairments. Even when students are labelled with specific disabilities, their personality, class, race and other social factors affect how their disabilities are seen by others and manifested in educational settings.

The resources and management of special educational schools and their settings are not consistent throughout the country. The methods that teachers employ are affected by available resources, the social demographic of their students, the ethos of the school and head teachers as well as the pedagogical standpoints of staff.

Odom et al. (Odom et al., 2005) point out that special education extends beyond the classroom into a much broader set of contexts. This includes healthcare, support at home, play and vocational contexts for older students.

Research in special education schools is not only concerned with students but also their carers, teachers, support staff and institutional settings. Research and design approaches that are based solely on students' institutionally defined impairments risk missing the rich interactions that occur between people students and staff and institution.

Vulnerability of participants

Children with SEN are some of the most vulnerable people in our society. They are at greater risk of being abused and neglected. Sullivan, (Sullivan, 2000) in a large scale study in a US city, found children with special educational needs to be 1.8 times more likely to be neglected and 2.2 times more likely to be physically or sexually abused than mainstream children. There are a range of very complex factors that can be attributed to this some of which are detailed by David Miller in his two reports for the NSPCC on disability and abuse (D. Miller, 2002; D. Miller & Brown, 2014).

Society devalues and disempowers people with disabilities, which make people with disabilities vulnerable within our society. There tends to be a general lack of communication and consultation with children with special educational needs over their experiences, views, wishes and feelings and the lack of choice and control they have over many aspects of their lives. Assumptions are sometimes made about children with special educational needs, for example, their moods, injuries or behaviours. This can result in indicators of possible abuse being mistakenly attributed to the child's impairment (D. Miller, 2002; D. Miller & Brown, 2014).

The vulnerability of children with special educational needs effects research in several ways. The first is the difficulty for the researcher of gaining access to children and the settings in which they work. There are many important and necessary safeguards in place that make it difficult to engage in research with children with special needs. Those with responsibility for children may limit what sorts of investigation can be done and what the engagement of the investigators with the children should be. This adds to the difficulties in finding a large enough population, excluding for the difficulty of low-incidence, for correlational studies. Working with such potentially vulnerable members of society places ethical demands on how, when and why research is conducted. Creating control groups in which educational practices are withheld from children would be unethical and against schools' policies of inclusion for all.

3.2.5 Summary

This section has discussed the term 'children with special educational needs', which is used as a statutory definition to define the range of children that attend special schools in the UK. I have through a review of literature shown that the term 'children with special educational needs' can be said to be is an over simplification of a diverse and heterogeneous population.

I then considered how the variation in students' abilities and needs and their vulnerability in comparison to typically developing children could affect the carrying out research within the setting of a special education school.

3.3 Technology in the classroom

Research into practice at classroom level in SEN contexts has been conducted from a number of different academic perspectives. Here I set out briefly the literature on the potential impact of Information and Communications Technology (ICT) within SEN educational contexts. The perspectives detailed are from multiple research disciplines including computer science, sociology, and educational and pedagogic research.

The section begins by looking at the areas of education and social development that ICTs can support. It then moves on to look at wider government initiatives for introducing ICTs into SEN classrooms and the impact of a close relationship between the educational computing industry and the government. Next it looks at discussions in literature on approaches to researching the design and impact of using ICTs in education that start from the social realities and institutional constraints of education. This section finishes by examining literature on the role of teachers in the introduction and sustained use of technologies in classrooms.

3.3.1 The role of ICTs in SEN educational contexts

A key contributor to the field of social and educational inclusion Lani Florian offers useful insights about the ways ICT can contribute to inclusionary pedagogy in special education (Florian, 2004; Florian & Black-Hawkins, 2011). She suggests that there is a wide range of sources from research, government, and industry that promote the use of ICT in SEN. She shows an agreement in this literature that ICTs can support students in overcoming obstacles to their learning or to their participation and interactions within learning activities (Florian, 2004, pp. 8-10).

While Florian broadly agrees that there is potential and some evidence for ICT to be used as a tool for inclusion for children with SEN, she argues that the overabundance of information, advertising, and teaching materials that are targeted at teachers can be overwhelming. Florian goes on to say that the liberating effects of technology for students with SEN are dependent on their skilled application by teachers and others who support learners. Teachers working in pressurized environments have little time

to consider critically where technologies could support their teaching practice and the learning of their students (Florian, 2004, p. 10).

Florian sets out four areas of educational practice in SEN within which ICT may have a positive impact, these are: as a means of communication and tutoring; as a way to explore the world; as a tool to mitigate impairments; and as a resource for assessment and management. She analyses ICTs in terms of their impact on the interaction between students and those that teach, with a particular focus on how the use of technologies can foster inclusion. She concludes that evaluating the effectiveness of technological interventions in SEN settings is incredibly difficult due to the variability and fluidity of the context (Florian, 2004, p. 18). Florian quotes Woodward et al.'s work on the design of educational software and their impact on student learning. Woodward et al. assert that:

> …simply because a program or approach has been validated by research does not necessarily mean it will be used as intended in practice. (Woodward, Gallagher, & Rieth, 2007)

What both Florin and Woodward suggest is that we need to consider the impact of using technologies 'in practice', that is within the day-to-day constraints and affordances of an educational setting. This might include factors such as the existing practices of teachers, differential abilities of children and the ethos of practices within a particular school.

Reports of research on the use of technologies in schools with children with special needs include considerations of a variety of specific topics. Among these are the use of digital technology in the design of alternative and augmented forms of communication (AAC) (Higginbotham & Caves, 2002; Light & Drager, 2007a); the development of social skills, (Avramides et al., 2010; Escobedo et al., 2011); assessment and diagnosis of impairment (Kientz, Boring, Abowd, & Hayes, 2005; Westeyn, Vadas, Bian, Starner, & Abowd, 2005); and supporting exploratory and creative learning (Botturi, Bramani, & Corbino, 2010; Kientz et al., 2005; Westeyn et al., 2005). This list is by no means an exhaustive one. It simply shows the breadth of applications that already exist in HCI research for children with SEN.

Lui et al. write about the intersection of HCI and SEN from a perspective of research in computer science (Liu et al., 2007). They argue that interactive technologies have the potential to support all areas of need that children with SEN face and that the potential

to support self-advocacy by SEN students is a key area to explore. They maintain that a lack of research into the usability of technologies that are developed for SEN contexts means that teachers are unable to adapt technologies to the individual abilities and needs of students. They identify the lack of a systematic methodology for bridging the requirements for SEN learners with ICT development as a main impediment to greater usability of technologies in SEN.

In setting out 'areas of need' for SEN learners, Liu et al. (Liu et al., 2007, p. 21) turn to the categories of need contained in the Department of Education and Skills (DfES) – SEN Code of Practice (Department for Education, 2001). These are: Communication and Interaction, Sensory and/or Physical, Cognition and Learning, Behaviour, and Emotional and Social Development. As researchers working in a field outside of education, Lui et al. make use of these categories as a way to build a set of system requirements on which technological designs can be based. This approach is a top down approach that treats the areas of need of SEN children as a set of system and managerial problems that can be addressed through the application of technology. A systems approach offers a means for non-educational specialists to focus their research on important areas for students with special educational needs but in doing so doesn't take into account the nuanced social context in which these 'areas of needs' occur.

Williams et al. in a meta-review of literature on ICT in SEN found that both adults and children with SEN are able to use and derive benefit from interactive technologies to self-advocate – that is the ability to express and have their opinions heard on matters that concern them. They conclude that there are few authoritative guidelines on the usability of ICT for people with SEN and see this as a barrier to the future design of ICTs for people with SEN (P. Williams, Jamali, & Nicholas, 2006). Unlike Liu et al., Williams et al. contend that design and research should reflect on the socio-political context in which ICTs are employed and a consideration of users such as teachers, carers and other support staff in tandem with the people with SEN that they support.

I have discussed above a range of literature that has shown the potential positive impact of ICTs for people with SEN in all aspects of their lives. The literature shows however that there is a lack of research on usability of ICTs in SEN to ensure that they are both appropriate and sensitive to the needs of users and the setting in which they are used.

3.3.2 Government and industry initiatives in educational technology for SEN

In order to examine the potential impact of ICTs in special needs education from a wider perspective I turn briefly to literature that discusses governmental and European strategies for ICT in education. I begin by looking at European policy and strategies and then turn to the work of David Buckingham and others who examine the close and sometimes problematic relationship between the educational technology industry and government.

Chris Stevens, a researcher on the use of computing in educational psychology, gives a detailed historical account of the main policy forces that drive ICT in special needs classrooms. He shows that the motivation for the introduction of ICT in special educational classrooms has come from a mixture of government and industry concerns at both national and international levels (Stevens, 2004). These initiatives and the implementation of what is regarded as best practice are monitored and controlled within frameworks established both in the UK and on a European wide scale. Until 2010 in the UK, the British Educational and Communications Technology Agency (BECTA) coordinated other government agencies and industry partners to make sure that governments' learning strategies incorporated the latest developments and research on the use of ICT in SEN contexts.[2] Since 2010 responsibility for coordinating the development of ICTs and purchasing of equipment has been in the processes of being devolved to local educational authorities.

In Europe examples of best practice are outlined in the joint 2011 report for the European Agency for Development in Special Needs Education and UNESCO, *ICTs in Education for People with Disabilities – A Review of Innovative Practice*. This review of innovative (Human Computer Interaction) HCI practice in SEN education defines the role of ICT in special education as:

> [Supporting] people with disabilities to learn life and social development skills to facilitate their full and equal participation in education; … (Watkins, 2011)

A useful guide to wider European strategies on the use of ICT with children and adults with SEN, are the European Agency for Development in Special Needs Education reports on ICT and inclusive teaching in Europe. There is a consensus in both UK and

2 For an overview of the role of BECTA see:

http://www.education.gov.uk/aboutdfe/armslengthbodies/a00192537/becta (Accessed 8/06/2012)

European government policy literature that the use of digital technologies in schools offers a means for children and young people with special educational needs to participate more fully in social, educational and cultural activities.

As a number of researchers have noted (Buckingham, 2007; Menchik, 2004; Stevens, 2004), the relationship between the educational technology industry and government is a complex one where educational interests and the interest in expanding markets do not always sit easily together. This relationship is explored in detail by David Buckingham, one of the leading international researchers in the field of media education and children's interaction with digital media. Buckingham, in his book *Beyond Technology – Children's Learning in the Age of Digital Culture*, explores and critiques this government/ industry framework and the effect it has on the means of marketing and acquisition of educational technology in the UK (Buckingham, 2007, pp. 1-14). He describes it as the 'educational-technological complex' that 'represents the powerful alliance between public and private interests' (Buckingham, 2007, p. 12).

This complex relationship is typified by the connections between British Educational Training and Technology (BETT) and Department for Education and Skills (DfES). Buckingham contends that the close relationship between industry and government concerns distorts and inflates the potential of technology to transform education. In his discussion of this relationship he quotes sociologist Daniel Menchick's observation on this educational-technology complex:

> …the line that separates benevolent, authentic concern for student learning enrichment from self-interested entrepreneurship [is] difficult to ascertain. (In Buckingham, 2007; Menchik, 2004, p. 179)

Buckingham argues that the pressure for innovation in ICT use in schools from government and industry results in a coercive approach that fails to take into account local contexts and the views of teaching professionals. This results in a disempowered and disengaged set of users that includes teachers, educational professionals and children. Buckingham offers an excellent overview and critique of the relationship between interested parties in the use of educational technology. In particular, he offers a systematic critique of the mismatch between the rhetoric surrounding the impact and growing use of technology in the classroom and evidence of its positive impact in real educational contexts.

3.3.3 Educational technologies – a positive project

This review now turns to literature on approaches to research for the design and implementation of technology in education from a sociological perspective. Literature is presented that argues for an approach to the development of technology in education that begins from the socio-economic reality of the school context.

Sociologist Neil Selwyn is a prominent researcher in the sociology of the use and non-use of technology in educational contexts who writes extensively on the politics of educational technology (Selwyn, 2009; 2011; 2012). In his 2009 paper *The digital native – myth and reality* (Selwyn, 2009), he argues that many of those working in the area of educational technology share an underlying belief that educational technology will in some way always be able to enhance learning and education. This, he contends, casts the role of the researcher as being one who:

> …finds ways to make these technology-based improvements happen and—to coin a phrase often used in the field—to 'harness the power of technology.' (Selwyn, 2011, p. 713)

Selwyn describes this as a utopian characteristic of educational technology scholarship describing it critically as a 'positive project'. He says that the 'positive project' has become a hegemonic characteristic of research into educational technology. The result is a lack of critical engagement with the complex socio-political issues involved in the use of technology in education (Selwyn, 2009).

In *In Praise of pessimism—the need for negativity in educational technology,* Selwyn calls for a pessimistic view of technology that starts by considering social implications of designing and introducing technologies into educational contexts and the socio-political struggles that those social changes cause. He maintains that there is a failure to recognize the engrained social, political, cultural and economic problems in the education system, problems that cannot be solved purely through technical interventions (Selwyn, 2011).

He continues by arguing for research that starts by accepting the formal constraints and 'social facts' of education and the limitations that technical interventions can have in solving them. He contends that by starting with no expectations of what technology can change, a researcher can critically appraise where educational technology may mitigate or indeed have a negative impact on the interactions of learners, teachers and the institution.

Selwyn takes the view that taking a pessimistic position on the use of technology in education offers a means to engage with the state of education as it is rather than as we would like it to be. Research can then explore ways to withstand, mitigate and offer alternatives to negative aspects of education and support and develop those that are positive.

> Pessimism can therefore provide a powerful basis for exploring ways that educational technologies can be used by individuals to better survive within an inherently imperfect world. (Selwyn, 2011, p. 716)

Buckingham further develops this critique of the 'positive project' in educational technology in his writing on the gap between the revolutionary rhetoric of the potential for educational technology and a realistic, evidence-based view of the current state of education (Buckingham, 2007).

He describes this 'positive project' as being informed by a determinist view of the technology. One that starts from the assumption that technology has inherent attributes that, if given the correct context to work, will impact on children and their learning. This quality of the technology is seen as universal, being applicable to all children and all learning environments. The qualities are embedded in the technology with people needed only to enact them to enable the equally disembodied force of 'information' (Buckingham, 2007, p. 90).

The contexts in which the technology is deployed and the participants that make use of it are only relevant in that the context and participants must be adapted to suit the requirements of the technology so that it is able to deliver its beneficial functions. The impact of the technology is then seen to be consistent, regardless of the political, social, and economic contexts within which the technology is situated. This implies that once the barriers to implementing technologies in schools are removed, for example due to lack of money, resistance by teachers and other professionals, or children's impairments, those qualities of the technology will be enacted (Buckingham, 2007, p. 55). Buckingham refutes this position, arguing that it is not the technology that brings about change in itself but that any changes occur within the social interactions in the classroom that accompany its use. This means that in order to understand the role of technology in classrooms we must consider the actual and potential social actions that accompany its use.

3.3.4 Teachers and the introduction of technology in schools

One of the main participants in the social interactions that occur in a classroom is the teacher. This section looks at the role of teachers in the introduction and sustained use of technologies in the classroom. This is done by looking at Larry Cuban's historical account of the role of teachers in the introduction of broadcast technologies set against contemporary critiques of teachers' roles in introducing new digital technologies into schools.

Larry Cuban offers a detailed, critical account of the use of electronic technology in schools as a means of altering teaching practice from the 1920s up until the mid-1980s (Cuban, 1986). He traces the promise of a revolution in educational practice that accompanies the introduction of each technology by what is mostly government, academic and industry educational reformers into schools. He argues that there is a consistency over those six decades in the claims that are made for each new technological innovation - the supplanting of books and 'old fashioned' media, a direct link to the experience of the world outside of the classroom, the efficacy of new technologies over old teaching techniques, and the reduction and in some cases the obsolescence of the teacher, as children begin to 'teach themselves' using these new technologies.

Cuban shows that from the introduction of the radio broadcast in the classroom in the early 1920s to the promised information revolution of computers in the 1980s, these claims of revolution and transformation fail to materialize. As each technology is brought into wider use in schools, complaints are raised by teachers about the difficulties of use and the unreliability and incompatibility with teaching practices of these technologies. He demonstrates through the use of a range of surveys and research from over the six decades that teachers would at best only make occasional use of the majority of these technologies. This would then lead to accusations aimed at teachers from researchers and administrators that it was due to teachers:

> … lack of innovation, adherence to old fashioned teaching methods, and the bureaucracy of schools that the potential of these new technologies were not fully realised. (Cuban, 1986)

These revolutionary claims and the accusations of resistance by teachers can still be seen in the discourse around the use of digital technologies in the classroom in the past decade. A good example of this is the work of Mark Prensky, an influential technology

commentator and educational researcher who first coined the widely used terms 'digital native' and 'digital immigrants' (Prensky, 2001). Mark Prensky writes and presents widely on the revolutionary potential of digital technologies in the classroom (Bruce et al., 2013; Prensky, 2013) (Prensky, 2007; 2008b; 2009). In his paper, *The role of technology in the classroom*, Prensky makes very clear what he sees as the role of new technologies in the classroom. Writing in bold and separating the quote in its own box on the paper he writes:

> **The role of technology in our classrooms is to support the new teaching paradigm.**

(Prensky, 2008b)

He contends that the role of teachers in this new paradigm is not for them to make use of new technologies in the classrooms but rather to support students to use them by themselves. Teachers are cast as guides, there to show students how to use these technologies and to offer some context and quality assurance, but that once the technology is introduced it will enable students to teach themselves.

He continues in his criticism of teachers and their resistance to making use of technology revolutions in *Backup education? Too many teachers see education as preparing kids for the past not the future* (Prensky, 2008a). He writes about a set of questions that teachers inevitably ask at the end of his talks on the need for removing old ways of teaching to make room for new technological innovation: questions about the reliability of technology; what happens when they fail? The need to fit in with their existing practice; what if it's inappropriate for me as a teacher?

These questions concern him not because he thinks they are valid but rather because they miss his point:

> So why is the teachers' attitude a problem?
>
> It's a problem because what the teachers are really saying is this: 'We don't trust the technology of today, or the future. We don't trust the world in which you kids are going to live. We believe the way we did it in our time was the 'real' way, the only reliable way, and that's what we want to teach you kids – 'the basics'. (Prensky, 2008a, p. 1)

Prensky's voice matches the chorus of voices that Larry Cuban demonstrates have followed in the failure of the technologies that they themselves have promoted since the 1920s. Cuban offers a far more convincing and complex reasoning as to teachers' reluctance to use the technologies that are introduced into the classroom since the 1920s, which he shows stems from a matrix of issues (Cuban, 1986, pp. 51-71).

There are practical issues to do with the levels of instruction that are needed to use the technology; the availability of technologies within the constraints of the school timetable; and the reliability and cost of maintenance of technologies. Where these pragmatic issues appear, Cuban maintains that there is a need for flexibility and simplicity that is found in older and widely adopted technologies such as blackboards/ whiteboards and textbooks that are lacking in these new technologies. These older technologies, he contends, are more appropriate for the complex context that the typical classroom presents.

The drive to introduce new technologies to reform education potentially ignores the day-to-day institutional conditions in schools and the adaptations that need to be made for the diverse settings in which the technologies might be used. Where they are left out of decision making about innovation, the design of digital technologies, and how they are introduced into the classroom, teachers will avoid the adoption of these technologies. This is not just because they lack 'ownership' of innovations that have been brought in to them from the outside, though this is of importance, it results from a failure to consider the pragmatic realities of schooling in which the digital technology is sited.

Cuban discusses the importance within teaching practice of what he calls the 'situationally constrained choices' that teachers must make in their day-to-day interactions with children. He sees value in the face-to-face interaction between student and teacher that is not always considered in technological interventions.

> [Teachers] can alter classroom behaviours selectively to the degree that technologies can help them solve problems they define as important and avoid eroding their classroom authority. (Cuban, 1986, pp. 70-71)

It is these constrained choices that dictate when and where a teacher is likely to adopt particular technologies into their classroom practice. Buckingham develops this by putting forward the idea that teachers approach the use of technology in their classroom incrementally. That is, teachers make use of technology when it supports what they are doing more effectively and efficiently.

> … studies suggest that teachers 'make do': in a context of scarce resources, escalating workloads, and the pressures of ever changing government initiatives, they seek merely to generate serviceable classroom strategies. (Buckingham, 2007, p. 63)

This is not to say that teachers are not open to developing and augmenting their practice but that within the pressured and time-constrained context they work within they will adopt first technologies that complement their existing practices. It is not due to a resistance to change that teachers do not adopt new technologies, Buckingham goes on to say, but for considered professional reasons.

This implies then that the effective design of technology should not just consider the technical qualities of the technology but also how they may fit within the existing teaching practices and educational context that teachers work within. This involves an understanding of the social reality of educational situations and limitations of technologies to bring about extensive social and pedagogical change in the educational system.

3.3.5 Summary

Within this section I have looked at the use of interactive technologies by detailing relevant literature on the potential uses for technologies, the wider governmental issues that affect their funding and implementation in schools, methodological discourses about how we approach research in this field and the role of teachers in the introduction and sustained use of technology in the classroom.

3.4 Digital media and storytelling

This thesis is concerned with the impact and development of accessible digital systems to support students with SEN and their teachers to use digital media in their learning activities. It focuses on the use of digital media to support students and teachers to share their ideas and achievements with others of significance to them. An important creative mode that is used in most aspects of teaching within SEN schools is narrative

construction and storytelling. It is used as a means of expression, personal and literary development and to share ideas with others. Here we focus on literature that researches the role storytelling plays in children's development and the impact of digital tools and media on the process of storytelling for both typically developing and children with SEN.

3.4.1 What is storytelling?

Storytelling covers wide ranges of diverse activities, approaches and traditions. It is a diverse practice and as such there are many different interpretations of what storytelling involves. Nicola Grove a researcher in the use of storytelling for early year's children describes storytelling as a set of oral traditions that involves the sharing of stories, which may be mediated through writing, sound and image (Grove, 2013, p. 66). The definition of a *story* depends on the context in which it is used and the perspective of the person using the term. In her paper *Describing and evaluating storytelling experiences*, Tuula Pulli focuses in her definition of storytelling on social qualities of stories emphasizing the value of stories as a means of social cohesion through entertainment**,** (Pulli, 2000) whilst Black et al. focus on the communicative value of stories through the development of tools for clear narrative construction for children with SEN. (Black, Waller, Turner, & Reiter, 2012; Waller et al., 2013) Madej notes in her historical account of children's stories the importance of human participation in both narrative and stories.

> Narratives are dialogues between people, between cultures, between different times. They are not only texts - human participation is integral. (Madej, 2003, p. 2)

The development of the skills necessary for storytelling and narrative construction are associated with the development of fundamental literacy, social and wider educational attainment including language development, sequencing, abstracting reasoning, the development of personal identity, (Bonsignore, Quinn, Druin, & Bederson, 2013; Fails, Druin, & Guha, 2014; Melzi & Caspe, 2007; Reese, Suggate, Long, & Schaughency, 2010) the development of children's imagination and creativity skills (Polkinghorne, 1991) and as a therapeutic tool (Gersie, 1991; Sunderland, 2000; Thomas & Killick, 2007).

Expressing past experiences as a narrative is a way in which we form and impose order on our experience and is an essential part of a person's educational and social development. Bruner contends that narrative and storytelling plays a fundamental role in children's construction and organisation of meaning (Bruner, 1991). Narrative

construction and storytelling allows children to impart their experiences to others whilst at the same time encourages them to consider and attach meaning to those experiences as an introspective process.

Van Puyenbroeck et al. in their literature review consider the role of reminiscing as a form of storytelling - the recollection and narrative construction of past events, with children and adults with SEN. They identify three approaches to using reminiscence with people with SEN in literature; as a means for people with special educational needs to become critically aware of their past, as a means to discuss behaviour and social contexts with others and as a clinical approach as a means of 'low-threshold' narrative based counselling. They found that whilst these three approaches to reminiscence through narrative had very different aims and approaches they all can potentially support the development of self-esteem, identity construction and social skills for people with SEN (Van Puyenbroeck & Maes, 2008).

Studies have identified the importance of oral storytelling in early childhood between parents and children and the effects this has on the development of self-image and identity formation in adolescence. Through a longitudinal study spanning ten years Reese et al. examined how children's abilities to express life-stories developed in early childhood affected measures of wellbeing and their ability to describe emotional content within those narratives. They show narrative skills are an important means for children to understand and express the significance of events in their lives but also as a means to shape their self-concept and the perception others have of them (Reese, Yan, Jack, & Hayne, 2009).

Other literature has focused on the use of storytelling in early childhood and the development of literary and abstract reasoning skills (Griffin, Hemphill, Camp, & Wolf, 2004; Reese et al., 2010). Curenton et al. in their study of storytelling between mothers and their preschool children showed that storytelling helped to develop comprehension skills in young children through the use of *decontextualised* stories - stories that deal with subjects and ideas in the past or future that are not part of the child's present environment (Curenton, Craig, & Flanigan, 2008). Additionally research has shown the importance of creative and fantasy based play in storytelling as a means for children to develop through embodied physical enactment of stories greater engagement with other students and learning environments (Paley, 2009).

3.4.2 Digital technology and storytelling

There is a range of studies that have considered how digital technologies impact on storytelling and narrative construction for children. In the literature there is evidence that digital technologies can extend the possibilities for individual and group based activities in the classroom and brings with it benefits for social skills, motivation in learning tasks, confidence in group work and improved narrative structuring (Blas, Paolini, & Sabiescu, 2012; Göttel, 2011; Rubegni & Paolini, 2010).

In his review of forty studies focused on digital storytelling technologies for children, Timo Göttel argues that digital technology for storytelling should be considered within an understanding of traditional storytelling activities as relying on social and communication skills, imagination, creativity, and full body interaction. (Göttel, 2011, p. 153). He sets out three areas of focus, synthesised from his literature review, of how digital storytelling can extend traditional storytelling activities.

Remote authoring – collaboration between remote authors through web, video and mobile-based interfaces.

Studies in this area include research on a remote-video systems for writing and reading bed time stories between grandparents and their grandchildren (Raffle et al., 2010); the design of mobile phone based apps for collaborative storytelling and reading co-design with children (Fails, Druin, & Guha, 2010), virtual collaborative storytelling that uses 3D avatars of children as a means to support live, remote collaboration over web based applications and the use of mobile storytelling systems as means to engage children with local and remote physical spaces (Bonsignore et al., 2013; Fails et al., 2014).

Collocated authoring – interfaces that support single story authoring as a collaborative activity.

Work includes the impact of collaborative digital storytelling software as a means to assess individual's digital literacy levels and teachers' approach to supporting students in narrative construction (Feher, 2008) and the development of social cohesion and motivation in a classroom through the use of software that enables single authored stories as a whole class activity (Blas et al., 2012). Studies have also considered non-screen based technologies for authoring by developing digital story rooms; as a means to support open and improvised physically based storytelling for children (Alborzi et al., 2000; Bobick et al., 1999).

Enriched experiences – the addition of multi-media elements and alternative presentation techniques such as projection, web-based publishing and augmented physical objects.

There have been several design-led studies that have attempted to incorporate recorded sound into children's physical drawing and writing as a means to extend written storytelling through tangible augmentations. This includes the Jabberstamp system which allows students to use a digitally enhanced stamp to record and locate a voice recording about their drawing anywhere on their page (Raffle, Vaucelle, Wang, & Ishii, 2007); the I/O Brush which allows children to record audio and video using a brush like interface then use their recorded media to create 'multi-media' paintings and stories (Ryokai, Marti, & Ishii, 2004); and a paper-based system for teachers that allows multi-media elements to be associated with paper based resources (Garzotto, Paolini, & Sabiescu, 2010).

Many studies that involve digital storytelling have pointed to literature that demonstrates the advantages of using digital and non-digital physical objects in the learning experience (Antle, 2007b; Ishii & Ullmer, 1997; Montessori, 1912; Resnick, 1998; Zuckerman, Arida, & Resnick, 2005).

Research that has been concerned with the use of tangible digital objects in storytelling has included: the use of digitally enhanced objects to simplify the complex processes involved in video capture, editing and presentation as a form of storytelling (Vaucelle & Ishii, 2009); the use of digitally augmented soft toys to record and enhance children's improvised story based play; the use of toys and other objects to represent small pieces of story text to be then composed into narratives by children's physical manipulation of the objects (Mazalek, Davenport, & Ishii, 2002); Zhou et al. designed and tested an augmented reality storytelling system that focuses on the telling of predefined, interactive stories using 'Magic Story Cubes' and 'Head Mounted Display' units (Zhou, Cheok, Pan, & Li, 2004).

Gottel concludes in his paper that these areas and combinations of these areas of focus in the literature for digital storytelling offer important design decisions and questions. He argues, however, that *digital storytelling* should be considered from the perspective of traditional storytelling.

> …we argue that digital storytelling at its best should primarily focus on enriched experiences and performing stories while providing authoring and sharing tools. (Göttel, 2011, p. 156)

This is echoed in the work of Cassell et al. who have developed a series of digital storytelling interfaces and environments for co-located collaborative storytelling (Cassell & Ryokai, 2001; Kehoe et al., 2004). Cassell et al. start in their design process by questioning the direction of influence of technologies on the storytelling process:

> Is the technology determining the content of the child's play, or vice-versa? Our philosophy is that good technology for children supports child-initiated and child-driven play. (Cassell & Ryokai, 2001, p. 7)

They argue that in order to develop digital storytelling systems that support language development, creative play, collaborative skills, and a development of self-image then the designer must consider the interactive nature of *traditional* storytelling and design systems where the interactive system becomes a listener of stories rather than a storyteller. This position is developed as a reaction to what they see as digital technologies for storytelling that provide for only finite, constrictive behaviour and narrative construction based on pre-defined text.

Storytelling and narrative construction are used in many aspects of the education and social development of children. There are a wide range of studies that have considered how both *traditional* and *digital* storytelling tools and approaches can support and benefit children. Whilst digital technologies potentially offer a range of new approaches, tools and opportunities for storytelling, digital storytelling is not a separate form of storytelling but a set of tools and approaches that may or may not extend the benefits of more traditional methods. Cassell et al. in their work on the StoryMat system for digital storytelling argue that it is not enough to develop technologies for children to listen to stories but to develop systems that help to have their voices heard and recorded as means to create, shape, interpret and present self-image and develop their knowledge of self (Cassell & Ryokai, 2001).

Whilst there are a range of experimental tools and authoring environment studies that are concerned with interactive systems for storytelling in the classroom, studies have also shown that teachers often carry out storytelling activities using non-specialist technical resources that are already present in the classroom for digital storytelling activities. This includes audio/ video editing software, presentation software, online

sound and image archives, and search engines. In some cases this replaces the need to use expensive custom technologies for storytelling. The use of these non-specialised resources still requires training and expert knowledge to use. A crucial aim of training must be to enhance the skills of teachers and of others working directly with children, and to enable them to put technologies with which they are already familiar to more effective use. One of the important virtues of doing it this way is that it helps to overcome teachers' own lack of confidence in their ability to use technologies (Feher, 2008; Pierre, 2006; Susono, Shimomura, Kagami, & Ono, 2008).

In their review on literature concerning the use of digital technology to support multimodal composition for children with special educational needs, Bruce et al. found that technology can provide ways to support children with special educational needs to compose stories but only if they are engaged and willing participants and are facilitated by an equally engaged and knowledgeable teacher. (Bruce et al., 2013). This is reflected in the findings of (Englert, Zhao, Dunsmore, Collings, & Wolbers, 2007) in their quasi-experimental study of the use of multimedia web based applications to support students with cognitive impairments to compose stories. They found that 'technology itself was not sufficient to teach or to affect long-term changes independent of the classroom instruction' (Englert et al., 2007, p. 195). In their study into the affects of blogging on writing and literacy development, McGrail and Davis (McGrail & Davis, 2011), found that teachers take on multiple roles in storytelling that include being a facilitator of classroom discussions, a sounding board, scribe and proof reader.

Multimodal storytelling is a term that is also used in literature to define forms of writing and storytelling that incorporate a range of non-print modes and includes drawing, photography, sound and video (S. M. Miller & McVee, 2013, p. 1). This ability to express meaning using a mixture of different modalities allows each mode to offer a unique set of constraints and affordances that depend on the context and the user. Miller et al. consider the evidence that multimodal technologies can support and improve the compositional skills needed to create stories for children with special educational needs by providing alternative forms of expression from text based modes.

Bruce et al. found that technology based multimodal forms of storytelling directly benefited students by providing methods of scaffolding for higher and lower levels of concern in story composition, a conceptualisation first coined by Claudia Keh (Keh, 1990). Lower levels of concern include spelling, syntax and the mechanics of writing, and higher levels include developing ideas, organisation of stories and reflecting on

compositions. The role of these multimodal technologies then is a means to increase the effectiveness of student's actions by moving the aspects that are either less important, or too much of a hindrance for the students, to tools that the technology provides. For example in their study on the use of audio narration and prompts in creating stories with children with a range of special educational needs, Faux et al. found that the scaffolding that the multimodal modes of instruction and expression that technology provided enabled students to mitigate the individual impairments that each student in the class presented.

Bruce et al. set out several findings that are pertinent to exploring how the use of digital media in special needs classrooms can support students with a range of special educational needs. Students must make compositional choices, enabling them to make multiple drafts and to examine the choices that they make. Where skilful facilitators lead the use of technology, students can find new modes of expression through the use of the tools that the technology provides. Multimodal technologies can support student motivation by helping them to take ownership of their learning, story composition and modes of expression (Bruce et al., 2013).

3.4.3 Special educational needs and storytelling

There are far fewer examples to be found in research literature on and the design of digital technology for storytelling for children with special educational needs than for typically developing children. What work exists focuses on design for children with specific diagnosis of impairment such as ASD and severe communication impairments rather than for mixed-ability groups.

Children with special educational needs often have cognitive and physical impairments, which impede their ability to communicate. Their ability to communicate is also affected by factors such as over-protection by carers and learned helplessness. These factors affect their ability to communicate their immediate needs and wants and the development of skills to shape and express self-image.

O'Mara et al. considered from the perspective of Alternative and Augmentative Communication (AAC) research how children with severe communication impairments can be supported in communicating stories about their day to day activities as a means of developing social skills, self-image and personal identity. They found that the existing communication systems designed for children with severe communication difficulties were focused on the expression of simple commands and

answers to basic questions. In their study they show that existing AAC systems lacked accessible means for narrative construction that are necessary for a range of social interactions and identity formation that natural language use provides. They found that AAC based systems that had been designed for narrative constructions were only suitable for literate adults and ill designed for the needs of children with SEN. They call for systems that promote independence for children with severe communication through the design and use of tools for narrative based communication (O'Mara, Waller, Tait, & Hood, 2000).

Annalu Waller and her team at Dundee University have focused on the development of narrative systems that extend existing AAC communication systems for children with severe speech and physical impairments (SSPI). The Chronicles system they have developed enables children with severe speech and physical impairments (SSPI) to share their day-to-day activities about their school day with others. They started from the observations echoed by O'Mara that existing AAC systems designed to support children with severe speech and physical impairments (SSPI) lacked any function for creating stories. This in turn limits these children's capacity to engage in extended conversation and to portray their day-to-day lives using their own voice. Through a series of studies the team developed a narrative, location based AAC software system. They found that the children that used the system were able to participate better in interactive conversations by gaining better access to relevant conversation and greater control in conversations that the usual state of interactions where the main control lay with the speaking partner (Black et al., 2012). In their later paper *Chronicles: Supporting Conversational Narrative in Alternative and Augmentative Communication,* Waller and her team extended the scope of the system to support children with severe speech and physical impairments (SSPI) to form and narrate what they call 'lifelong personal narratives' as an important means for those children to develop self identity and form relationships with others. (Waller et al., 2013)

Several studies have considered the role of digitally augmented storytelling for developing social skills for children who have Autistic Spectrum Disorder (ASD). Research has focused on the use of virtual peers which can support children with ASD to listen to, write and tell stories about social situations they may find themselves in (Tartaro, 2006). MOSOCO is an augmented reality mobile phone application that was developed by Escobedo et al. to study how digital storytelling and augmented reality based technologies could support children with ASD to improve their social interactions with other children and adults. They found that whilst the system was able

to increase the quality and quantity of social interactions that autistic children made with their mainstream classmates, the system was based on a specific story-based curriculum which meant that its use was limited to supporting a specific approach and set of activities. They suggested any future work they pursued should attempt to work with resources and approaches that are likely to be found in a majority of classrooms.

Garzotto et al. studied the impact of their paper-based multimedia storytelling tool, which allowed teachers to quickly and simply associate media with paper-based resources. They worked in a mainstream school over several months to develop the system with typically developing children in the classroom. The system was designed to be used with the two children with profound and multiple difficulties. Through a series of evaluation sessions with the two children, Garzotto et al. claim that their system offered a range of benefits for the two participants. This included linguistic and narrative capabilities, an increase of self-esteem and engagement with learning tasks but as they themselves note the system was only used for a short amount of time with only two children. They emphasise the design of the system to work with a 'real' school context but don't discuss the factors that affect the deployment of such a system in a 'real school' context such as how it fits within existing teaching practices and/or the difficulty of deploying the system during a classroom activity with multiple students with differing abilities.

3.5 Self-advocacy

An important aspect of children with special educational needs lives that can be supported by ICTs is self-advocacy. This is both through the design of suitable technologies for children and those that work with them and through the design and research processes that are used to develop them. (Department for Education, 2001; Department for EducationDepartment of Health, 2015; Druin & Fast, 2002; Keay-Bright & Gethin-Lewis, 2011; Lewis & Porter, 2011; Liu et al., 2007; P. Williams et al., 2006).

In this section I discuss the meaning of the term self-advocacy through appropriate literature before turning to the complex matrix of skills, knowledge and opportunities that are required in order for children with SEN to self-advocate. The section finishes by discussing the issues that arise from self-advocacy as a methodological position for research concerning children with SEN.

3.5.1 Self-advocacy and children with SEN

The idea of self-advocacy is rooted in a political struggle for the normalisation of and self-determination for, disabled people. The term self-advocacy as it relates to disabled people has many different definitions in academic literature. Early uses of the term, such as Williams & Schoultz's account of the 'People First' disability rights movement, focus on self-advocacy as a component of a political struggle concerned with the pursuit of rights for all disabled people (P. Williams & Shoultz, 1984). Others emphasise self-advocacy as a skill or act performed by the individual (Hartman, 1993; p. 40 in Lynch & Gussel, 2011). Hayden and Shoultz offer a definition that focuses on self-advocacy as a skill that enables individuals to make *choices* about their own and other's lives.

> Self-advocacy is teaching people with a disability how to advocate for themselves and to learn how to speak out for what they believe in. It teaches us how to make decisions and choices that affect our lives so that we can become more independent. It also teaches us about our rights, but along with learning our rights, we learn our responsibilities. (Hayden & Shoultz, 1991)

What is consistent in these definitions is the importance of self-advocacy as a means for people with special educational needs to make informed choices that affect their own lives and the lives of others.

In his 2003 review of literature and 2014 report on children with special educational needs and levels of abuse for the National Society for the Prevention of Cruelty to Children (NSPCC), David Miller reported that children with SEN face greater difficulties in communicating their views, emotions, and experiences than their mainstream counterparts. This, he says, leaves them with limited agency in decisions that affect their lives. He attributes this to both an individual's impairments and wider disabling social factors (D. Miller, 2003) (D. Miller & Brown, 2014).

This is reflected in Test et al.'s argument that lack of self-advocacy for children with special educational needs derives not from an individual's impairments but through overprotection and the social perceptions of disabled children as being incapable of making decisions for themselves. Institutional arrangements for children with SEN, if they are to protect and enable students to develop socially and educationally, will impose constraints. These constraints may also lead to children with special educational needs relying on others to articulate their ideas and needs (Test, Fowler, Wood, Brewer, & Eddy, 2005, p. 43).

There is a complex matrix of reciprocal skills, knowledge and opportunities that are necessary for children with special educational needs to 'self-advocate'. What constitutes self-advocacy for one child with special educational needs differs greatly from another depending on their capacities, the context in which they are acting and whom they are addressing. Through an analysis of relevant literature from 1972 to 2005, Test et al. offer a conceptual framework of self-advocacy for students with special educational needs to support children and their support workers to learn and evaluate self-advocacy (Test et al., 2005). They set out four key components derived from their literature review that make up self-advocacy; *knowledge of self, knowledge of rights, communication,* and *leadership*. They propose that the foundations of self-advocacy are based on *knowledge of rights* and *knowledge of self,* arguing that once an individual knows themselves and their capabilities and the rights they are due, only then can they develop the skills and knowledge to *communicate* those skills to others. They see the final component, *leadership,* as enabling a move from individual self-advocacy to advocating for themselves and others as part of a group. They note that this leadership aspect is not essential in order for students to become effective self-advocates but is nevertheless an important part of self-advocacy as a wider concept. They provide a diagram to illustrate the large number of components and subcomponents that make up their conceptual framework, clearly demonstrating the wide range of skills, knowledge and opportunities that are involved in self-advocacy for children with special educational needs.

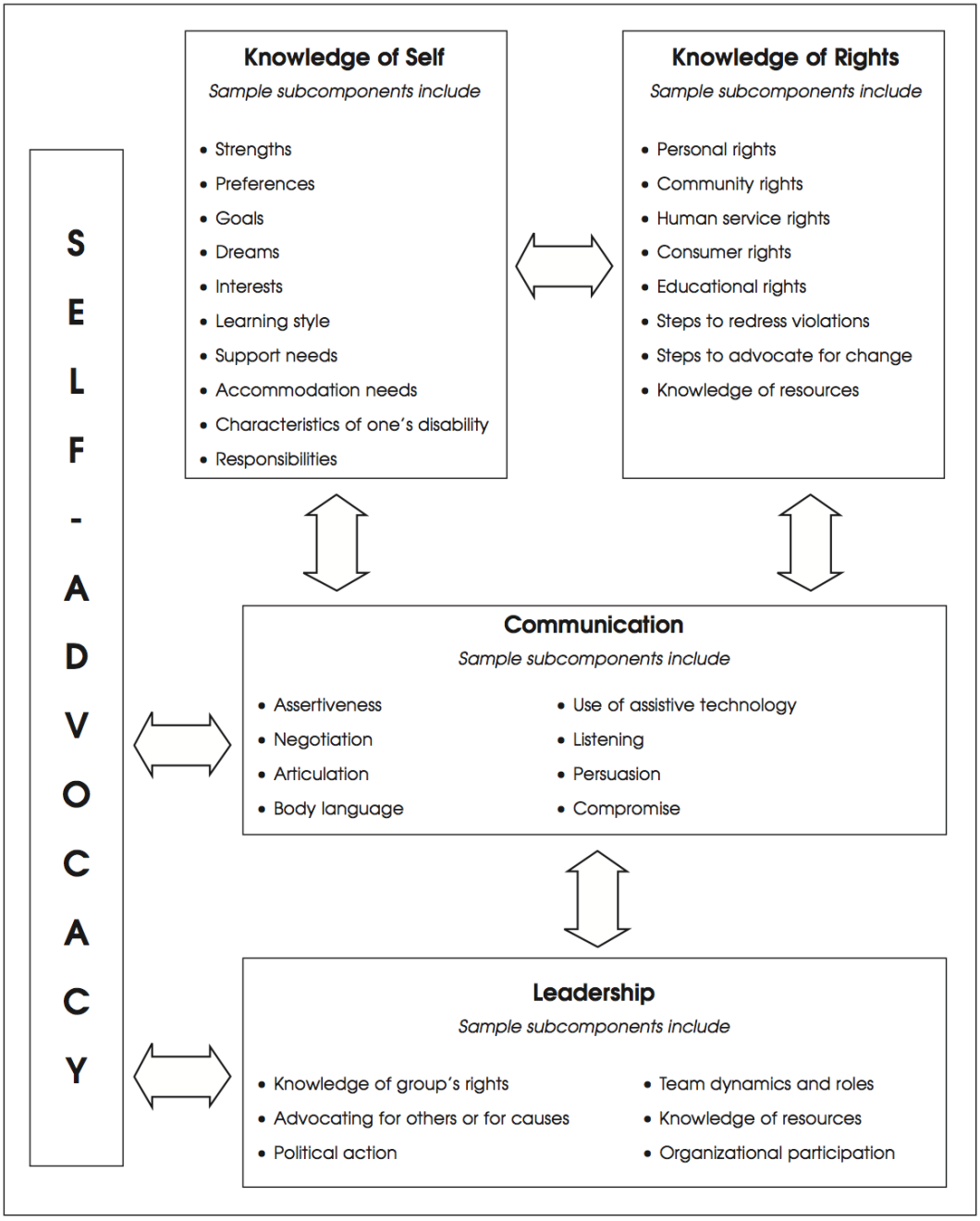

Figure 2 - A conceptual framework of self-advocacy (Test 2005 p. 49)

It has been argued that the development of self-image is intrinsically tied with early communication skills and in particular narrative formation (Reese et al., 2009; Van Puyenbroeck & Maes, 2008). Therefore it could be argued that the notion of *knowledge of self* and *knowledge of rights* are not precursors to, but are in a reciprocal relationship with communication.

What is clear from the conceptual framework that Test et al. provide is that there is a complex set of skills and knowledge and opportunities that constitute the ability to self-

advocate. There can be no single approach or tool that will ensure that all children with special educational needs can self-advocate. What researchers and designers can do is to support children with special educational needs and those that educate, support and play with them to address aspects of the multiple skills, knowledge and opportunities necessary for children to self-advocate.

3.5.2 Self-advocacy for children with SEN in research

There is a call in policy-oriented literature for the involvement of children with SEN in research processes that concern their lives and learning (Brownlie, Anderson, & Ormston, 2006; Disability Rights Commission., 2006; Illingworth, 2008). Researcher Anne Lewis's work considers the moral and ethical implications of self-advocacy for children with SEN within research (Lewis, 2009; Lewis & Norwich, 2004; Lewis & Porter, 2011).

Lewis describes two different positions to an emancipatory approach to research with children with special needs. A '*strong'* position that is held by some within disabilities studies that says participants are essential to the research process either as co-researchers or as the researcher themselves. For a wider discussion see (Goodley & Moore, 2000; Oliver & Barnes, 2002). One of the key principles of the disability studies informed by the politics of disability activism is often stated as 'nothing about us without us' (Charlton, 1998, p. 3- 20)**.** This strong stance is also found within policies that concern children's health (Bewley & McCulloch, 2006), education, and social care (Brownlie et al., 2006).

Lewis describes the 'weak' position as being one that involves children within the research project but not as equal research partners. Both the weak and strong positions provide a means for children with SEN to have their opinions and value position become part of discourses on policy and research that is essential to their lives. In their report on three case studies of working with advisory groups of disabled children in research, Lewis et al. say that while the case studies that are presented fall within the *weaker* position, their explicit goal is to move towards the *strong* position of co-research. There are values that are implied here in the use of the terms 'strong' and 'weak' to designate these two positions. With these terms, she sets up a hierarchy of participation but goes on to explore the political and pragmatic issues that affect the type of involvement for children with special educational needs in the research process.

Lewis asks: if we take a stance that children with impairments should be included in research and policy that affects them, how do we bring them into the research process with a realistic appreciation of their capacities and skills. Children with special educational needs may have impairments in speech, understanding of questions and concepts, and use trusted third parties to communicate. These elements make gaining informed consent from participants difficult. When research concerns the provision of care to participants, this can be further complicated when the subject under discussion may be the third parties that participants have to rely on to communicate such as communication devices, teaching assistants and parents (Lewis & Porter, 2011).

In her introduction to a series of essays on the development of research on children and childhood, *Conceptualizing child-adult relations*, Leena Alanen contends that the researcher must consider how they make observations and elicit responses, and whether these are reflective of the children's experiences or of the researchers' (Alanen, 2001). She argues that children must be provided with a context in which the effects of the inherent power relationship between adult and child and other social and institutional processes are mitigated, so that they can provide responses that are in line with their own views.

> The researcher can put to the child in all honesty the proposition that they are uniquely positioned to give evidence on their own lives. (Alanen, 2001)

Pia Christensen argues that children exist within social and institutional contexts that are as complex as those inhabited by adults. They are sensitive to the power relationships and problems of disclosure that exist between adult and child. Their past experiences may have lead them to follow the directions which are given by those with authority over them, especially when these are to their benefit or to protect them from harm. Not only are children aware of the possible 'exploitation' of information but confidentiality has a particular resonance among children whose relationships and friendships are often performed through the telling and keeping of secrets (Christensen, 2004).

Scaife and Rogers question the notion that children and designers can be treated as equal partners in design processes. They point out the difficulties in overturning embedded child/ adult power relationships and that interpreting children's dialogue and actions poses a different set of difficulties than when working with adults. Scaife et al. position their involvement with children as situated between user-centred and

participatory design. Whilst they acknowledge the importance of involving children in different stages of research they are sceptical of generalising the relationship that is possible between child and designer/researcher and in particular the claim in studies for children working as co-designers by 'entering into their [children's] worlds' which they argue is an incredibly complex task due to adult/child power relationships and the differences and limitations of children's experience, knowledge and time. (Scaife & Rogers, 1998)

The accounts of self-advocacy that have been presented demonstrate the complex set of moral, methodological, political and practical issues that must be considered when conducting research that is concerned with self-advocacy. It also shows that we must be cautious about the claims we make for our research approach and outcomes concerning self-advocacy and children with SEN.

3.6 Participatory methods in design research

The literature review now examines methodological approaches in design research that are concerned with the inclusion of research subjects in design and research processes.

3.6.1 Participatory design (PD)

I begin by considering the history and critical focus of participatory design (PD) from its historical roots in the Scandinavian trade union movements, then briefly set out other research methodologies that are concerned with user participation in the design and research process. I then conclude by looking at arguments that call for a continual and critical questioning of the value of and approaches for participation.

Participatory design (PD) as a research methodology can be traced back to the 1960s in the work of Kristian Nygaard with the Norwegian Iron and Metal Workers Union {Bjerknes:1995un}. It was not until the research carried out in the *UTOPIA* project in 1981 that the focus on the design of technologies became a central theme for PD research {Bjerknes:1995un}.

PD as a research methodology places emphasis on a critical engagement with the impact of the design of new technologies on the working conditions of people. A foundational concept is that of self-determination for workers where employees are able to directly influence the working conditions they inhabit. (Bansler, 1989; Bjerknes & Ehn, 1987)

The critical focus of Scandinavian PD is the design and development of interactive systems in the work place. PD is used within HCI research as a means to promote the design of computer artefacts that support workers in developing and enhancing their skills rather than replacing them (Ehn, 1988; 1993). Scandinavian PD is embedded in a political discourse that identifies and engages with groups who have little say on the conditions in which they work. Through an emancipatory design process workers are co-opted into a research process that seeks to understand the impact of new technological tools and systems that directly affect the participants' working conditions and lives.

PD was developed to go beyond the consultation of users in the system-design process to a position where they are equal and active partners (Bødker, Ehn, Sj o gren, & Sundblad, 2000). Techniques for prototyping and evaluating have been developed to give workers co-determination in the development of technologies (Schuler & Namioka, 1993). Techniques of mutual learning were developed to help train participants in research techniques; in other words, people need to be trained to become active and informed participants (Floyd, Mehl, Reisin, Schmidt, & Wolf, 1989).

From these foundational principles PD developed into a series of techniques and research 'tools' for engaging people directly in design processes. These techniques include cooperative prototyping; where participants are involved in both the initial design and evaluation of interactive systems and the contextual enquiry; where an understanding of the context in which technologies will be situated inform any subsequent design. For a more detailed overview of methods for PD see (Schuler & Namioka, 1993; Sears & Jacko, 2009, pp. 165-180).

Bodker et al. argue that the motivation of PD is not simply to build useful systems for participants but also to support those participants in the realisation that they have a choice in that development process (Bødker et al., 2000). They argue that these emancipatory aspects of PD are often superseded in research that borrows from the PD tradition by focusing on PD as a means for more effective design (Bødker et al., 2000, p. 7). PD may potentially lead to more effective design and may or may not then benefit workers but it is the emancipatory nature of the research that Bodker et al. say should be the focus.

Peter Asaro offers a useful discussion on the relationship between designer, technology and user in his socio-political historical reading of PD. He describes PD as being a

convergence of two approaches; an approach to develop more efficient and successful system designs as a logical development of technological rationalism and a politically motivated approach to address the imbalance between workers and management as caused by the introduction of technologies in the workplace (Asaro, 2000, p. 277). He goes on to say that the role of PD is to facilitate a feedback loop between those who determine the direction and aims of technologies, the users of those technologies, and the materials that make up the technology.

> (1) users engage directly in a dialectic with the material and practical implications of a technological design, (2) enabling them to reformulate their desires and objectives within the dialectic between designers and users of the technology, (3) which in turn motivates designers in their dialectic engagement with the technology. (Asaro, 2000, p. 288)

Participatory design is not the only design methodology that focuses on users within the design process. The development of User Centered Design (UCD) in the USA in the 1980's (Abras, Maloney-Krichmar, & Preece, 2004) emphasises the importance of design for users in opposition to a more system led approach that requires a user to adapt to the technologies being developed. This approach is different to PD in that it focuses on design *for* users as opposed to *with* users (Sanders, 2002). Other emancipatory methodologies include Inclusive Design (ID) and Universal Design (UD). Universal design is primarily concerned with developing designs that are useful and usable by all users (Burgstahler, 2011). Inclusive design is a design framework developed in the UK to ensure that designs are suitable for people of all abilities. For example by creating designs that support people with mobility issues such as wheelchair users that at the same time support users without mobility issues to move more safely and quickly (Keates, Clarkson, Harrison, & Robinson, 2000).

Richard Heeks considers the role of participatory design in the development of information systems from the perspective of international development. His insights are useful here as they call for a shift in focus in research using participatory design from the techniques of participation to:

> … a deeper or continuous questioning of the value of participation per se (Heeks, 1999, p. 2)

Heeks puts forward three questions that he says need to be asked when participatory methods are to be used or when assessing the use of participatory design in research.

- What is the political and cultural context?
- Who wants to introduce participation, and why?
- Who is participation sought from? Do they want to, and can they, participate?

He introduces the notion of a 'veneer of participation' (Heeks, 1999, p. 4). Where participation becomes orthodoxy, he argues, researchers may feel they must demonstrate at least a veneer of participation even if the contexts mean that the participatory methods used are inappropriate. A veneer of participation can be used as a means to cover up a more top-down 'authoritarian approach'. It may also be used to hide methods and techniques that may not be participatory but are more appropriate for the research and design aims. He develops this argument by saying that where the value of participation is in it being seen to be used, the research processes becomes preoccupied with the indicators that participation has occurred.

Indeed, he goes onto say that where participation is imposed from the outside the delicate and long-term relationships of participants that already exist can be ignored and potential damaged. This introduction of participation by an outsider, if done without sensitivity to the context can lead to resentment of the researcher and their methods and vice versa.

There are particular skills required of participants in order to engage in participatory design depending on the research aims, the participants and the context in which the research occurs. These include the ability to express themselves publicly, to evaluate their own and others decisions, and to absorb information. There can be an assumption that individuals and groups possess the necessary skills or capacities or that they can be learned during the research process where sometimes this isn't the case (Heeks, 1999).

Lucy Suchman in her discussion of the visibility of work practices argues that by creating an objective representation of a user the political and social realities for the user tend to be neglected. The objective representation of a range of users based on consultation with a representative group will only ever be a partial representation and one that will tend to serve the intentions of the designer rather than that of the individual users. (Suchman, 1995, p. 59)

She goes on to say that regardless of how accurate a representation of participants is the ways in which those representations are used by designers can limit their autonomy at work. For example computer systems no matter how flexible offer limited

options for how tasks are ordered and conducted meaning they may restrict how a user chooses to conduct other related tasks and interact with other people. In short she argues that the application of knowledge acquired from users will have practical consequences that will not always be in line with a designer's intentions (Suchman, 1995, p. 60).

3.6.2 PD methods in HCI research for children

I now explore research within the field of Interaction Design and Children (IDC) that incorporate children within research and design processes. This section starts by considering the methodological approaches of prominent researchers in the field before examining arguments that call for great disclosure by researchers of their underlying values and assumptions in using PD methods within their work with children.

Alison Druin has written extensively on the incorporation of children within HCI research and design processes. Her work has been widely cited by other researchers in this field and presents different strategies and frameworks for considering and incorporating children in the design of new technologies (Druin, 1999; 2002; 2010; Druin et al., 2001).

In her much cited paper *The Role of Children in the Design of New Technology* (Druin, 2002)**,** Druin offers a detailed description of the history and development of children's involvement in HCI research. She develops a conceptual framework of four different historical roles that children have taken in the design of new technologies: User, Tester, Informant and Design Partner. These roles are based on an exploration of three different aspects in the design process: goals of the inquiry, relationship to the adult participants and the types of design artefacts that children are presented with (Druin, 2002).

For each of these design roles Druin considers how they present different strengths and challenges for the researcher, the child and the research aims. She is clear that gauging the appropriate level of involvement of children in the design process is dependent on many different factors including what research questions are being asked, what resources are available and what are the ages and abilities of the children and the philosophical position of the research team. She also notes that no matter what the children's level of involvement teachers and support staff in the classroom will also play a role in the research process. This might include changing class times and plans

to accommodate researchers through to collecting and contributing to data directly. She does not suggest that one approach is necessarily superior to any other. Druin's account is based on a reinterpretation of PD as a means to engage children as partners in research and design processes. This is evident in the use of commonly used PD methods such as mock-ups and communal prototyping combined with techniques such as technological immersion and contextual enquiry (Druin, 2002, pp. 23-27) as a means to develop technologies that:

> …support children in ways that make sense for them as young learners, explorers, and avid technology users. (Druin & Fast, 2002, p. 1)

And in the emancipatory tone she uses when discussing the advantages of having children as *design partners:*

> Children have so few experiences in their lives where they can contribute their opinions and see that they are taken seriously by adults…Children can grow to see themselves as something more than users of technology. They can come to believe that they can make a difference. (Druin, 2002, p. 27)

Druin's accounts of the participation of children in HCI research are cited as a basis for developing novel methods for cooperative design led inquiry in research on interaction design for children. This includes the use of comic books as a design method for eliciting design ideas (Escobedo et al., 2011; Moraveji, Li, Ding, O'Kelley, & Woolf, 2007); employing lo-fi prototyping techniques with children, (using paper and craft materials) to include young people in the design of table top interfaces (Rick et al., 2010); the design of tangible interfaces in a classroom (Stanton et al., 2001) and the use of narrative construction to gain insights into the attitudes and opinions of teenagers (Toth et al., 2012).

A uniting principle in the use of participatory methods in these studies is to develop technologies that are suitable, engaging and useful for the differing abilities of children but without Druin's emphasis on the emancipatory nature of working with children as design partners.

Another important researcher in the field of interaction design for children is Janet Read, Professor in Child Computer Interaction and Director of Child Computer Interaction (ChiCI) at the University of Central Lancashire. Read identifies three modes of participation for children in design research; 'facilitated design', with children

expected to initiate the ideas and take a lead on making design decisions and creation with adults facilitating, 'balanced design', which is where an equal balance of participation is found between adults and child participants, and 'informant design', where children are given the opportunity to inform the designer but the adult designers make the final decision and build the technology away from the child participants.(Read et al., 2002).

Read et al. describe two distinct approaches to participatory design studies that involve children, the first being to make better technology and the second to empower child participants. They argue that whilst the two approaches are not mutually exclusive, the approach that a research team takes determines how children's contributions are generated and used within the research and design process (Read et al., 2014).

Bossen et al. (Bossen, Dindler, & Iversen, 2010) (Bossen, Dindler, & Iversen, 2012) contend that both of these approaches lead to what they call 'user-gains', that is the benefits for participants arise from the emancipatory nature of the research process; mutual learning and opportunities to influence their worlds, and the longer term benefits of the resulting technology produced through the research process. Bossen et al. are wary of claims made in the literature for these user gains as they argue that it is very hard to empirically measure these benefits. They call for detailed and clear descriptions of the research process alongside longitudinal research that can demonstrate the user gains for participants.

Guha et al. (Guha, Druin, Fails, & Foss, 2013a) 2raise the issue of a 'power pendulum' in participatory design with children whereby the adults become so engaged with the notion of children having a voice in the design and research process that the researcher and adult participants' voices are not included.

Iverson et al. argue that whilst this reasoning for using participatory design methods present in much IDC literature is compatible with the aims and principles of participatory design, the methods used and resulting impact of the studies do not reflect the democratic and emancipatory aims of PD.

> Whereas needs, interests and abilities are something that can be unearthed by designers during a PD process, democracy, quality and emancipation can only be obtained through a highly dialogical process between designers and children. Here, children necessarily have to have a legitimate voice in the design process. (Iversen & Smith, 2012)

They go on to say that whilst there are many studies in IDC that use participatory design methods, research on how the use of these techniques affects the design process and outcomes of that processes are lacking (Iversen & Smith, 2012, p. 107).

Yarosh et al. echo this argument in their meta-analyses of nine years' worth of papers for the IDC conference. They found that whilst there are a large number of papers that explicitly use participatory methods in their research on the design of technology for children (Yarosh, Radu, Hunter, & Rosenbaum, 2011), these usually do not explicitly share the values that underlie their methods and research leading to what they term 'cargo cult science'; whereby the techniques of participatory design are superficially employed but without an understanding of the underlying reasons and assumptions that drive it (Yarosh et al., 2011). By values Yarosh et al. include:

> …values that motivate the author's contribution, attributes fostered in the child, the populations they design for, the theories that guide research, and the criteria for the design of technologies. (Yarosh et al., 2011, p. 9)

Yarosh et al. argue that the sharing of these values should be explicit in the research process. By making the values that drive a participatory approach clear, the reader, researcher and participants can evaluate the research methods and outcomes against those values. This argument reflects Heeks' call in the previous section for a careful and continuous questioning of the values of participation (Heeks, 1999).

3.6.3 PD methods in HCI for children with SEN

The UK government's 2014 SEN Code of Practice (Department for EducationDepartment of Health, 2015) highlights the requirement for those working with SEN populations to support and advise children to enable them to not only offer their opinions in discussions and decisions about their support but to have some influence on those decisions. An important part of supporting children with SEN, as we have seen, is the use of technology. Whilst the involvement of children in technology design research is well developed, the involvement of children with SEN in design research has only recently started to become more established.

Within the relevant literature it is difficult to find as clear an overview of the historical development of children with special educational needs as participants in design and interaction research as can be found for typically developing children in HCI research. Whilst there is literature detailing design studies in HCI that involve children with special educational needs as participants there is as yet only a few conceptual and

practical frameworks that have been put forward for working with children with special educational needs as participants in design research (Benton, Vasalou, Khaled, Johnson, & Gooch, 2014b; Frauenberger, Good, Keay-Bright, & Pain, 2012b; Guha et al., 2008; Keay-Bright, 2007).

In the following section I discuss research projects that explicitly use participatory design research methodologies to include children with SEN in the design process. I consider the stated aims and research methods of several projects in order to bring out some important methodological issues when applying participatory design methods with children with SEN.

In their review of the literature, Benton and Johnson (Benton & Johnson, 2015) present studies that use participatory design methods with children with special needs. The majority of studies they present are concerned with children with specific impairments. Of the forty-nine papers they reviewed, more than half were focused on children with autism and another seven on children with cerebral palsy. Out of all the articles, less than five discussed studies that worked with groups of children with more than one type of diagnosed impairment. Benton et al. also found that a majority of the studies, with a few outlying cases, focused on a small cohort of students (typically ten) with the number of design sessions on average being five or less (Benton, Vasalou, Khaled, Johnson, & Gooch, 2014b).

A number of studies have developed novel participatory methods for including children with SEN in HCI research. Zarin et al. worked with children with Down's syndrome in a series of prototyping and user-testing workshops to develop narrative based, multi-touch table-top applications (Zarin & Fallman, 2011). Through the use of participatory design methods, Malinverni et al. have developed a motion-based game to support students with autism to learn social initiation skills (Malinverni et al., 2014). In their longitudinal design study to create interactive environments to help students with autism learn social interactions, Parsons and Cobb question the extent that participatory design methods can lead to robust technologies due to the challenges presented by their participants (Parsons & Cobb, 2014). Karna et al. have developed the 'Children in the Centre' framework to support the design of bespoke creative play technologies for individual children by engaging students, parents, and carers outside of an educational context in longitudinal design based workshops (Karna, Nuutinen, Pihlainen-Bednarik, & Vellonen, 2010). McElligott developed an audio game space for and with blind and partially sighted children through a series of low-fi mock-ups and

group ‘inquiry sessions’ where children explored both the functionality and ergonomics of the design (McElligott & van Leeuwen, 2004). Piper et al. describe a collaborative design process using observation, prototype testing, and interviews with adolescents with Autistic Spectrum Disorder to develop a computer game to help develop social skills (Piper, O'Brien, Morris, & Winograd, 2006). Foss et al. discuss how they modified cooperative design methods to work with a group of middle school students with a range of mild learning and behavioural impairments to develop a range of prototype technologies for the participants to use (Guha, Walsh, & Foss, 2013b).

As part of their PD4CAT project, de Faria Borges et al. (de Faria Borges, Filgueiras, Maciel, & Pereira, 2014), worked with a non-verbal four year old girl with cerebral palsy to develop a communication device to improve her language skills. They discuss the serious challenges they faced in attempting to work with the girl in a participatory manner. They highlight the issue of children’s active participation in the design process by claiming that the child was ‘…as active as any other team member because she provided the peculiar knowledge she possessed about herself and her capacities and limitations’ (de Faria Borges et al., 2014, p. 21). They contend that even though the participant did not directly contribute her opinions vocally, she participated through the team’s observations of her actions, preferences and use of design interventions that they introduced.

Garzotto et al. developed a set of paper based interactive communication technologies for children with severe communication impairments in a classroom of both mainstream and special needs children. They describe a series of co-design workshops where the mainstream children in the study stood in as ‘proxy’ designers for the special needs children in the class. The co-design activities involved the development of multimedia content and learning activities. The study involved forty typically developing children and two children in the class who had Profound and Multiple Learning Difficulties (PMLD). The children with PMLD were included in a short evaluation stage only after co-design activities had been conducted with mainstream children. The paper does not give a clear reason for not including the children with special needs in this co-design process or discuss the implications of using their mainstream students as proxy designers/users. They claim however that this approach fosters a closer group dynamic, an increase in ‘tolerance’ between the mainstream students and children with PMLD and results in:

> … a means to achieve *true* inclusive education. (Garzotto & Bordogna, 2010, p. 79)

This is a big claim to make and as we have seen in previous sections supporting inclusion and students' voice takes more than the introduction of a technical intervention into a classroom.

The literature presented represents a sample of the range of studies that have used participatory methods in HCI research with children. Within these studies there are large variations in the participatory methods used, the frequency and intensity of their use within a project, and the focus that is given on the impact these approaches had on the participants and design outcomes of the studies. The participatory methods ranged from observation of participants using prototypes, interviews with teachers, typically developing children and carers as proxies for children with SEN's opinions, to prototyping, narrative exploration, and storyboarding techniques. All of the studies reviewed acknowledge the importance of including participants in the design and research process. They follow Scandinavian PD notions that participatory methods offer an 'inclusive' means of design – offering children a voice in the design process, and as means to develop suitable designs. Few of the papers reviewed unpacked the values behind and the practicalities of using PD methods with children with SEN or the impact that those methods had on the design outcomes and the participants themselves as called for by Iverson et al. and Yarosh et al. (Iversen & Smith, 2012; Yarosh et al., 2011).

In their paper *Designing technology for children with special needs: bridging perspectives through participatory design,* Frauenburger et al. (Frauenberger, Good, & Keay-Bright, 2011) review literature concerning the participation of children with special educational needs in HCI research. They point out that in the majority of design studies they reviewed, the focus is on participants giving feedback on the evaluation of designs and prototypes rather than their involvement in other stages of the design process (Frauenberger et al., 2011, p. 4). They argue that this gives limited agency for participants to influence the development of the design, limited participation in the research as a whole and thus assertions that their research methods support self-advocacy for children are unsubstantiated.

Guha et al. in their 2008 CHI paper *Designing with and for children with special needs: An inclusionary model* draw on Druin's 'levels of child involvement' and their experiences of working within the KidsTeam research centre headed by Alison Druin at the University of Maryland, USA (Druin, 2002; Guha et al., 2008). In their paper Guha et al.'s model sets out guidelines for including children with special needs in the design

and research process.

Guha et al.'s proposed inclusionary model starts from Druin's 'co-designer' role for a child in the design process and adapts it for children with special educational needs by identifying their impairment then considering what support is needed and pragmatically available in order to include that child as a co-designer. Guha el al. state in the paper that although they have worked with many different children as design partners in the past ten years using the cooperative design model, there have been only a very small number of children that have had special educational needs. It is these children that are used as a case study for the design of their inclusionary model (Guha et al., 2008, p. 63). Their approach is to use the existing participatory design methods they employ for typically developing children and compensate for a child's impairments through additional support or by excluding them from unsuitable activities.

Larson et al., in their paper on the PD design methods with children with PMLD are critical of Guha et al.'s approach seeing it as starting from children's impairments rather than their capacities (Larsen & Hedvall, 2012). They argue that PD approaches for children with special educational needs should start from the strengths and capabilities of children rather than focusing and compensating for their deficiencies. The children they work with in their project cannot directly communicate their ideas about the designs nor in many cases comprehend the idea that they are part of a design process.

Larsen et al. acknowledge that in order to claim for a design approach that is participatory, issues around how these children can participate must be addressed. They introduce the notion of 'voice by proxy', where someone speaks on behalf of another, and argue that whilst a proxy voice does not directly engage with a participant's perspective it is possible to take an approach as a designer that combines design interventions, observation, and discussion with support staff in order to achieve some level of agency for participants who do not have a direct means of communication.

Larsen et al. give an account of their 'practice-based' approach where they introduce simple, interactive artefacts to children and staff and use observations of the children's interaction with the artefacts to redesign and explore potential avenues for subsequent design. This is how they describe the role of the artefacts in the design process:

> The artefacts can be seen as basic questions as well as materialized hunches and understandings relating to the design program. They are continuously being reshaped and reinserted and in a sense giving form to designerly dialogues. (Larsen & Hedvall, 2012, p. 39)

Larsen et al. argue for an approach that means researchers work closely with support staff, acknowledging the importance of their pedagogical and intimate knowledge of individual participants. The video recording and observational notes are used with teachers as a focus for discussion and design deliberations. It is in the feedback obtained from close observation and interpretation of children's actions and subsequent discussion with support staff as proxy users of those observations that brings the child into the design process. Whilst they do not claim that children are co-designers in this process they see their approach as starting to address the power issues that surround voice by proxy. More over their approach starts from a child's actions rather than preconceptions of what their impairments make them capable of, thus moving away from what they call 'thinking in deficits'.

Gustavo Armagno argues that the majority of work done on designing technology for people with special educational needs is based on the outmoded 'medical model' of disability and calls for HCI researchers to: i) interrogate the discourses on disability underlying their research and ii) to consider alternative models of disability such as the social model (Armagno, 2012).

Benton et al. (Benton, Vasalou, Khaled, Johnson, & Gooch, 2014b) have developed a framework for conducting participatory design with children with nerodiverse conditions such as ADHD, ASD and anxiety related conditions. Instead of finding ways to overcome the challenges presented by children with nerodiverse conditions the framework begins by considering the strengths of those children and ways to mitigate any disabling factors to working with them that result from environmental and social factors. Some of the strengths of working with children with nerodiverse conditions that they set out include; *divergent thinking, spontaneity, prodigious memories, high precision in tasks* whilst balancing these against disabling factors such as *over stimulating environments* and lack of *suitably readable social cues.* The D4D (Design for Diversity) framework that they offer sets out three main factors for collaboration and carrying out design activities with nerodiverse children. These are 'structuring environment', 'understanding culture' and 'tailoring to individuals'. These factors reflect their position that it is factors disabling the students that are of concern, rather

than the abilities of the students themselves. What's important about this framework is less the practical means of working with these students, though this is useful, it is more the repositioning of the underlying assumptions about disability on which the framework is based.

In their project, *Working with Children with Severe Motor Impairments as Design Partners*, Hornof et al. outline a project where they emphasise the amount of time spent working with students as a means to generate important high level factors around the individual's use of eye tracking software for drawing (Hornof, 2009).

In *The Reactive Colours Project: Demonstrating Participatory and Collaborative Design Methods for the Creation of Software for Autistic Children*, Wendy Keay-Bright considers the participatory process she used to create a set of interfaces for creative, embodied play for children with Autistic, Spectrum Disorder (ASD). She proposes an approach that uses Druin's notion of 'key informants' (Druin, 1999) as the bases of the study's participatory design methods. This she describes as meaning that whilst the final responsibility for decision-making was with the researcher and adult participants, children's views and contributions were taken as significant and important to the design and process and outcomes (Keay-Bright, 2007, p. 8). She goes on to say that the participatory techniques such as low-tech development, brainstorming and iterative prototyping would have been beyond the capacities of the participants she worked with. She did however use these techniques with the adult participants – teachers, teaching assistants and other support staff. She emphasises a participatory process that works from an understanding of the capacities of students to participate, the role of staff as contributors and the context in which the process and outcomes will reside.

ECHOES is a longitudinal, cross-institution research project involving a cross-disciplinary team of researchers in the visual arts, computer science, HCI and special needs education that has been running since 2008. Whilst there are a range of studies in the use of PD in HCI with children with special educational needs, *ECHOES* is one of only a few large scale and longitudinal projects that attempts to unpack the practical, ethical, and conceptual issues when using PD with children with special educational needs.

The project has produced a body of literature detailing the project aims, participatory methods they have employed with young people and recommendations/ guidelines for other researchers working in this area of HCI (Escobedo et al., 2011; Guldberg & Keay-Bright, 2010; Keay-Bright & Gethin-Lewis, 2011; Keay-Bright & Porayska-Pomsta, 2010).

The *ECHOES* project uses participatory design methods when working with children with Autistic Spectrum Disorder (ASD) and typically developing children to develop a 'technologically-enhanced learning environment' (Frauenberger, Good, & Keay-Bright, 2010, p. 2), an interactive computer system using touch-screen and face tracking technologies that enables a student to interact one-to-one with a virtual character within different environments.

The stated aims of the project are to:

> Scaffold children's exploration and learning of social interaction skills. (Frauenberger et al., 2011)

In *Designing technology for children with special needs: bridging perspectives through participatory design*, Frauenburger et al. (Frauenberger et al., 2011) describe the different research methods that they have employed to bring children with ASD as well as teachers and educational specialists into the design and research of the *ECHOES* system.

They state clearly the position that the children in the research project take:

> As design partners, they are recognised as equal stakeholders in the design process and involved throughout the process. The latter role takes participation to the full extent and shifts the final responsibility for design decisions from the adult researchers to a collaborative decision-making process in negotiation with the child design partners. (Frauenberger et al., 2011, p. 3)

This makes clear the role that children are to take in the research – that of equal and full participants, and is a strong statement on the nature of the participation of children in the research. They offer a set of key considerations when conducting HCI research with children with SEN in a participatory capacity. These include a focus on the ethical questions of the involvement in research of children with SEN, with particular attention to considering whether the goals and aims of the research are in line with the benefits and educational outcomes for the participants. They outline the need to develop honest

and open relationships with children, teachers and carers, with particular care to be taken in managing expectations of the research process for both participants and researchers.

What is not explored is the potentially large disparity between the skills and understanding of the student and researcher. As discussed earlier in this chapter, in order for participants to become equitable members of a design process in PD, participants must have or be trained in the necessary skills in order for them to participate in the research process in an equitable way. There is little discussion within the paper on the capacities of children to take on responsibilities for final design decisions or the training that they have been given by the researchers in order to do this. It is possible to consider the use of methods that seek to identify the choices and opinions of participating children and to treat these with respect without necessarily seeking the ideal of an equal partnership as described in this research.

Another aspect of the design process that Frauenburger et al. discuss in some detail is how the participatory work with children is interpreted into design considerations. The researchers in the studies pool together what they feel are relevant observations in relation to the aims of their studies, then use what they call 'mindful interpretation' to develop design ideas for the development of the *ECHOES* system. In *Interpreting Phenomenology, a Framework for Participatory Design* (Frauenberger et al., 2010), Frauenburger and Keay-Bright describe this mindful interpretation technique as:

> Separating the deeper phenomenological experiences children have described from the seemingly arbitrary details of their [children's] input. (Frauenberger et al., 2010, p. 2)

Looking more closely one can see a gap between the methods they employed, which might be said to include their tacit knowledge and observational skills as researcher as well as the participatory task, and the elegant theory of 'mindful interpretation' that they employ. The theory allows them to consider particular actions of a child within a task and detail exactly how that is used as a design consideration in the development of the *ECHOES* system. This however seems to lead to over interpretation of what comes across as a subjective reading of children's actions into design.

An example they give of 'mindful interpretation' is their interpretation of a child's drawing that resulted from a PD workshop with a special educational needs school. In their 'projecting contexts' task a child is asked to draw objects that might be in a

magical garden. They are then asked to choose a word on a list to represent what the object would start doing. Finally they are asked to draw what the objects are like after the action they have chosen has occurred. The drawing shows a slide, a tree house and a swimming pool on one side of the paper, and then a boomerang, a mouse and a person on the other. The child has drawn a line between the objects connected by the word spin, which is one of a selection of action words written on the paper. From this drawing the researcher drew out design ideas through their 'mindful interpretation' technique - the formation of design considerations by looking 'beyond the literal meaning of objects' (Frauenberger et al., 2010, p. 4). In this example they assume that the transition from one object to another in the drawing signifies particular 'magical' qualities that the child would like enacted in the design:

> We have derived a third design idea from the drawing: objects of similar shapes can have almost diametrically opposing functions. The slide is heavy, firmly grounded on the floor, but when spun and turned into a boomerang, a similar shape becomes light and flies through the garden. (Frauenberger et al., 2010, p. 4)

This interpretation of children's drawings into design concepts is then able to:

> … create a design that is firmly rooted in the children's experiences, practices and creativity. (Frauenberger et al., 2010, p. 4)

It is unclear how their interpretive method grounds their subsequent designs in a child's experience and practice. In focusing on demonstrating a connection between a child's action in an activity and a particular design consideration they paradoxically fail to consider how a child's interaction with their environment, the researchers, their peers and support staff might inform their design in a less prescriptive manner.

If we look to the *ECHOES* studies to consider a real classroom situation in either special or mainstream schools, they offer only limited guidance on how to approach research in classrooms where there is a diverse range of capacities, as occurs in both mainstream or special needs classrooms within the UK.

3.6.4 Participatory design in this thesis

As discussed in the previous section, participatory design as a research methodology covers a wide range of methods and approaches. The research methodologies for working with and for children with special educational needs and staff that support them used in this thesis borrow from and are informed by those of participatory design

but do not strictly follow any one participatory design approach. In this thesis I align my methodological position closer to that of the Scandinavian inception of participatory design. That is, I am concerned with giving children the tools and opportunities for making decisions which in turn may result in more effective design (Read et al., 2014) (Larsen & Hedvall, 2012).

The aims of my studies focused on the use of digital media to support students to learn and discuss their ideas with people of significance to them. I consider this to align with the Scandinavian, emancipatory PD approach but also borrow from the methods of inquiry put forward by Druin (Druin, 1999) and others for developing more effective digital tools for children. My embedded approach allowed me to work with children and staff closely and incorporate their ideas and opinions within my data collection and analysis. I did not always involve students and staff directly in the design of my studies, data collection and analysis and so cannot claim that the research I undertook strictly followed a PD methodology.

There are a number of critical assumptions discussed in the previous section about PD that have directly informed my research approach in this thesis. Richard Heeks calls for the researcher to continually question the value of participation in research and to be cautious of a 'veneer of participation' (Heeks, 1999). Lucy Suchman builds on this work and shows us that creating an objective representation of a user group through PD methods can lead to the political and social realities for a user being neglected in research. (Suchman, 1995) This insight and Heeks' note of caution in the use of PD methods led me to focus not only on the interactions of children with technology in a SEN classroom but also the staff and the institutional context of the school in which their social interactions occur. This need to take into account social and political realities when designing for classroom contexts is reflected in the work of Buckingham, Selwyn and Cuban(Cuban, 1986; Selwyn, 2011) whose work is discussed in detail in 3.3.3 - Educational technologies – a positive project and 3.3.4 - *Teachers and the introduction of technology in schools,* and heavily influenced my approach to the research in this thesis.

In their meta review of PD methods in research for children with special educational needs, Benton & Johnson show that the majority of studies they looked at focused on small numbers of children and 1-3 design sessions. This and the embedded, longitudinal participatory design approach used to work with teenagers and digital media by Larsen and Hedval (Larsen & Hedvall, 2012)influenced my decision to

develop a long term, embedded relationship with my participants and the institution they work within.

The Social Model of disability discussed in 3.2.3 *The social model of disability*, was a major influence on my work in this thesis. In particular, Armagno and Benton's separate calls for research involving children with special educational needs to start from children's strengths before considering how to mitigate environmental and social factors that prevent them from participating in research was a particular influence on my approach and is in direct opposition to Guha's model where the focus is on compensating for children's lack of ability (Armagno, 2012; Benton, Johnson, Brosnan, Ashwin, & Grawemeyer, 2011; Guha et al., 2008). This led me to spend time getting to know children in the context of their classroom rather than starting from their medical diagnosis and using technology to 'fix' their disabilities.

In summary the research approaches taken in this thesis are heavily influenced by a Scandinavian approach to participation in research. I do not claim that the methodology used in the studies in this thesis is participatory design, rather that my methodology is participatory. It shares many of the critical concerns and methods of inquiry discussed as a means to empower children, staff and to create more effective design.

3.6.5 Ethnography

Ethnography is a methodological approach that arose from the work of cultural comparative anthropologists in the early part of the 20th-century as a means to develop an understanding of the social actions, systems and cultural structures that exist within culture sharing groups of people. (Creswell, 2013). As with the other participatory forms of research discussed in this literature review, ethnographic research is concerned with the shared social actions (behaviour, language, and beliefs) of culture-sharing groups of people (M. Harris, 1968)as they occur and emerge over time.

As a method of inquiry, ethnography requires the researcher to spend an extended period of time working with a group of people, immersing themselves in the day to day lives and interactions of that group. The researcher becomes a participant observer and it is their role to document, describe and interpret the actions under study in order to map out and draw meaning from the shared behaviours, languages and actions of the group.(Hammersley & Atkinson, 2010)

There is no single orthodox approach for ethnography and as such there are many different forms of ethnography including feminist ethnography, narrative ethnography, and visual ethnography. Methodologies such as experienced-centred design, action research, participatory design and cultural probes also draw upon ideas from ethnography as approaches to conducting research in social science (Blomberg, Giacomi, Mosher, & Swenton-Wall, 1993).

Whilst there is no single approach to ethnographic research, there are a number of common elements that are generally associated with ethnography: a predisposition towards understanding social actions from a participant's perspective, rich descriptions of people and place and a 'wide angle' perspective of the context in which the group under study interacts (Blomberg et al., 1993). Ethnographic research will often collect and record 'everything and anything' that is observed in the field. Observational notes and A/V recordings can be used to try to record all social actions possible to ensure that events the researcher may only realise are of significance after they have taken place, are included within the research data. (Millen, 2000) This approach requires the researcher or multiple researchers to be immersed for long periods of time and potentially for many years. It also requires the collection and analysis of vast quantities of empirical evidence.

3.6.6 Ethnography in this thesis

The methodological approach taken in the studies does not follow an ethnographical approach but does borrow from and make use of some of the methods of inquiry associated with ethnographical research. The pragmatic constraints of conducting my research in contexts where my access to staff and students had to be constantly negotiated and in line with time restrictions set by my university's ethics committee meant that although I spent a lot of time working with participants I was unable to spend the extended periods of time (every day for an entire school year for example) that would be required to become immersed as a participant observer in the ethnographical conception of research. For the majority of the studies I worked alone to design my studies, develop my designs, collect empirical data and to analyze and write up my subsequent insights. This required me to focus my data collection around the topics of my studies and thus prevented the 'wide angle research lens' required in an ethnographical study.

3.6.7 Experience-centred design

Peter Wright and John McCarthy have developed a body of work in the past decade that foregrounds the importance of what they describe as an experience-centred approach to design in HCI (Wright & McCarthy, 2008; 2010). Experience-centred design is less a prescriptive set of methods to be employed in HCI research than a way of considering the relationship between researcher and user in the design process in HCI. Experience-centred design can be considered a configuration of participatory design though it is distinct from the Scandinavian approach discussed at the start of the chapter. Wright and McCarthy use the term 'designer' to include different members of a design team in research that encompasses those who focus on user experience as well as the technologists and makers (Wright & McCarthy, 2008, p. 637). They argue that HCI is increasingly incorporating research that considers ways to engage with and enrich the lived experience of people through and with technologies. By considering and designing for those experiences, there is the potential to include the voices of those that may normally be excluded from design and research processes. They ask: 'if we agree that there is a role for HCI in supporting the experiences of users, how then do we understand and incorporate the lived-experiences of a user in the design processes?' (Wright & McCarthy, 2008, p. 637)

Wright and McCarthy position themselves within a pragmatic approach, that user-experience is the interaction of multiple aspects of lived-experience that intersect and evolve continuously. They state that they take:

> …a holistic-relational view of user experience that treats as inseparable, people's intellectual, sensual, and emotional responses, and that conceptualizes self, artefacts, and settings as multiple centres of value interacting with each other. (Wright & McCarthy, 2008, p. 638)

It is only through meaningful emotional encounters between researcher and participant, they argue, that an understanding of the user's lived-experience can be understood and employed in the design process. They describe this meaningful encounter as resulting from the development of an empathic relationship between participant and designer. They do not prescribe specific methods to develop these meaningful encounters. The methods that are used are dependent on the context and the aims of the design and research being carried out. They do, however, put forward three qualities that are needed in developing this empathic relationship:

- The development of a relationship between the participant and designer that enables both parties to be attuned to one another's needs.
- A focus on the emotional qualities and effects of both the participant and researcher's experiences.
- A compassionate approach to the users. (Wright & McCarthy, 2010)

In their most recent book on experience-centred design, McCarthy and Wright explore different methods and case studies that take what they see as an empathic and user-centred approach to HCI research (Wright & McCarthy, 2010). This offers a useful overview of the broad range of methods that can be employed including cooperative inquiry, cultural probes, narrative based methods and other novel participatory methods (Wright & McCarthy, 2010).

Battarbee et al. contribute to an interactionist approach to user experience within HCI by considering 'co-experience' as a means of informing HCI research and design. Co-experience ties in closely with McCarthy and Wright's notion of an empathic relationship with users in design. They see co-experience as the emergent experience of people when they use objects and how these relate and become part of wider social interactions. Included in these experiences is the emphatic relationship that emerges between the user, the designer and the object.

> Co-experience focuses on how people make distinctions and meanings, carry on conversations, share stories and do things together. By understanding these interactions, opportunities for co-experience can be designed into the interactions of products and services. (Battarbee & Koskinen, 2005, p. 15)

Lindsay et al. discuss the importance of an empathic approach to HCI research as a means to bridge the gap between participants' day-to-day experiences and those of the designer/researcher. In their own experiences of working and designing with users that have dementia Lindsay et al. stress the importance of developing a quality relationship between researcher and user that considers participants' views not just to develop considerations for design but as a legitimate perspective on their own and other lives. What is interesting in Lindsay et al.'s account is the absence of intermediaries, in this case carers, who work with their subject group day to day. Whilst there are concerns about treating carers as proxies for the voice of others in research (Lewis & Porter, 2011), it should be noted that in some cases these carers will have worked closely with participants for extended periods, and will offer a useful

perspective on their ideas and experiences and indeed are part of the social dynamics of the group they are seeking to understand (Lindsay, Jackson, Schofield, & Olivier, 2012).

3.6.8 Experienced-centred design in this thesis

Experience-centred design (ECD) influenced the approach to research taken in all four of the studies presented in this thesis and was used as the main methodological approach in the second study, *Chapter 5 – My photos, your photos*. As discussed in the previous section, experience-centred design places an emphasis on developing an empathic dialogue between research participants, designers and researchers as a means to understand and improve the lived experience of people using technology.

The research conducted in this thesis was informed from the start by a continuous, empathetic dialogue with the students and staff at each school, the research partner. The empirical data collection, analysis and subsequent design processes were all grounded in the practicalities of working within the social and political realities of a special educational needs school. This continuous dialogue led to the development of significant relationships between myself and the students and staff. This in turn allowed me to become attuned to the needs of the participants and enabled me to adjust my research to work within the institutional constraints of the school as an institution. It also allowed me to develop what Wright and McCarthy describe as "a compassionate approach to users" (Wright & McCarthy, 2010).

Developing a compassionate and dialogic approach is important in all research that involves people, place and technology. It is particularly important when working with vulnerable participants with complex needs and when negotiating the organizational constraints of a special educational needs school. This is imperative to ensure that you do not negatively impact children's lives and to challenge assumptions that are made about the abilities and needs of your participants. Using a methodological approach that is informed by experience-centred design has led me to develop a nuanced understanding of the social actions between participants, context and technologies.

3.7 Grounded theory

Grounded theory (GT) and the qualitative design approaches detailed in the previous part of this section are the main methodological approach used in the mixed-methods approach taken in the empirical studies in this thesis. They are used following the

reasoning set out in the *Position* chapter. That is they allow for an inductive, non-determinist approach to researching interaction design with SEN schools. The use of these methodological approaches is reflected on in the individual studies and within the discussion chapter at the end of this thesis.

In the following section I briefly discuss and reflect on the history, conceptual underpinnings and methods of grounded theory.

The following overview discusses some of the main methods and approaches of grounded theory as a methodological approach. Grounded theory directs us to consider our data through inductive and iterative processes of collection and analysis (Glaser & Strauss, 1967). It focuses on the importance of 'grounding' analysis and emergent theories in empirical evidence. It is not a set of prescriptive procedures but rather a set of principles and practices to be employed in making sense of social phenomena (Charmaz, 2006). The history, development and processes of grounded theory are covered in a number of texts (Bryman, 1994; Charmaz, 2006; Glaser, 1992; Locke, 2001; Strauss & Corbin, 1998).

The researcher in grounded theory

The role of the researcher is and has always been central to the collection and analysis of data in grounded theory. Barney Glaser and Anselm Strauss first developed the principles of grounded theory in their seminal work *The Discovery of Grounded Theory: Strategies for qualitative research* published in 1967 (Glaser & Strauss, 1967). In this original conception of grounded theory, Glaser and Strauss call for the researcher to be a 'tabula rasa', approaching the study of a phenomenon without any preconceived ideas or concepts. They contend that there should be no preliminary literature review as this may bias the researcher, desensitising them to possible new concepts and ideas. In later revisions of his theory undertaken with Juliet Corbin, Strauss calls for a more flexible approach to literature reviews when devising research problems and to support emergent theories (Strauss & Corbin, 1998, pp. 48-50).

In her 2006 book *Conducting Grounded Theory,* Kathy Charmaz offers a succinct history and overview of the development of grounded theory. In this book she develops an alternative conception of grounded theory from Strauss, Glaser and Corbins's positivist approach. Charmaz argues that Glaser, Strauss and Corbin's approaches are founded in a positivist approach that assumes there is an underlying reality that will emerge from the data produced in a study, that is external to the subjective perspectives of the

research and its participants. She describes her methodological position as being that of a constructivist. She assumes that we as researchers construct grounded theory from our past experiences and our involvement with people, settings and the contexts that are being studied. Charmaz proposes that grounded theory research is:

> …an interpretive portrayal of the studied world, not an exact picture of it. (Charmaz, 2006, p. 10)

Charmaz maintains that as the central instrument of the research, researchers must respect and attempt to understand participants' views. She shows that we do this by developing a rapport with our participants and the setting in which they reside. Listening, understanding, experiencing and respecting their perspectives of the worlds they inhabit allow us to develop this rapport. This does not mean we attempt to simply adopt these views as our own. As researchers we compare and interpret their views, developing some understanding of not only what participants say but also what they think and do (Charmaz, 2006, pp. 8-12).

Grounded theory is an inductive research process that begins with open questions and concepts that direct the research to particular areas of interest. It is not used as a method to prove or disprove an initial hypothesis but rather to create theories and conceptual frameworks through *inductive* analysis of the data. Hypotheses are generated and tested through an inductive process between data and data analysis. Following the principles of grounded theory allows the researcher to ground an analysis in the data they collect, allowing new and unexpected ideas, concepts and theory to emerge, be tested and pursued.

Charmaz maintains that the quality and importantly the credibility of research are dependent on the data that is collected. It must be sufficiently rich to assure readers and reviewers that any findings and recommendations are credible. The evidence that is collected needs to be relevant, and substantial enough to describe in depth the phenomena within the remit of the research aims. It must also be sufficient enough to build grounded 'core categories' and theory (Charmaz, 2006). What then constitutes rich and sufficient data?

In his first single-authored work on grounded theory, *Basics of Grounded Theory analysis: emergence vs. forcing,* Glaser, suggest that qualitative data must reflect a sustained engagement by the researcher with the participant's world (Glaser, 1992).

Charmaz suggests a series of questions to ask yourself about your data as a researcher employing grounded theory methods. These questions enable the researcher to assess whether their data provides enough background information on their participants, the setting and their processes to portray a wide enough range of contexts.

> Does the data demonstrate the changes that occur in the phenomena over time? Can analytical categories be developed from the data that is collected? Are there sufficient multiple views of the participants actions? (Charmaz, 2006, p. 20)

The ability for grounded theory to 'ground' analysis in data is an outcome of several processes. Alan Bryman in his reference book on qualitative methods outlines the main aspects of building a grounded theory:

> Concept(s): - refers to labels given to discrete phenomena; concepts are referred to as the 'building blocks of theory', concepts are produced through open coding.
>
> Category, (categories) - a concept that has been elaborated so that it is regarded as representing real-world phenomena.... a category may subsume two or more concepts. As such, categories are at a higher level of abstraction than concepts. A category may become a core-category around which other categories pivot.
>
> Hypothesis - Initial hunches about relationships between concepts. Properties - attributes or aspects of a category.
>
> Theory - according to (Strauss & Corbin, 1998, p. 22) 'a set of well-developed categories... that are systematically related through statements of relationship to form a theoretical frame work that explains some relevant social... or other phenomenon.'
>
> (Bryman, 2012, p. 554)

Coding

Coding is one of the main processes in grounded theory. Unlike coding in most quantitative methodologies, grounded theory coding does not rely on predetermined codes. Instead it uses codes generated by the researcher that emerge as they review their data. The researcher reads through transcripts, field notes and/or other gathered texts pertinent to their study. Short codes are assigned to lines or sections of text that seem to be of significance to what is being studied. Coding allows the researcher to

select, separate and sort data. This process enables them to then begin constructing analytical codes and concepts that will potentially lead to the development of theory.

> Coding is the pivotal link between collecting the data and developing an emergent theory to explain these data. Through coding, you define what is happening in the data and begin to grapple with what it means. (Charmaz, 2006)

The codes that are produced should be flexible; they are to be treated as indicators of concepts rather than fixed conceptual categories. These codes are constantly compared to each other in order to generate concepts and see which concepts that may have already been described they best fit. There are two distinct types of coding in grounded theory; initial coding and focused coding.

Initial coding is a way for the researcher to be receptive and open in their interpretation of data. The purpose of this first stage of coding is as Strauss and Corbin put it, to:

> uncover, name and develop concepts by opening up the text and exposing the thoughts, ideas and meanings contained therein (Strauss & Corbin, 1998, p. 102)

Initial coding is done line-by-line, sentence-by-sentence or section-by-section as soon as possible after the data has been obtained. Initial coding is designed to spark ideas and explore further avenues for data collection and analysis. It relies on making short, quick codes that define the snippet of text that is being analysed.

The next stage of coding is the focused coding stage. The researcher examines the codes that have emerged from the initial coding of several data sources and decides which are most salient. The researcher compares codes and looks for recurring themes that allow initial codes to become refined into more focused, conceptual and selective codes.

Initial coding breaks down data into smaller, contained sections that the researcher can begin to interpret. Focused coding begins to reconstruct the data, firstly into concepts and then eventually categories. These categories are the 'building blocks' that form theories of how these social worlds work. By identifying salient codes Charmaz says that the researcher can start to make decisions about which codes categorise the data 'inclusively and completely'. (Charmaz, 2006, p. 58)

Theoretical sampling & theoretical saturation

Focused codes may suggest that the researcher return to their data sources to ask new questions in light of these codes. They provide a way of identifying not only what is

present in the data but also where there are gaps in our information. This process is known as theoretical sampling and works in a very different way than sampling in quantitative methods. The researcher does not declare the sample group at the start of the study but alters it in response to the study findings:

> ...the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges. The process of data collection is controlled by the emerging theory, whether substantive or formal. (Glaser & Strauss, 1967, p. 45)

Theoretical sampling is not the same as the sampling process that occurs before the study starts. A study that uses a grounded theory approach will start with initial sampling. This is where the researcher identifies sample groups that are suitable to address the initial research questions and or area. As Charmaz explains, initial sampling is where you set out the criteria for participants, settings and situations before the study begins. Theoretical sampling is used to expand and hone the categories that emerge from the data. Theoretical sampling forms part of an iterative process of data collection, coding and categorisation. The iterative process continues until a category is saturated with data (Charmaz, 2006, p. 100).

Theoretical saturation is another key concept in grounded theory. Charmaz describes theoretical saturation as being when:

> ... gathering fresh data no longer sparks new theoretical insights, nor reveals new properties of your core theoretical categories. (Charmaz, 2006, p. 112)

Muller and Kogan see this process of theoretical sampling and coding as the point where concrete data moves through to abstract concept. The point of saturation they contest is when new data produces no more changes in the abstract concepts and categories. This stability of a category is a sign that it connects with other categories and fits within the core theory that is being produced. (Muller & Kogan, 2010)

We have discussed the different tools that grounded theory provides for collecting and analysing data to produce concepts, categories, hypotheses and eventually theory. The diagram below shows the processes of grounded theory proposed by Charmaz (fig 3.) She notes that grounded theory must be considered as a craft not a prescribed system. Researchers will concentrate on particular aspects of this diagram but they must

consider the whole and disclose their limitations if they are to produce coherent and reliable knowledge.

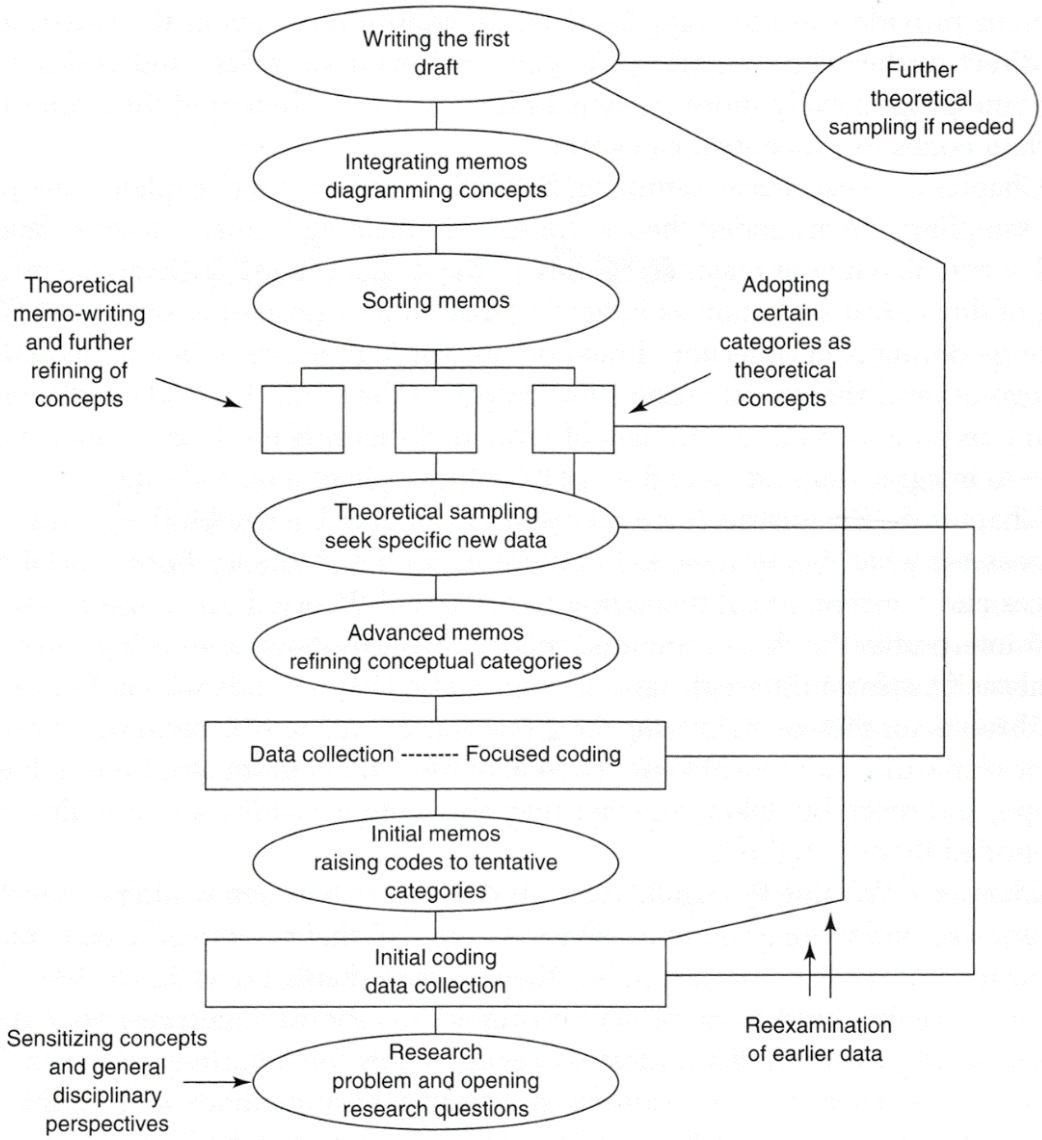

Figure 3 - The grounded theory process | (fig. 2 Charmaz 2006 pg. 10)

3.7.1 Grounded theory in this thesis

As stated in the *2.2 - Methodology* section of this thesis, the four studies presented in later chapters do not follow any one methodology. Instead they use appropriate tools and ways of thinking about phenomena offered by grounded theory (GT), participatory design (PD) and experience centered design (ECD). Working in a special needs setting requires a nuanced approach arising from the complexities and conceptualisation of special needs research, and the need for sensitivity that are discussed earlier.

The thesis is not concerned simply with the technical aspects of design but rather the complex social and cultural interactions that occur over time in designing and implementing digital resources in special educational needs settings. The complexities lie in the contingent processes that occur between role holders, resources, educational and institutional processes and the unforeseen consequences that can result.

Grounded theory enabled me as a researcher to make use of the expertise and multiple perspectives of participants in SEN settings. It equips the researcher with systematic processes to compare, interpret and draw out implicit meanings in participants' views. Making use of insiders' perspectives, as Hegarty states:

> …provides a realistic account of the world as participants experience it and such research can be used to air their understanding of the world (Hegarty, Evans, Economic, & Great Britain, 1985).

This is important in a SEN context. Research that deals with large sample groups and experimental designs in special education risks ignoring the views of those it most affects: the students, the teachers, and the support staff. The methods of inquiry and underlying methodological approaches of grounded theory have supported me in gaining a rich understanding of the perspectives and needs of individuals. This parallels the adaptive approach used in customising curricula for individual learners in special education. I am able to consider individual perspectives but within a wider context of other role holders and educational and institutional processes.

The iterative process of data collection, analysis, and theory building of grounded theory (GT) grounds the research in the world in which I am studying. Whilst grounded theory requires an engagement with the setting and participants, it doesn't necessarily require the prolonged engagement of the researcher in the field as with ethnographical studies. Research in special education must be conducted with sensitivity and flexibility in the methods that are employed. As a researcher in this context I am constrained by the need to minimise any disruption to staff and students. I must fit within existing norms of behaviour in the setting and be prepared to change my methods and assumptions when the educational setting demands it. Grounded theory provides this flexibility and indeed directs me to employ an open approach to data collection and analysis.

Grounded theory provides a way to construct a 'thick description' of specific settings in which technology is used and designed to support children with special educational

needs. As (Hegarty et al., 1985) notes, grounded theory enables us to report on the distinctive character of social and educational phenomena. It will provide descriptive and theoretical insights that result from a grounding in data that is collected in the field. By following and disseminating a systematic approach to data collection, analytical process and subsequent theory building, I will be able to demonstrate a transferability of the knowledge about the particular setting to the reader.

3.8 Summary

I have in this chapter discussed a range of discourses in literature that situate the empirical research conducted in this thesis. In the next chapter I present my initial study at a special needs school in the UK that establishes the focus and context for the three design-led studies that follow it. The study examines how a special needs school's interaction designer works with teaching and specialist management staff to develop interactive technologies that meet the varying needs of students and staff within mixed ability classroom settings.

4 Study 1: The Scented School

4.1 Introduction

4.1.1 Overview

This chapter details an inductive, qualitative study at a UK special educational needs school. The study explores how staff, including a resident interaction designer and teaching staff in a UK special educational needs school attempt to meet the differing needs of students within a mixed ability setting through the design of interactive and communication technologies.

It considers how the school's interaction designer works with the access manager and teaching staff to develop interfaces and software for using digital media in teaching. It then highlights the importance for students of providing supportive and accessible environments and tools with which students can develop their communication and creative skills and demonstrate those abilities to others. The study was conducted using a practice-led approach, which means here that the researcher developed and delivered an arts project for the school as a means to integrate with and observe teachers, students and other staff in the school.

The chapter begins by setting out the methodological approaches and methods used in the study. It goes on to give a description of the setting and the main participants in the

study. In the *4.3 Discussion* section it then considers three conceptual categories; *Accessing Education*, *Design Processes* and *Reflections on Approach* that have arisen from a grounded analysis of the qualitative data gathered in the school. The first category – *Accessing Education* results in three design personas based on the insights developed in this study are provided to support members of the interaction design community working in the context of a special educational needs school. These categories are discussed in relation to pertinent literature and insights for the interaction design community are set out.

4.1.2 Aims

The aim of this study is to look at the processes and challenges of designing and using interactive digital tools in a special educational needs school from the perspective of four key staff members. The aims of this study are to:

- Develop and discuss, through a grounded theory analysis, qualitative categories that provide insights into the processes and challenges of developing digital tools in a special needs school from the perspective of four key staff members.
- Reflect on the research and design approach taken in this study.

This study is inductive. It is grounded in empirical data collected by the researcher in the context under study. As such there was no single research question I sought to answer. Instead the following questions guided the data collection and analysis in this study:

- Which staff are involved in the design and use of digital tools in the school?
- What role do they play in designing and using interactive digital tools?
- What challenges do they face?
- What are the collaborative processes that occur?
- What are the challenges people face during those collaborations?

4.2 Approach

4.2.1 Methodology

This study used a mixed methods approach with the grounded, inductive and iterative approaches to data collection and analysis offered by grounded theory as a basis for its methodological approach. This approach resulted in three theoretical categories that

are used as the basis for discussion in this chapter; *design approaches*, *accessing education* and *reflecting on approach.*

While this study uses methods of empirical evidence collection and analysis from grounded theory, it does not result in a full grounded theory of the social actions of individuals in the school. Rather it uses grounded theory approaches and methods in order to pursue an inductive research process which, rather than starting from extant theory, develops a set of conceptual categories that serve to illustrate an understanding of the situation under study.

The observations, interviews and subsequent analysis that form the main empirical data of this study were conducted as a part of a practice-led and multi-modal research approach. Practice-led means here that a creative arts based practice was enlisted as part of a pragmatic form of inquiry that informed both the insights of the study as well as the modes of inquiry themselves.

4.2.2 Methods

The Scented School project

This initial study conducted at Delmore School used a creative arts project as a means both to situate the research and researcher in the social context of the school and to directly support teachers and students directly using my skills as an arts practitioner and technician. Whilst I worked as a part of a team during the arts project, I worked on my own to conduct the research discussed in this study. Specifically, I designed and managed the study, collected the empirical evidence, analysed the data and wrote the following study as a result. By setting up and supporting a term length, digital storytelling project at Delmore School I was able to immerse myself in the everyday interactions of students, facilitators and technology. I initiated the arts project having discussed the idea of developing a joint creative arts and research project with the school's creative co-ordinator Nick. The school wanted to develop a project around scent as part of their multi-sensory approach to learning and access to learning within the school. I approached Lizzie Olstrom, a scent artist and designer to co-design and lead an arts project for the school based on scent. The project consisted of a digital storytelling project lasting one term, with five weeks preparation time including the initial consultations and preparation of the teaching materials. The following is part of the project description developed by the school's creative co-ordinator Nick, the scent artist Lizzie Olstrom and myself:

Pupils will investigate how scent can be captured and recreated to help with the recounting or construction of stories. Pupils will be engaged in the use of scent to represent emotion and mood in their stories along with literal representations. Pupils will be encouraged to develop their own interpretation of which scents should be used to bring their stories to life. Following in the footsteps of famous scent artist Sissel Tolas, students will explore the notion of a geography of scent within their locality and around Bath. PhD student and interactive performance artist Keir Williams will explore work with students to bring their stories to life in the sensory theatre, whilst London-based scent artist Lizzie Olstrom will lead pupils through a magical journey of scent exploration. Delmore's own interactive content designer David will lead the technical elements of scent distribution in what is considered to be genuine cutting edge research.

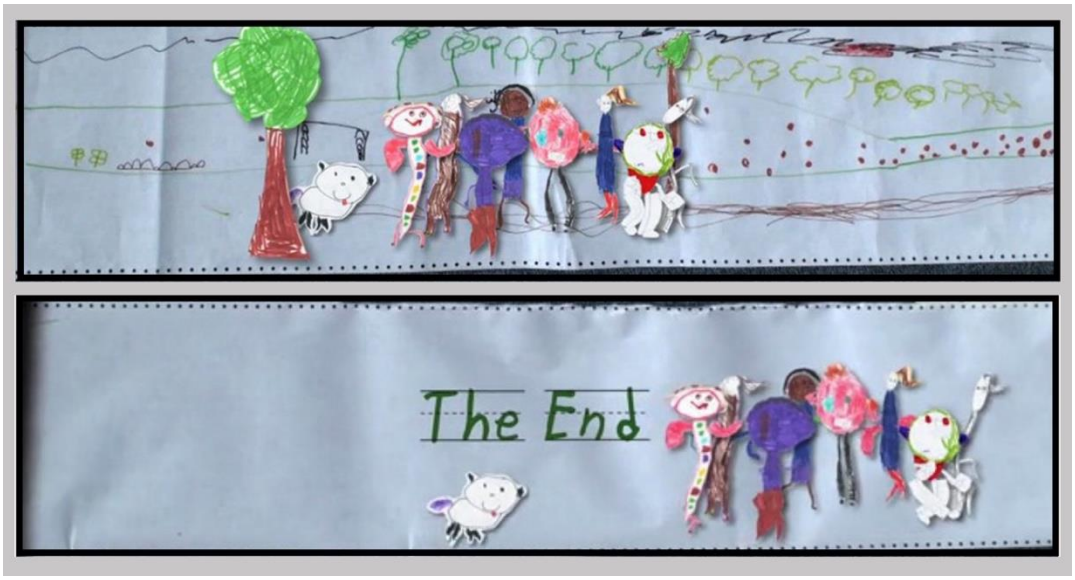

Figure 4 - Screenshots from the final performance of The Scented School. (The video was projected onto a half dome, wrap around screen.)

Figure 5 - Photos of students on a field trip as part of the project.

I focused on the initial setup, development, and co-ordination of the arts project; contacting and liaising between the lead artist, the school's creative co-ordinator and other supporting staff. My role within the create arts project was as a performance and interaction design specialist. The main delivery and programming of the project was left to the lead artist, Lizzie Oestrum in order to leave room for my role as researcher and observer. I supported Lizzie during the creative workshops at the school and worked as a teaching assistant with two form groups outside of those workshops. I also worked with the interaction designer on the animation and live digital performance of the students' stories. The schools interaction designer developed an ingenious interactive digital scent delivery device to trigger different scents during the performance. The bubble scent machine used a hacked commercial bubble machine and different bubble mixtures scented with essential oils and allowed the different bubble machines to be triggered using a simple software patch and an iPad.

Figure 6 - The bubble scent machines in the school's digital sensory studio.

As a researcher in this context, there is an ethical responsibility to clearly and directly support the school, as they support and enable the research by giving access to the institution and participants. Whilst this is an important ethical position it also provides an opportunity for the researcher to develop trust and rapport with the staff, students and institution, leading to greater access and more candid and natural observations. By facilitating a situation that was in line with my research interests I was open to

learning from the setting and interactions of those within the school whilst ensuring that those interactions lay within their research interests. Developing and supporting this arts project also enabled me to directly support the students and staff at the school by using my professional skills as an artist and technician.

Data Collection

I kept observational notes and memos throughout the study in a private research diary. I also conducted informal and semi-formal interviews with students and staff. I spent three days each week for the duration of the project working in the school. One full day was split working with two different classes on the arts project. On the other two days I divided my time between the two form groups that participated in the arts project working as a teaching assistant and observer during the classes' timetabled activities.

I was careful to ensure that my note taking in front of staff and students was kept to a minimum in order to ensure that staff and students did not perceive me to be testing or evaluating their work and capabilities. I would move out to neutral spaces within the school in order to make quick shorthand notes during breaks and by taking extended 'toilet breaks' in order to get my notes written as close to the event as possible. At the end of each day I would sit and talk with the class teacher and support staff. On the train journey back I would write my thoughts and evaluations up in my research diary and include points that needed to be further explored on the next visit. I used a series of iterative, coding based techniques that are discussed in detail in the *Explaining the Coding Process* subsection later in this chapter.

These methods of data collection were deliberately chosen over other forms of data collection, such as video and audio recording, in order to minimize disruption during the sessions. The embedded approach I took in this study was designed to develop trust with my research participants and to illicit candid and natural observations of their social actions. Placing cameras and audio recording equipment into the classroom sessions would have been problematic for both students and staff. My concern was to reduce staff and students' perception that I was recording and evaluating their work and to be sensitive to the important professional issues around disclosure of staff and student conversations and actions. There were several points in this study where teachers were reluctant or refused permission for me to record our conversations. The other issue that shaped my choice of data collection was pragmatic. I worked three full days a week with students and staff in multiple locations around the school and local area. Recording these sessions would have meant carrying multiple cameras between

each session, a large amount of time setting up and maintaining the cameras and would have resulted in hundreds of hours of video to be edited and analyzed and this was beyond the time and resources I had. It would also have increased the disruption to each class and reduced the time I spent with children and staff during the sessions.

4.2.3 Participants

Delmore School, UK.

Delmore School supports a broad range of children and young adults with special sensory and educational needs. It currently has around 150 students, with ages ranging from three to eighteen. It is located on a purpose-built site and is an amalgamation of three different SEN schools from the local area. The school was rated as 'outstanding' or 'good' for all of the inspection categories in its 2010 Ofsted report. It has a range of specialist staff including teachers, teaching assistants, a music therapist, physiotherapists, speech and language therapists, and a range of specialised carers and creative practitioners.

The school has exceptional digital resources throughout, with projectors, sound systems and interactive white boards in every classroom. They also have a range of audio and video equipment for children to use in classroom and field trip activities. The school is unique in the UK in having a digital sensory theatre, which includes state of the art 3D audio, 180-degree video projection, and interactive, sensor based lighting systems.

Delmore School offers an interesting site for reflecting on the interactional dynamics between technology, facilitators and students. Like many other SEN schools, Delmore has used external consultants in developing content and interactive systems. Unlike a majority of schools, and possibly uniquely for a UK SEN school, the school has a dedicated digital sensory room and a full-time interaction designer to create software, hardware and digital content for use by teachers and students in the school.

This position of interaction designer and programmer was created in 2010 and is still held in 2015 by David.

Classroom participants

The children and young-people in this study participated in the creative arts project and were observed interacting with staff and other students as well as with me. They were encouraged to discuss their ideas during the project with staff, each other and

myself through classroom discussion and more informal talks. They do not make up any of the interviewees in the formal interviews for this study. The interactions between the students and me were however vital in developing an understanding of the context and its participants.

The two classes involved in the storytelling project were made up of around twelve students. The exact number of students present during each class fluctuated over the term. Both classes presented a broad spectrum of abilities and needs, which included visual impairment, autism spectrum disorder, cerebral palsy, communication impairments, and difficulties in fine and gross motor co-ordination. The age of the students ranged from nine up to thirteen. This diversity of needs and abilities provided an exciting but challenging setting for the research.

Teaching and support staff

Each of the classes had one main class teacher and two teaching assistants and around twelve children. Other staff involved in The Scented School arts project included an artist with an expertise in scent, the school's creative co-ordinator, a curriculum access manager, an interaction-designer and a teaching assistant with specialist knowledge of video and sound production.

Interviewee selection

During the setup, delivery and evaluation of the creative scent project I worked, discussed and observed a range of staff and students within the school. This included meetings, informal conversations, emails, time spent helping in the classroom and during visits outside of the school. Some of these were recorded digitally and in my research diary. These interactions informed the research interests that in turn informed the selection process for the following interviewees.

- David, the schools interaction designer,
- Rosa, the curriculum access team manager,
- Lucy, video maker and teaching assistant,
- Nick, the head of the primary department and creative co-ordinator for the school.

I selected these staff members by considering their expertise, their role in the school and the perspective they could offer on approaches for supporting students in the school and the development of interactive systems for staff and students. The selection

process was informed by the time I spent working with them and others as a teaching assistant and artist during the creative arts project.

The school's interaction designer offers a unique opportunity to understand the issues that arise in the design of interactive digital systems for special educational needs classroom from the perspective of a full-time embedded designer. The remaining three participants all worked closely with each other and myself during the creative arts project and with David independently of the project.

Interview structure

The interviews began with open questions designed to investigate certain areas of interest whilst allowing for wider discussion around those areas. The interviewee's areas of concern and interest were included in the interviews and subsequent analysis. The main areas of interest that guided the interviews were:

- The interviewee's role in the school and creative arts project.
- Their experience of the use of digital technology in the school.

After each interview I transcribed and analysed the interview and used this information to consider the next set of questions and areas of interest for that and the other interviewees.[3] In the next section the roles of the interviewees and their relationship within the school are detailed.

Interviewee's roles and responsibilities

In this next section the roles of interviewees within the school are discussed. The short descriptions below are based on official job descriptions, their replies to interview questions, informal talks between myself and other staff and on the observations I made whilst working at the school.

[3] See *Explaining the Coding Process for more information*

David

During his interviews, David describes what his role in the school entails. He summarizes his responsibilities as:

- Sourcing, editing and creating content to be used with the interactive systems he has designed.
- The development of new software and hardware for use with students
- The maintenance and development of the infrastructure in the sensory room
- Technical support for teachers and students using the sensory room
- Working with teachers to develop uses for his technology

David's small office and workshop are in the school's digital sensory room. He is based there five days a week and, using the space, supports classes, groups and individuals ranging in age from two to eighteen. The work he does requires not only technical skills but also sensitivity and social awareness in order to support the wide range of abilities of both students and staff. David is trained in a range of industry standard media production software such as Flash, After Effects and Photoshop. He is a skilled sound engineer with a BA in Music Technology. He is also a skilled programmer and an expert in physical computing for interactive art applications.

This range and combination of skills is not unique in the digital interaction industry but it is a rare set of skills to find for a staff member at such a low pay grade and within a school.

Rosa

Rosa's role as curriculum access co-ordinator is to ensure that each student at the school has accesses to an education that is appropriate to their abilities and needs.

Rosa works with and manages a team of health and educational specialists that includes staff with mobility, communication, mental health and multi-sensory specialisms. Rosa and her team work with teachers and students to manage issues that affect access to learning and social activities in the school for students: mobility, health, communication, and individual learning styles within the context of different lessons and activities. She describes her role as being that of supporting teachers, coordinating different professionals, and modelling and disseminating good practice for those working within the school.

The need to consider and work to ensure that every student has access to learning is not unique to, but is of particular concern, in SEN schools. This is due to the wide range of needs and abilities, which disproportionately affect SEN students' ability to access learning compared to their mainstream peers.

Nick

Nick has several roles in the school. He is the head of the primary department, deputy head of the school, class teacher and creative coordinator for the school. His role as creative coordinator involves developing and managing creative projects that use both staff from within the school but also bring in practitioners and funding from outside agencies. It was through his work with the creative schools fund that Nick and I were able to develop the *Scented School* project.

Throughout the project Nick has provided a central point for discussion, understanding and support to me and for the project itself. Within the study his insights and knowledge have helped to steer the interests and focus to the importance of providing supportive environments and tools with which students can develop their communication and creative skills and demonstrate them to others.

Lucy

Lucy is a teaching assistant at Delmore School. She was, at the time of the interview, a recent graduate, having completed a degree in film and television production two years prior to the interview. She is employed as a senior teaching assistant but takes on a number of tasks that go beyond working to support the teacher during lessons.

She works with students from most of the different age groups and areas of the school. Her responsibilities include working with small groups of students on music therapy under the supervision of the school's music therapist, as a teaching assistant for classes working in the digital sensory room, and in several activities for the extra-curricular creative program at the school of which The Scented School project is one.

4.2.4 Explaining the coding processes

This section concentrates on the analytical processes used in this study that draw on the methods and methodological approach of grounded theory. First the interview process is discussed and then key points in the analytical process are described including coding, creating a visual model and a producing a written account.

At the end of each day of the project and at breaks during the day I talked informally to staff and students and made notes in my research diary. Based on these informal discussions I arranged and led eight semi-structured interviews with four key staff members at the school. These were carried out towards the end of and after the digital storytelling project had been completed at the school (between April and July 2011). After each interview my recorded material was transcribed and anonymised. After transcribing a text I started the coding process by creating a set of *open codes* for each text. That is, I went through the text sentence by sentence, applying short text labels to short sections while constantly comparing those labels with one another to decide where they might join or contrast each other. The important aspect of this open coding is to constantly compare the codes that are generated with each other so that ideas, themes and meaning begin to emerge. This coding and areas of discussion were directly informed by my research diary which itself was informed by the processes of observation, participation and informal meetings in the school.

The purpose of this first stage of coding is as Strauss and Corbin put it:

> …to uncover, name and develop concepts by opening up the text and exposing the thoughts, ideas and meanings contained therein (Strauss & Corbin, 1998, p. 102) .

The initial open coding was carried out as soon as possible after conducting and transcribing each interview. This enabled me to quickly engage with the text and to cross-reference it with other interviews and the observations in my research diary. This in turn helped me to identify codes and proto-themes to inform the coding of other interviewee's responses.

The next part of the coding process was to group these separate codes into more focused codes that reflect common traits. This focused coding is used to cluster codes around ideas and points of connection. It is the researcher that brings their analytical skills and experience to begin to abstract meaning from the coding process. This process left me with a set of around one hundred focused codes generated from the eight different interviews with the four members of staff and cross-referenced with my research diary. These focused codes were used to inform the subsequent interview questions and areas of discussion with the interviewees.

I then constructed visual representations of these codes. This was done in order to bring the coding from the four different interviewees in to one place, enabling me to see how those codes related to each other. At this point I worked with a fellow PhD

researcher who was working on a related research project at the school and asked him to review the emerging codes and to use these to recode a portion of the transcribed interviews selected by the lead researcher. Once he had completed this I compared the two texts and saw that although there were some minor differences in how the codes were applied, overall the two sets of coding seemed in accordance with each other. I discussed my coding and resulting categories with the researcher throughout the project as a means to reflect on my coding process and to draw out meanings between codes that I might have missed without discussion with another expert in the field.

Rather than developing an overall framework at this point I decided to split the codes back into the original interviewees creating four individual code maps. I then began to write *memos* about the conceptual categories that had appeared from the coding process. These were informed by the interviews but also the information gathered in my research diary and time working in the school. The memos consisted of short texts that discuss a category and any relationship that the category had to others in the coding map. The memo writing in turn led to a focusing and movement of codes in the individual code maps. In an iterative fashion these maps were then added back into the larger code map to see how they related to the other four interviewee's codes and categories before being split back again analysed and more memos written.

Through this process, themes and categories were developed in the larger map, which were then used to structure the catagories that inform the discussion section of this chapter (*accessing education, design processes and reflecting on approach)*. During the writing of these accounts the individual coding maps were altered to reflect the developing narrative and in turn these alterations were reflected in the larger code map of all four interviewees. From these final maps three major categories appeared which are discussed in *4.3 - Discussion* section of this chapter. This account of the coding process and the subsequent visual representation of the framework are a simplified representation of a complex, contingent and non-linear cognitive process that I used to analyse both the interviews of participants and the informal observations made during the project. The conceptual leaps that are made when linking ideas and responses cannot be adequately represented in a visual presentation or written account. However, the account, the visual maps and interview transcripts provide a means to understand and evaluate at least part of the analytical process that occurred in this study.

In claiming this process to be grounded in the experiences and opinions of its participants, it must be recognized that I bring my own knowledge, interests, and orientations to the process from the start. Kathy Charmaz, as detailed earlier in this thesis, argues that, as the central instrument of research, the researcher must be aware of and disclose their influence on the process. More than this, it is through the researcher's tacit knowledge and experience that they are able to compare and interpret participants' views leading to the development of an interpretive understanding of a context. (Charmaz, 2006)

Whilst this study makes use of grounded theory methods to develop pertinent theoretical categories it does not lead to a *grounded theory.* This thesis takes a cross-disciplinary approach, being concerned with both the research methods but also the design, building and use of interactive systems. As such the researcher is not setting out to gather enough empirical evidence over enough time to produce a theoretical saturation leading to a cogent and testable theory of interaction between members of staff at the school in part due to limitations in time and resources but also the nature of the context under study. The focus instead is to produce a detailed account that can inform approaches to the design and use of technology in the school in further studies in this thesis and in the wider research community.

4.3 Discussion

This chapter has presented an embedded, inductive study that explored the processes and challenges of designing and using interactive digital tools in a special educational needs school from the perspective of four key staff members. The practice-led approach taken in this study resulted in a rich body of empirical evidence. Through the iterative, grounded analysis of this empirical evidence, three conceptual categories; *Design Processes*, *Accessing Education* and *Reflections on Approach*, have been developed and are discussed here. These categories help us to identify, describe and explain discrete aspects of the interactional dynamics of students, facilitators and students within the school as they relate to the processes of designing and using interactive digital tools in a SEN school environment and reflect on the research approaches used to investigate them.

This case study and the resulting discussion provides those in the interaction design community with valuable insights into the role of staff members in interaction design

research in this SEN school context. Each of the conceptual categories is discussed using relevant examples from the study and academic literature.

An analysis of the insights developed in 4.4 *Category 1: Design* and of my shared experiences of working in the school with my participants is then used to create three detailed design personas for three of the staff members; the special educational needs teacher, the curriculum access coordinator and the special educational needs teaching assistant. These personas are presented as a set of generalised guidelines and recommendations for those in the interaction design community working with staff in SEN school environments.

The second category: *Accessing Education* leads to insights concerning the importance of designing user experiences that support children with special educational needs to become confident and competent learners. This is considered from the perspective of emotional blocks to learning that students who attend special needs schools face and the classroom management practices of teachers and other staff in the school. These insights are used to inform the further studies in this thesis and to call for interaction design research that considers and attends to the 'social realities' (Selwyn, 2011) of SEN schools.

The discussions of these conceptual categories and resulting insights all contribute to meeting the study aim to:

"Develop and discuss, through a grounded theory analysis, qualitative categories that provide insights into the processes and challenges of developing digital tools in a special needs school from the perspective of four key staff members." The third category *Reflections on Approach* provides insights into the specific research approach taken in this study to "Reflect on the research and design approach taken in this study".

Figure 7 – Chapter 4 – The Scented School, final conceptual coding map

4.4 Category 1: Design processes

The collaborative process that occurs between David and teachers at the school is a nuanced and ever evolving process. I spent time working with David and observing his interactions with teachers in the digital sensory room and classrooms in the school over two school terms. Over this period, I conducted several interviews that were informed by, and in turn informed, my observations of his design processes.

In this section I will use those observations and David's interview responses to discuss those processes and focus on the different ways he works with staff within the school and his design practice and consider what they can tell us about developing interactive systems within special educational needs schools. In one interview David described a constructive dialogue with teachers as one that provides both the designer and teacher with insights into each other's practice. Whilst David notes the importance of this dialogue, he is well aware of the difficulties he and teachers have in achieving this in practice.

4.4.1 The interaction designer and the access co-ordinator.

Rosa, the school's curriculum access coordinator, works with teachers to ensure that in the planning and delivery of their teaching activities they consider how to adapt them for the needs of the individuals and groups of students in their class. In a similar way she works with David to help him consider how the resources he designs and his existing designs can support this adaptive teaching strategy.

Rosa works directly with David at the start of the design process to help him consider how his designs can be adapted to the different contexts and users in the school. She also works with David to consider the potential for the resources he has already created. Rosa's work with David is not always about working with him directly. It is about enabling David to be sensitive and knowledgeable about how his body of designs might fit within and extend teachers' practices and be adapted for different contexts, different teachers, students and situations.

It is not enough that David can develop technologies that are suitable for teachers in the school. If teachers are unaware of how these technologies can support their teaching and conversely David is unaware of how the nuances of teaching need to be addressed in his designs, then David's designs will rarely be used by teachers. David's role then is to help bring David and teachers together in order to reach a shared understanding. Developing this understanding ensures that not only are the resources

suitable for the various contexts in the school but that teachers will see the value of those resources as a part of their day to day teaching.

The way in which Rosa works with David is to an extent an idealised version of what is in reality a messy and sometimes frustrating process. What this account does do is to foreground the importance of an interaction designer working in a SEN school developing an understanding of the users and context in which their designs will be used and the important role an intermediary can have in facilitating this process.

4.4.2 Designing with teachers

In this section we consider two of the approaches that I observed the school's interaction designer using to gather feedback and work collaboratively with teachers in the school. The first is an approach that starts from an imagined range of technologies and the second one that starts from simple prototypes that act as starting points for development and discussion.

Visualising uses for technology

> Some really want to use the space [the digital sensory room] but have trouble, you know, visualising what they can do with all of this technology.
>
> – (David interviewed by the researcher in Delmore School, May 24th 2011)

An approach that David uses when working with teachers to develop new digital resources is to offer them a wide, seemingly endless, range of possibilities for the functionality of the technology. The teacher is then expected to consider these possibilities and come back to David with an idea of what they would like. This is done without showing or working with an example but rather by discussing a range of possible functions of the technology with a teacher.

> I can put anything you want on the screen, we can do anything you like with the lights, I can do anything you want with the sound you know. We can have any sort of trigger you want; buttons RFID, WI-FI. You know iPhones what ever. And they go, 'well great!' but don't know what to do with it.
>
> – (David interviewed by the researcher in Delmore School, May 24th 2011)

This approach is technology led. It requires the teachers to start with an understanding of the functionality of a technology and then to devise a way to use those functions in

an activity or lesson without an opportunity to try them out. When observing David working with teachers this appeared to overwhelm teachers with possibilities without them engaging with physical objects. Speaking about how well this method worked with teachers David said that he would receive little or no feedback from them.

Demonstrating uses for the technology

A second method that I observed David using with teachers and one we discussed in our interviews was the use of prototypes and examples of existing designs as talking points for working with teachers on new designs. This method gives teachers and David solid physical examples as points of discussion. The issue that David found with this method is that teachers see them as finished resources moving the focus of their discussion from what new resources they can develop to asking David 'how can we use this example in our lessons?' David says he gets frustrated by this as he feels that it's a teacher's role to understand the application of his resources in their classrooms and as such provide feedback on how existing resources can be used and developed.

> I say, 'here's an example of something you can do'. And they go, 'great, great'. Or 'how do we use that in my lesson?' or something. And I say, 'No this is just an example of what you can do. I'm expecting you to now give me some ideas for something to do with that sort of technology… And it's getting something back from that. I'm not the teacher I don't decide what the children learn.
>
> – (David interviewed by the researcher in Delmore School, May 24th 2011)

If we consider these two approaches – visualising and demonstrating uses of the technology there seems to be a fine balance between being too prescriptive and leaving little room for the teacher to think of their own ways in which a technology might serve their practice, and offering too many functions and uses for a technology leaving a teacher overwhelmed and unsure where to start. Finding this balance and developing a good relationship with teachers is, for David, central to creating effective teaching resources for the school. Whilst this process is complex, David provides in his interviews an account of projects that he felt involved a successful dialogue between him and the teaching staff.

Cars crossing – an example of a good practice

This example of a simple interaction design project highlights important considerations and approaches to involving teachers in the design process so that the technology can become an effective teaching aid.

The initial idea for this project came from a discussion with a teacher at the school about how a lesson they had planned that used wooden blocks to create bar graphs could be made more exciting using the digital sensory room. David and the teacher worked together to design a piece of software that allowed the user to choose the number and colour of a set of cars that would then drive across a screen at a specific time. The students would then count these cars and the results turned into bar graphs using the wooden blocks.

David created a prototype with a simple GUI (Graphical User Interface) and the functions that they had discussed. The teacher then used this, with support from David, during a lesson. After the session both the teacher and David provided feedback resulting in a set of simple suggestions as to how it could be improved.

David then demonstrated the updated program to a group of teachers from each year in the school during a monthly teachers meeting. During the meeting he showed how the software worked, got them to use it and asked them if they would try it with their students. During the session teachers made suggestions as to how it could be used for their particular class or lessons. This included adapting the software for road safety lessons by including traffic lights, zebra crossings and other road signs and adapting it for letter tracking for students with lower levels of cognitive ability.

> Someone said... I had them going right to left and they said, 'make it go left to right it helps with their reading.' And someone else said if you could slow them down and get them to move up and down that's going to help with tracking. [eye tracking]
>
> – (David interviewed by the researcher in Delmore School, May 24th 2011)

David used a modular design approach for the coding of the program and interface which allowed him to quickly modify, add, and reduce the functionality of the software to suit teachers' requests. This speed of redesign allowed him to respond and feedback quickly.

> That is a very good example of something that's developed by me just bunging something together from an idea. Someone... one teacher saying it will be good for this, another teaching saying can it do this? It'll be good for that. And another teacher saying, 'Can we put road safety into that?' 'Can we add a zebra with red, yellow and green light? Press different buttons to make the lights go or the cars go. Blah blah blah', so that one, yeah that one had legs. It adapted to a lot of different things and different teachers had input in it.
>
> – (David interviewed by the researcher in Delmore School, May 24th 2011)

The processes David undertook with teachers allowed him to develop a simple but useful design with a single teacher. The design was simple and easy for teachers to use. Teachers were then able to suggest uses and adaptations for the design on which David could give feedback. From this session David and the teachers began a dialogue, which resulted in variations on a design adapted for the various needs of students and teachers. When asked during our interview why he thought this resource had a good uptake from teachers he said that he thought it was the adaptability of the program for different contexts and students, the clarity of the functionality of the software and the simple interface that attracted teachers to the program.

Teacher approach to using the digital sensory room

An observation that was backed by my subsequent interviews with the school's interaction designer was that teachers approach the resources in the digital sensory studio in different ways. Here we identify and discuss two different approaches that we observed teachers using. The two different approaches highlight the important role that teachers have in helping students to engage with and learn from the resources offered within the schools digital sensory room.

The first approach is where the teacher will use the space as a place to watch and listen to screen based media. Teachers will enter with a class and ask David to start content playing then sit and watch with their class with little or no intervention from the teacher. David described teachers who use this approach as having a 'cinema mentality'.

The second is where teachers will use the content David has created as a starting point for the lesson and use questions, props and activities to engage students, with the digital resources becoming part of the wider structure of the lesson.

David illustrated these two approaches when he discussed his 'Around the World' drama session that he had developed for the school. He developed content and used projection, lighting, 3D sound, and various interactive effects to develop a series of scenes that depict environments from around the world. Some teachers, he says, would come into the space and simply sit and watch the projections with their class.

Others engaged more with the environment David had created using the effect of the space to engage students in wider discussion.

> David: Other people would come in and say, 'Think about what it might smell like in *this* country; think about the people you'll meet and the languages you'll hear.' And they might dress up and try some food and stuff. And that's how it should be used. It should be an aid to teaching. It shouldn't be the focal point of everything.
>
> – (David interviewed by the researcher in Delmore School, May 21st 2011)

David implies that there is a need for a change in the attitudes of teachers towards the use of technology in the classroom in order to make use of the potential benefits that new technologies offer.

This 'traditional' approach to technology is less a result of teachers' attitudes to technology and more an inherent quality of their teaching style. That is some teachers no matter what the tools and resources are, are better at using the resources at hand to engage students rather than leaving them to passively listen and watch.

The difference is in how teachers make use of the environment that the interactive technology provides. In the first example, the teacher plays a passive role with the interaction occurring between screen and student with little or no intervention by the teacher. In the second the teacher uses the environment to support and explore a range of ideas in a creative and engaging manner.

Teachers make use of the resources offered by the digital sensory room in different ways. The two approaches identified here show that some teachers use the space as a place to watch content, the other is an approach that uses the resources in the room as a starting point for activities and multisensory engagement. The way in which teachers use the resources may be affected by their familiarity and understanding of what is possible when using the studio. This shows the importance of the teacher's skill in using the tools that the technology provides.

Training teachers

If there is a need for David to develop an understanding of how teachers practice then it is also important for teachers to develop an understanding of the technologies that David works with and designs. Demonstrating his designs and carrying out training with teachers is a strategy but one that appears difficult to achieve.

> What we should do really is have a, you know, a training day or something at the beginning of each term or the end of each term.
>
> – (David interviewed by the researcher in Delmore School, June 7th 2011)

David has had some opportunities to carry out training with teachers but these opportunities are rare and time limited. When David talks about a need for teacher training there seems to be at least two different types of training he's talking about.

The first is the need for teachers to gain technical training in using not only the software and hardware he designs but also in commercial software such as video, sound and editing software to create and prepare content to use with the technology.

The second seems to be finding a space where he can present new technologies he has developed and can gain feedback from teachers on how they could be used and adapted for their work with children. Again he has had some opportunity for this but the emphasis has seemed to be on demonstrating the technology and less on gaining feedback about adaptations and possible uses from teachers. He is realistic about the amount of time that he will ever get to set up training sessions due to his own workload and the time limitations of teachers.

> ...there's already inset days every term that are set aside for things. Getting teachers to come in during holidays is not going to happen. …People are busy as well and maybe they are just too busy and experimenting with something that they don't know is a risk that they don't want to take.

– (David interviewed by the researcher in Delmore School, June 7th 2011)

4.4.3 Design Processes Summary

This category has discussed design and collaborative processes between staff members when developing interactive resources for a SEN school environment. It has shown the importance of developing dialogues between participants that enable each side to consider the needs of the other. Designers need to take into consideration the complexities and professional practices that teachers use in their classrooms and not to expect that teachers and staff will conform to their requirements. Conversely teachers need to have both the time and the training to consider the potential of digital technologies and how they themselves might participate and contribute to the design process. If we consider this point within wider discourses on the use of technology in schools, we can see that it speaks directly to the discourses discussed in 3.3.4 *Teachers and the introduction of technology in schools*. Cuban describes the pragmatic and professional issues that dictate when, how and if teachers will choose to use a technology within their teaching as "situationally constrained choices". (Cuban, 1986, p. 70)

> [Teachers] can alter classroom behaviours selectively to the degree that technologies can help them solve problems they define as important and avoid eroding their classroom authority. (Cuban, 1986, pp. 70-71)

If our aim is to ensure designs are not only *useful* but are also *used* in a learning enviroment then as designers and researchers we must understand these 'situationally contrained choices' and address them in our design processes and resulting artefacts. As with the students they teach, each teacher will have their own needs and ways of working which our designs can support. As designers and researchers caution should be taken when introducing new collaborative design methods, as existing strategies will already be in place. As Selwyn argues, if we start as designers by understanding the existing 'social realities' of the school environments we are designing for we can develop technologies that are not only appropriate for that environment but are also used by the teachers and students they are designed for. (Selwyn, 2011)

Heeks calls for caution in seeking to understand the views and 'social realities' of participants through participation by acknowledging the long-term relationships of participants that already exist within a setting. (Heeks, 1999) Researchers and designers should offer alternatives but must also be aware of how their design interventions will complement or disrupt existing strategies for learning and collaboration within the school.

This category of *design processes* has shown us several strategies that can be used as designers and researchers to develop *useful* technologies that are *used* by teachers with their students. As a designer in this context it is often necessary to make use of an intermediary in order to develop a mutually understandable dialogue between designer and teacher. In this study the curriculum access coordinator worked with both the interaction designer and class teachers to ensure that the designer understood the needs of the teachers and their students and conversely that teachers understood the abilities and needs of the designer and their work. This speaks to Wright and McCarthy's call for interaction design research and participants to have 'emotional and meaningful' encounters that facilitates a mutual understanding that grounds designs in the lived experiences of both designers and participants and in this case was enabled by an intermediary; the curriculum access coordinator. (Wright & McCarthy, 2010)

The study has shown that another strategy for developing useful design was the need to provide training for teachers. As Florin argues, the benefits for teachers and students comes from the skilled application of technologies rather than from the qualities of the technology itself. (Reed, Hyman, & Hirst, 2011) By incorporating training for teachers into our design strategies we can ensure that those designs will compliment and extend teacher's practices. As seen in the Scandinavian inception of participatory design (Asaro, 2000; Bjerknes & Ehn, 1987) teachers need to not only learn how to use the functions of a particular artefact but also how to express themselves publicly, to evaluate their own and other's decisions, and to absorb information as a means to develop strong participatory structures. This then results in technologies that are not only *useful* but are also *used* by teachers in their everyday practice.

4.5 **Personas**

The category *design processes* has resulted in unique insights into the perspectives of and challenges for staff involved in the design and use of interactive technologies in a SEN school. In this section I present three personas based on the embedded and inductive research processes conducted in this study that led to this category; the special educational needs teacher, special educational needs teaching assistant and curriculum access coordinator. These personas have been created in order to support those in the interaction design community working in this context by providing an overview of staff roles that designers and researchers are likely to encounter in this context. The personas provide an overview of each staff member's role in the school, their role in the interaction design processes, their priorities for interactive resources

and the challenges they face in those processes. The personas presented are based on this case study and should be not be seen as providing statements of fact. Rather it is the reader's responsibility to consider how the insights inform and apply to the particular context in which they are working. These personas make up one of the main contribution of this study.

4.5.1 Special Educational Needs Teacher

Role in the School

Special educational needs teachers are concerned with the educational, social and emotional development of the children they teach. There is a wide variation in the ages, abilities and needs of the students they may teach and in the practices and tools that they use. There is no single approach to teaching in a SEN context, and how teachers work with students will be dependent on their professional experience, their approach to pedagogy and the students and institutional context in which they are working. There are however common responsibilities and concerns which they will share and it is important that designers and researchers take these into account when developing technology for use in SEN classrooms.

SEN teachers work with class sizes that are typically smaller than their mainstream counterparts. It is their responsibility to prepare lessons and resources for students, develop and adapt teaching methods and resources to suit the varying needs of their students and to maintain records of student progress. Teachers have to ensure they consider the individual needs of students within the wider group dynamics of a classroom context and to develop activities and resources that can be used flexibly to differentiate between the various levels of ability. They must also manage student behaviour in order to provide a safe, fun and engaging environment. It is their responsibility to choose, develop and adapt equipment and facilities, including interactive technology, to provide engaging ways for their students to learn. They will also coordinate learning activities outside the classroom such as field trips, sports events and outings.

In addition to teaching they are also involved with students' pastoral care which can be far more complex than that of their mainstream counterparts. They will attend and contribute to student's annual reviews and other related reviews including Heath and Care plans. It is their responsibility to liaise with a range of professionals, including educational psychologist, speech and language therapists and physiotherapists and to

work with parents, guardians and the students themselves to ensure that they receive the support they need.

SEN teachers must be able to respond to the needs of their students by adapting and changing their teaching activities and resources in response to the ever changing demands of a SEN classroom context. They are accountable to parents, the school management and the educational authority. They must ensure that they demonstrate through evaluation and constant oversight that their teaching practices conform to school policy and government legislation. The job requires patience, skill, empathy and the ability to work within a challenging but ultimately rewarding setting.

Priorities for the design and use of interactive technology

The first priority for SEN teachers is their students' educational, social and emotional development. Their priority for the design and use of interactive technologies in their classroom is for tools that support their teaching practice. There is a wide range of areas of teachers' practice that technology can potentially support and the priorities for different teachers will depend on the particular context in which they work. There are a number of important qualities however that are likely to be shared by the majority of SEN teachers.

Teachers work in time and resource limited settings where they must balance behavioural management with their teaching practices. Working with a class of children all with individual needs and abilities requires resources that complement and extend teacher's existing classroom work rather than disrupting and negatively impacting those practices. SEN teachers require interactive resources that are reliable and robust enough to be used in the strenuous environment of a SEN classroom.

It is the small pragmatic details that become a priority for teachers such as the amount of time it takes to set up and develop content for a particular interactive resource, and ensuring they can focus on the classroom activity at hand rather than troubleshooting with the equipment. Individuals and small groups of students in a class need to be engaged in different ways to suit their learning styles and needs. The dynamics in a classroom between students, teachers and the space they work in are always changing. Ensuring technologies are flexible enough to meet the demands of such a fluid environment is a priority for teachers in a SEN classroom, and therefore for designers.

Another important priority for teachers and their students is the use of digital tools and media for documenting and sharing student's achievements and the teaching practices used to support them.

Role in the interaction design process

SEN teachers offer the interaction designer intimate knowledge of their students, the classroom dynamics and of their own teaching practice. When designing for a SEN classroom context it is not only children that you are designing for but a complex set of social actions that occur between teachers, students and the institution. Teachers will ultimately decide whether technologies introduced into the classroom are used, who they are used with and for how long. As interaction designers developing tools for the classroom it is not our job to replace teachers and their professional practice with the tools we create but rather to compliment, extend and offer new possibilities for teachers and their students.

Working with students every day for extended periods enables teacher to provide essential insights into the impact of design interventions on student learning, social skills and classroom behaviour. They can also be an important guide in negotiating the political structures and alliances that exist between members of staff at the school.

Challenges for designers and researchers

Teachers all have different teaching styles, experiences and levels of ability. Their engagement with and understanding of the use of technology in their teaching will also vary between teachers. Many teachers will see the value of and be engaged with the possibilities of designing and researching the use of technology in their classroom. It is likely however that they will be cautious when approached to participate in or have their classroom used as a site for interaction design research. SEN teachers work in pressured environments where time and resources are limited. They are under constant pressure to conform to ever changing school and government policy.

If you are asking to observe and participate in a classroom, teachers may be understandably wary. They will be cautious in order to protect their students but also to protect their professional standing. If you plan to make observations or record their teaching and interaction with students, then they may be cautious of how their work will being evaluated and disseminated. They may also be concerned about the impact your work will have on their time and energy and how it will affect the behaviour of their students. When working in a classroom environment it is imperative that you

negotiate with the class teacher from the start of the project and update them on the progress of the research as it develops. You should negotiate what resources will be needed, who will be involved, how you will maintain contact and to be clear on what the outcomes will be for the research and the participants. Ensuring that you are realistic about the contribution your work will make to teachers and students will help you to maintain a productive relationship and ensure continued access to the classroom environment.

Projects change and develop as they progress. Maintaining clear communication and negotiating any changes with teachers helps to manage expectations and provides a means to check in about insights and designs you are developing with an expert participant. When working with teachers and students for extended periods there will inevitably be times when timetables and meetings are changed at short or no notice, students and staff who are key to your studies may be absent and rooms made unavailable. This is all part of working in schools and interaction designers should be patient and understanding and ensure they have contingency plans for issues that arise at the last minute.

As an interaction designer you do not know more about their classroom, students or teaching than teachers. You need to respect their work and understand that your research will be for them only one of a number of competing demands. You can offer an outside perspective on their work and offer new tools and approaches to compliment and extend their teaching but it is not your job to replace them or their professional practice.

The interaction designer involved in these studies discussed two different techniques for working with teachers to develop interactive resources for their teaching; visualising uses for technology and demonstrating use for technology. There is a balance to be found between being too prescriptive about how technologies are to be used and offering so many options that a teacher becomes overwhelmed. Finding this balance is difficult and requires the interaction designer to spend time working with, observing and discussing teachers' practice in the classroom. The interaction designer and teachers must find a shared language that allows the teacher to understand and inform the design of technology and at the same time enable the interaction designer to understand the nuances of their teaching practice, the students they work with and the classroom setting which they work within. In order to do this designers and researchers must take time to get to know the environment they are working within,

understand the existing collaborative and professional practices that occur. Include time to teach and learn from teachers through informal conversations and allow yourself and the teacher to observe and discuss each other's work. By doing this it is possible to develop designs and conduct research that is rooted in a shared understanding of the existing and potential impact of introducing technologies into a special educational needs classroom.

This study highlighted the different approaches teachers take when using interactive resources in their teaching; passive and proactive. The passive approach is where teachers rely on the interaction between the resource and the student with little or no intervention needed by the teacher. A more proactive approach is where the teacher uses the resource as part of a wider multiple modal approach to actively engage students with the subject, each other and the teacher. Every teacher will have their own approach to using interactive resources in their work. Where possible, interaction designers in this context should try to find ways to support and encourage teachers to use interactive resources as part of their wider practice rather than as a substitute for teaching. In order to do this designers must again understand the nuances of the people and setting they are designing for. Interaction designers should plan for and deliver training and example content for the resources they design, at the end and throughout the design process.

4.5.2 Curriculum Access Coordinator

Role in the school

Students in a special educational needs schools present a vast range of mental, physical and economic needs all of which must be considered when managing issues that affect their learning. Each SEN school in the UK has a team of health and educational specialists that will include experts on mobility, communication, mental health and multi-sensory teaching. It is the job of the curriculum access coordinator, also known as the special educational needs coordinator, to manage those staff. They will work with teachers, students and parents to ensure that every student in the school has access to an education that is appropriate to their abilities and needs. They will also be in charge of purchasing and commissioning equipment for students. They must take a strategic overview of all the forms of support available and consider the needs of individual students within the competing needs of the school as a whole.

Their work for students might include coordinating physiotherapy sessions, ensuring that they are provided with teaching resources that fit their particular needs, ensuring that parents are supported and must fit this within the class and timetabling structures of the school. They work directly with teachers to ensure that they adapt their planning and delivery of activities for the differing abilities of individuals and groups of students in the classes. In order to do this the curriculum access coordinator must have a clear understanding of the health, social and educational issues that affect their students. They also require an intimate knowledge of individual students, their carers and the staff that support them.

Priorities for the design and use of interactive technology

The main role of the curriculum access coordinator is to ensure that students are provided with access to an education that is appropriate for their abilities and needs. In order to do this, they must coordinate the use of a range of tools including people, equipment and training. Their priority for the design and use of technology in the school then is focused on technologies as tools that can help to remove barriers to students' access to learning, be they physical, mental or social. Whilst they are concerned to find technologies that suit individual needs they must also be strategic. SEN schools have limited budgets and resources. The technologies purchased or commissioned by the school need to be adaptable for the needs of multiple students and cohorts to ensure they present good value.

It is also the job of the curriculum access coordinator to ensure staff are trained to choose and use technologies that are appropriate for the students and the context they are working in. If a technology that is introduced to the school cannot be used by teachers in the correct context, then from their perspective that technology has no value.

They are also concerned with technologies that can support the coordination, monitoring and evaluation of the multiple professionals and tools that are needed to support each student in the school.

Role in the interaction design process

The curriculum access coordinator provides the interaction designer or researcher with an intimate knowledge of the school setting they are working within. They work with the majority of staff and students within the school and will have a wide understanding of issues that can affect students with SEN including health, mobility,

communication, child protection and sensory needs. They can also introduce the designer to different professionals in the school and provide opportunities to work with them.

Staff in this role have the potential to act as an intermediary between the designer and class teacher in the design process. With their strategic overview of the different forms of support that students and teachers require, they can offer the interaction designer insights into the ways their designs will fit within the existing resources and teaching practices in the school. They may suggest ways to adapt and redesign technologies to match individual student's needs whilst simultaneously considering how they can be used with a range of students in mixed ability classroom contexts. Importantly they understand the pragmatic issues that teachers must deal with in a classroom and can help designers to develop technologies that fit within and extend existing teaching practices. Conversely they can work with teachers to train and help them understand how new technologies can support their teaching.

Curriculum access coordinators are responsible for monitoring and evaluating the success of different teaching and support strategies in the school. This includes organising, implementing and evaluating the annual educational reviews of individual students. They can therefore offer designers useful evaluation techniques for evaluating the effectiveness of technology based interventions in the school.

Challenges for designers and researchers

A curriculum access coordinator's main priority is to protect and provide value for the school's staff and students. They will have worked with a range of suppliers, companies and organisations in their work and will be cautious when being approached by a researcher or designer even if they have been sanctioned by school management. From the accounts of participants in this study it is clear that designers and researchers who work with SEN schools often over promise and under deliver on technology projects. As an interaction researcher or designer working with a curriculum access coordinator you must ensure that you are realistic in the aims of your project, that they can see the value for the school and students and in the work that you want to carry out and that you are working in consultation with them rather than imposing what you consider to be the correct design process and solution. Staff in SEN schools work hard with limited resources in a sensitive and pressured environment. If you are asking for support from a number of professionals and students in the school, the curriculum access

coordinator is going to be justifiably concerned with the impact your work will have on their team and the students they support.

As a designer and or researcher you must also consider that the curriculum access coordinator's view of the school's staff and students may provide insights into a wide range of activities and practices but in doing so may miss the fine grain understanding of classroom behaviours of people such as teachers and teaching assistants. Whilst they work with a majority of staff and students in their role, curriculum access coordinators do not spend every day working with the same group of students in the way that teachers do. Also part of their role is outward facing. It is their responsibility to present what can be an idealised picture of the school to outside organisations. It is therefore important to spend time developing a relationship and shared language with them, understand the limitations of their view of the school and to work with others in the school to ensure that you gain a nuanced understanding of the school from multiple perspectives.

4.5.3 SEN Teaching Assistant

Role in the School

The role SEN teaching assistants have in a school is dependent on the needs and abilities of the children they work with and their level of experience and training. They may support a single student in a class or work with groups of students. As with SEN teachers, SEN teaching assistants are concerned with the educational, social and emotional development of the children they work with but under the supervision of the class teacher. They have less responsibility than SEN teachers and are not expected to plan and develop teaching materials or liaise with parents, guardians and other professionals. Their main responsibility is to help children understand instructions, carry out aspects of children's care plans (social, educational, personal), document student's work and classroom activities, support students during social and extracurricular activities, help prepare learning resources for the class teacher and help keep records for student evaluations. SEN teaching assistants may also have specialist communication skills to support students including sign language, deafblind communication and other forms of accessible communication.

Priorities for the design and use of interactive technology

The main priority for special educational needs teaching assistants are their students and the teaching practices and resources they use to support them. They require interactive resources that compliment and offer new opportunities for supporting their students. SEN teaching assistants are low paid and often paid hourly. They are likely to be asked to set up resources before and during classroom sessions at short notice. They have little time allocated for learning how to use and maintain digital resources and so require technologies that are simple and quick to set up and require only a short amount of training to get started with them. Teaching assistants are often asked by class teachers to document class activities and student work using digital cameras and video. Developing technologies that support the documentation, editing and display of content will directly support SEN teaching assistants. Designing technologies that support SEN teaching assistants to monitor and record information about students educational and behavioural development is another priority for interaction designers developing technologies for SEN classrooms.

Role in the interaction design process

SEN teaching assistants offer a number of potential contributions to an interaction design process. They work closely with individuals and groups of students and can provide detailed insights into students' needs, behaviours and the impact of design interventions on their work. Where SEN teaching assistants work with individuals with severe or complex needs they can help to communicate between the designer and student and in some cases act as a proxy for their voice. They also work closely with class teachers and so offer an alternative perspective on the teacher's approach to teaching, their use of resources and relationship with students.

When working with students in a classroom setting SEN teaching assistants can provide practical support in setting up classroom furniture and other resources, communicating and supporting students in tasks and recording activities using video and stills cameras. As a researcher or designer it is also a role that you can take on as a means to get to know students, teachers and the classroom setting. It is a job that although demanding is also accessible for designers with only a small amount of experience of working with children and in education.

Challenges for designers and researchers

As previously noted SEN teaching assistants work for low pay and are often paid hourly. This means it may be difficult to arrange to have SEN teaching assistants participate outside of their designated classroom hours. Working with teachers and management staff to ensure they are compensated for their time is one way to ensure they are able to engage with the project. SEN teaching assistants may also be cautious of discussing the work of other staff. As with SEN teachers they are concerned with protecting their students and their professional standing in the school. This means it is important to discuss with them how any information they provide will be recorded and used. Another issue for designers and researchers to be aware of is that SEN teaching assistants are not always assigned to a specific class and may change from session to session during a project. This means they may be unaware of who you are and the work that you are doing in the class. Ensuring SEN teaching assistants are given at least an overview of your project at the start of a session can mean they are more willing to help and discuss their work with you. As with any staff member or student you are working with never assume that you know more than they do about their teaching practice, the environment they work in and the students they work with.

4.5.4 Summary

This section has presented three detailed personas of key staff members that those in the interaction designer community working in the context of a special educational needs school are likely to encounter. These personas provide pragmatic advice on three staff member's roles in the school, their potential role in an interaction design process, their priorities for interactive technologies and the challenges that researchers and designers may face when working with them. These personas also offer an overview of the staff who are participants in this and the other three studies in this thesis. There are a number of insights and suggestions in this section for working with these staff members. The key points are that it is essential to spend time with staff in the context they work, to respect their professional practice and to find a shared language to discuss and develop interactive technologies with and for their work with students.

4.6 Category 2: Accessing education

This section considers two categories that arise under the wider theme of *Accessing Education*; The *emotional blocks to learning* that affect students' ability to learn and *Classroom Management* strategies that are used within the school to ensure that students can access an education that is appropriate for their abilities. These are considered as a means to tackle the social and pedagogical issues that inform the design and research of technologies to support children with special needs in a mixed ability, educational environment.

4.6.1 Emotional blocks to learning

Students at the school experience a range of complex emotional blocks to learning. This section considers some of the issues around self-image, competence and confidence that effect students' ability to learn and explore some of the approaches that the school and its staff use to address them.

Many students within the school have a negative perception of themselves that in part results from their perceived failures in mainstream schools, at home and within the wider community. The school attempts to address these negative experiences by providing a supportive environment within which students can identify and understand the value of their abilities. Working with students to develop a positive self-image is a complex and multi-faceted task that requires time, resources and a range of expertise.

A strategy used in the school to support students to develop a positive self-image is to help students develop confidence in the validity of their ideas and skills by sharing those skills and ideas with people of significance to them. In order to do this, students must develop the skills to express their ideas and achievements and be given a safe forum in which to share them.

The kind of communication skills that a student might hope to achieve varies greatly from student to student depending on the physical and cognitive abilities of that student. For a student with profound and multiple learning difficulties (PMLD), developing the ability to signal that they want to stop a particular activity may be a substantial achievement for that student, whereas a student functioning at a higher cognitive level might find presenting their story to the rest of their year group a great personal achievement.

It is important for students to develop communication skills but also to develop a confidence in using those skills. One way to develop these is to provide opportunities to develop, test out and share creative skills in front of others who are significant to them. In this way, teachers can support students to gain greater confidence in their own skills and thereby a more positive self-image.

> Walking down the corridor and [teachers] being able to comment on something they've (the students) done enhances their self worth. It gives them more value. 'Hang on what I did is really cool and it is an achievement and the whole staff have seen it.' – (Lucy interviewed by the researcher in Delmore school, June 7th 2011)

Managing the levels of anxiety a student experiences when taking part in activities is important in how a student engages with a particular activity, their teacher and the other students they are working with. If a student has the means to communicate their ideas but not the confidence to share them then they are unlikely to engage in or to enjoy the experience of sharing.

Overcoming the emotional blocks that adversely affect students' development is not simply a case of developing communication skills and sharing their abilities and achievements but it is one strategy amongst many that helps students to engage with learning and work.

Sharing practice and achievements

An important aspect of a teacher's practice is the sharing of their methods and achievements of their students with other staff. This sharing of practice serves to help teachers learn from each other but also to increase their reputation and standing within the school. Existing methods for sharing teaching practices at the school include staff meetings, development sessions, informal talks in the staff room and observation. Whilst sharing of practice is recognised by teachers and the school as an important goal, it appears difficult for individual teachers to achieve within an already busy workload.

A predominant method used by teachers to share work in the school is the design and presentation of wall-displays: collections of text, artwork, and photographs of classroom activities and outside trips. Teachers guard the limited spaces that they are allocated for displaying work on walls in the classroom and corridors of the school. What will appear on the board and how it is shown is carefully considered. Nick talked to me about the way that he very carefully plans each display over the school year to

ensure that it will convey both his students' learning and enjoyment but also his teaching methods. Whilst wall displays are an important means to share work, teachers only have limited wall space and time to create them.

4.6.2 Classroom Management

A central tenant of the school's approach to education is that every student in the school should be given access to an education that is both suitable and accessible for their emotional, physical and intellectual needs.

> Our approach is child-centred; it takes account of the differing abilities and experiences of children and endeavours to provide an education that is appropriate to individual pupil needs.
>
> – (Nick interviewed by the researcher in Delmore School, 21st May 2011)

Rosa and her team are employed to ensure that teachers and support staff plan and deliver their lessons and activities with this accessible approach in mind. Whilst a teaching approach that supports and is accessible to every child is desirable it is not always achieved or even possible within the constraints of resources, the varying levels of training and ability of staff and wider educational policy.

Throughout *The Scented School* project, Rosa attended a majority of the planning and evaluation meetings. Her role in the project was to ensure that the artists, interaction designer and class teachers considered how the range of needs and learning styles of students would be addressed in the project. She discussed various strategies that staff could use for each class and would offer advice on specific students, particularly those that had more complex needs. We will discuss two important strategies that arose from our interviews and time spent with Rosa and her team during the project: *individual achievement* and *adapting activities*. This is done to offer interaction designers working in this environment strategies and tools that can be used to improve their designs as well as providing areas of focus for the devices they create.

Individual achievement

When attempting to address the individual needs of students in their class, teachers are encouraged to consider what they want each student to achieve from a particular lesson and how this fits within a wider, tailored educational plan for that pupil.

> The ideal would be that you would provide an activity or stimulus and to get a response from the pupil from within that lesson. So what we would say is 'what are the pupils expecting to learn or achieve in that lesson?' Because it may be that a teacher does a wonderful presentation and produces this all singing all dancing session. But the kids just sit there and watch with nothing happening.
>
> – (Rosa interviewed by the researcher in Delmore School, June 7th 2011)

Rosa and/or her team will work with individual teachers and staff to consider this within their lesson planning, delivery and evaluation. The aim for Rosa is to train teachers to constantly assess the individual needs of students and ensure that the resources and activities that they use are suitable and engaging for those needs. Whilst this is true of teachers in mainstream schools it is particularly important when teaching students with the range and complexity of learning styles and needs presented in a special educational needs school to ensure every student is engaged. Attending to the needs of every individual in a class requires resources that are flexible enough to use in multiple situations and with different students.

Adapting activities

A continuation of this strategy is encouraging teachers to adapt activities for individuals and groups of students in their class to ensure that all the students in a class are engaged in a lesson. A teacher might plan how to adapt activities before lessons but has to also respond reflexively during a lesson to the interactions of the class or to any unanticipated problems that may arise on that particular day.

How a teacher engages a particular group or individual in their class is dependent on what they want that group or individual to achieve and the best way to engage them. It could involve simplifying a task, or using a different set of resources, for a particular set of students. Some students may need tactile and highly stimulating objects to work with whilst others require a simple and calming setting with very few distractions.

Ideally a teacher would tailor activities for every student but Rosa acknowledges that with the practical constraints of cost and numbers of staff this is unrealistic. A method that teachers use in adapting activities for a class is to split the students into three rough groups; students that function at a higher, medium and lower level of cognitive ability. Where classes are made up of students with a similar level of ability, for example a class of students with PMLD, it is still possible to divide the group into three groups by students' differing levels of ability and learning styles. For each of these

levels a teacher needs to consider how they will address the differing levels of stimulation and complexity of an activity and how these groups will respond.

This method of dividing a class is not always based on levels of cognitive or physical ability. There are a range of attributes that students in a classroom possess that effect how they learn and how they interact with the staff and students in that classroom; this might include different learning styles, the subject being taught, communication needs, issues of mobility, and friendships between students. A teacher will constantly assess and make decisions about how an activity is working whilst delivering the activity and make decisions about how to split the group and adapt activities based on this. This differentiation of how a task will be carried out happens both in the planning and evaluation stages of an activity but also during the activity itself.

Planning for and evaluating the responses of each individual student during each lesson is, she says, an idealised way of working. She notes that teachers are under immense time constraints and their teaching assistants are paid very little. These time and financial constraints makes constantly planning for and delivering activities that engage all of their students in every lesson incredibly difficult and in most cases unlikely. This does not mean that teachers should not work towards this goal and many teachers employ a range of strategies in their teaching practice in order to do this.

What is important is that teachers think about how they can be flexible in the planning and delivery of activities in response to the plurality of needs within a class. Where teachers do not consider the issues of individual learning within groups, students become passive spectators, unable and/or unwilling to access the learning that is their right. As interaction designers we must then attend in our design processes to the importance of creating devices that support both the individual needs of students and at the same time works for groups of students with mixed cognitive and physical needs. To do this we must work closely with teachers and students to understand what those variations in needs are and how discuss with them how we might need those needs through our designs.

4.6.3 Accessing education summary

This category has highlight the importance for designers and researcher to pay attention, in their work, to the role of technology in supporting the social development of children with special educational needs. Children live within social contexts that are as complex and pressured as those inhabited by adults (Christensen, 2004; Nass,

Alberto, & Clifford, 2008) For children with special educational needs, identity formation and social standing are even more acute than for their typically developing peers (Newbury, 1996; van Dijck, 2008). The social model of disability (Clough & Goodley, 2004; Oliver & Barnes, 2002; Sandahl & Auslander, 2005) shows us that children with special educational needs are disabled by assumptions about their abilities and potential contributions to society in opposition to their impairments which require support to mitigate. (D. Miller & Brown, 2014) There has been a call in social policy (Edwards, 2006; Watkins, 2011) and the HCI communities (Avramides et al., 2010; Escobedo et al., 2011) for research and design into technology that attends to the social as well as pedagogical and medical needs of children with special educational needs.

Williams et al. showed in their meta review of HCI literature that technologies have the potential to support children with special educational needs to self-advocate as a means to support social development. They also note however that there are few authoritative guides or case studies that reflect on the socio-political context in which ICTs are employed. (P. Williams et al., 2006) How then do we support the social development of children with special educational needs through the use of digital media and associated technologies?

We must acknowledge what Cuban describes as the 'situational constrained choices' (Cuban, 1986) of our participants, be they teaching staff of students. We must understand that the variations in students' abilities and barriers to their participation in society derive from the disabling social factors as much if not more than from their individual impairments. As researchers and designers we must move away from the techno-determinist approach to technology typified by Prensky (Prensky, 2001; 2008a), towards research and design that is grounded in the social realities of the context we are designing for (Selwyn, 2011). We can do this by working with participants in our research to develop 'meaningful encounters' (Wright & McCarthy, 2010), to address the resulting insights and apply them in our design processes.

Teachers develop contingent strategies to ensure that resources and activities are suitable for the abilities of individual students whilst simultaneously having to consider those approaches within the context of a mixed ability, group context. Teachers employ strategies to devise and tailor activities to suit the day-to-day requirements of their class that are constrained by their students' capacities and by the dynamics of the classroom group. This adaptation is part of a teacher's professional practice and

requires experience and creativity to be effective. By taking these practices into consideration the designer can create digital technologies that can be incorporated into teachers' existing practices rather than being imposed on them.

There is no single strategy, tool or solution for supporting students to become more competent and confident learners. What has become apparent from these accounts is the importance of providing supportive and accessible environments and tools with which students can develop their communication and creative skills and demonstrate those abilities to others. In order to do this, students must be able to access appropriate learning activities, be supported to take risks and have people that are willing to listen and appreciate their achievements. As a designer then we must see where we can support, mitigate or offer alternatives to the tools and strategies that are used by teachers and the students themselves to support and demonstrate student's confidence and abilities.

4.7 Category 3 - Reflections on Approach

During this study there was an interesting tension between the various roles that I as a researcher have taken on. These roles were dictated by the research aims and methodological approach as well as the pragmatic constraints and affordances of working in this particular social context.

These roles were fluid and included working as a designer, researcher, artist, teaching assistant and technician. These different roles presented different restraints, affordances and insights during the research process. They allowed me to draw on, observe, make and reflect on the different behaviours and interactions of participants and myself in those roles in relation to the participants.

By working as an artist and teaching assistant whilst maintaining the role of researcher I was able to make observations about the multiple processes and social interactions within the school and use these to inform my questions and findings. By facilitating a situation that was in line with my research interests I was open to learn from the setting and interactions of those within the school whilst ensuring that those interactions lay within my research interests.

Developing and supporting this arts project also enabled me to directly support the students and staff at the school by using my professional skills as an artist and technician. As a researcher in this context you have an ethical responsibility to clearly

and directly support the school as they support your research in giving access to the institution and by participating as individuals.

Whilst this is an important ethical position it also means that the researcher is able to develop trust and rapport with the staff, students and institution leading to greater access and more candid and natural observations. I consciously took on the role of artist and co-ordinator for the storytelling project but had to be careful to demarcate my roles in the school.

There was some tension between myself and some of the staff as a result of this fluidity in my roles; an example of this was with the teaching assistant, Lucy. She thought I was being paid by the school to run the arts project, which was in fact the role of the lead artist. This became a point of contention when she told me she felt I wasn't spending enough time co-ordinating the various staff in the school and that she was taking on too much of the 'making' of the digital content.

This tension was resolved by meeting with the staff involved in the project and discussing and demarcating our roles and ensured I was clear about what my responsibilities were in the project and what my main role as a researcher entailed. This led unexpectedly to staff talking to me more in my role as a researcher than before the meeting. Overall this also made me realise the importance of setting out clear roles at the start of the study/project and maintaining a dialogue about those roles as the project progressed.

4.8 Study Summary

The study detailed in this chapter has, through a grounded analysis of observations and semi-structured interviews, detailed the processes and challenges of designing and using interactive digital tools in a special educational needs school from the perspective of four key staff members. There was no single aim for this study but rather a set of guiding questions which informed the study design, analysis and subsequent discussion:

- Which staff are involved in the design and use of digital tools in the school?
- What role do they play in designing and using interactive digital tools?
- What challenges do they face?
- What are the collaborative processes that occur?
- What are the challenges people face during those collaborations?

The collection of empirical data and iterative analysis led to three theoretical categories. These categories have in turn been discussed and developed into a set of design personas and insights for those in the interaction community working in the context of a special educational needs school. This discussion and the personas in particular go some way to addressing these questions.

In this study I took an embedded longitudinal approach that resulted in certain restrictions and affordances as a researcher. Working as a teaching assistant, interaction designer and arts co-ordinator in the school resulted in research insights that are grounded in the experiences and interactions of staff, students and myself. The multiple roles I took on in the school led to tensions between myself and staff about my responsibilities and the expected outcomes of the research. This was resolved by ensuring that these roles and responsibilities were constantly evaluated through a continuous dialogue with staff.

Conducting research, developing and supporting a creative arts project and working as a teaching assistant in the school is time consuming and hard work for a single researcher. It was however a rewarding process that ensured that my research was both grounded in the context and its participants and also was of direct benefit to the school.

This chapter has given a macro-view of developing ICTs in the context of a UK SEN school with a focus on the roles of four key members of staff in an interaction design process. It has shown the importance of supporting students and teachers to express their ideas and achievements with others and the importance for designers to work in situ so that their designs are rooted in an understanding of classroom practice and thus compliment and extend those practices.

The next study moves to a more focused view by situating the research in a single mixed ability classroom within a special educational school. It focuses on the role of photographic practices in supporting students and teachers to share ideas and achievements with others of significance to them. The study is conducted by a multi-discipline research team and uses a mixed method, design-led approach.

5 Study 2: My photos, your photos

5.1 Introduction

This chapter details a design-led case study that uses five creative-photography workshops to explore the social and expressive function of digital photography within a special educational, mixed ability classroom in a special needs school in the UK. The aims of this study are:

- To produce a set of transferable design insights relating to the social and expressive function of digital photography in a mixed ability SEN classroom.
- To demonstrate how an experience-centred design (ECD) research process can be used to develop a prototype novel photographic tool that supports students and teachers in a mixed ability SEN classroom.
- To discuss how a design-led, multi-researcher method of inquiry impacted on the insights and design of these prototypes.

Over a series of five creative workshops, a multi-disciplinary team of researchers including myself, used an ECD research approach further informed by other participatory approaches to interaction design with children (Druin, 2002;

Frauenberger et al., 2011; Wright & McCarthy, 2010) to investigate the existing and potential social role of digital media in a SEN classroom.

The five workshops were carried out in a mixed ability SEN classroom. The study discusses our shared experience of the workshops and the main insights developed from each one. The insights gained from these workshops are then used to develop a set of design considerations which we as a team used to develop a photo-sorting console for the class to support interpersonal and expressive communication.

Once the workshop series and design process had been completed I individually conducted a grounded analysis of the empirical evidence: insights from the workshop series and observational and interview data from our workshop and design processes. This resulted in two conceptual categories: *Design processes* and *Accessing Education*. These are discussed in the 5.7 - *Further analysis of the workshops data and implications for interaction design in a SEN classroom* section of this chapter and considered in relation to existing literature. Each category results in one or more insights designed to support those in the interaction design community concerned with the development of technologies for and with children with SEN. At the end of the discussion section I reflect on the study's methods and approach and consider how they impact on incorporating the views, opinions and lived-experiences of the participants.

The case study presented here was a collaborative group research project that was carried out by myself and researchers from an interaction research centre in the north of England. With my specific research interests in developing interactive systems with children with special educational needs, I was asked to join a new research project that was tasked with considering the social interactions that were mediated by the use of photographic practices in a SEN classroom.

I worked as part of a multidisciplinary research team from the very beginning of the project. We collaboratively developed the research approach, delivered the workshops and carried out data collection in the school. The account and insights presented here were written by myself. The insights discussed in the workshop series section of this study were developed through round table discussions and group analysis involving the research team which took place between each of the workshop sessions. The console was developed collaboratively as a team. My specific role in the design process is discussed in the 5.6 *The photo-sorting console* section. The 5.7 - *Further analysis of the workshops data and implications for interaction design in a SEN classroom* section

was the result of my individual analysis of the available research data through a grounded theory process which resulted in two conceptual categories. This coding process is discussed at the start of the 5.7 - *Further analysis of the workshops data and implications for interaction design in a SEN classroom* section of this chapter.

5.2 Motivation

As we have learnt from the research in the first study, providing students with SEN the opportunities to share ideas and achievements is an important means by which they can develop social and educational competences. The study also demonstrated how important it is for interaction designers in this setting to work with and observe staff and students in situ, to ensure that any designs developed are grounded in the needs and experiences of those they are designed for. The following are three insights that arose from the first study *Chapter 4 – The Scented School* which motivated the study design and the design process discussed in this chapter, *Chapter 5 – My photos your photos*.

1. **Managing individual needs in a group setting:** Teachers develop contingent strategies to ensure that their available resources and planned activities are suitable for the abilities of their individual students whilst simultaneously having to consider their utility within the context of a mixed ability, group context. Designs for interactive systems that are to be used in the school must then take into consideration not only the abilities of individuals or specific impairments but also how those systems function within a mixed ability classroom situation that is typical in the school.

2. **Dialogue:** Teachers and designers and researchers need to find a shared language in order to bridge their separate perspectives and practices and to articulate their needs. The researcher and the designer need to take into consideration the complexities and professional practices that teachers use in their classroom. Teachers need to consider the potential of digital interactive systems and how they as individuals can participate and contribute to the design process.

3. **Motivation:** Understanding and developing tools and systems to facilitate supportive and accessible environments in which students are motivated to express their ideas and opinions in creative ways should be a priority for design research in this setting.

As has been discussed in more detail in the literature review chapter, schools for children with special educational needs in the UK are increasingly using digital technologies, including photographic tools, within their curriculum to support communication and expression in learning and teaching.

The social function of digital photography to support and enhance communicative environments, including educational ones is well documented in HCI and related research fields (Cao, Lindley, Helmes, & Sellen, 2010; Druin, 2010; L. Good, 2005; Levin et al., 2007; Mäkelä, Giller, Tscheligi, & Sefelin, 2000; Newbury, 1996; Rogers, Lim, & Hazlewood, 2006). The social function of digital photography as a means of expression and communication in a special educational needs classroom is a relatively unexplored area from an interaction design perspective.

The previous chapter *Chapter 4 – The Scented School*, has shown that working with teachers and students with special educational needs in a UK SEN school presents a challenging space for interaction designers and researchers. We must consider the multiple complex needs of students, the resources and strategies that teachers use to support them, the dialogical research processes between participants and researcher, and the institutional context of the school.

5.3 Approach

5.3.1 Methodology

The experienced-centred design (ECD) approach used in Study 2 allowed for an interaction design process that was grounded in an observed, tacit and experiential understanding of the context under study. As with the methods used in Study 1, the approach was inductive, that is the aims and subsequent designs were formed through an iterative and empathetic relationship with the school and its participants. As discussed in 3.6.7 - *Experience-centred design,* ECD as a methodological approach takes the position that by designing empathic and meaningful emotional encounters between researcher and participant we as interaction designers can understand and incorporate the lived-experiences of users into our design processes. (Wright, 2004; Wright & McCarthy, 2008; 2010)

Like the Scandinavian inception of participatory design (PD), the ECD approach taken in this study promotes a form of democratisation in the design process by incorporating, facilitating and observing the interactions and perspectives of

participants. (Wright & McCarthy, 2008, p. 637) (Read et al., 2014) This was done by working with and facilitating situations that engage participants with each other and the research team aesthetically and empathetically. In this study a series of design-led workshops were used to engage *meaningfully* with our participants. The emphasis however differs from that of the Scandinavian inception of PD in that it focuses on understanding the social complexities and tensions that occur between participants as they work within the context, so that the designer can design *for* the particular community as opposed to directly with it as would be the case in PD.

The study design was informed by our shared experience as researchers and participants within the social context of the classroom. In turn the design process was grounded in the pragmatic considerations of working and engaging children with a range of needs and abilities within the institutional and physical restraints of a special educational needs classroom.

5.3.2 Method

The case study was conducted using a design-led approach, grounded in our observed, tacit and experiential understanding of the interactions that occurred during our classroom activities. 'Design-led' is used to describe the use of creative design practice as a practical, applied form of inquiry that directs how the study proceeds.

The aim of this study was to understand how the practices of using digital photography affected the social interactions of staff and students within the specific context of a mixed ability SEN classroom. As such the research team was focused on their experiences of the context rather than responding to general pedagogical and medical aspects associated with special educational needs. The study design was informed throughout the process through a dialogue with the school as an institution and with the staff and students in the classroom that the study was conducted in.

The data collection and analysis for this study was split into three distinct parts: the series of practical workshops, the design of a photo-sorting console and my individual, grounded analysis of the study data. The workshop series was planned, run and analysed collectively by the research team and resulted in a set of insights and design considerations for a photo-sorting console. During the workshop visits and meetings, the team recorded our interactions and conversations using five digital video cameras capturing video and sound. We also made field notes and used images taken by staff and children using the digital cameras we provided. After each session, the team took

part in a recorded and noted round table, discussing our perspective of the session and of the participants' interactions. These recorded round table discussions and the other research materials were used to reflect on and to analyse the interactions of the participants, researchers and digital photography practices. The resulting data was stored on a secure server and was made accessible to all of the research team. The workshop insights developed from the workshop series then informed a set of design considerations and a design-led question which guided the subsequent design of a photo-sorting console.

In the final part of this study I used the data collected during the workshop and console stages to develop a series of grounded categories through a grounded coding approach. I discuss these categories in the 5.7 - *Further analysis of the workshops data and implications for interaction design in a SEN classroom* section of this study. Through this analysis I extracted a set of transferable insights that will support those in the interaction design community working to support the use of creative modes of communication in a mixed ability SEN classroom. My coding process is discussed and illustrated through the coding maps shown in the 5.7 - *Further analysis of the workshops data and implications for interaction design in a SEN classroom* section.

5.4 Background

ICT has a clear social function for children with special educational needs; the European Agency for Development in Special Needs Education's 2011 review of innovative HCI practice in SEN defines the role of ICT as enabling people to learn social development skills to facilitate their full and equal participation in education (Watkins, 2011).

Issues of self-image and identity-formation, which are important for all typically developing children, are of particular significance to children with special educational needs. As has been explored in this thesis, children with special educational needs often face difficulties in communicating their views, emotions, and experiences, leaving them with limited agency in decisions that affect their lives. If we consider the social model of disability we can see that this limited agency results not only from an individuals' impairments but also from people's perceptions of children with SEN as having limited capacities for expression and learning. Developing skills for communication and being able to share those ideas and achievements with others is integral to the development of a positive self-image for children with special educational needs.

The case study presented here is concerned then with the social and expressive function of digital photography within a special educational needs classroom group and how this might inform the technical functioning of a new digital photographic tool.

5.4.1 Designing for a special educational needs classroom

The qualitative, mixed method approach that was used in this case study was used in order to incorporate the views and opinions of our participants. This approach was taken to include the ideas of teachers and students and ensuring that any resulting designs from the study were responsive to and useful in the environment they were designed for.

As discussed in more detail in the literature review, there have been a small but growing number of studies in HCI on co-design with children with special educational needs. Recent studies have been concerned with how different levels of abilities, and the contexts in which they occur, determine the types of contribution a child with special educational needs can make (Guha et al., 2004; Karna et al., 2010) and how to interpret children's input into the design process (Frauenberger, Good, Keay-Bright, & Pain, 2012b; Hornof, 2009). The studies referenced here take up the roles set out by Druin (user/ informant/ tester/ design partner) (Druin, 2002) and to an extent take this as a hierarchy of roles with 'design partner' as an explicit ideal. This means that in order to take on the desired role of design partner, a participant's impairment must be compensated for in the research approach (Iversen & Smith, 2012). Emphasis is then placed on the participant's diagnosis and shortfalls rather than considering their potential in contributing based on the situated resources and capabilities of the participant and context of the research setting.

HCI studies that address design for children with SEN have emerged relatively recently and have a tendency to focus on specific forms of disability and impairment (Hornof, 2009; Kientz, Hayes, Westeyn, Starner, & Abowd, 2007; McElligott & van Leeuwen, 2004). This can be seen in the work of the *ECHOES* project (Frauenberger, Good, Keay-Bright, & Pain, 2012b): which focused exclusively on children on the autistic spectrum outside of a mixed classroom setting. These studies offer insights into how design supports particular impairments and to some extent insights into the design of interactive systems for all children with special educational needs. The study in this chapter however is concerned with the mixed levels of ability and impairments that are found in many special educational needs classrooms in the UK and speaks to Bruce et al. and Benton et al.'s calls for design research to focus on a wider set of impairments than is currently the case (Bruce et al., 2013) (Benton & Johnson, 2015).

These HCI studies speak to a wider discussion on 'children's voice' in HCI that aims to support children in contributing directly to the design and evaluation of technology and call for research to consider the 'real world' settings in which children will interact with technology (Druin, 2010; Read, Fitton, & Mazzone, 2010; Robertson, Macvean, & Howland, 2012).

In order to take these recommendations on board the research team adopted methods put forward by a range of research studies in this area which include the work of Druin, Guha, Frauenberger et al., Wright and McCarthy and Larsen et al. (Druin, 2002; Frauenberger et al., 2011; Guha et al., 2008; Larsen & Hedvall, 2012; Wright & McCarthy, 2010). As described in the account that follows, the study was concerned, methodologically, with the day-to-day practical realities, contingencies, and lived experiences of the staff and students in the special educational needs classroom setting.

The study that follows discusses the design of interactive tools for a special educational needs classroom by first considering the complex participant group and setting in which the participants interact. The students that participated in this study presented a range of skills and abilities. They presented a complex range of impairments and resulting needs, which included combinations of cognitive impairments, behavioural, social and emotional control as well as profound communication difficulties. The staff members who participated in this study - the classroom teacher, headmaster and teaching assistants, also had a range of different experiences, skills and perspectives from one another.

The participants interact within an institution, the school. The institutional arrangements for children with SEN, if they are to protect and enable students to develop socially and educationally, will also impose constraints. In this study, the school's policy on the production and distribution of photographs made ethical issues of privacy and disclosure a priority in the study design and execution.

This account presents a number of challenges for interaction design including design for complex and mixed user groups, design in sensitive settings, and design for older children with individual communication needs. Its aim is to describe and discuss a case study that demonstrates how a design-led, participatory approach can support designers in understanding and responding to the complex interactions within a classroom for children with special educational needs and produce a prototype to support the use of digital photography as a means of communication in a special educational needs school.

5.5 Workshop series

In this section the case study is described in which the research team worked with students and teaching staff at a UK special educational needs school, running a series of 'creative photography' workshops to better understand the social role of digital photographic tools within a classroom for children with special educational needs.

The planning for the workshop series was informed by three preliminary visits to the school where we were invited to sit and observe classroom activities in several different year groups. During these visits the research team were also able to talk with teachers and teaching assistants about the use of photography in the school. The team found that one of the main uses for photography in the school, used throughout the different year groups, was in making wall-based displays in classroom and public spaces to share students' recent activities and achievements with the rest of the school.

From these preliminary visits and based on the experience and knowledge of the research team, we planned five workshops to be carried out over the school's Spring Term. The workshops were structured as follows:

Workshop one was designed as an introductory session that would draw on existing photographic resources in the school including cameras, photo displays and printed photographs in order to see how staff and students used these existing resources. The next four workshops were designed to explore different aspects of photographic process including technical, creative and social uses of cameras and displays through a reflexive planning process.

5.5.1 Reflexive planning and design-led inquiry

Following the introductory workshop session, each of the subsequent workshops were developed in response to the analysis of the previous workshop. In between each workshop the research team analysed the empirical data from the previous workshop then planned and built bespoke props and activities in response to insights and issues that resulted from that analysis.

The research team made 'project books' for each of the students. The books were simple, leather bound albums that were designed by the research team. The aim was for students to add images during each workshop to record their work and as a means for them to reflect on the workshops and inform the case study.

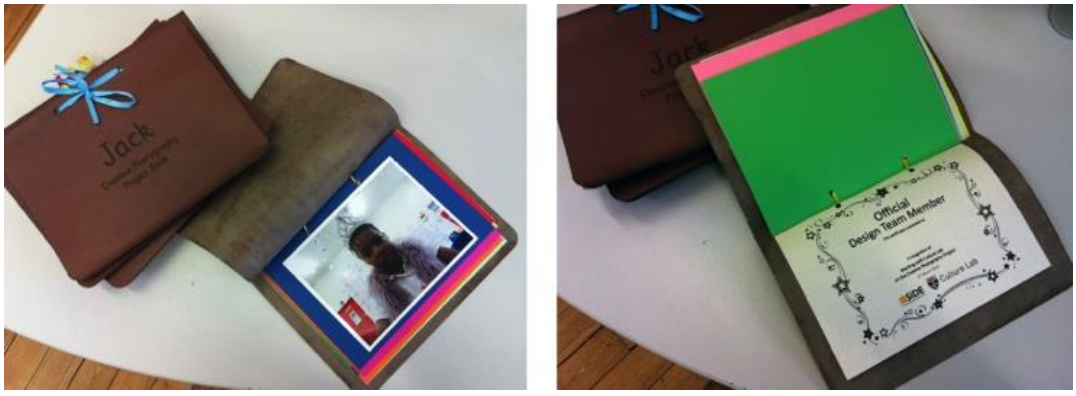

Figure 8 – Student's photography project book

The workshop activities are part of the design-led method of inquiry. The intention of this method was to engage participants and researchers in a shared creative activity. The aim of these shared photographic activities that made up the workshops was to enable the research team, and to some extent the participants, to understand, through a shared creative experience, how design might support and enhance a social aspect of photographic practice in the classroom. The activities not only looked at existing uses of photography in the participants' classroom, but also offered new and alternative ways in which photography could be used.

The following section discusses the five creative workshops that we ran with our participants in the school. For each workshop I describe what happened, what insights arose from our analysis of the session and present a discussion of how these insights informed the design of the subsequent workshops.

5.5.2 Workshop One: Introductions

This initial session was planned to introduce ourselves and the project to the students and staff. It made use of existing photographic resources (the class's digital cameras) and was designed to give us an opportunity to observe staff and students working together in a simple photographic activity.

At the start of the session the team met with students to introduce the research team and the aims of the project. The students were told that the team were there to work with them to design a tool that would help them do new and exciting things with photography. The team spoke briefly with the class about when they had used cameras in school and at home. The team then introduced the project books to the class explaining that they were to be used as albums for the work they created during the workshop series.

The first workshop activity was a 'photographic portrait task'; students were put into pairs and asked to select several items from a costume box that we had brought with us. Each pair was given a digital camera and assigned an adult helper who would either be the class teacher, one of the teaching assistants, or a member of the research team. The pairs were then asked to take photos of each other in the costumes in and around the classroom. The students were given 20 minutes to complete the task and were then asked to review the photographs they had taken on the digital cameras. The next task was to select a favourite image and to share the image and reasons for choosing it with the group and add it to their project book. For this task the research team organised the pairings of students simply by proximity, 'the student sitting next to you'. The idea for this first workshop was to introduce the project and us and to run a fun and creative activity with the students.

The task offered the research team an insight into the practical challenges of managing a group of children with a mix of complex impairments and needs. It allowed the team to both observe how Jane, the class teacher, and her teaching assistants worked with this challenge and respond to these challenges themselves whilst working with pairs of students. At the end of the session the team and Jane discussed their experiences of the

workshop. Jane described how staff learnt about each student's needs and ways to manage them within the classroom group by working with them and observing them over time. Jane suggested that it would be helpful if she chose future groupings of students during subsequent workshops. We were unable to record our conversation with the class teacher after this session as she refused permission but allowed us to take hand written notes. Also the teaching assistants declined to discuss the session with us and left straight after we finished.

The research team analysed workshop one through a combination of a round-table discussion, in which each of the team members' experiences were discussed, supported by video data taken from several angles in the classroom and the notes taken from our discussion with the class teacher.

This initial session was designed to allow us to observe some of the social interactions that occur between students, staff and the digital cameras they used during a simple, creative photographic activity. Through our round table discussion and review of our recorded data two key insights were developed which guided the design of the second workshop; the importance of considering how students are grouped during sessions and the need to consider both cognitive and physical abilities when designing for children in a mixed ability SEN classroom.

The research team arbitrarily grouped students during this initial workshop. Subsequently both Jane and the researchers observed social tensions and disruptions in the tasks resulting from those pairings. This included arguments between students, lack of motivation and refusal to swap roles between photo taker and subject.

An issue that became apparent when discussing and reviewing the recorded material from the workshop was that many of the students had difficulties using the digital cameras. The majority of students were able to use the cameras to take a photo but struggled to frame images using the view finder and zoom function on the cameras. At first it seemed to be related to a lack of fine motor control needed to control the zoom buttons on the cameras. When reviewing footage of teaching assistants explaining how the zoom worked to more dextrous students it was clear that they struggled to understand the concept of zooming itself.

This insight highlights the need for designers and researchers working in the context of a mixed ability SEN classroom to consider not only the physical impairments of students when designing interactive resources but also the cognitive difficulties participants may have in understanding the functions and uses of interactive resources.

The realisation that students struggled with the physical process and the concept of zooming and framing images using the cameras, informed the design of tools to be used in the next workshop. These were designed to draw student's attention to how and what they were framing in the photographs. In order to address the insight about the impact of different groupings on students' engagement with a task we worked with the class teacher to choose the student groupings for the next workshop. The process of identifying pairings of students that was likely to work is a subtle one that is not easily open to generalisations. The best way for designers and researchers to go about this in their work is to consult with the class teacher, who will usually have developed a detailed understanding of each child over time, to decide which children are likely to work best together.

5.5.3 Workshop Two: Ways of looking

This session began with an activity requiring students to reflect on the previous session before the new creative activity was introduced. Students were asked to talk to the class about the images from workshop one that they had put in the project books. Based on the research team's analysis of the first workshop the class was asked to discuss how using a camera could change the way we look at things. In particular, the group talked about how we use a camera's picture viewer and zoom function to frame images we want to take. As team we decided to create simple design interventions that would allow our participants to use and consider zooming and other filters in a playful manner.

The second part of the session was a creative task using the bespoke 'magic frames' props that the team's product designer and myself designed and made for this session. The students were once again split into pairs but this time the pairings were chosen in consultation with Jane, the class teacher. The students were asked to use the magic frame props to frame images taken around the classroom. The magic frames also had 'magic filters' that could be slotted into the frames to alter images they captured. The frames and filters were designed to draw student's attention to how they frame images. By creating easy to handle frames, external to the digital cameras the two students had to negotiate what would be photographed, what filter would be applied and how it was

framed.

Figure 9 - Magic frames and filters

The research team was also interested in looking more at how the students worked together in pairs. The frames and filter props were designed to be used as an extension of the cameras, acting as a zoom lens (using a magnifying lens and movement), colour filter, crop and distortion filter and framing device. The magic frames had to be manipulated in pairs with one partner holding the frame and filter and the other taking the image.

The magic frames and filters further demonstrate the study's design-led method of inquiry. The props were designed to help the research team explore the initial insights from workshop one as to the apparent difficulties some students had in framing and using the zoom function of the cameras. These difficulties seemed tied to issues of both physical accessibility and cognition of the process.

Figure 10 - Magic frames being used by students.

We concluded the workshop by asking the class about the images they had taken and asked each pair to choose four images they would like to keep in their project books. The teacher Jane and two pupils talked about the importance of having a physical, printed image to see in opposition to digitally displayed images. During the discussion

with Jane after the class had left, the team and Jane discussed the importance of having physical, non-digital materials to accompany and document activities. The literary abilities of students were also discussed and the important role that speech over writing had in students describing their opinions and ideas. Jane described the role of herself and the teaching assistants in the class as acting as 'personal secretaries' that would take dictations for students when describing ideas and opinions to be shared.

Jane showed us digital audio books or 'talking books' that the class used as a way to support the varying level of literary ability in the class. These were paper books with pages embedded with electronics to enable audio recordings to be made and played back on a small speaker.[4] They were used as different ways of storing and sharing ideas and activities; including as a way for students to share with parents what they had done that day at school, as well as a way for staff to remember students that had left the class and school.

A number of insights arose from this workshop relating to the 'magic frames' design interventions. These are; the need of the class teacher to arbitrate in the storage and selection of photos, the successful use of recorded voice to annotate photographs, and the importance for students of having printed photographs.

The magic frames externalised the process of framing, zooming and adding filters into an easy to manipulate physical object that required two students to negotiate and use. This design-led method of inquiry and design intervention demonstrates that interaction designers can introduce simple low-tech interventions as a way to support students to collaboratively explore and learn creative techniques and physical controls for using digital tools, in this case digital cameras.

Another insight that arose from this workshop was the difficulty for students and staff to select and share a favourite image with the class. We asked students to pick four images and share one with the class. After the session we then printed these images and placed them in the students' photobooks ready to be sorted in the next workshop. When trying to share the images with the class the screens on the cameras were far too small. We could have linked each camera to the class projector but doing this with every camera would have taken far too long and broken the flow of the session. To ensure we recorded which photo each student wanted for their photobook we had to get each staff helper to note the number of the photo, the SD card number and the name of the

[4] http://www.talkingproducts.com/talking-photo-albums.html

student. This then allowed us to print the images and place them in the correct photobook outside of the session. Whilst this was a time consuming process and one that could be vastly improved we learnt that the process of selecting and physically printing photographs was important for students and teachers. The physical prints act as memory aids for students and allows them to share their activities with their peers and other people of significance to them.

Our discussion of the 'talking books' with Jane the class teacher showed us the role of the recorded voice as a means to annotate images and share students' activities as an alternative to written annotations. Many students in the class have very low level reading and writing abilities and as such the simple voice recording function of the 'talking books' made the process of recording and listening back to annotations of photographs more accessible for students in the class.

At the end of the workshop the class teacher Jane asked the team to take the project books away from the students and to add photos to the books after each workshop *on behalf of each student.* She suggested that students should only handle the project books and photos they had taken *during* the workshop sessions. The reasons for this were to address ethical and pastoral issues around the unwarranted distribution of photographic content outside the classroom. This highlighted for the team the needs of the teacher to arbitrate in the storage, selection and sharing of images taken by students in their class.

The initial focus of this workshop was to introduce the magic frames as a means to support students to work in pairs to consider how they frame, zoom and filter their digital photographs.

In the intervening week between sessions the team started to discuss alternative ways of triggering cameras to take photographs. That is, instead of simply pressing the shutter button on the camera, which some students still struggled with, could we use sound, movement or other physical events as triggers. Instead of creating technical prototypes at this stage we decided to introduce a simple activity that would draw students' attention to when we take photos and to continue to see how students worked together to choose and pick moments to take photographs.

5.5.4 Workshop Three: Capturing photos

At the start of this workshop, the team reviewed the photos and discussed the previous session's activity with the class. Students chose two photos from their four favourite images from the first two workshops to stick in their project books. Students were asked and replied to a set of open questions about the different reasons and ways a camera could be triggered to take a photograph. This discussion then led us to introduce the main workshop activity. Students worked in pairs with one partner taking the photos and one performing different actions. The props that the research team designed were 'trigger cards'. These each had a different action that when performed by the students would 'trigger' the other partner to take an image. The trigger cards were designed to encourage students to collaborate and draw attention to why and when we take images at particular times. The actions on the cards included 'Be a lion' 'Jump and show something blue'. The playful actions that these cards encouraged allowed students to play with each other, for example several pairs would choose three cards and make the photographer guess which action they would perform. At the end of the session the students were asked to review and share some of their favourite images with the class, talk about why they liked particular photos with their support worker, and choose which images they wanted for the project books.

After the workshop, Jane talked about how the task revealed an important aspect of photography for her students saying, 'Seeing the achievement of taking a photo needs to be instant'. In further discussion with the research team it became apparent that for many of the students, value is placed on the ability to connect their actions (taking a photo) and seeing the results of that action (reviewing the photo). Furthermore, students placed significant value on being able to share those images instantly with other students and teachers to share their achievement. Jane stressed the importance of seeing images as an accomplishment for students and that scaffolding the sharing and subsequent recognition of that achievement was an important aspect not only of our workshops but more generally during most teaching activities in the school.

There are two insights that result from this workshop session which follow directly from those of workshop one and two. These are; the value for students of connecting their actions (taking a photo) and seeing the results of that action (reviewing the photo), and that sharing images is a way to scaffold the sharing of students' achievements. These insights link to those from workshop two. That is that teachers need to arbitrate in the selection process. This then raises the question of when, in the process of reviewing, selecting and sharing images, do students and staff participate in the process?

The insight that photography and the sharing of images was a means to scaffold students' achievement moved the teams' focus from the processes of taking images in class to the review, selection and sharing of images that had been taken by students. We had in our work started to see the wider social value of photography and digital media in this environment and now wanted to consider what existing methods for sharing and displaying images in the school were used, to discuss these with students and staff and consider how we might support this through design.

5.5.5 Workshop Four: Display and share

This workshop focused on the social aspects of sharing photographs with other people. During this session we asked students to talk about the places they shared their images and what they used to do this. The session involved a group discussion and a presentation of selected images from the previous workshops, which were shown on different displays present in the school. This included iPad's, a flat screen TV, the classroom computer and a set of prints. We then went out as a group to the corridor space immediately outside of the classroom to look at and discuss the photo wall display that the teacher Jane had been making from our workshop sessions. This session proved less engaging for students though we still gathered some valuable observations. Whilst the previous sessions had involved hands on activities this session was discussion based which many students seemed to find boring or disengaging. This may be due to our facilitation rather than their level of comprehension of what was being discussed.

Whilst this session was less engaging for the students than previous sessions it resulted in several interesting insights about how digital photographs are stored, selected and shared in the class. Wall displays are the preferred methods of sharing photos and the achievements of students and are preferred by staff to screen based slideshows. Images are chosen by the class teacher for display with little or no intervention from the students, and although images are transferred from cameras to the class computer they are rarely sorted or edited.

The corridor displays created by the class teacher are the main site for sharing images of class activities, outings and the achievements of students. Each class is allocated an amount of wall space to use over the year. Teachers and teaching assistants will select photos taken by staff and students to be displayed alongside students' work, objects relating to the project displayed (for example leaves or flowers) and printed text explaining the images displayed and project as a whole. The images used and the design of the wall display is always decided by the class teacher with some assistance from the class teaching assistants and little input from the students in the class.

The class teacher told us that the flat screens in the reception area were sometimes used to display images and videos from class projects, though she felt these were less effective at sharing students' achievements than the wall displays. What differentiated the screens from the wall displays in her opinion was the ability to use mixed media on the displays and create narrative timelines using the length of the corridor wall. Displaying images on the screens also required the class teacher to work with the school's IT technician to prepare and upload their images to the computer whereas with the wall displays they could design and create the display on their own.

Students, the class teacher and teaching assistants use the class iPad to take photos during outings and classroom activities. They will sometimes connect this to the class projector and white board to share with the class the images they have taken. The images they take with the iPad and class digital cameras are usually transferred to the class computer by a teaching assistant after the teaching sessions. They don't sort through these images with students and will normally only review and select images when they are needed for wall displays or student evaluations. This means they have a lot of images stored on the computer which are not looked at or used. Periodically they will delete whole folders of images when computers run low on space.

This workshop then led to the following insights about the use and social role of digital media in this mixed ability special needs classroom. Students have little choice in what images and other media are selected to represent them by the class teacher. The photographs and other digital media the students and teaching staff collect are rarely used because of the time it takes to transfer, review and collate images. The design of a better tool for sorting and using images may lead to the more effective use of this digital media in the classroom. This workshop also showed the teacher's preference for physical displays over screen based ones for sharing media. Physical representations of students' work, such as on a wall display, allows for a more natural integration with other physical artefacts and can show the flow of time, making them a more preferable display solution for teaching staff. Finally, the role of the documentation of class activities goes beyond supporting the learning experience of the students taking part and is used to illustrate class activities to the school more generally as well as to external entities such as parents and visitors.

In our final workshop we decided to draw the workshop series to a close by completing the participants' photobooks and talking through each of the workshops we had run with them.

5.5.6 Workshop Five: Store and keep

This final workshop allowed us to present the students with their final project books, review the sessions we did with them and give each student a certificate to mark their participation and contribution to our research team. After the session we were able to talk through issues that had been raised during the series of workshops with the classroom teacher but again she did not allow us to use a voice recorder only to make hand written notes.

This session was an important part of the design-led, participatory approach methodology chosen for this study. It allowed us to review with our participants the work we undertook with them during the workshop series. The certificates, project books and the images the participants created all served to show our appreciation for their work and demonstrated to them what they had achieved during our time together.

5.5.7 Workshop Summary

The five design-led workshops that were conducted demonstrate the social complexities that occur in the context of a mixed ability SEN classroom and show that the social tensions within it have implications for the design of interactive technologies.

The first session highlighted the importance of considering how the grouping of students will affect the findings of design-led research sessions and the need for designer and researcher to consider the range of cognitive, as well as physical, abilities of students when designing in this context. In the second session the main insights were that the process of reviewing, selecting and sharing images needs to be simplified, that the class teacher needed to arbitrate in the storage and selection of images for sharing with others and that recording students' voices offers an alternative mode for annotating photographs, particularly for students with limited literacy skills. As designers and researcher in this context we must keep an open mind about the various alternative media: sound, objects, video, that can be used to help support classroom tasks. Workshop three showed us the value for students of connecting their actions (taking a photo) with the results of that action (reviewing the photo), and that sharing images through displays and in class is a way to scaffold the sharing of student achievement. The fourth workshop showed us that students have little choice in how they are represented through digital media, that the range of media collected by staff and students is rarely used due to the amount of time required to index the material, that teachers have a preference for physical displays and that the documentation of class activities can be used to illustrate the work of students and teachers to parents and visitors. Although the final workshop did not lead to any direct insights it was integral to the design-led, experienced-centred approach that this study takes.

5.6 The photo-sorting console

5.6.1 Design considerations

The insights raised through this workshops series show the complexities of the social context of a mixed ability SEN classroom including: considering classes as 'a group of individuals', considering the differing abilities of students and the accessibility of technology when pairing students for constructive group work. The institutional and pastoral concerns of the school determine the power relationship between students and staff, requiring image making and sharing through wall displays to be arbitrated by adults on their behalf. The experiences from and analysis of the workshop series led us to ask the following question:

How can students have agency in using digital photography as a means of expression and sharing of achievement but within the constraints made necessary by the institutional and pastoral concerns of the school?

This question sets out a design space for this particular context but is also a question that needs to be pursued by other designers and researchers in the interaction design community. Based on our design-led research, we as a team developed the following design considerations which guided our design process for developing interactive resources that support students to use and share digital media in a mixed ability SEN classroom.

1. Design to support storytelling and the annotation of photographs to scaffold the sharing of students' achievements.
2. Design to support the classroom management of the range of individual's complex needs within the needs of the class as group,
3. Design to support students' involvement in the processes of recording, selecting and displaying media in and outside of the classroom.
4. Design to support staff arbitration in the processes of recording, selecting and displaying media in and outside of the classroom.

In the following section I discuss how the above question and design considerations were used to inform the design section of this study.

5.6.2 The design process

The following section describes the design process and resulting photo-console that was designed for use in our mixed ability SEN classroom. Our design processes were based on the question and design considerations set out in the previous section. The ECD methodological approach taken in this thesis enabled staff, students and the research team to participate in the research design process. It also allowed the team to respond creatively to the design question and considerations set out above.

Initially we ran three design sessions with two of the team's researchers, the team's project designer, the software designer and myself. These sessions enabled us to brainstorm ideas for interactive systems based on our design question, design considerations and the insights developed during the workshop series. These three collaborative design sessions resulted in a list of required features and a system design for a physical console and piece of interactive software. We then split the task of designing the console and software into different parts with members of the team being assigned different tasks. We worked in the same lab space and would periodically meet as a group to test and check different aspects of the design.

I designed and built the wireless RFID reader for the main console, selecting the internal components and designing the casing and software that allowed it to talk to the main console. This included creating custom acrylic RFID tags for the reader. I then worked with the team's product designer to design the casing for the console. We designed and made the wooden casing for the console ensuring that the internal electronics would fit, be protected from knocks and spills and that the button layout and design would be accessible for all of the students in the class. I then worked with the software designer on the UI layout of the console's software, creating icons and screen layouts for the various functions. Finally, I worked with the team's product designer to design and make the RFID magic wands used for audio playback on the classroom wall display.

The photo-sorting tool that was the result of our research and design processes was intended to help children express their opinions about how photos taken by and of them could be used in displays (classroom wall, corridor displays and in personal albums). The photo-sorting tool was designed to support student's agency in how photographs were used in display making at the school thus opening these photo displays as locations for students to express themselves and share their achievements whilst providing the class teacher the ability to arbitrate which images are stored,

deleted and shared. The design comprises of three key elements: A 'photo-sorting console', a 'teacher's application', and an 'audio-photo wall display'.

5.6.3 A photo-sorting console

Figure 11 - Photo-sorting console with RFID card & reader

The photo-sorting console is a controller for a software application running on the classroom PC. The application displays on a monitor screen any images that have been loaded from an SD card inserted into the card reader attached to the PC. The physical controller is designed for individual and small group collaborative use and consists of a number of brightly coloured arcade style buttons that perform the following functions in the software application:

Three buttons control the browsing and orientation of photos:

The left (yellow) and right (blue) buttons browse through the photos. The rotate button (white) rotates the image clockwise.

Three buttons allow students to express their opinion about a photo:

To share the image on a wall display (orange button); to delete the image (grey button); and to keep the image safe for personal consumption but not to be shared (purple button). When one of these images is pressed the student's opinion is recorded and the photo gets a matching coloured border.

To support the use of photography as a storytelling medium the console had two buttons for recording audio and associating it with a photo:

The record button records audio through an omnidirectional microphone and associates it with the photo on screen. The green button plays back the audio associated with the photo on screen.

The console used an RFID (radio frequency identification device) to allow individuals and groups of students to place an RFID card on the reader and ensure that their identity was associated with the options about the photos they gave. When the RFID card was removed from the reader the student or group of students was logged out. The students' opinions and associated sounds are saved onto the PC so that when the same RFID card is placed on the reader the same interface appears. When there is no RFID card on the reader the monitor displays a slideshow of the students' photos that have been selected to display (orange button).

The photo-sorting console was developed using the Microsoft.NET Gadgeteer prototype system (Villar, Scott, Hodges, Hammil, & Miller, 2012). The body of the console was made with laser cut plywood and acrylic. The use of rapid prototyping techniques allowed the research team to quickly develop, adapt, experiment and test different interface configurations and functionality.

5.6.4 Teacher's application

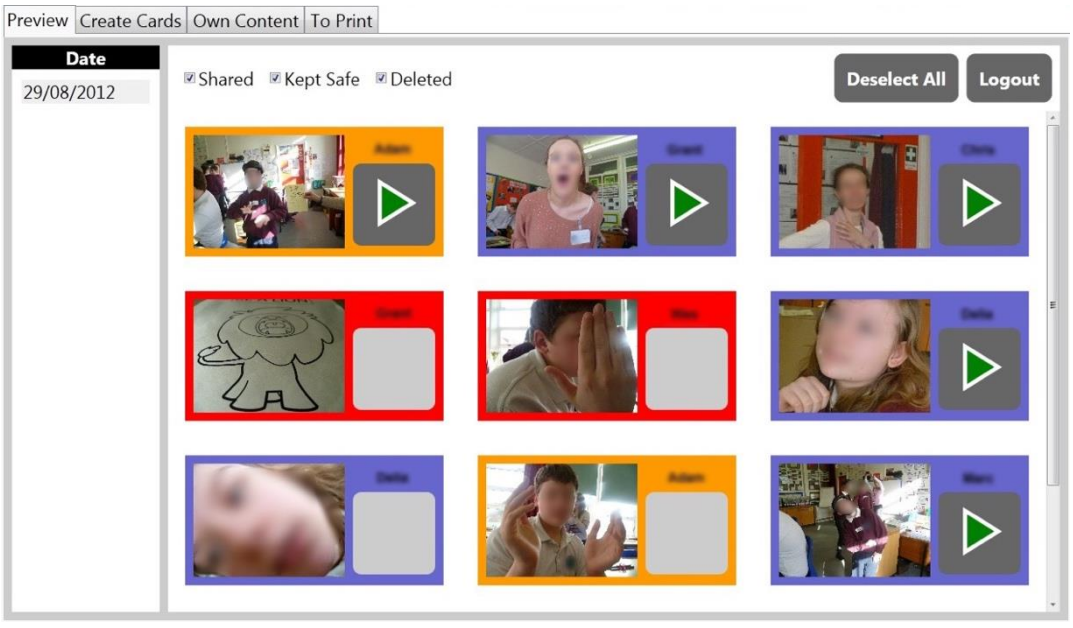

Figure 12 - Teacher's user interface

The next element of the photo-sorting tool is the teacher's application. This software application is designed to give the teacher overall editorial control of what is included in wall displays and what is deleted or stored, whilst enabling students to give their

opinions about the photos and how they are used. It was designed to support the existing practice of using wall displays as a means of communication in the school and to fit with teachers' creative display making skills.

The application allows a member of staff to view the opinions of students on their photos, to listen to the audio they have recorded and then to print chosen photos for display. The teacher logs into the application by placing their unique RFID card on the reader. The opinions of students are displayed as a rectangular element that shows a photo, the student or group name and a coloured border indicating the choice of the three buttons (share, keep safe, delete). If a photo has a play symbol next to it the teacher can press this and listen to the student's recorded sound. The images can be sorted by student choice (share, keep safe, delete) allowing the member of staff to contrast student's opinions of images.

Teachers can then select photos to print. If a photo that is being printed has an associated sound then a Wizard is generated that allows the image to be physically associated with the printed copy. Once the photos have been printed the Wizard displays the images with associated sounds that have been printed in turn then asks the teacher to stick a small adhesive RFID tag onto the back of the printed copy and place it on the RFID reader. The sound is then associated with that unique RFID tag and the image that it is stuck to.

The teaching application allows for administrator functions such as deleting any old and unwanted images and a mechanism to create RFID identity cards for individuals and small groups of students. These functions and the simplicity of the interface is to support teachers in designing their own rather than prescribed uses for the device.

5.6.5 Audio-photo wall display

The third element of the photo-sorting tool allows the wall displays made up of photos from the first two stages of the photo-sorting tool to be augmented with sound. When photos with associated sounds are placed on the wall display and a 'magic audio wand' (a wireless RFID reader) is moved over the photo, a nearby PC reads the RFID tag and plays the associated audio file.

5.6.6 Reflecting on the design process and initial design considerations

The design considerations that resulted from a group analysis of the workshop series and presented in the 5.6.1 Design considerations section were met through the design of the

photo-sorting console. How each consideration was attended to is discussed below.

1. Design to support storytelling and the annotation of photographs to scaffold the sharing of student's achievements.

   The photo-consoles allows users to quickly review, triage, add audio annotations and prints images with an RFID tag that associates the audio annotation with the specific photo. This enables teachers and students to quickly create collections of annotated images for use in narrative based physical and screen based displays as a means to share activities and achievements with people of significance to them.

2. Design to support the classroom management of the range of individual's complex needs within the needs of the class as group.

   The teacher's application allows teachers to arbitrate and monitor the decisions made by students about which images are to be used, deleted and the annotations they make. This and the ability to save and load individual projects using the RFID system directly supports the classroom management in the classroom by attending to important issues on disclosure and managing individual student projects.

3. Design to support student's involvement in the processes of recording, selecting and displaying media in and outside of the classroom.

   The console enables students to consider and make choices about the media that is used to represent them all be it within the necessary arbitration of teaching staff.

4. Design to support staff arbitration in the processes of recording, selecting and displaying media in and outside of the classroom.

   This had been met in the design of the console through the teacher's application as discussed above.

5.6.7 Initial evaluation sessions

In a continuation of our design-led research process an initial evaluation of the photo-sorting tool was conducted with the original participants. The aim of the evaluation was to get critical feedback about how the tool functioned in a real-world classroom setting and to gather empirical data to support the design considerations from the initial workshop study. The evaluation was conducted over two sessions and re-oriented the staff and students from the original study as 'testers' of our prototype

(Druin, 2002) whilst maintaining the empathic relationship that had already been developed.

The initial session followed the format of the workshop. In an hour-long session students were introduced to the photo-sorting tool and asked to use and reflect on using the photo-sorting tool. Two students volunteered to be testers of the console. They were asked to come to the front of the class and one of the researchers talked them through the operation of the tool using photos on an SD card taken from the five initial workshops. The students were asked to browse through the images, rotating any that needed to be adjusted and then to stop on photos and ask the whole class if they should be 'shared', 'kept safe', or 'deleted'. They were also asked to record short pieces of audio to explain a small selection of the images that were selected to be shared. Another two sets of students were then asked to repeat the process with the class.

In the second half of this first evaluation session the class moved outside to the corridor display and were shown a demonstration of the audio-photo wall display. The display had been arranged with a number of pre-prepared photos with RFID tags and associated sound files. Students were shown how to use the magic audio wands to play back the associated sound for each of the prepared photos and given an opportunity to play with them.

At the end of the session students and staff were asked to give feedback on the console and magic wand tools. There was a generally positive response with students and staff raising minor usability issues. All of the students from the original participant group were able to use both the console and magic wands with some needing the support of their peers. Several students offered design adjustments for the tools. Peter and Phillip both suggested that the console should be wireless to enable it to be passed around the classroom during group activities. Gabi, Josh, Luke and Phoebe suggested different forms that the magic wand could take to be made customisable for pupils. This included an extension rod for wheel chair users and a suggestion by Josh of making the wand into a car.

After the students had left the classroom the teacher's application was demonstrated to Jane who was then asked for her opinion and critical feedback of the potential role and impact of the console in the school. She made no major comments on the tool's design but highlighted the importance of her ability to be 'the arbiter of the photos'. She

asked that it should 'not allow students to actually delete photos', as she again made it clear that it was important to note that photos that students deemed insignificant or non-representative could be useful for her own purposes. She also said that she would like to see the tool developed so she and other colleagues could use it for other functions with a range of media in the school.

Figure 13 - Magic audio wands

After this session the feedback from the participants was used to refine the design and develop a second iteration for a second evaluation session. The major addition to this iteration was the development of three different magic wand designs, containing wireless RFID readers, each of which was designed to encourage users to interact with the wall display in different ways and by students with different physical needs. When this new iteration of the tool was introduced to the class staff, the new magic wands engaged students as they explicitly incorporated the ideas of participants such as Josh's car idea. Additional adjustments were made to the teacher's application allowing all of the student's choices included deleted images to be viewed on the monitor. During this evaluation session both Jane and the head teacher suggested that they would like to see how the tool could be used as a way to communicate the school timetable.

Further analysis of the workshops data and implications for interaction design in a SEN classroom This chapter has given a descriptive account of the design-led research approach grounded in the experiences of the design team running the workshops and evaluation session with staff and students. This approach allowed participation of students and staff in the research and design process whilst enabling the team to respond creatively using the tacit knowledge gained in their experiences in the research study and their expert knowledge. The approach enabled the design of the photo-sorting tool to be based on the social complexities of the special educational needs classroom context and to engage with and include the ideas and positions of the different participants.

5.7 Further analysis of the workshops data and implications for interaction design in a SEN classroom

In the final part of this chapter I will discuss a set of qualitative findings that arose from my individual analysis and grounded coding of the data from the workshop series conducted after the team's group analysis and development of the photo sharing console. I began the process by reviewing my observational notes from the workshop series and considering them in light of the insights that were developed collectively. I then returned to the recorded camera and audio data and used this to develop my initial coding maps. From these maps I iteratively moved between my coding and my data and formed two main categories which are discussed in the following sections. These categories led to important insights that arose from the design-led, ECD approach taken in this study. These insights are considered within the wider discourses of the interaction design for children community and provide transferable insights for those supporting children in mixed ability SEN contexts. At the end of the discussion of each category, having reflected on the insights and experiences from the workshop and design of the photo-sharing console, I address in *Transferable insights* section in this chapter, the study's aim, "To produce a set of transferable design insights relating to the social and expressive function of digital photography in a mixed ability SEN classroom." These insights are presented with the hope that they will be taken up by those in the interaction design community concerned with the social value of digital media as a means to support interpersonal expression in a SEN classroom context.

5.7.1 Digital Media and Representation

This category 'Digital Media and Representation', concerns the social complexities of using digital media as a form of communication in a mixed ability SEN classroom. It considers these social complexities through two sub-categories: the representation of self through digital media and the representation of others through digital media. The discussion results in two transferable design insights for the interaction design community: the need to support students' self-advocacy through an active engagement in the selection process and the need to support students' voice within the management and pastoral requirements of teachers.

Figure 14 - Chapter 5 - My photos, your photos, final conceptual coding map

Representing the self

During the workshops, pupils discussed the use of photos to demonstrate *personal achievement,* both to themselves and to others in and beyond the classroom. In classroom discussions, students said that they had supervised access to digital cameras in school, using them to document school projects and field trips, and to record and share learning achievements with others. All the students said that they had access to digital cameras at home and although they were used less frequently than during school, they were occasionally used to share activities that they had participated in outside of school. The most prominent means for sharing photos in the classroom was through photo wall displays in the classroom and in outside corridor spaces. In our classroom discussions, students expressed a preference for tangible records of photos and activities, which was demonstrated in their appreciation of the project books and

certificates of achievements, a suggestion by Jane the classroom teacher that each student received at the end of the workshop series.

A key theme in the use of digital photography in the participants' classroom was the sharing of stories of school and outside experiences. The important contribution of photo-displays was to share not only the students' experiences and achievements but also the teacher's practice with other staff members. This was evident through conversations with staff and students but also in the wall displays that Jane created during our study to share the work that had been done in the workshops. Every week Jane would add new photos from the workshops with explanations about what had been happening and who had been involved. During our fourth workshop session Peter told us that the display was, 'to show people what we've been doing, the work that we've been doing.' When talking about the wall display, students also brought up the value of using photomontage for creating a narrative.

> Josh: 'If you've only got one picture, you can't tell nothing what you've actually being doing.'
> Luke: 'And it would be less boring as well.'
>
> Peter: 'Yeah you've got three weeks, Week One, Week Two, Week Three.'

In discussions with students, in some cases with assistance from teaching assistants, all students said that they occasionally brought in printed photos, taken by them outside school, to share interesting things they had done. The PC in class was used occasionally to review photographs that had been taken by students and teachers of activities but what was clear was that printed photo displays were the most important and used form of photo display in the classroom. The importance of printed, tangible records of achievement was evident from the positive reaction by staff and students to the project books that were made during the workshops. In workshop two, the important role of voice recordings for annotating images in the class as an alternative mode for students who struggled with reading and writing was shown.

During 5.5.5 Workshop Four: Display and share, the team and class discussed where they would like to display pictures from the project. Different students had different ideas with some saying that they didn't want particular images being shared with others in the school, preferring them to be seen by the class only or in some cases only by themselves and their families. There may be various reasons for this, but an important issue seemed to be about the impression that the photo gave of an individual

and the activity. The importance to students of giving a positive impression in photographs is not surprising considering the sensitivity that emerging adolescents and in particular children with special educational needs have over identity formation and representation of that identity (Newbury, 1996; van Dijck, 2008).

Representing others

An important insight that arose in the analyses of the staff-pupil-researcher interactions during creative digital photographic activities were issues around sanctioned and unsanctioned photographic representation of students by other people. Issues concerning the creation and choice of photographs for the participants' project books highlighted this sensitive issue.

Jane instructed the team to take the children's project books away from them in between each workshop session. This was in order to keep the books safe but also to manage the quantity and security of the large amount of images that were produced during each workshop. The research team and Jane would then select and choose photos to be included in their photo books.

These choices where influenced to some extent by the student preference but when these photos were presented to students they were often not what they would have chosen. Peter's responses are a good example of this. He repeatedly rejected the photos that had been chosen and printed for his project book saying that they were 'not like me' or made him 'feel silly'. It was deemed necessary by the class teacher that staff and researchers arbitrate the use of photos for students. This however resulted in tensions over the representation of students. Peter's response, which was not unique, highlights the desire of students to make choices about how they are represented through photographs and how those images are stored, deleted and shared.

As highlighted in the discussion of 5.5.4 *Workshop Three: Capturing photos,* teachers need to arbitrate in the selection, storage and sharing of photographic images and other media taken of and with students. This is to comply with the school's media policy, data protection and to ensure that any images shared reflect students and their work in the school in a positive light. The other reason for the lack of student involvement in this process is pragmatic. Students and teachers produce large numbers of images when using digital cameras. Asking each student to review their images on the camera or transferring the images to a computer is a time consuming and complex task. As shown in the write up of 5.5.5 *Workshop Four: Display and share* images taken by students and

staff are transferred by teaching assistants then left on the school computer and only reviewed briefly by staff before being deleted periodically. Images that are to be shared will usually be printed. All of these processes of transferring, storing, selecting and printing images require a staff member to work with small groups of students and are beyond the cognitive and physical capabilities of the majority of students in the class to do unsupported.

Transferable insights

Having reflected on the insights and experiences from the workshop and design of the photo-sharing console I now address the study's aim, "To produce a set of transferable design insights relating to the social and expressive function of digital photography in a mix ability SEN classroom." These insights are presented with the hope that they will be taken up by those in the interaction design community concerned with the social value of digital media as a means to support interpersonal expression in a SEN classroom context.

Support self-advocacy through digital media tools and practices

An important insight developed from the workshop series was that children in the class rarely had a choice as to which photographs and written annotations were used to represent them in the school. This discussion has shown the social value of using a design-led research approach and creative design process to support students to actively engage in the representation of their ideas and achievements using digital media. The photo-sharing console that was designed as a result of our research enabled students to make decisions about which images were or were not used to portray themselves and their actions and to use their recorded voice as a means to annotate those images.

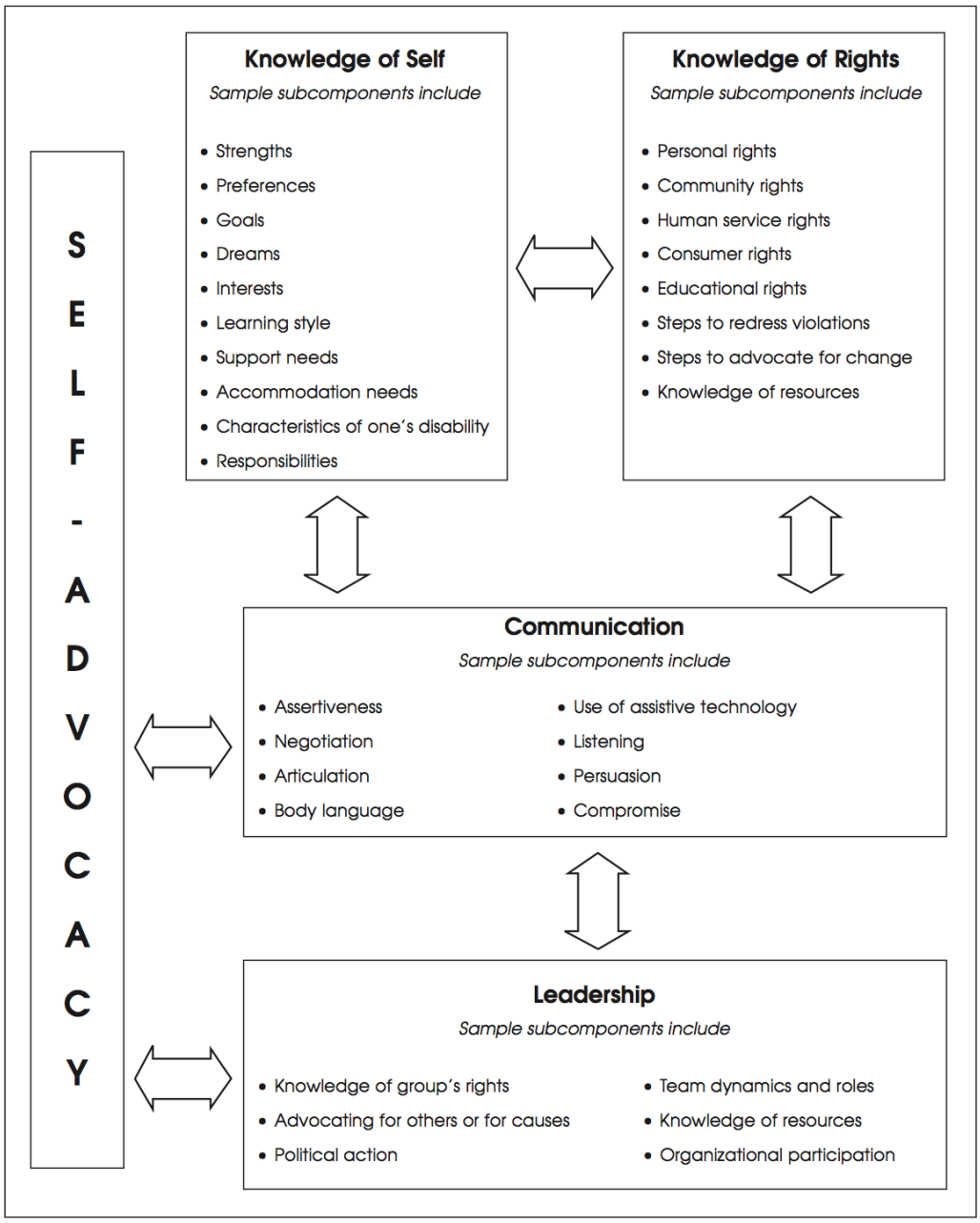

Figure 15 - A conceptual framework of self-advocacy (Test 2005 p. 49)

If we consider the conceptual model of self-advocacy that is put forward by Test et al. and discussed in the *Background and literature review* of this thesis, (Test et al., 2005) we can see how this study's use of ICT and digital media to support interpersonal communication and expression fits with the matrix of skills, tools and opportunities for supporting students with SEN to self-advocate. This study demonstrates the use of digital media in supporting students in a mixed ability SEN classroom to *communicate* and to develop a *knowledge of self.* The photo-sharing tool that we developed aimed to support students to *articulate* their *strengths* and *interests* by supporting them to express their *preference* about how they were represented to others.

Support student's and teacher's voices

The *reflecting on others* discussion in this section shows the need for designers and researchers in this context to balance the right of children to use and have their voice heard in the research and design process, with the institutional and management requirements of the school and teacher. Whilst there has been a focus in literature on the promotion of the child's voice through interactive systems, the work in this study demonstrates the challenge for developing interactive systems in a SEN classroom that incorporates the negotiation of both the student's and teacher's voices in the design process.

This study took a participatory approach to understanding the social complexities of designing to support interpersonal and creative communication in a mixed ability SEN classroom. There is a wide range of literature that demonstrates the value of incorporating children with special needs into a co-design process. (Benton & Johnson, 2015; di Blas, Garzotto, Paolini, & Sabiescu, 2009; Frauenberger et al., 2011; Guha, Druin, Fails, & Foss, 2013a; Read et al., 2002; Waller et al., 2013) The design-led approach enabled students and staff to contribute to the research and design process. In terms of Druin's framework of participation for children in HCI research, students and importantly staff became (Druin, 2010) 'informants' and 'partners' at various points in the study.

The work in this study demonstrates the vital role that teachers and other supporting staff in a SEN classroom context have in informing a design process that is grounded in the social complexities and pragmatic professional and managerial issues that arise in a SEN classroom context. This speaks directly to the literature on the role of the teacher in the introduction of technology in the classroom discussed in detail in 3.3 - Technology in the classroom. (Buckingham, 2007; Cuban, 1986; Selwyn, 2011). Cuban calls for technology in schools that takes into account teachers' 'situationally constrained choices' (Cuban, 1986, p. 63) with Buckingham and Selwyn calling for design and research approaches for introducing technologies in schools that start from 'the social-economic' realities of school contexts. (Buckingham, 1996; Selwyn, 2012). It also aligns with the Scandinavian PD approach that calls for people who use interactive systems to be part of the process of designing those systems that affect them. (Bødker et al., 2000)

This study and the participatory approach taken has allowed us to develop an understanding of the social context and social effects of digital media in a mixed ability classroom and contributes to a discourse that calls for design and research on HCI in schools which takes into account the social complexities of the context and the lived-experiences of teachers and students.

In terms of *communication*, we developed a console based on our research in the setting that served as a form of *assistive technology* as it was accessible to the range of abilities in the class and helped students to *articulate* on behalf of *themselves* by making choices about the images they wanted to use. The development of a tool using a design-led, participatory approach, that supports children with SEN's *knowledge of self* and *communication* also speaks directly to the aims of the original, Scandinavian conception of Participatory Design; to develop tools and practices that not only support people's ability to advocate but help them to realise they have a right to advocate. (Bødker et al., 2000).

The photo-sharing console and the insights that informed its design demonstrate the effectiveness, in supporting students with SEN to self-advocate, of designing a tool that enables them to be actively engaged in decisions about how images representing them are to be shared, stored or deleted. This triaging technique should be considered by other designers working to develop digital media tools and practices to support expressive and creative communication for children with SEN and speaks directly to the research that seeks to understand the role of the child's voice in the interaction design processes. (Druin, 2010; Frauenberger, Good, & Alcorn, 2012a; Iversen & Smith, 2012; Read et al., 2002; 2014)

5.7.2 Classroom Management

The category *Classroom Management* discusses how the professional and pragmatic practices of a mixed ability SEN classroom informs what is required of digital media in a mixed ability SEN classroom. This category results in a transferable insight that designers must design for active classroom management when working in this context.

Group of individuals

As the workshop series progressed, the relationships between students and staff were recognised as being significant to understanding the role of photography in the classroom. As such the responses and perspective of the teacher was foregrounded when collecting and developing insights from the study material. A central theme was

how teachers and staff use existing strategies and practices in the classroom to manage and include students in learning activities, and how students respond to those strategies and practices with the teacher and other students.

In discussions with Jane on using digital technology in special educational needs contexts, Jane discussed the challenges of managing 'a group of individuals' with a range of abilities that need to all share the same resources. She emphasised that every student she works with has a mix of conditions, some diagnosed and some not. For every student an individual learning plan has to be made with individual pastoral concerns. In light of this she said that, 'designing for a particular special educational need is a moot point'.

Jane's classroom management of individuals with a broad range of abilities and impairments can be considered in terms of the complexity of the context in which she must employ a range of contingent strategies. In this context photography was used to mediate this complexity and contingency in some interesting ways. Students join and leave Jane's class over the months for various reasons that are often related to their special educational needs. These include medical and behavioural issues. When discussing the use of talking books during *Workshop Four*, Jane described how they had been used as 'memory books' to maintain a presence for, 'pupils who are no longer with us' and those 'who we don't see as often as we like'. These Memory books contained photos and messages from and about past students who had either moved to another school or in some cases passed away. In discussing the tangible quality of the books, Jane talked about the availability of the books for students so that they were 'always just there' when students in the class wanted them.

The classroom management of complexity and contingency was also evident in the management of cameras and photographic content. The heightened sensitivity of issues such as disclosure and child protection that working with vulnerable children entails meant that the supervision of materials that could potentially identify students was of great importance. This was highlighted by the home status of Janine that meant that all photos and video recordings had to be checked and edited before leaving the school premises to ensure that no identifiable record of her was taken out of the school. With four video cameras and various still cameras, although helped by purposely trying not to record Janine, this was a time-consuming task. Alongside this all recorded material had to be password protected and encrypted on storage media before leaving the school and kept on a secure server in the research lab.

Grouping students

The design-led workshops led to an appreciation of how photography mediated the social dynamics of students working in pairs during creative tasks. The pairings of students during the workshops resulted in constructive and disruptive interactions between students. Certain pairings were constructive in encouraging and supporting friendships. Students were asked to work in pairs and to swap between roles during the session. Ingrid and Duncan worked together during workshop three on the trigger card activity. One of the actions asked them to 'Dance!' Duncan held the camera, started laughing and told Ingrid to 'Wiggle you bottom'. The camera and cards enabled the partners to encourage each other to play with both the subject of the photos and also when a photo was taken. The pair enjoyed the activity and the photos they took during the activity were later shared and the class agreed that they showed the fun that they had working together.

The behaviour of students differed between workshops and pairings. Tammas for example was patient and supportive with Cass but in another session was impatient and dominant with Josh. This differing behaviour during the activities was not only a symptom of personalities but was also about the differing levels of ability of each student in relation to the technical operation of the camera and task.

Working in pairs was constructive in the way that one of the students would support another. In workshop one, Phillip was observed to be helpfully and patiently showing his partner Cass how to use the zoom controls on the digital camera they shared. When this supportive work was commented on by a teaching assistant, Phillip appeared pleased to have helped. After the first workshop we asked the class teacher to advice on the pairings for subsequent workshops. Whilst this helped to mitigate some of the problems from the first session there was still issues that arose from the pairings in terms of behaviour and engagement in the task.

The pairing of students and use of camera was not always constructive even between friends. When using the magic frames and filters, Josh and Luke's disagreements in who should use the camera first led to disruptive behaviour. Luke tried to keep hold of the camera and told Josh to act out the cards because he was 'the best photographer'. This may be due to the kudos attached to using the camera or impatience with the length of time it took for Josh to take photos due to his impairments but it may equally have been due to a reluctance to appear 'silly' in subsequent photographs.

The fact that students will respond differently depending on who they are working with may seem an obvious insight when working in a classroom but what this insight highlighted was the importance, for interaction designers and researchers, of considering the social complexities of running design research in a SEN mixed ability classroom. Teachers in mainstream and SEN classrooms have to learn and manage the dynamics of the students in their classroom to ensure all their students are engaged and happy. This need becomes far more acute when working with the complex needs of a mixed ability SEN class. Interaction designers should be aware that the grouping of students they select for their research will have an impact of any subsequent results and observations. An important approach then is to work with the class teacher and teaching assistants to plan which students will work together and how this may affect the way they engage with a task or technology.

Transferable insights

Design for active classroom management

This discussion of the category *Classroom Management* has built on the discussion of the previous category *digital media and representation:* that designers working in this context need to consider the pragmatic 'situationally constrained choices' that teachers make in selecting and using technology in their classroom (Cuban, 1986).

The social value of photography as a form of interpersonal communication and self-advocacy has been discussed, but in order to design systems that support this we as designers and researchers must take into consideration the social, pragmatic issues of managing a class that consists of students with multiple abilities and needs within the institutional restraints of a SEN school.

This 'group of individuals' needs to be managed by the class teacher and teaching assistants and any interactive systems that we introduce must become a tool within that active management process. This means developing tools that are adaptable, robust and are accessible to students and teachers with a range of abilities and needs. This insight on the need for tools that can be appropriate for multiple situations arose in part from the flexible and creative design-led research based approach that was required in order to respond pragmatically and empathetically to the classroom setting and participants we worked with.

The call for design in SEN classrooms that supports students and teachers of all abilities, aligns with the ethos of Inclusive and Universal Design. That is that designs

should be usable to the widest possible range of people regardless of physical or cognitive ability as a means of inclusion but also as a means of developing simpler and ultimately better design (Burgstahler, 2011; Keates et al., 2000).

As designers and researchers concerned with the design of interactive systems to support social inclusion in SEN contexts, we must not only design for social interaction but understand how interactive systems disrupt and complement existing social practices.

5.7.3 Reflections on Approach

The approach taken in this study has two main aspects that I would like to reflect upon here. The first is the research team's approach that is the use of multiple research team members to carry out the study. The second is the use of our design-led research approach.

The research team comprised six members, all of whom had a range of technical and research skills that brought advantages to the study, as a group of researchers we could each focus on our individual strengths and rely on others to support parts of the study that were outside of our skill set. Unlike the other studies presented in this thesis, I found I had multiple view points and skills to draw on during the design, delivery and analysis stages of the study. As a research team we were based in a recognised and well respected research institution, which provided us with institutional clout when negotiating with our partner school. As a team we could collect a vast range of video, audio and written evidence during the delivery of the workshops. We could also, alongside the teaching staff, provide one-to-one and one-to-two support for students during the workshop delivery.

This multi researcher approach however brought out a range of issues. The first was the need to negotiate my own aims and ways of approaching the research within a team of researchers who were based in a different research institution. When delivering the workshops in the schools the large number of researchers present in the classroom at one time meant that the typical ratio of staff to students was out of balance. During the workshops we also had at least three handheld cameras being used at any time, which led to both teachers and students feeling they were being watched and potentially evaluated throughout the duration of the workshop. This is evident in the teaching assistants choosing not to provide any feedback directly at the end of the classes and the need for the class teacher not to be recorded when discussing the workshops. As

we have seen schools are extremely sensitive environments not only for the students but also for the staff who work within them. When asked about her choice not to be recorded at the end of the study in an informal conversation, the class teachers said that she was reluctant to have any recordings that might undermine her teaching and professional standing within the school. Though we developed a good working relationship with the class teacher and school I think there were aspects of our approach that meant our participants didn't fully trust or relax around us.

At the start of the project we worked with the head teacher in the school to find a class and an aspect of the school's curriculum that we could fit within to deliver our workshops and conduct our research. This supported a reciprocal approach in that we wanted the research to help support the participants and school as a whole. The approach that was used was intended to help us as researchers identify a design space and to develop an understanding of the context we were designing for. We already had to an extent a firm agenda for our research, which may have prevented us from identifying and designing for situations that were outside of our initial approach for the study.

Transferable insights.

Design-led research approach

This study has demonstrated the use of an ECD methodology to frame interaction design research in a mixed ability SEN setting. The ECD methodology allowed us to develop empathic and meaningful emotional encounters between researcher and participants enabling us to incorporate aspects of the lived-experiences of participants and researchers in the design process. (Wright & McCarthy, 2010) The study shows how design artefacts; magic frames, photo-sharing console, can be used to creatively engage participants and act as points of discussion and departure for research and design. This study then directly contributes to an emerging literature on research through design to ground design for children with SEN in the social complexities and lived-experiences of the participants. (Benton & Johnson, 2015; Benton, Vasalou, Khaled, Johnson, & Gooch, 2014b; Frauenberger et al., 2011; Garzotto & Bordogna, 2010; J. Good & Robertson, 2006; Iversen & Dindler, 2008; Porayska-Pomsta et al., 2011) It also demonstrates how an ECD research methodology can be used to develop and understand interactive systems in a mixed ability SEN classroom context.

Challenges in this context

There were a number of challenges for conducting our research in the context of a mixed ability SEN classroom which both shaped our research and design process and which may be useful to consider for those in the interaction design community working in similar SEN contexts. As discussed previously, working in special educational needs contexts is ethically sensitive and requires careful planning and the ability as researchers to adapt to the pragmatic constraints that arise. When collecting, reviewing and storing media you need to ensure that you not only confirm to your funding body or university ethical guidelines but also the school's media policy. Care should be taken to ensure that if teachers and other staff are asked to comment on their or other's professional practice that this will not detrimentally affect their professional or social standing in the school. As discussed in the 5.7.2 *Classroom Management* section of this study the creative and design-led approach to research taken in this study allowed us to understand and articulate the need for systems and interfaces that could be used responsively within the ever changing pragmatic and social complexities of a mixed ability SEN classroom.

5.8 Study Summary

This study has presented a design-led research case study that has explored the current and potential social role of digital media in a mixed ability special educational needs classroom. Through a reflection and group analysis of five design-led workshops, the subsequent design of a photo-sorting console in a special educational needs classroom and an individual grounded analysis of the study data, this chapter has resulted in a detailed account of a design-led study, a set of insights developed through group analysis of our workshop series, and a set of conceptual categories and resulting insights on the use and development of digital media tools for expression and communication including a discussion of the research approach taken.

The workshops series and resulting analysis demonstrates the social complexities of using and designing to support the use of digital media in mixed ability special needs classroom. The insights that are discussed in the 5.5 *Workshop series* section of this chapter can be used by others in the interaction design community working in this area.

The 5.5.2 *Workshop One: Introductions* section showed the need to consider how the grouping of students will affect the findings and running of design-led research sessions and the need to consider the range of physical *and* cognitive needs of

participants when designing for this context. The 5.5.3 *Workshop Two: Ways of looking* section showed the need to design tools and strategies to simplify the indexing and sharing of images and other digital media in the classroom. It also showed the need for teaching staff to arbitrate in the storage and selection of images of students that would be shared and that sound could be used to support students to annotate images of their work and activities. The 5.5.4 *Workshop Three: Capturing photos* section showed the importance for students of linking their actions (taking a photo) and the results of that action (reviewing and sharing the resulting image). It also showed the role of digital media in scaffolding the sharing of student's activities and achievements. The 5.5.5 *Workshop Four: Display and share* section showed us that students have little choice in which images are used to represent them, that teachers prefer physical displays over screen based ones and that most of the digital media taken and collected by staff and students is rarely used.

In my individual grounded analysis of the empirical data the following conceptual categories and insights arose. The conceptual category of *Digital Media and Representation* discussed the social complexities involved in the use of digital media to *represent the self* and how it is used to *represent others* in a mixed ability SEN classroom. This resulted in two transferable insights for the interaction community; for designers to negotiate and make affordances for student's and teacher's voices in the development of ICT in SEN classroom contexts and the potential role that digital media has in supporting students to self-advocate. The *Classroom Management* category discussed how the professional practice and pragmatics of a mixed ability SEN classroom influence the requirements of tools for using digital media in the classroom. This category resulted in a transferable insight that designers must design for active classroom management when developing ICT in this context.

The final category *Reflections on Approach* discussed the research approach taken. This study was conducted using a multi-disciplinary team workshop based approach. This approach had certain advantages and disadvantages for the research. I was able to draw on the skills and experiences of my fellow researchers and during the workshops we could collect a range of detailed evidence. At the same time the large number of researchers meant we inevitably affected the everyday interactions that would occur in the classroom that we sought to study. The workshop series enabled us to gain some important design insights and in turn led to the development of the novel sorting tool. It meant however that we brought new photographic practices into the classroom that had not existed before our interventions and so our aim to understand existing practices was impaired.

In light of the findings of this chapter the next study places a single researcher into a special needs classroom for some weeks before using the photo-sorting console as a design intervention. It begins with the insights gained during the last two studies, that supporting students to make choices about how they are represented and to have the opportunities and tools to represent themselves is an area that can be supported through digital media practices. It starts by identifying existing situations in the school where photography is used by students to represent their ideas and achievements to others. It then redesigns the photo-sorting console through an iterative process of design testing and remaking to support a small group of students to represent themselves during two different and important end of school year presentations.

6 Study 3: This year I have…

6.1 Introduction

6.1.1 Overview

This chapter details an embedded design-led study that considers the social and design implications of using digital media to support self-advocacy for children with special educational needs in a mixed ability classroom using a series of creative narrative workshops. It presents a detailed case study of the research and design process and a set of qualitative insights, developed through a grounded and iterative analysis process, concerned with the social role and implications of using digital media to support self-advocacy in a mixed ability special educational needs classroom environment. The study adds to the continuum of knowledge and discourse around the development of digital tools to support communication and identity formation for children with special educational needs in the HCI and interaction design communities.

6.1.2 Motivation and aims

Study 1 – *The Scented School* considered the interaction design processes that occur in a SEN school from the perspective of key staff members and an embedded interaction designer. The insights developed in the study showed the importance for students' emotional and educational development, of providing the tools and opportunities for sharing their achievements with people of significance to them. The next study, Study

2 – *My photos, your photos*, investigated the social role of digital media as a means to support interpersonal communication in a mixed ability special needs classroom. The design-led, experience-centred design approach led to a series of design considerations for a photo-sharing console that were grounded in the shared experiences of the research team and participants. Both studies have provided insights into the social role and pragmatic 'situationally constrained choices' (Cuban, 1986) that need to be made when developing digital media technologies for a mixed ability SEN classroom environment. They also demonstrate the importance of taking an embedded, grounded approach to collecting and analysing empirical evidence in a SEN school context as a means to ground design and research findings in the lived-experience of participants.

This study builds on the findings of the first two studies to investigate from a different perspective the social role and social implications of supporting students to use digital media as a form of self-advocacy. This study aims to:

- Provide a case study of a design led research project that considers how we design and integrate digital media into a mixed ability classroom environment as a means to support students with special educational needs to self-advocate.
- Develop, through a grounded theory analysis, qualitative categories that provide insights for the interaction design community into the use of digital media for self-advocacy in this context.
- Reflect on the research and design approach taken in this study.

6.2 Approach

6.2.1 Methodology

The methodological approach in this study follows from the approach taken in Study 1 – *The Scented School* and Study 2 – *My photos, your photos* and discussed in detail in *Chapter 2- Position* and *Chapter 3 - Background and literature review*. This third study takes an embedded, design-led and experiential approach and uses the participatory methodological position of experience-centred design (Wright & McCarthy, 2010) and the grounded analytical an inductive methods of grounded theory (Charmaz, 2006; Glaser & Strauss, 1967; Strauss & Corbin, 1998) to provide research that is grounded in a deep knowledge of the mixed ability SEN classroom environment that is the focus of this thesis.

The design approach starts by embedding the designer within the context and with the participants that they are designing for. The design is then developed iteratively through a series of design sessions, which are reflected on and used to further develop the system. Both the design and research approach taken in this study are backed by a deep understanding of the context developed through the time spent working within the schools.

6.2.2 Methods

This study was conducted over a single school term from the 3rd of June 2013 until the 25th of July 2013. Over that time I worked with six boys from Nick's class in the primary department of the school. Over the seven weeks that the study ran I worked for three weeks as a teaching assistant (TA) supporting the class and collecting images with the participants, led five sessions with the prototype consoles, led a session presenting the resulting student presentations and two days conducting follow up interviews. The main data collected in this study was:

- Observational notes written in my own short hand during the sessions which were then written up more fully away from the classroom in a quiet office space in the school.
- Informal conversations with staff at the end of the days I was present. The majority of these were not recorded but instead written up as notes immediately after the conversations.
- Transcripts of recordings of *design dialogues* with the school's interaction designer, David and class teacher Nick. The important thing to highlight here is the fact that these were conversations where I worked closely to develop and reflect on the sessions with the class teacher as much more informal *design dialogues* rather than a more formal interview style. This ensured that as the project progressed I was able to define and reassess the aims of the research and designs I was creating with the participants and to clarify what the participants and the school expected to gain from working with me.
- Transcripts of semi-formal, open-ended interviews with class teacher Nick and student Leo after the student's annual review. Video recordings taken from a single camera during the prototype video console sessions.

As with the first study I used an iterative, grounded coding method to analyse and inform the main insights at the end of this chapter, the study, my interview questions and workshop approach as the study progressed. At the end of each week's sessions I

transcribed any interviews and typed up my observational notes and used these as a basis for my initial coding. As I collected more empirical data I was able to focus the codes into more refined themes, which in turn informed my conversations with students and staff, the design of the console and my approach to the workshop sessions.

During the coding process I asked a colleague working in the same field of interaction design for children with SEN to code small sections of my observational notes and interview transcript. We then sat together and talked through our different coding schemes. I wrote short memos for the different themes and talked these through with my colleague and used his feedback to again reform and refine my coding. At the end of the study I brought all of my coding data into a single code map, which was refined to produce the themes that in turn inform the main insights set out at the end of this chapter.

6.2.3 Dates

Date:	Activity:
Week of the 3th June 2013	Initial visits: Introduction, teaching assistant (TA) work, photos, interview with Nick
Week of the 10th June 2013	Initial visits: teaching assistant (TA) work, school festival, photos, TA support
Week of the 17th June 2013	Initial visits: teaching assistant (TA) work, trip to the City Farm, group photo sharing
25th June 2013	Workshop Day 1 – Console 1 Session 1 - William and Dan Session 2 - Oliver and Richard
27th June 2013	Workshop Day 2 – Console 1 and 1-Wire Tag reader Session 1 - Dan Session 2 – Leo
4th July 2013	Workshop Day 3 – Console 2 Session 1 - Leo Session 2 – Mark
9th July 2013	Annual review presentation, Leo
25th July 2013	Presentation to class by students about their year

6.2.4 Participants

Students

The following section provides a short narrative style paragraph about each of the students that participated in the study. This is a very small sample of students but by providing detail about each student the reader is given some insight into what happened and why during the workshop sessions. The narrative style is used to provide the reader with important information about the abilities and particular needs

of the students without focusing on their formally diagnosed impairments and medical conditions. This information has been gained through my time spent with the students and through conversations about them with the class teacher and teaching assistants.

Leo – Male, 12 years old

Leo is a friendly and excitable student who can struggle with focus. He joined Nick's class and the school at the beginning of the school year having come from a local mainstream primary school. Nick described the student's time at the previous school as being 'horrendous" and told me that he was very shy when he first joined the class. Over the year he has regained a lot of confidence to the point where he can become over animated and disruptive to the rest of the class. He has a light speech impediment and can speak very eloquently when prompted. He struggles with literacy skills such as reading and writing. Whilst he doesn't have any physical impairments he does present a range of subtle emotional and cognitive impairments that are not obvious when first meeting him.

William – Male, 13 years old

An engaged student who is chatty, friendly and who supports other students when they require it. He is very engaged by technology and is he first to volunteer when I ask for any help with setting up or breaking down equipment.

He has a degenerative physical condition, which means he requires the use of crutches if standing for a long time. His condition affects his fine motor skills but to what extent varies from day to day. He has some moderate learning difficulties, which become more apparent when asked to do more pressured tasks such as demonstrating skills or ideas to others, though this is also affected by his difficulties with speech.

Dan – Male, 12 years old

A friendly student who presents a range of challenging behaviours and will often choose to ignore instructions from staff. He gets excited around technology and will methodically test every button and function on any new system presented to him. He has no physical impairments but his behavioural and emotional impairments makes working with him with other students a challenge.

Oliver – Male, 12 years old

A very quiet student who takes time to listen to instructions and will engage in activities if given space to work things out for himself. He can struggle in group

situations, as he needs to be prompted to talk and try things out in front of others. He has difficulty with his fine motor skills which can affect his use of technology though will resist physical support from staff.

Mark – Male, 13 years old

A likeable young man who is very enthusiastic about any task you set him. He has moderate learning difficulties, which can cause his focus to drift from the task at hand but can be brought back with some encouragement and time. He has some serious difficulties with literacy, which means he is unable to read and write without a lot of support from others. He sometimes wears ear mufflers to help him focus as too much background noise can on some days lead him to get very distressed. He is able bodied but his terminal illness sometimes requires that he leave the room for coughing fits and in some severe situations to spend time with the school medical team.

Richard – Male, 12 years old

Is a very chatty and engaging student who responds to instructions and works well with other students, though can dominate when paired with quieter students. He has difficulty with memory retention and has to be reminded of events that occurred as recently as a few hours previously. He presents moderate learning difficulties but is physically very able. He becomes most animated when talking about his activities with friends and fellow students.

6.3 Background

In the following section I consider discourses around the use and development of tangible interface design and augmentative and alternative communication for children with special educational needs. These two areas of HCI are considered as a means to frame my approach to the design and my design choices for the prototype photo-sharing consoles developed during the workshop series.

6.3.1 Tangible User Interfaces and children

Tangible User Interfaces (TUIs) are physical, graspable forms embedded with digital technology that allow people to interact with computer technologies in novel ways. (Ishii & Ullmer, 1997) Ishii and Ulmer describe TUIs as 'augmenting the real physical world by coupling digital information to everyday physical objects and environments''. (Ishii, 2008, p. 236) TUIs as a field arose from HCI with overlaps in the fields of psychology and interaction design. They are developed as a means to imbue physical

objects, through the use of digital technologies, with the possibility of manipulating digital and physical actions. (Ullmer & Ishii, 2000). TUIs have the ability to engage people across multiple modes of perception such as sound, sight, and touch. (Antle, 2007a; Hornecker & Buur, 2006; Ishii & Ullmer, 1997) Zamen et al. discuss the usability benefits of tangibles in terms of learning, collaboration and fun. They discuss the potential of tangibles to support collaboration as arising from people having equal and shared access to interacting with a system. They argue that the learning benefits to children of tangibles stems from links between cognition and concrete manipulation. (Zaman, Vanden Abeele, Markopoulos, & Marshall, 2011, p. 368)

The pedagogical value of manipulating objects has been shown since at least the beginning of the last century by Maria Montessori "'Children build their mental image of the world, through the action and motor responses; and, with physical handling, they become conscious of reality.'' (Burnett, 1962) and in the later work on computers and learning of Seymour Papert (Papert, 1984; 2005). The constructionist philosophies underlying this work is seen in the early tangible studies in HCI: Eisenberg et al.'s (M. Eisenberg, Eisenberg, & Gross, 2002) digital enhanced construction sets and Resnick's digital manipulatives. (Resnick et al., 1998) More recently the positive contribution to learning and social development for children using digital, tangible interaction has been shown by a number of studies. (Horn, Crouser, & Bers, 2012; Soute, Kaptein, & Markopoulos, 2009; Zuckerman et al., 2005).

Lucchi et al. describe the advantage of TUIs over graphical user interfaces in the classroom as being able to "exist outside of the space defined by the projection screen" providing tactile, audio feedback in addition to the visual. (Lucchi, Jermann, Zufferey, & Dillenbourg, 2010) Zuckerman et al. discuss the advantage of tangibles in classroom environments over GUIs as stemming from the improvised accessibility of the interaction and building on every child's existing experiences and skills in manipulating the world. (Zuckerman et al., 2005) Other work has considered the implementation of TUIs in real word educational environments. Parkes et al., through a longitudinal study of the 'Topobo' augmented assembly set in multiple contexts, consider how the complex interplay between educators, students, context, time spent working with a system and age of participants influence the success of embedding systems in classroom environments. (Parkes, Raffle, & Ishii, 2008)

The development and use of TUIs for children with special educational needs has been shown to support their social and educational learning in a number of different ways.

Research has included studies of the impact of TUIs in supporting collaborative learning and the development of social skills for children with special educational needs. Farr et al. show how a tangible, digitally enhanced construction set supported children on the autistic spectrum to engage in more social and collaborative behaviours than when playing with conventional Lego, suggesting that TUIs encourage social interaction by allowing for a broad range of interaction styles. (Farr, Yuill, Harris, & Hinske, 2010) The powerball system showed how a TUI, an augmented reality pinball machine, was used to encourage play and social cohesion in a group of mixed ability children. (Brederode, Markopoulos, Gielen, Vermeeren, & de Ridder, 2005). Hengeveld et al. consider how tangibles can support socially anxious children to integrate with their peers by developing a tangible system for toddlers with multiple special needs. They argue that the benefits shown in their study are affordance of the TUIs they created; the opportunity for facial, gestural and verbal expression, and being closer to toddler's typical mode of exploration than GUIs. (Hengeveld et al., 2009)

In her work on supporting children through tangible interactions, Antle argues that the social functions of tangibles as points of meaning and representation are as important as their technical function. She shows that the feedback loop created between children and TUIs affords social interaction as they discuss the potential play outcomes of a TUI's use. In turn expressive activities occur when the TUI enables children to present new meanings by creating structures in the form of stories and models. (Antle, 2007a) In their case studies on interactive tangibles for storytelling, Garzotto and Bordogna (Garzotto & Bordogna, 2010) demonstrate how TUIs can support children with a range of special educational needs to create multi-media narratives resulting in a number of emotional, cognitive and social developmental benefits.

6.3.2 Designing Augmentative and Alternative Communication technologies for children

In the following section I consider literature concerned with the development of Augmentative and Alternative Communication (AAC) technologies for children with complex communication needs. AAC is a field of HCI research that aims to develop technologies that support children with complex communication and educational needs to access modes of communication appropriate to their abilities. Light and Drager describe the potential of AAC technologies for children with special educational needs to:

> Maximise their development of communication, language and literacy skills, and attain their full potential. (Light & Drager, 2007a, p. 2)

This literature offers insights into the challenges of improving the user experience of children with special educational needs when using assistive technologies and offers empirically based design recommendations for the development of tangible interfaces to support them. A key finding of AAC research is that children with special educational and development needs rely on a wide range of modes to meet their communication and social needs. (Binger & Light, 2006; Blackstone, Williams, & Wilkins, 2007; Light, Collier, & Parnes, 1985) The choice of the mode they use is based on the context, partner, task, facilitation and intent. (Blackstone & Berg, 2009) If children with special educational needs require multiple modes to communicate and express themselves then how we design technologies to support multiple modes of communication is of vital importance.

In their position paper on the current and future state of AAC technologies, Light and Drager argue that to better meet the needs of children with special educational needs we need to enhance the appeal and reduce the learning demands of technologies through the use of developmentally appropriate design elements; layout, representations, navigation, colour, materials, facilitation and feedback. (Light & Drager, 2007a, p. 10) Light and Drager argue that attending to the user experience and design elements of technologies leads to technologies that are more appealing for children with special educational needs and reduces the learning demands placed on the child. Increasing the appeal of technologies for children offers, they argue, three important benefits: children are more likely to use AAC systems they find appealing, children's peers are more likely to be accepting and engage socially with those children and thirdly, children are more likely to view themselves and their use of assistive

technologies in a positive light if those technologies are aesthetically appealing and simple to learn and use. (Light & Drager, 2002; 2007a)

The other measure that Light and Drager (Light & Drager, 2007b) highlight for improving the user experience for children, is the reduction of the learning and attention demands of technologies. When using technology to support communication, children with special educational needs must coordinate their attention across multiple modes and activities (partner, self, technologies, shared activity). (Blackstone et al., 2007) The difficulty of coordinating these multiple points of attention becomes more acute for children with special educational needs than their typically developing peers due to their physical and cognitive difficulties. Cress (Cress & Francisco, 1999) in their study of augmented play and children with special educational needs, recommends two ways to reduce the attention demands for children with special educational needs: reduce the complexities of tools, reduce the number of tools and integrate the communication system into a play or learning activity all of which reduce the total number of attention points required. In their empirical study comparing existing AAC systems for children and the design of popular toys for children, Light et al. suggest design features that can increase the appeal of AAC technologies. (Light, Drager, & Nemser, 2004) These design suggestions cover the use of colour, materials, layout, movement and action. In the following section these are discussed with reference to other literature in order to ground my initial design choices for the photo sharing console developed in this study in relevant theory. I then return to the AAC and tangibles literature in the discussion section of this chapter to frame my subsequent design decisions in light of my shared experiences in the workshop series.

6.4 Design rationale

The starting point for the console in this study was the system developed for *Study 2: My photo, your photos*. Whilst it shares many of the design attributes of the console used in study 2, the new console was totally redesigned using different electronic components, buttons, switches and software. Whilst I thought the triaging, physical interface and audio annotations functions of the console were all interesting areas for development, there were a number of reasons for not simply using the original console. The most pressing issue was that I was moving from a team based research project which resulted in a collaborative design to a single researcher based project in a different classroom context. Developing a new console from scratch ensured that ownership and design of the console was solely mine. All of the design and technical

aspects of the system were developed and understood by me and during the iterative development of the console during the study I was able to make any adjustments needed. I was also able to reconsider and re-evaluate all of the aesthetics and materials used in the design of the console.

The colours used for the buttons, the main body of the console and GUI design for the photo-sorting console were carefully considered. Research has shown that children prefer toys that use a range of five colours or more, (Light et al., 2004)and that children under 10 typically prefer primary and bright colours like red, blue, yellow, green, orange and pink. (L. M. Walsh, Toma, Tuveson, & Sondhi, 1990; Zentner, 2001) Kovach & Kenyon show that using bright, primary colours can improve visual attention to digital systems. (Kovach & Kenyon, 2003) Wilkinson and colleagues have conducted a series of studies that demonstrate the important role that colour cues play in memory and visual processing and that colour is an essential means to designate different functions of an interactive system for children (Wilkinson & Jagaroo, 2009). I selected bright colours with enough distinction in hue between them so that it was clear that each button had a distinct function. I then used the same colours for the text and symbol for each button. This was then replicated in the symbols and navigation system on the software GUI to ensure consistency across the physical console and screen.

Scally notes in her work on the implications of visual design in UI that colour is not the only display variable that can influence learning and use in the design of physical interfaces, and that choices concerning background colour, pattern, type font, texture and size all have implications (Scally, 2001). With this in mind and noting the importance of multiple modes of communication to support children with special educational needs I used a combination of accessible font and raised plastic symbols to denote the function of each button on the console. The Infant Sassoon font I used on the console and associated resource was developed, and has been evidenced, to increase reading speed and comprehension for children, including children with special educational needs over more typically used fonts. (S. Walker & Reynolds, 2003; A. Wilkins, Cleave, & Grayson, 2009). This use of text, colour and icons allows for multiple modes to denote and distinguish between functions on the console.

Treviranus and Roberts {Treviranus:2003w p231} contend that the use of touch screens in technologies for children with special educational needs, are increasingly being used due to the cost and simplicity of manufacturing them over switches with kinetic feedback. In his seminal book on *The Design of Everyday Objects*, Norman (2013)

shows that when feedback between the system and child is delayed their learning is impeded as they are then unable to develop an appropriate conceptual model between the systems operation and the outcome of their actions on the system. Taking this into account and the potential of using materials from toy manufacturing in AAC systems proposed by Light et al. (Light et al., 2004), I considered a wide range of types of button and materials for the buttons for the controller. I settled on a specific 'competition' grade arcade button, which contains a small and highly robust micro switch, which is designed for long term use in public spaces. These buttons are cheap, reliable, and robust and came in the range of colours that matched the acrylic I was using. What I was looking for was a button that gave a clear tactile response when pressed as I found in the previous study that when users were unsure as to whether they had pressed a button on the console it led to unintended interactions with the console. I used a commercially available arcade PCB to send signals from the buttons and switches to the main software. This was used as it was cheap, reliable and was designed to work specifically with the arcade style buttons I used on the console.

My choice of materials for the tops and main body of the consoles was shaped by the need for materials that were durable, inexpensive, quick to redesign but at the same time aesthetically pleasing so as to appeal to students and staff. I used acrylic for the top part of the consoles and for the raised symbols and text for the buttons. Acrylic is a non-toxic, rugged, cheap, waterproof and thus wipeable material that is hard to break. These qualities are all essential for the physically intensive environment of a mixed ability special educational needs classroom. It is also a material that works well for laser cutting, which allowed me to quickly and precisely create different designs over the duration of the study. Acrylic is readily available, comes in a range of colours, thicknesses and is cheap, an important consideration when self-funding the studies. The main base of the consoles was built using birch plywood. As with acrylic this is a cheap, durable material that can be easily sourced and laser cut. It can also be sanded and stained to produce an attractive and engaging quality.

In order to reduce the attention demands of the system for my participants I ensured that it was quick to set up, was made up of as few modules as possible and contained a minimal amount of components. I built a USB hub into the console into which ran the card reader, PCB and microphone. I wrote a custom piece of software so that I could add or remove functions as I developed the consoles in response to my experiences working in the classroom. I used my own laptop as this allowed me to work in different parts of the school with students and meant I could ensure that I had a stable environment with the correct software and plugins. The school has a highly restrictive policy on adding new programs and plugins to the classroom computers.

6.5 Workshop series

This section describes a series of design-led workshop sessions with children in a mixed ability special needs classroom environment using digital photo-sorting prototypes as a means to consider how digital media can be used to support the sharing of achievements and to express preferences in matters that concern their lives. The workshop series was part of my participatory, design-led method of inquiry and was used as a means to embed myself as a researcher and designer into the mixed ability classroom context under study. There are six sessions that make up the workshop series which resulted in students presenting annotated photo slideshows in class to their peers and family and a student presenting their achievements in their annual review. For each of the workshops I provide an overview of the prototype used in the workshop, describe the individual sessions with students, reflect on the insights that arose from an analysis of each session and include a brief discussion of how each session informed the next.

6.5.1 Preliminary visit

As has been shown there is a growing number of studies that call for the participation of children with special needs in the interaction design research process. (Druin, 2010; Frauenberger, Good, & Alcorn, 2012a; Iversen & Smith, 2012; Read et al., 2002) In the previous two studies I have demonstrated the importance of working with teaching staff and students to develop *meaningful emotional encounters* (Wright & McCarthy, 2010) as a means to incorporate the lived-experience of participants (Hammersley & Atkinson, 2010) and understand how the existing social actions and structure that exist within a class can be incorporated into the design of interactive resources for SEN classrooms.

My methodological approach was inductive and grounded. I began my study by working as a participant within the context under study. This was done as a means to develop a focus for the study that was grounded in my shared experiences with my participants and as a means to familiarise myself with my participants. I returned to the Delmore school at the very start of the summer term. I worked for the first three weeks as a teaching assistant with the class. This allowed me to re-familiarise myself with the students and staff and the physical layout of the classroom. It also allowed me to discuss and mould the study so that it complimented the aims and activities planned for the class that term.

At the end of my first day with Nick and his class I presented the first iteration of the photo-sorting console from *Study 2: My photos, your photos*. We spent some time discussing how the study might be integrated with the activities and outcomes that he had planned for his students that term. We also conducted a formal interview in which we discussed the importance of providing the tools and opportunities for students to have their opinions listened to. Our conversation led us to identify a group of students and outcomes for those students that would be useful for informing my work on self-advocacy and digital media and benefit directly from the research process.

The group of students we identified were six boys who were all due to move up to the secondary school at the end of the school year. As part of their personal development and English language work that term the students had been asked to create a short document or presentation about their achievements that year and their worries and hopes for their move to secondary school. We decided that the console with its photo sorting and audio recording capabilities would be a great tool for the students and myself to use to develop these presentations.

Nick thought that Leo, a student who had only joined the school at the start of that school year, might particularly benefit from the workshops. At the end of the term the student was due to have his annual review, which was a meeting where the school, his guardians and other members of his support team would decide on what support he required over the next year and most importantly if he was to remain at the school or return to mainstream education. Nick made it clear how important it was for students to be given the support and opportunity to have their opinion about their care and education heard within that meeting so asked me to work with him to develop a presentation, which he could present at the meeting.

These two presentation opportunities allowed me to design a series of workshop studies that would both help me to understand the social complexities of designing to support self-advocacy through the use of digital media and provide a clear, advocacy based goal that myself and the participants could work towards.

In order to develop a set of photographic material to work with and to embed myself further in the class I decided to work with Nick and his class teaching assistant for three weeks before beginning the workshop series. I worked as a teaching assistant alongside the two other TAs, both of whom I knew well from my previous year's work with the class. Each week I worked with students to document each other using the class's iPad and digital camera. The first week was fairly typical with maths class, drama and other activities. During the second week the primary school had organised a musical festival with Nick's class making fresh pizza and performing in the music tent. During the third week we spent one morning visiting a city farm, which provided some exciting photo opportunities.

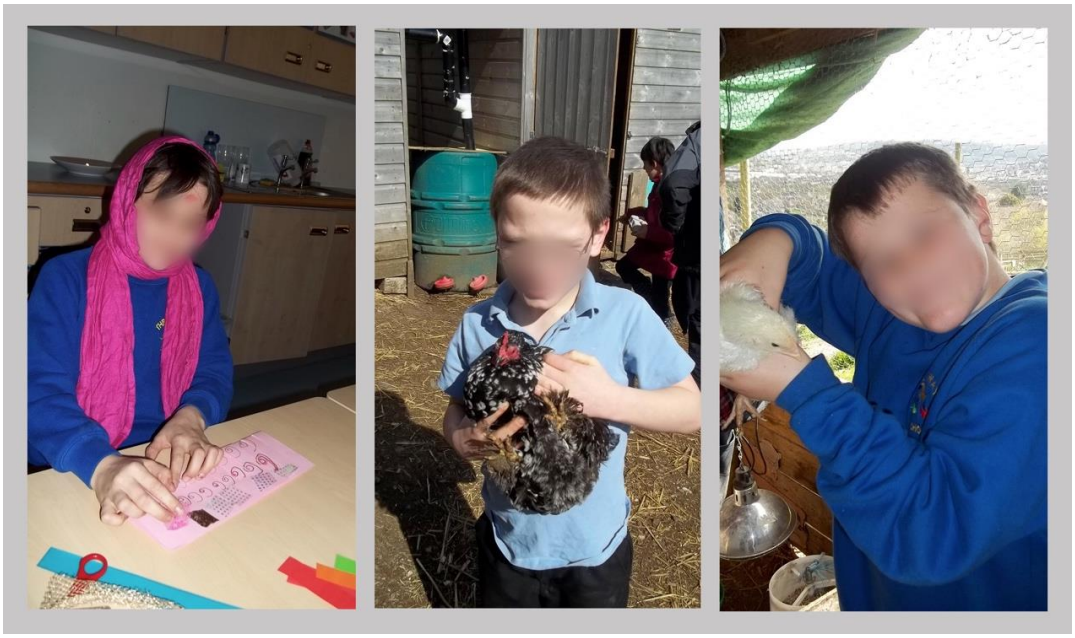

Figure 16 - Photos taken of students during the course of the study

Towards the end of my third week working as a teaching assistant with the class Nick asked the students and myself to go through the images we had been taking over the previous three weeks. This activity was done using standard classroom equipment and demonstrates well an existing strategy used by the class teacher to review photos taken of and by his class.

The class was seated in a semi-circle around the digital white board, which Nick had hooked up to the iPad we had used to take photos over the last three weeks. Sitting at his desk, to the side, Nick moved through each image offering his own commentary and inviting students and TAs to provide their comments. Around ten minutes into the activity Nick was called away from the class by another teacher and he asked me to carry on the activity. This gave me the opportunity to work with the students as a group and to see what kind of response I could get from the group. At the end of the day I spent some time talking with Nick about the photo reviewing session.

Nick mentioned that he carried out these photo review sessions every two to three weeks with the class. He said there was a range of reasons he would do this. As Nick explained, the majority of students in the school had serious memory retention problems to the point that they would need to be reminded of what they had been doing in a morning session, in that following afternoon. These reviews helped to remind students about the activities and experiences they had taken part in. It also enabled students to share their experience and gain praise for their achievements with the rest of the class. When Nick was creating wall displays and presentations, the comments made during the review and the students' responses helped him to make choices about what images to share and what to say about them.

At the end of the three weeks I felt I had returned to the relaxed and accepted position I had gained working with the same class the year before. Whilst there were some changes in the students, the TAs and class teacher and the physical space were the same. We had also identified a group of six students to work with and two outcomes for the studies that would benefit both the students and my research: a set of presentations that the students could give to the class about their move from primary to secondary school and a presentation by a student about his achievements that year during his annual review.

The workshop sessions were structured as small group interactions with two students taking part in each session. This use of small groups of students compliments the findings of Mona et al. of the importance of small group interaction to engender active engagement in co-design and testing with children. (Guha, Walsh, & Foss, 2013b). The small groups also supported an informal, flexible approach which was integral to encouraging students' interest and participation in the sessions.

6.6 Workshop 1 – Console 1

This session was design to introduce the project to my participants and to use the first iteration of the photo-sorting console to review the photographs that we had taken as a class over the past three weeks. It was also an opportunity to add a commentary to the students' chosen photographs using the audio annotation function. The workshop was split into two sessions with groups of two students working with me and the console during each session and was conducted in the participants' base classroom. For this session I was originally supposed to work with five students in groups of two with the remaining student Leo, working with me on his own. Leo was going to work with me on his presentation for his annual review but unfortunately was taken out of class and excluded from the session due to his bad behaviour that day. The class teacher was apologetic but said that it was important that any sanctions that had been promised were taken if Leo misbehaved in the fairly serious manner that he did.

This left me with four students to work with who had been put into pairs by the class teacher. The choice of students and partners, as mentioned at the start of this chapter, was based on pairing together students who had not always worked well together in the past, as the teacher felt that this activity might serve to help them develop a positive relationship. Before the individual sessions started I talked with the four students together. I explained that they would be helping me to develop a tool for students like them that would help them to select and talk about things they had done and photographs they had taken. I then told them we would be giving presentations about the activities we'd been doing that year to show to the class and our parents at the end of the term. This led into a discussion facilitated by Nick about what they had enjoyed and achieved that year and what they were looking forward to and were anxious about in their move to secondary school.

6.6.1 Prototype overview

This session introduced a prototype photo-sorting console without any function for associating images with RFID or One-Wire tags. The console allowed students to move between images and choose if they liked the image or not. They could then use the record function to record a short audio commentary about the image. The console had a turning function to rotate images that unfortunately wasn't working on the day. The software for this session allowed students to choose to keep or not keep images using the yes and no buttons on the console, filter the images by those images they had said yes or no to on the console and to save the project data for reviewing later.

Figure 17 - Screenshot of the sorting software showing an image that a student has chosen to keep and with a symbol indicating an audio recording of their voice is attached to the photo

Figure 18 - First iteration of console with no RFID reader.

6.6.2 Session 1 - William and Dan (20 minute)

This first session was fairly short (20 minutes) as both of the students had medical appointments that I was unaware of until just before the session started. The two students didn't always work well together but both seemed excited to be included in the study.

We worked in the corner of the room next to the 'quiet time' chair that was used for students who needed some time away from the rest of the group. I placed the console on a semi-circular table with the laptop and console within reach of the two students. The software was already loaded and the console plugged in. I recorded the session using a video camera on a high tripod that was clearly visible for the participants.

At the start of the session I showed the students how the console worked by asking them to try out the different buttons to see what happened. They seemed to pick up the functions of the different buttons quickly. At one point William pointed out that an image was upside down. He asked if there was a button to correct this. Whilst there was in the console I explained that the wiring for the button had broken on the way to the school that morning and that I would have it working for the next session. When recording the audio annotations, we started by recording ourselves making stupid noises. What was quickly apparent from this was that the students were unaware of where the microphone was and, with no countdown for the recorder, when to start speaking and when to finish.

We worked through and made choices about 92 photos. These included the images we had taken over the previous three weeks as well as photos Nick had given me of the students working during that year. We managed to sort through and select five images for each student. We then were able to record simple commentaries about those images.

The session ended abruptly with the TA James coming over and reminding the students of their medical appointments. The students left and I ensured I had stored the images and recordings for the next week to review and order for the presentation and then wrote up my observational notes of the session.

6.6.3 Session 2 – Oliver and Richard (1 hour)

We started the session by talking about the project again and the presentations we were aiming to make. I introduced the console and the software by using the images

we'd collected as a class over the last few weeks. I worked with two students Oliver and Richard. There was an interesting dynamic between the students in terms of turn taking and figuring out how the console worked. Richard was the more dominant of the two and began by pressing every button on the console before focusing on moving back and forth between the images but seemed to struggle with the concept of moving backwards as well as forwards through the images. I had to interrupt Richard and ask him to let Oliver have a go on the console as he had been sitting patiently watching. Oliver immediately used the forward and backward buttons on the console to find an image of Richard at the farm earlier in the week. He then showed Richard how he had moved backward and passed the console back to Richard to have a go. This initial turn taking showed that although Oliver was the more passive participant he was watching Richard and able to help him with using the console by demonstrating and getting him to try out what he had showed him.

Whilst reviewing our images I talked about the kinds of buttons that we might add to the console. I started by asking questions that were too leading. That is, they would simply mimic what I had suggested as a starting point. After a while though Oliver suggested a button that would 'make us look like aliens or funny'.

Around 20 minutes into the session it became obvious that the students were becoming unfocused and agitated. As I talked to them it became apparent that whilst they recognized the different activities in the photographs that they had taken part in (the festival, city farm, classroom activities) they didn't remember taking any of the images themselves (though I worked with both of them taking images at some point).

Instead of carrying on with an activity they had stopped focusing on I decided to take them outside to think about and record places and activities in the playground that held a special significance for them. I decided this on the spur of the moment as I needed to engage the students and the activity I had planned was failing to do this. I spontaneously made up an activity that I called 'Think, Chat, Snap'. Students were asked to do three things. Think about a place that held a good memory for them, Chat about where it was and why and take a Snap of the place to remind them.

The classroom opened out onto a small paved area then into the much larger primary playground. We went out and after some initial running about, which was needed after sitting in front of a screen for 30 minutes, the students found, talked about and photographed several spots in the playground with positive memories. Whilst we

carried out the task I was constantly talking to the students about why they liked a certain activity or area and what memories they had of it. Not all of the images that the students took had any particular significance but they enabled me to start conversations about their school year. It also gave us a body of images to review back in the classroom. We took around 120 images in 25 minutes. At this point we returned to the classroom.

When we returned to the classroom I was able to quickly load the images onto the computer having used a low file size setting on the camera. The students were then asked to go through each of the 120 images and choose whether they would like to include it in their presentation or not. We then spent time using the recording function to add commentary to the different photos. As with the first session the students struggled with the timing and lack of a focal point for speaking into. At the end of the session we reviewed the images and again the session ended abruptly when Oliver decided to stand up and join the others in the class who were spending free time with a set of iPads. Though Richard stayed for a few minutes it was clear he wanted to join the rest of the class and so on my suggestion he did. At the end of the session I stored the video, images and recordings and left to write up my notes on the session.

6.6.4 Reflections

These sessions raised an important issue about how I planned and ran my design-led research tasks with the participating students. The two sessions had to be adjusted in different ways in response to classroom issues that occur regularly in this environment, that a teacher would be expected to respond to and manage flexibly. The first issue was one of communication. When working in a special educational needs classroom, students often require medical appointments at short notice meaning they won't always be available for planned research sessions. Having an agreed form of communication with the class teacher that lets them notify you of any last minute changes to student's availability or other issues is important.

The second issue was one of behaviour management and engagement. In the first session Leo was excluded from participating due to his behaviour previously in the day. This meant I was unable to work with him but demonstrated that a teacher's decision about student management will sometimes supersede the needs of your research. In the second session I had to quickly respond to the students' lack of engagement which I determined was due to the length of time they were sitting and the disconnection between their actions and the photos we were using.

Going outside and using the Think, Snap, Chat approach that I spontaneously created allowed the students to refocus by moving away from a screen and thinking about their environment by physically moving within it. It also gave us a body of photographs and comments to work with when returning to the session. Helping students to maintain focus and engagement is an important aspect of teaching that is realised through appropriate types and length of activities, support and encouragement. As a researcher and facilitator during the workshop I needed to respond quickly and flexibly to the situations that arose and be able to adapt my approach during the session in order to engage my participants and get them to work towards their goal (of presenting through photographs and sound their achievements that year). I was able to do this because of my experiences of working in the school and by adhering to the teaching and behavioural management techniques used by the class teacher and teaching assistants.

The workshop sessions highlighted several design issues, which the students either expressly pointed out or became evident in observing them using the console; the need for a rotation button that worked, the position of the microphone and the need for an indication of the timing of the recording. When attempting to illicit some design ideas from the students I found that if I asked leading questions then the students simply repeated what they thought I wanted to hear. Through a more relaxed approach in the second session and using more fantastical ideas we ended up with an idea for 'distortion' buttons to use on the photos.

6.7 Workshop 2 – Console 1 and 1-wire tag reader

The next workshop consisted of three sessions: a morning photo taking session using the Think, Chat, Snap approach from the first workshop and then two sessions with single students using the console from the previous workshop and the new 1-wire tag reader prototype I had created. The photo taking session was conducted around the secondary department in the school and the two prototype sessions were conducted in the classroom.

In the morning I worked with three of the five students I had planned to work with (two students were both unavailable due to illness which kept them off school for a number of weeks). The day before, the students had spent half the day in the secondary school being introduced to the teachers, classroom and the facilities they would be using at the start of the new year. Continuing our work on the students' presentations we walked around the secondary school taking photographs with the class's digital

camera. The idea was to take images of places and people that could represent things they were excited and anxious about for their move up to secondary school.

The Think, Snap, Chat, approach provided two important things: material to work through for the presentations and to test the console with, and an opportunity to facilitate conversations with the students about their move to the secondary school which would in turn inform their photograph commentaries.

The students collected a range of material though at times the students would get distracted and try to push the limits of what they could do having been given the freedom to move around areas they wouldn't or hadn't been to before. This included the need to take power tools off two students and moving out of the design and technology rooms.

6.7.1 Prototype overview

Using the insights gained from working with the students and feedback from the class teacher I redeveloped some aspects of the console and software. In the software I adjusted the design to make it clearer when an image had been tagged and audio associated with the image. I then added a three second countdown from when the record button was pressed on the console. A large *recording* symbol was also displayed above the countdown. This was added in order to make it clear when the student should start to talk.

Figure 19 – Tag reader with 1-wire tag reader on left hand side

I created a separate unit, which used the one-wire system[5], this allows the user to link an acrylic tag with an onscreen photograph and associated audio commentary. The reader allows the user to place the metal 'button' on the bottom of the tag into a reciprocally shaped slot. When they then press the record button, the image on screen and any associated sound recordings are associated with that tag. When the tag is located on the reader and the play button pressed the associated image and sound are displayed on screen. This tagging function was designed as a means for students to physically and visually order the images that they had chosen for their presentations. I chose the one-wire system to enable students to clearly see the connection between placing a tag into the slot on the reader and the resulting interaction on screen.

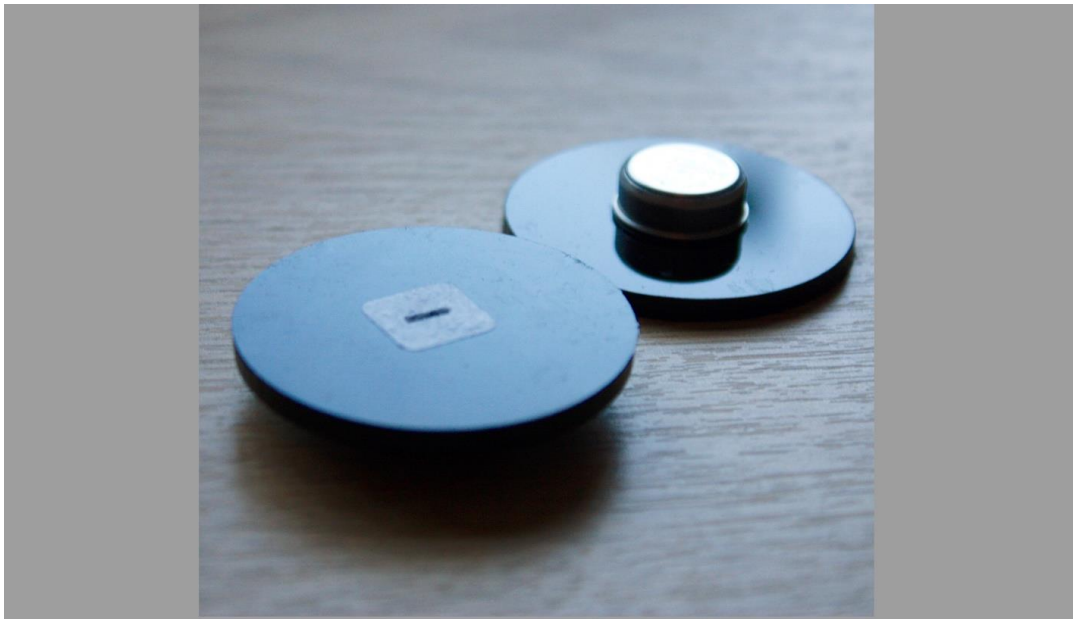

Figure 20 – Close up of 1-wire tags

6.7.2 Session 1 – Dan (24 minutes)

The session was again conducted in a corner of the classroom next to the 'quiet time' area. The console and laptop were placed on a semi-circular table within reach of the student and researcher. The session was then recorded by a single video camera on a tripod to one side of the table.

There were several problems with the setup of the console, meaning I had to reset the software several times and physically open the console in order to adjust and reconnect some of the components that had shifted during a long journey on public transport.

[5] For more details see http://www.maximintegrated.com/en/products/comms/one-wire.html

This took around 10 minutes and during this time Dan became agitated and distracted by other activities going on in the classroom and playground, which he could see, from our position by the classroom window.

Once I had the system working we were quickly able to upload the images from the morning photo session. I allowed Dan time to use the console and see how much he could remember from the previous session. We loaded the previous week's images and recording and Dan decided that he wanted to delete the previous choices and to add the text and images from the morning photo session.

He was then able to quickly move through and tag images and remarked that the recording countdown made it easier for him to use. He still had difficulties with knowing when to start talking once the button had been pressed and when to release the button to stop the recording. He was able though to quickly check what he had recorded and to make a decision as to whether to keep the recording or not. Dan worked through around one hundred images and made a selection of fifteen that he would like to include in his presentation to the class. We used the morning photo session as a way to develop a commentary for the images and I used the notes I had made as a way to prompt his ideas. He managed to record eight commentaries although four of these were somewhat confused and unusable for the presentation.

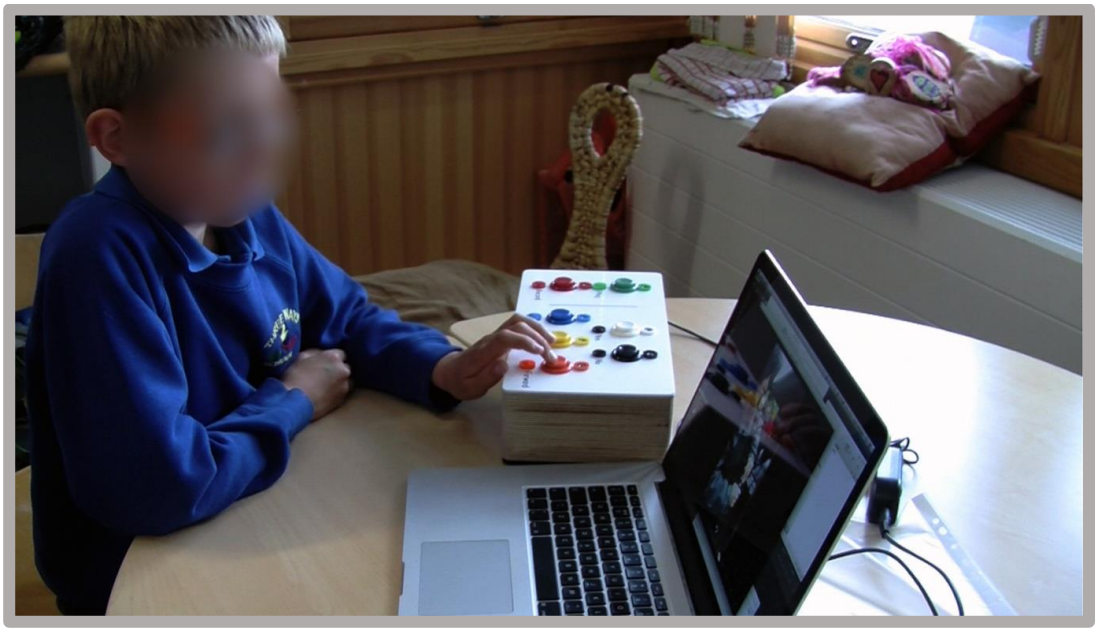

Figure 21 - Dan Working with the researcher

We then tried to use the tag system to make a choice about ordering the images. The system however was still behaving erratically so we used paper again to make tags

instead. I wrote a single word onto a paper tag to remind us which image was which. Using the paper tags we eventually decided on an order though it was confusing for the student as each time we changed the order I wasn't able to instantly find the image on the console and instead had to scroll through the filtered 'yes' images.

Towards the end of the session Dan was keen to show the class teacher and asked Nick to come over. We showed Nick what we had done and Nick was able to talk through the images and commentary with Dan. At this point Dan was becoming distracted to the point that he walked away from the table and joined other students and had to be called back by Nick. We decided that this was a good point to finish. I then had a brief discussion with Nick about preparing the material for the class presentations. We decided that I would create a PowerPoint presentation using the images, commentary and ordering that we had done during the session which Dan could then check and decide on before giving the presentation. When discussing the difficulties, we had with the console Nick highlighted again the importance of creating a supportive environment for the student to present in which the technology being used needed to be, or at least perceived to be, as reliable and as stress free as possible.

6.7.3 Session 2 - Leo (57 minutes)

This was a much longer session and allowed us to make up the lost time from Leo's exclusion in the previous week. We started the session by talking through the images we had taken in the morning session. Using my notes and the photographs we discussed what he was excited and anxious about in moving up to the secondary school. This also led into a talk about what he felt he had achieved and what he was proud of in his year at the school.

The system was set up on the same table as the previous sessions with the console and software preloaded with photographs from the morning session, images from the three weeks I spent with the class and images provided by Nick of class activities from the previous year. I had worked on the console over the morning break and had the sorting function working consistently.

We started the session by setting up a project for the session that I asked Leo to name. He was excited by this and after some deliberation he came up with 'Leo's Amazing Adventure in Krispy Creams'. This was a compromise between his two favourite ideas, (he really likes Krispy Cream donuts!).

I talked through the system and the plan for creating a presentation for his annual review. Leo was excited at the idea of giving a presentation but at this point was more excited about pressing as many buttons on the console as possible. I let Leo play with the console partly for him to explore it but also as a way to test the ruggedness of the buttons and console as a whole. After 5 minutes or so I moved Leo towards the task at hand. That is when we talked through the 'yes' and 'no' function on the console and asked Leo to move through the different sets of images and to make quick decisions about whether or not to keep images for the presentation. We talked about this as the first run through; a way to quickly narrow down the images and remove pictures that were either unsuitable or for example of someone's thumb. Once we had a base selection of images to work through (we moved from over a hundred and fifty down to around thirty), I asked Leo to consider each image more closely and to think about what he might say about each image.

As we moved through the images I prompted Leo to talk about the images using our shared photography session from that morning and our time over the previous weeks as a way of selecting his ideas for the presentation commentary.

I found that I was leading Leo too much when trying to get him to add to the commentary. That is I would first ask him to say something about the photograph, when he didn't respond or have any ideas I would suggest something to say which he would then repeat when asked. What I then did was start by asking him to make a silly noise for each of the images; a chicken for the farm image, a raspberry for another. This seemed to loosen him up a little and get him used to the recording system.

Nick came over at this point and offered us the copy book that Leo had been working on which detailed his achievements and aspects of his work at school that he would like to improve over the next year. This gave us material to start from. What I noticed was that when Leo was left with the system for a while without prompting from me he was able to select an image and record a commentary. Having recorded and listened back to several images and recordings Leo talked about his speech impediment and how strong it sounded on the recording. We talked about this and resolved that he would rerecord the commentaries where he was unhappy about his lisp until he was happy. This seemed to open Leo up and after re-recording the previous commentaries he became really animated when talking through the remaining images with me. There was however a big difference between how eloquent he was when talking to me directly about an image and what he recorded. The recorded commentary would tend

to be fairly short and his speech more formal. The other issue with the recording was the location of the microphone as it was unclear for Leo where he should be speaking. The countdown however seemed to work well with Leo able to record his commentary with little clippings of his words at the start or end of his recording.

Once we had a selection of images with recorded commentary I introduced the tag system to Leo. Whilst the system worked more consistently this time, when a tag was placed on the reader the positioning of the tag and the reader had to be quite exact. Aligning to the reader and tag proved to be difficult for Leo and resulted in the system only working intermittently. This quickly left Leo disengaged with the system.

Having talked with Leo about the idea it seemed that he understood the concept of the tags as a way to represent the images and to create an order for the images, the execution of the system however left him frustrated. The tags were black acrylic discs with a flat number between one and ten written on each. Leo said he found this confusing and that it would have been good if we could draw or write on each of the tags to remind us what they were. We talked for a while about this idea and used the paper tag designs I brought with me on which he drew a picture that represented each photograph. We then talked about creating tokens that were different shapes to represent the different images for the final presentation to the class. We didn't order any of the images during this session leaving this for the following week.

Figure 22 - A selection of photos used in the presentations

By the end of the session Leo had selected around thirty images that he might use in the final presentation and had recorded a commentary for around eight images. This gave us a good start for the session the next week. Once we had the images Nick the class teacher came over and talked with Leo about what we had been doing. Leo was excited about showing the images he had gathered and he talked through what the console did and played the commentary he had recorded. This done, Leo was excused and I managed to talk with the class teacher for 10 minutes or so about the session. He said that he had been watching the session and was impressed by Leo's behaviour and length of concentration on the task as these were both issues that Leo had been working with Nick to improve. He also asked for a copy of the images and commentary so far so that he could review it and use this as a part of his work with Leo that week on preparing for the annual review.

6.7.4 Reflection

These two sessions highlight several issues about the design of the console, the planning and setup of materials and balancing risk and confidence for students sharing their achievements. In the first session not having the system setup before we started and technical issues with the console meant that the session started with the student already distracted and disengaged with the process. This was made worse by having to set up and check the two different units. It also meant that I needed more desk space and more leads to make it work. This highlighted to me the importance of considering the setup time and reliability when designing for the classroom. This may be an obvious point but if teachers are to use an interactive resource with students they need to be able to setup and use the resources without it disrupting the flow of their teaching or the students' engagement with an activity. As a designer, paying attention to details such as the length of cables, the amount of units that need to be switched on, adjusted and configured will lead to design that is useful and more importantly used in the classroom. Preparing for failures through contingent strategies when facilitating students' use of interactive resources, as in the paper tags I used, is another important consideration when developing and testing resources in this context.

The Think, Chat, Snap session in the morning provided a useful structure for the two sessions. As this was the first session on the console for Leo, the morning session helped to provide structure and helped Leo to understand what was being asked of him. I found again that using leading questions meant Leo's commentaries ended up being more about what I wanted to hear or had suggested. Using the playful tactic of

making noises for the photographs helped Leo to learn how to use the functionality of the recording button as well as relaxing and opening up more about his ideas. Giving Leo space to talk and think about the photos rather than pushing him to record answers combined with the material he'd already created (the book Nick introduced) led to some interesting commentaries. With Dan I was able to draw out more ideas from him than in the previous session using the notes and conversations we'd had in the morning session. This shows the role that facilitation has in supporting students to share ideas and achievements with digital media. It emphasises the importance of considering how interactive resources will be used as part of a wider set of social actions that goes beyond the functionality of the device and the interaction between user and device.

The sessions also stressed the importance of risk and confidence in the process of supporting students with SEN to use digital media to share their ideas and achievements. The class teacher Nick reviewed both students' work at the end of each session which provided useful feedback but also provided positive reinforcement for the students and gave them confidence in the work they were doing. The failure of the tag system led Nick to reiterate that it would be a shame if the presentation designed to boost the students' confidence was the cause of stress and worry over the function of the system. This then shows the need to balance the act of providing opportunities for students to speak and share ideas, with the risk of failure in the process, thus harming their confidence and ability to speak.

There were several issues regarding the design of the console that arose from these sessions. The recording timer appeared to help with getting the correct timing for the commentaries and the two students commented on this unprompted. Dan was however unhappy with the previous recordings and once he was able to use the recording function consistently was able to continuously record, review and rerecord until he was happy. Once Leo was comfortable with the recording function he was excited to be able to re-record his commentaries, as he was worried about the sound of his speech impediment. Being able to record, review and re-record his commentaries allowed him to control how he sounded to others.

A major issue was that the tags needed to be exactly aligned on the reader. The limited motor skills of the students meant that this wasn't always possible and became confusing for the students. Also the terminology, colours and symbols used on the second unit; 'record' and 'play', were exactly the same as the recording functions on the first unit. This was again confusing for the user. Another issue was the use of numbers

to represent which media was connected to a tag as it was hard to quickly remember which number represented which image and recording. What came from this however was a joint decision with Leo to redesign the tags so that you could add a piece of writing or drawing on them and have a shape that represented the media connected to them. These design issues are then considered in the next iteration of the console and tag reader.

6.8 Workshop Day 3 – Console 2

This workshop consisted of two sessions with single students. These were shorter sessions than intended as when I arrived at the school the entire class was out at a concert in the local city hall. All though I had planned the session with the class teacher they had forgotten to let me know about the concert. Issues such as this are an expected part of working with the school. The class arrived back in the afternoon giving me a short time to work with the two students.

Figure 23 - Console 2 with built in RFID reader and 'sorting button'.

6.8.1 Prototype overview

For the third workshop sessions I redeveloped the console to include the tag reader in a single unit. I also switched from the one-wire system I had used previously to a RFID reader and tags. This was in response to the issues of space, wiring and the need to accurately place the tag on a reader. The 1-Wire system used in the previous tag reader surprisingly proved harder to use for students than the RFID system I had used in

previous studies. With the 1-Wire system the tag needed to be placed precisely on the reader which proved too difficult for several of the students who had issues with their fine motor control. The RFID reader allowed the student to place the tag on and within around 2cms above and next to the reader for it to read.

Figure 24 - Close up of numbered RFID tags and paper tag.

I also changed the method of associating a tag with an image. Instead of the record and play buttons I had a single button with LINK written under it. When a tag was placed on the reader and the 'LINK' button pressed it associated whatever was on screen with that tag. To play back the image the user simply placed the tag on the reader and it would trigger. I also created a 'paper tag' template, which I could use as a means to compliment or replace the RFID digital tag system. I also removed the accessibility switch plugs as none of the students I worked with used switches and it made it much quicker to create the new prototype without them. They could easily be added at a later date if needed. Finally, I added a 'filter' button, which allowed the user to filter the images by the YES/NO/AUDIO tags. This was in order to speed up the review process for users.

6.8.2 Session 1 – Leo (30 minutes)

This was a shorter session than intended as when I arrived at the school the entire class was out at a concert in the local city hall. All though I had planned the session with the class teacher there was obviously a timetabling error, which is an expected part of working with the school. The class arrived back in the afternoon giving me a short time to work with the two students.

The first thing we did was talk through the new RFID tagging system on the console, which required a less exact alignment of the tag and the reader. I showed the system to Leo and he tried it out using a set of the unsorted images we had been working with last week. This seemed to be a much more reliable and consistent way to attach tags to images. We then spent time reviewing the images and commentaries that Leo had recorded the previous week. Whilst he was happy with the images he had chosen he wanted to delete and rerecord the majority of the commentary as he felt that his lisp was too prominent on some and that the sound quality and use of words weren't clear enough.

Figure 25 - Leo working with the console

Leo at this point told me he had brought some images from home on a USB pen that he would like to add to the console. Due to child protection issues I decided that it would be sensible to briefly check with the class teacher. I made it very clear to Leo that this was a great idea but that we could look at the images with the class teacher to get his opinion about them first. Nick was fortunately free for 5 minutes to quickly go through the images with him and commented that this was a sensible precaution but that he trusted me to make a decision about the appropriateness of using images brought in from home. Still this was a good opportunity to review the images and talk with Leo and myself about his goals.

We then returned to the console and added the images to the body of images he had been sorting through the previous week. The colour coding allowed us to quickly

review which had been chosen and discounted and those yet to be tagged (including the images added that day).

Leo worked through the images once again and we recorded a series of new commentaries. I noted at the time something here which when reviewing the other sessions seemed to be true of all of the participants. When talking about the images with Leo I was able to get an animated and interested response about the images and the activities that they represented. Once I asked Leo to record his commentary he immediately reduced this to a more stilted and less informative commentary. The more times we recorded the same commentary the more it was simplified and the less interesting and informative it became. The way I worked around this was to take Leo's focus away from the recording and to ask him to speak to me about a different image. I would then take notes and feed back what he said and work with him to create a set of very short bullet points that summed up his response on the 'tag sheets' I had created. We then attempted to record this using the console. This worked but meant we needed to take more time to return to the open and engaged response he began with.

Figure 26 - Screenshot of photo sorting software with red tag indicating the image has been tagged as 'not for use'.

Once we had our set of images with recordings we started to play with the tagging system. Whilst it was a lot more reliable than the previous week the numbering and blank cards meant that Leo again struggled to remember the association between tag and image/commentary. We ended up using the tag sheets to record the name of the image, the commentary and a symbol that we could use to draw onto the tag using a white board marker. We played with this until we had a set of ten images with audio commentary, a set of tag sheets that contained the name of the image, the commentary as text and a suggestion for a symbol to represent the image. Leo and I discussed creating tags in the shapes of the suggested symbols that he could then use to trigger the images and commentary during the presentation.

At the end of the session we brought Nick in to look at the images and to play through the order that we had provisionally decided on. This allowed Leo to show Nick his work and for Nick to check on the images and commentary that he had decided on for his annual review. We decided that Nick would take a copy of the tag sheets and would work with Leo that week to check if he was happy with the images and ordering for the presentation. He would then get back to me with the final order and choices and I would prepare the console and PowerPoint for the review the following week. I would also create a set of tags shaped to represent the different images as decided by Leo during the session.

6.8.3 Session 2 – Mark (38 minutes)

Figure 27 - Mark working with the researcher

The last session I conducted with the console was with Mark. I had planned to work with Mark over the past two weeks but due to illness and medical appointments he was only available for this session. We had worked together during the previous week's photo gathering session around the secondary school and during the initial three weeks working with the school as a TA. Mark was excited about the session.

This session was conducted in the primary school office away from the classroom as the teacher felt that Mark would focus much better on the task if he was in a quiet and calm space away from the distractions of others.

We talked through the presentation that we were working towards and I explained how the console and software that we were using worked. Mark has some difficulties with his fine motor skills so it took him a while to get used to the arcade style buttons on the console. This meant I found myself leading Mark to use the console as well as making decisions about tagging the different images. I found that Mark would agree with or repeat what I had suggested without seemingly giving his own opinion. After 10 minutes or so working through the images I decided to try and give Mark more time to make his own decisions about the images. This meant that for a while there were some fairly long silences and points where he became unsure about what he should be doing. I found though that by not interrupting him and by leading less, Mark started to make more independent decisions about the images he wanted to include. This also led Mark to start talking more about what was going on in the images and the stories that they represented. We started recording commentaries for the images. Mark really struggled with pressing and releasing the recording button at the correct time so we agreed that I would press it and count Mark in. Again the commentary he recorded was less eloquent than when he was speaking to me about particular images.

Once we had recorded and sorted a set of images I decided that the tagging system wasn't going to be the best way to make a decision about the ordering of the images in the short time we had left. Instead we created a tag sheet for each of the images and used these to create an order for the presentation. I then associated the tags allowing me to play back the order of the images to Mark. We ended the session by showing Nick the slides, audio commentary and ordering for the presentation. Nick gave Mark positive feedback and commented on how hard Mark must have worked to get so much done so quickly. We talked about the presentation to the class which Mark felt he was happy to do but wanted to make sure that he'd be able to show the pictures without 'looking silly or messing up…'. Myself and Nick reassured him that it would be a good

opportunity to share his achievements and that we would be on hand to help him present if he needed us.

6.8.4 Reflections

As with previous workshops, this session highlighted the need for clear communication, the importance of student confidence when supporting self-advocacy and the need to adjust your facilitation and the setting in response to the needs of students.

The audio annotation function of the console offered the affordance to allow Leo to rerecord his voice until he was happy with how his speech impediment affected the recording. This was a clear opportunity for Leo to choose how he represented his achievements by choosing how his voice sounded to others. Mark at the end of his session was concerned about how his presentation would be received, which we responded to by reassuring him and letting him know we would be there to support him if needed. This, along with the positive feedback from Nick the class teacher at the end of the sessions, demonstrates again the importance of supporting student's confidence through facilitation and enabling them to inform decisions about how they are represented.

The new tag system seemed to work better for Leo and in this session he was able to add and review tags with little of the difficulty he had with the 1-Wire system in the previous workshop. With Mark I found that the console didn't really suit his limited motor skills and that I had to take control of working the recording function and tags so that Mark could focus on making decisions about what to say. The tag sheets provided useful additions to the system. Both tools complimented and reinforced the ordering process for Leo by adding additional modes of drawing and writing to the process. The tags also provided a contingent strategy for Mark as he was unable to use the RFID system unaided.

6.9 The annual review

In preparation for Leo's annual review we had finalised the presentation the week before using the custom made RFID tokens. I had prepared the presentation to be played on the RFID sorting console as well as a PowerPoint presentation. Due to the sensitive nature of the review I was asked not to attend. This meant that there was the potential for the console to stop working during the presentation without me being

able to trouble shoot or reset it. After discussing this with Leo and Nick we decided that using the PowerPoint presentation would be safer and ultimately less stressful for Leo. Leo did however ask that he could bring in the tokens to show the team. I was able to speak briefly to Leo and his parents after the review and was rewarded with a thumbs up from Leo and was told by both his parents and the review team that it was a successful way for Leo to show how much he had enjoyed being at the school.

The annual review was an opportunity for Leo to share his achievements and preferences in a meeting that would determine his continuing educational and social support, including whether he would stay at the school the next year or return to mainstream education. This annual review provided a structure for myself and Leo to review, annotate and present images and accompanying audio annotations that represented work and experiences that were of importance to him. It provided an opportunity to present to people of significance to him and within a meeting that would directly affect his educational and social life. The presentation not only allowed him to share, but also to a small extent allowed him to realise that he had the ability to express his opinion to people and in a situation that mattered.

Figure 28 - Custom RFID tokens made for Leo's annual review.

6.10 Class presentations

In the final week I worked with four students and Leo to give presentations to the class, which we had developed, using the console. We used PowerPoint for the presentations and I created a very simple console with three arcade style buttons. These moved the presentation forwards, backwards and played the audio recording for each image. I decided to make this having seen the difficulty some students have when using keyboards and also to make the experience as stress free for the students as possible.

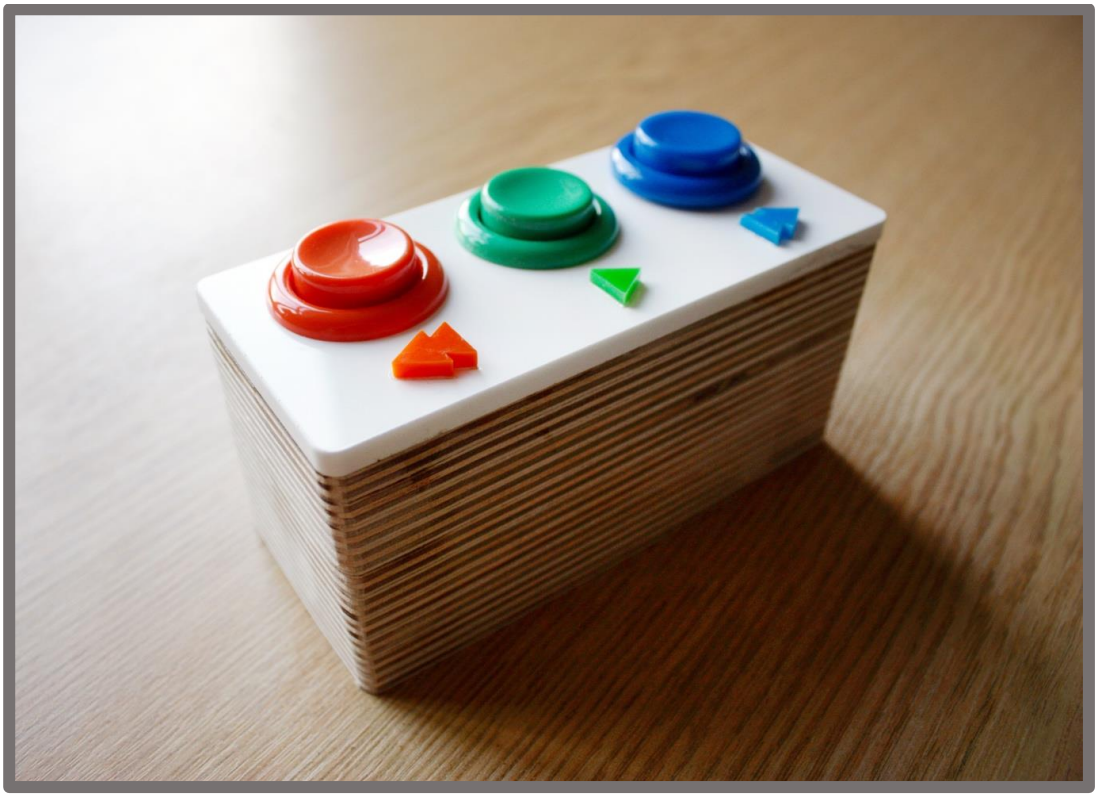

Figure 29 - PowerPoint control console

The button console was a very simple system consisting of two arcade style buttons and a small and cheap (under £20) hobbyist arcade PCB. It consists of a small box with the two buttons embedded into it and a USB leading from the inside of the box. When a button is pressed the signal is converted into a single press of a USB keyboard. This was then setup to work with PowerPoint so that one button moved the presentation forwards and one back. Under each button is a symbol and text and a switch socket. The unit is plug and play; it will be seen by any Windows or Mac computer as a USB keyboard.

The presentations were well received by the class with students laughing and making positive comments. At the end of the session I presented every student in the class with

a wooden star with their name on which they could paint. For the students who had taken part in the project we created a set of photo books of their presentations to take home. For the teacher and TAs I gave them cards and small presents of wine and chocolates to say thank you for the time they had spent with me.

The presentations were very well received and the unit worked for all of the students without any major problems. Students talked about their experiences using the images and recordings as prompts. They were also able to move back through their presentations at the end and talk about specific images in response to questions from staff and students. There was positive feedback from staff and other students and giving the students photo books allowed them to share their achievement with their parents and guardians.

The class presentation again offered students an opportunity to express their ideas and achievements to people of significance to them within a supportive though not risk free environment. It also provided a structure for the workshops and gave students and the research sessions an achievable goal that directly supported students' school work.

After the session the class teacher asked if they could keep the unit to use in other class presentations. I agreed and what was interesting was that it was clearly used in the following term as I was contacted by the Nick and asked to make another two units, one to replace one that had been lost and another as a backup for the class. This simple Powerpoint controller allowed the students to use a technology that was already widely used by the class teacher but provided large buttons and a simple selection of functions thus reducing the chance of students making a mistake when moving through their presentations. This then again speaks to the need to design to mitigate some risk in the design of interactive resources whilst still facilitating opportunities for students to share their skills.

6.11 Workshop Summary

The workshop series demonstrates a range of issues and insights relating to the design and use of digital media and ICT to support students in SEN classrooms to express their opinions and achievements to people and in situations that affect their lives. It demonstrates that designers and researchers working in this context need to attend to the social complexities and tensions within a SEN mixed ability classroom in their planning and running of research sessions in the design of the resources they create.

The first workshop raised issues relating to the planning of sessions, student behaviour and the need to respond flexibly and to adapt sessions in order to ensure students are engaged. It discussed the need for designers and researchers in this context to develop a clear communication strategy with participating staff, to take into account the limited memory and concentration spans of students when planning and running sessions and the support that simple structures such as Think, Chat, Snap can provide in collecting and discussing digital media. The second workshop highlighted issues around the setup of materials and balancing risk and confidence for students when supporting them to share their opinions and achievements. It showed the need to pay attention to details such as setup time, cabling and speed of adjusting interactive resources. It showed that having contingent strategies as a designer, facilitator or researcher ensures you can respond to the social tensions and complexities that occur in a mixed ability SEN classroom. The third workshop again raised the need for clear communication with your research partners and the importance of supporting students to be confident in their abilities and the resources they use to share their ideas. It also demonstrated how the audio annotation function helped a student to mitigate in his presentation the embarrassment he felt about his speech impediment. The annual review and class presentations both showed that students can use digital media to share their opinions and achievements with people that matter to them and in situations that affect their circumstances, through careful facilitation and design.

6.12 Discussion

This chapter provided a descriptive account of a study grounded in the shared experiences of the researcher, student participants and teacher in a mixed ability SEN classroom. Through a series of workshops using prototype photo-sharing consoles and creative narrative activities this study has developed a body of empirical evidence on the social role of photography in a SEN classroom and the ability of digital media and associated tools to support self-advocacy for children with special educational needs. In the following section I discuss the insights that developed from my analysis of the empirical evidence gathered in this study. During the study I conducted an iterative, grounded theory analysis using my observational notes, transcribed interviews with staff and video evidence from the workshops and shared experiences of working with my participants. This coding process led to three distinct categories which are discussed in this section: *Designing for self-advocacy*, *Design Concerns* and *Reflections on Approach*. These categories are considered in relation to wider literature and

discourses of interaction design for children with special educational needs and result in a case study and insights that speak to the IDC community of designers and researchers working in this context. The following illustration represents my final coding map and some of my early stage focus codes.

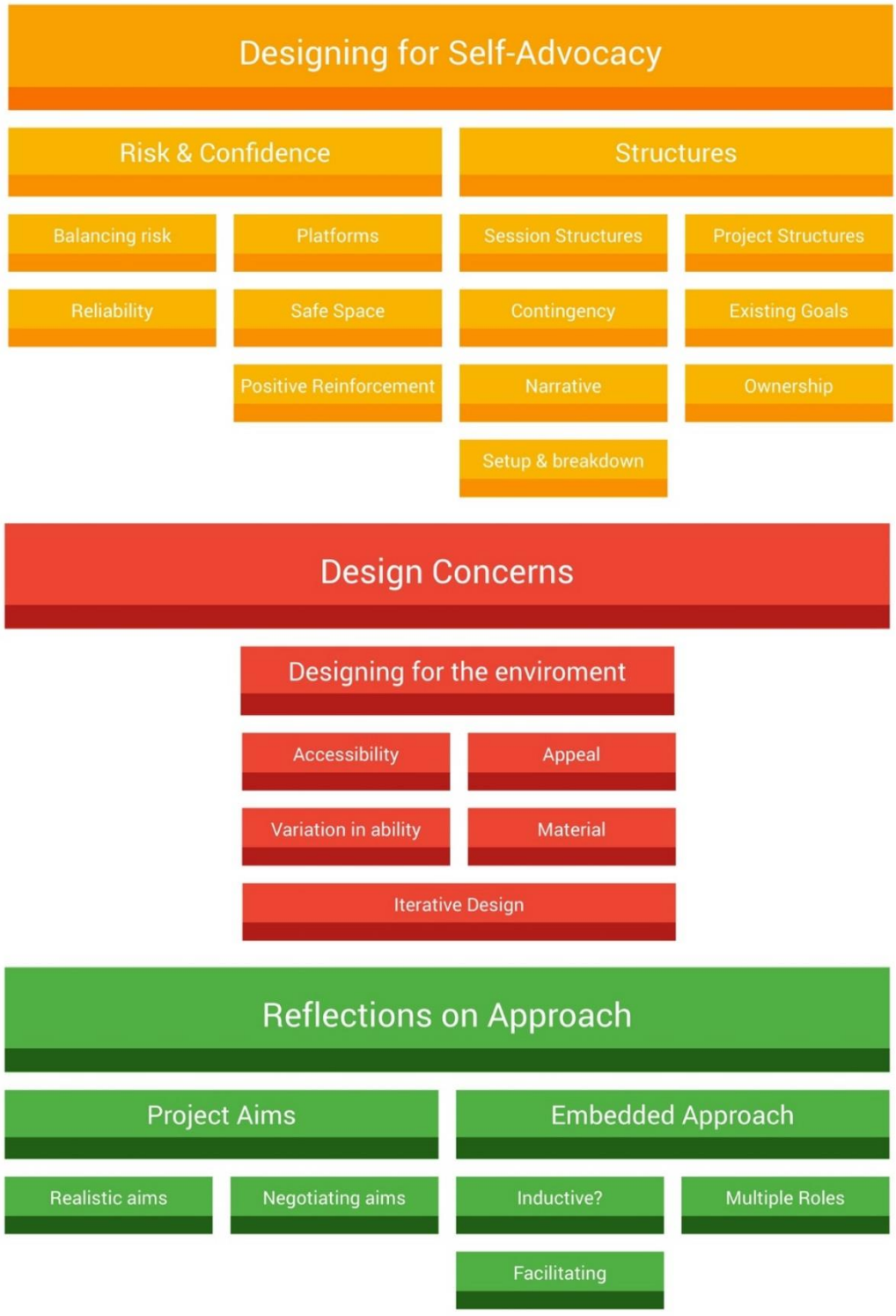

Figure 30 – Chapter 6 - This year I have..., final conceptual coding map

6.12.1 Category 1 - Designing for Self-Advocacy

The work in this study has shown that where students are given suitable tools, opportunities and appropriate facilitation they can *articulate* their *preferences, interests* and *goals*, to people of significance to them and to some extent have some say in important decisions that affect their lives. (Test et al., 2005) The design of the console allowed students to look through a large set of digital photographs whilst making quick and intuitive decisions about the images that they would like to keep and those they wanted to discard. The audio recording function of the console allowed students to re-record their observations and to think about particular images until they were satisfied with how it would be heard by others in a presentation providing a *choice in representation.* The conceptual category of *designing for self-advocacy* is concerned with the social role of digital media in supporting children with special educational needs to share their achievements and opinions with people of significance to them and in situations that concern their social and educational development as a form of self-advocacy. This category is considered through the following two sub-categories: *Risk and confidence* and *Structures.*

Risk and Confidence

During the workshop series there were several examples of how the balance of risk and confidence was managed and integral in the use of digital media to support self-advocacy for the participants. The students who participated in the workshops and presentations all took a risk in presenting their goals and achievements to people of significance to them, through the digital media presentations they created. They risked the possibility of their peers and adults not considering their achievements worthwhile or something going wrong in their presentations, both of which could potentially harm their self-esteem and identity formation.

As has been discussed in *Chapter 2: My photos, your photos* and in the literature on digital photography and identity formation (van Dijck, 2008), older children (aged 8-18) are sensitive to issues concerning the representation of their identity, with photographic representation having a particular resonance. This is made more acute when we consider the devaluing of children with special educational needs as they are often marginalised and disempowered in society through the inaccurate perception that they lack skills and abilities. (D. Miller, 2002; D. Miller & Brown, 2014)

The risk for students was balanced and managed by myself and the class teacher through the sessions with the console and the affordances of the console (audio annotation, photo sorting) which enabled students to have a choice in how and what media was used to represent them and their achievements. This process of reflecting on and making choices about how they were represented was then reinforced through positive feedback from both me as a facilitator and from the class teacher at the end of workshop sessions. The class presentation and annual review were also designed to provide a platform for students to share in front of friends, staff and family which was an inherently risky activity for the students. This risk was managed through the careful use of digital tools (PowerPoint controller), a carefully prepared presentation and the reinforcement of people of significance to them praising the presentation the students gave.

The opportunity provided by the presentations and use of digital media to represent students' opinions and achievements, speaks to the literature on the need for children with special educational needs to be part of the processes that concern their lives (Brownlie et al., 2006; Disability Rights Commission., 2006; Illingworth, 2008) and learning and is a key principle in disability activism of 'nothing about us without us'. (Charlton, 1998, p. 3- 20) Waller et al. in their work on technology, narrative construction and children with special needs demonstrate the important role that narrative through digital media has in supporting children with special needs in developing personal identities. This use of technology to support narrative has also been shown in Bruce's review of multimodal composition for children with special needs to support the development of confidence, motivation and a willingness to take risks in their creative work. (Bruce et al., 2013, p. 36)

The workshop series also demonstrated the need for caution in the claims that are made for technologies that enable students to self-advocate. In this study we can see that the use of the photo console supports students to *communicate* and develop knowledge of *self* to a limited extent and enabled at least one participant, Leo to have some input into important decision making processes. I cannot claim however that the technology enabled students to identify and express deep-seated beliefs or more importantly develop the awareness that they have the skills and right to express themselves and advocate for their own needs. As Pia Christianson (Christensen, 2004) argues, children exist within complex social situations where disclosure and the power relationship between adults and children are of acute importance. Working to mitigate this when trying to enable students to express their needs will not be achieved through

technology on its own but rather through wide ranging social pedagogical change on which new technologies may or may not have some affect.

An important insight that arises from this category of risk and confidence then speaks to Test et al.'s conceptual model of self-advocacy in the setting of mixed ability SEN classroom (Test et al., 2005). If children with SEN need to develop *assertiveness* in order to self-advocate, then facilitators, designers and researchers all need to balance the potential risk for failure that students face in expressing themselves against the potential benefits of sharing their voice.

If a student has the means to communicate their ideas but not the confidence to share them then they are unlikely to be engaged in or be enjoying that sharing process. Managing the levels of anxiety a student experiences when taking part in activities is key as it impacts on how a student engages with a particular activity, their teacher and the other students they are working with.

> For lots of kids explorative learning is brilliant but it's only brilliant and it's only enjoyable and engaging if you feel confident enough to do it or if it has an acceptable degree of risk. – (Nick interviewed by the researcher in Delmore school, 21st May 2011)

It is important then for students to develop communication skills but also to develop a confidence in using those skills. One way to develop these confidences is to provide opportunities to develop, test out and share creative skills in front of others who are significant to them. In this way, teachers can support students to gain greater confidence in their own skills and thereby a more positive self-image. Overcoming the emotional blocks that stand in the way of students is not simply a case of developing skills and sharing achievement but it is one strategy amongst many that helps students to engage with learning and work.

The management of risk involves creating safe spaces and opportunities for students to express themselves and providing the right tools and training with which to do it. There will always be some risk to a child that they might fail in a task and that doesn't mean that we should never expose them to risk but we must be aware as facilitators, designers and researchers of what constitutes risk for the particular group or individual children that we are working with.

Working with any digital technology in the classroom will always involve some risk for teachers and students. In order for teachers to engage with these technologies, that risk must also be managed. The risk is in the potential for technologies to disrupt a teaching session and the affect it has on students' learning and behaviour. These risks stem from how likely teachers are to be able to use a tool successfully for themselves and with others. These risks are often difficult to predict in changing situations and may even be unforeseeable. When one change is introduced, everything else does not stay as it is. Ensuring that a technology will work each and every time in a way that they expect is a way to reduce the perceived risk for teachers and students and allows them to develop a confidence in using that technology. This means that teachers and students will be more willing to use a technology and further develop new and creative strategies for the use of that technology.

As designers working in this environment it is important that the role that risk and confidence has in students' learning is considered in the design and use of digital resources that support children with special educational needs to self-advocate, for both the children using them and the adults facilitating their use. In order to do this we must understand the potential risks and benefits of particular approaches and affordances of the systems we build and introduce.

Structures

The sub-category of structures encompasses insights into the structures that were used to construct and run the workshop series and presentations in this study. These structures are discussed using examples from the study and relevant literature.

When structuring the study, I worked with the class teacher Nick to ensure that the workshop process and resulting presentations were structured around clear and constructive goals for students that were in line with the teacher's aims for the participants that term. This also talks to Light and Drager's call to reduce the attention load for children with special educational needs using technologies by integrating learning and play based activities into technologies that support communication. (Light & Drager, 2007b, p. 11) Providing a thematic structure that underpinned the use of the system; the 'my achievements this year', provided meaning and context for students, staff and the researcher and provided a level of structure for both the individual workshop sessions as well as for the project as a whole. This use of structure was intended to support both active participation and ownership by the staff and students. Gathering materials for use on the console allowed the researcher to interact with

students away from the console and develop an understanding of their opinions and personalities away from the confines of the technology led sessions. This talks to McGrail and Davis' assertion that teachers and facilitators need to take on multiple roles in digital storytelling processes as technicians, sounding boards, scribes, proofreaders and discussion instigators. (McGrail & Davis, 2011) This structure was designed by working and negotiating with the class teacher throughout the duration of the project.

The presentations used narrative as a means to structure and reflect on the achievements that each student had made that year. Waller et al., in their work on technology, narrative construction and children with special needs, demonstrate the important role that using digital tools to develop personal narratives has in supporting children with special needs in developing personal identities that are shared with people of significance to them. (Waller et al., 2013) To better support the user experience of children using AAC interfaces, Light and Drager also call for AAC technologies that go beyond static speech prostheses alone by creating technologies that support multiple functions (e.g. play, communication, artistic expression, narrative construction, learning).

The workshops addressed both low and high level concerns, using Claudia Keh's terminology (Keh, 1990), for story composition through the tools provided by the photo sorting and audio recording function of the console. It enabled students with cognitive and physical impairments to mitigate issues around the mechanics of writing by offering two modes; using images and voice recordings to tell stories that did not require the literacy and fine motor skills needed for handwriting or typing. The console also focused on higher-level concerns by enabling students not only to reflect on and make decisions about how the photos that they were in or had taken would be used, but also to reflect on the aspects of their life that the story represented. Using the console, RFID and paper tags, students made decisions about the order of images and sounds and were then able to reflect on the stories that they created. The use of these resources allowed both the sharing of moments through the annotated slideshows and acted as points of departure for discussion and reflection during our shared workshop experiences. This supports Antle's assertion that tangibles have a social function as points of meaning and representation which are as important as their technical function and that expressive activities occur with tangibles by enabling children to create structures in the form of stories and models. (Antle, 2007a) and Cassell and

Ryokai call for systems that not only allow students to listen and create stories but also tell stories and have their voices heard (Cassell & Ryokai, 2001).

The workshops in this study highlighted issues around the planning and structure of sessions in terms of student behaviour and the fluid nature of timings in a classroom context. The first workshop showed the need to respond flexibly and adapt to the priorities of teachers and to develop clear communication strategies with partner staff to ensure that the researcher can respond appropriately and flexibly to any last minute changes in the timetabling of sessions. This need for flexibility and contingent structures as a researcher and designer in this context was also exemplified by the 'think, snap chat' that I developed in response to the need to reengage and revitalise students during the first and second workshops. Another low level concern that was highlighted in the workshop series was the need to plan for the time it takes to setup and breakdown technologies and the acquisition and setup of tables, chairs and cables in research sessions. By planning for this in your study design you then can then take these issues into consideration when developing systems that are left for long term use in classrooms by teachers outside of research sessions.

For researchers and designers working in this context it is important that we consider not only the functionality and user experience between student and system but also the social and learning structures that our systems will sit within and create. By attending to both the pragmatic 'situationally constrained choices' that teachers, designers and researchers must make in the day-to-day interactions with children (Cuban, 1986) in a classroom environment and the structures we use to develop shared experiences (Wright & McCarthy, 2008) we can develop digital tools and approaches that are not only useful but also used in a mixed ability SEN classroom context.

6.12.2 Category 2 – Design Concerns

This category encompasses the design concerns that both informed the initial design of the console and the iterative design process that occurred during the workshop series. As has been discussed in the *background* section of this study, research has shown that children with special educational and communication needs rely on a wider range of modes to meet their communication needs than their typically developing peers. This includes the successive or simultaneous use of speech, signs, non-digital systems and digital communication tools. (Binger & Light, 2006; Blackstone et al., 2007; Light et al., 1985) The use of tangible user interfaces have been shown to provide multiple modes of perception and communication for children (Antle, 2007a; Hornecker & Buur, 2006;

Ishii & Ullmer, 1997) and support learning through multisensory links between cognition and concrete manipulation. (Zaman et al., 2011, p. 368).

The photo-sorting console, tagging system and paper resources I developed in this study provided multiple modes of communication through the photo triaging functionality and audio annotation functions. The use of tangible augmented and paper tags to represent the components of their narrative presentations provided a means for children to structure and manipulate their narratives through physical manipulation. They also worked, alongside the forward and backward functions of the console, as tools for navigating the participant's presentations. Navigating through images and symbols using digital tools has been shown to be particularly difficult for children with special needs (Fallon & Light, 2003). It has also been shown that mnemonic cues (visual, tactile, auditory) can be used to improve navigation for children with special educational needs by making explicit the relationship between the piece of media and its place within a wider structure. The plain and numbered augmented tags used in *workshop 2* and *workshop 3* proved to be too abstract to support students but the paper tags and laser cut 'shaped' tags I created for Leo speaks to Light et al.'s call (Light et al., 2004) for tangibles that are linked to their communication purposes thus strengthening the cognitive link between the system and its function for the user. The use of non-digital tags as points of discussion and reflection as part of the wider constellation of console and augmented tags also supports Antle's assertion that the role of tangibles as points of meaning and representation is as important as their technical function.

In order to improve the user experience of children with special needs in using digital tools to support communication and self-advocacy we must make the tools we develop appealing to children and reduce the learning and attention demands of technologies. (Light & Drager, 2002; 2007b) The use of bright colours and engaging materials in this project were all used as a means to appeal to my participants and the integration of the RFID system into the console served to reduce the attention demands on students function in a system (Antle, 2007a).

The console used arcade style buttons and bright colours to distinguish different functions. These buttons proved an excellent choice and one that speaks to Treviranus and Roberts' argument for a multiple physical modes of control for communication systems for children with special educational needs. (Treviranus & Roberts, 2003). The arcade buttons are designed to provide clear tangible feedback for an arcade user

which serves, in the design of my consoles, to provide kinetic feedback and made the connection between the action the student performed and its intended outcome clearly perceivable through visual and haptic feedback. The workshop series showed that although the 1-wire tagging system potentially offered a more concrete connection between action and system function, the motor control difficulties of the participants meant that the easier to manipulate RFID tagging system was more appropriate for this context and users. As designers and researchers working in this context we must pay particular attention to the aesthetics and material choices we make, the pragmatic 'situationally constrained choices' of the classroom environment and consider the design of devices within a matrix of facilitation, activities and social actions.

6.12.3 Category 3 – Reflections on Approach

By reflecting on the initial motivations for this study and the subsequent issues and successes this section will highlight some important considerations for approaching the design of systems for using digital media in a SEN classroom.

The initial motivation for this study was to develop an interactive system to support students to share their opinions and achievements with people of significance to them as a form of self-advocacy. This was to be achieved in an inductive manner by developing the system through a dialogue with the teaching staff and students and through the experience of embedding myself in the classroom over a period of time.

Through the experience of working and developing a system in this context a number of issues arose in relation to these aims. Communication was an important consideration in this study. When initially developing the project I needed to maintain clear communication with the class teacher, the school and my own university in order to create a study that had clear and mutual goals for both partners and one that was conducted and approved under the strict ethical guidelines of both institutions. This dialogue had to be maintained throughout the study.

A problem that surfaced after the first set of workshops with students was re-evaluating the contribution I would make for the students in the study. I think I overstated how much I would be able to achieve in terms of creating presentations for students that reflected their deeply held opinions about their time studying in the class that year. Whilst I was able to work with students to create presentations that showcased their achievements this is different from creating presentations that really express the complex emotional and educational journey they had made that year. We

must be cautious when making claims about the ability for an interactive system enabling students with SEN to self-advocate. This supposes that it is a quality of the technology itself rather than the use of the technology as a tool by students and staff that allows students to self-advocate. As has been discussed in the literature review of this thesis (Test et al., 2005) (Longhurst, 1994) (Weimer, Cappotelli, & DiCamillo, 1994) and in the first two studies, supporting students to express their opinions and ideas is a complex and on going process that cannot be met by a single device or system. The role of the teacher or facilitator in this study was central to helping students develop and refine their opinions even before they could find the appropriate form, photographs in this case, to express those opinions. In terms of this study I was able to support students to share their achievements with others of significance using a combination of interactive tools and facilitation and by creating platforms to share those achievements. This does not mean they have somehow been emancipated from the emotional and social problems that can prevent students with SEN from sharing their opinions, but in a small way may contribute towards it.

A key motivation for the study was to develop a tool that would support existing practises in the school in response to my experience of participating with the context itself. In order to achieve this aim I started by working with the class teacher to understand what part of the current goals and curriculum of students I could support. This 'open agenda' approach was undermined by the introduction of a fairly developed console that was rooted in a study with specific aims. Whilst those aims closely tied to the aims discussed with the teacher for his students; communication through photography, the system itself was already developed in response to another context. This approach is not wrong and could be valuable in evaluating and extending the design of a system. If this was to be a truly inductive design process this use of an existing and fairly restrictive approach was inappropriate. It meant that small changes were made to the system in response to the needs of students and their experiences of using it in the context but these were changes to an underlying system that at its core remained the same.

By embedding myself in the context as a teaching assistant, technology developer, designer, researcher and arts facilitator I was able to experience new situations and develop new skills all of which contributed to a more nuanced understanding of the SEN classroom context. It was however very demanding and stressful at times to maintain all of these roles whilst attempting to undertake and document the research.

Interestingly some of the most successful interventions were the simple and low-tech solutions that were developed in response to situations as they arose during the study. The tag sheets worked as a complimentary system to the RFID tagging system in ordering and setting out the media that was to be used for the presentations. The presentation button console was developed in response to the potential risk of using the more complex digital system and the success of this system was shown by its on-going use in the classroom after the end of the study. This shows the importance of creating systems that are focused on need and informed by experience rather than on a specific set of functions or technologies.

6.13 Summary

Through an embedded, design-led and experiential research approach this chapter has investigated the social role and design implications of using digital media to support self-advocacy for children with special educational needs in a mixed ability classroom. This chapter has resulted in a detailed and descriptive design case study in a mixed ability special educational needs context which provides important material for those in the interaction design community planning or reflecting on their work in similar educational contexts. Through an iterative grounded theory based analysis of the empirical evidence, this study resulted in three qualitative categories which discuss insights and literature relating to *designing for self-advocacy*, the *design concerns* that arose in the iterative design processes in the study and *reflections on the approach* to design and research taken in this study.

As was discussed in the *Reflections on Approach* section there were problems in the study that resulted from the expectations of the school and the resulting output of the researcher. By being embedded in the classroom at the school I became aware of the difficulty of supporting the students I worked with to self-advocate through the use of the photographic sorting console. One of the most important findings of this chapter is that self-advocacy for children with SEN is a complex task that requires a range of opportunities, facilitation and tools in order to occur. The study also reinforced my position that embedding yourself as a designer and researcher allows you to be sensitive to problems and issues that arise from the classroom situation that otherwise might be missed in shorter, theory led design approaches.

The next study turns from the use of photographic practices to support expression to researching how novel interfaces for digital media can support classroom activities

with a focus on literacy tasks such as storytelling and phonics. The study consists of an account of seven design interventions that are used with students in a single SEN classroom over two school terms. The interventions are informed and then developed in an iterative loop during my time in the class as a teaching assistant, introducing interventions based on my experiences and then developing new interventions in response.

7 Study 4: Stories and Sounds

7.1 Introduction

7.1.1 Overview

This chapter is an account of an embedded, design-led case study in a special educational needs classroom conducted over two consecutive school terms. The study details the design and implementation of interfaces for incorporating digital media into existing teaching activities with a focus on phonics and storytelling within the institutional context of a mixed ability special educational needs classroom.

This chapter details the in-session observations that I made during a series of six design-led workshops with students and teaching staff from a single Year 8 form group within Delmore School. It also details an account of a preliminary focus group discussion with teachers from each year group in the school on the potential uses for the RFID interfaces I developed in this study. Through a grounded analysis of the empirical data gathered in the workshop series I developed two conceptual categories: *Category 1 – Existing Classroom Practices* and *Category 2 – Reflections on Approach*, which are set out in *7.11 Discussion*. These are discussed in relation to wider literature and result in transferable design insights for researchers and designers concerned with developing tools for integrating digital media in a mixed ability special educational needs classroom environment.

7.1.2 Aims and Motivation Aims

This study gives a detailed account of an embedded design-led research study within a mixed ability special educational needs classroom. The aim of the study is to develop a range of novel interfaces for integrating digital media into existing classroom activities as a means to:

- Consider how the design methods used and the resulting prototypes, work within the constraints of this classroom setting.
- Provide for the interaction design community a descriptive account of a design-led research study in a mixed ability special educational needs classroom.
- Develop a set of qualitative design insights for those in the interaction design community developing digital media tools to support teaching activities in mixed ability, special educational needs classroom settings.

The motivation for this study comes from both the findings and experiences of earlier studies combined with insights found in relevant literature. A central finding of AAC research is that children with special educational needs rely on a wide range of modes to meet their communication and social needs. (Binger & Light, 2006; Blackstone et al., 2007; Light et al., 1985) Providing the appropriate modes to do this is dependent on the context, partner, task, facilitation and intent of the task (Blackstone & Berg, 2009). This is reflected in the findings of *Chapter 4 – The Scented School*, that students with special educational needs require teachers to use a range of multisensory modes of communication in order to engage with the differing needs and learning styles of their students. Using digital media in SEN classrooms offers the potential to use audio, olfactory, tactile, audio and visual modes of expression in teaching and to re-appropriate media with pre-existing meanings.

Tangible user interfaces, as discussed in detail in the *6.3 Background* of *Chapter 6 – This year I have…* have been shown to imbue physical objects with the ability to represent and manipulate digital and physical actions (Ullmer & Ishii, 2000). They have also been seen to support children's communication using digital systems by providing multiple modes of perception including sound, sight and touch. (Antle, 2007a; Hornecker & Buur, 2006; Ishii & Ullmer, 1997) For children with special educational needs, tangible interfaces have been shown to support collaborative learning and play (Brederode et al., 2005; Farr et al., 2010) and are a means to enforce learning by embedding meaning and representations of abstract concepts into physical, maniputable objects (Antle,

2007a). It has also been shown that it is a complex interplay between educators, students, the environment and the needs of students that determine how tangible interfaces affect learning activities. (Parkes et al., 2008)

As we have seen in *3.3 Technology in the classroom* and through the findings of the previous three studies in this thesis, developing technologies for classroom environments requires careful consideration of the 'social reality' of a school environment(Selwyn, 2011), the existing teaching practices being used (Buckingham, 2007) and the 'situationally constrained choices' of teachers (Cuban, 1986). This literature and the experiences and insights gathered in my other studies has led me in this study to consider how to develop digital tools that compliment and extend existing teaching activities and strategies in a mixed ability SEN classroom.

7.2 Approach

7.2.1 Methodology

This study takes a design-led, embedded approach which is used to gather a rich body of empirical evidence through shared 'meaningful encounters' with participants (Wright & McCarthy, 2010). The approach taken in this study is in line with the wider methodological approach of this thesis (discussed in more detail in *3.6 Participatory methods in design research* and *3.7 Grounded theory) and* the methodological approach taken in the last three studies. This approach results in qualitative findings that are grounded in a tacit, observed and phenomenological understanding of the user experiences of participants in a mixed ability SEN classroom. It places the researcher within the context of study over an extended period of time and uses the development of prototype interfaces and software as a means to understand and negotiate the complexities of developing and using digital media to support existing teaching activities in this particular teaching environment,

I worked as a researcher, designer and teaching assistant over two school terms, integrating myself within the day to day interactions of staff, students and tools in a mixed ability special educational needs classroom setting. This approach also supported the reciprocal relationship with the school ensuring that the school gained from my skills as an educator and artist while I gained from the access to the school and the people within it. It makes use of the data gathering and analytical coding processes of grounded theory to develop a set of conceptual categories and qualitative design insights (Charmaz, 2006).

7.2.2 Methods

The study was conducted over a three-month period from 11th January 2012 to the 22nd March 2012. I worked with a junior class in the school over two school terms. During this time, I worked as a teaching assistant and workshop facilitator in addition to the focused prototype testing and feedback sessions I conducted with the class. My work as a teaching assistant and workshop facilitator served two main purposes: it allowed me to closely observe and participate in the day-to-day interactions of the students and staff in the school and allowed me to support the school in a reciprocal manner using my background as a digital artist and arts workshop leader for young people.

Over the twelve weeks the study ran, I conducted six explorative design sessions with the class and one focus group session with a range of teaching staff at the school. These sessions where conducted on average every two weeks and always after lunch in the class form room during the 'literacy and personal development' session timetabled in the afternoons.

Data for the study was collected from two main sources, my shorthand notes and follow up interviews with the class teacher and teaching assistants. As with the initial study at the school, shorthand notes of my observations were made during each of the exploratory study sessions then written up more fully immediately after the session in a quiet space away from staff and students. I wrote up these notes into the prose describing the 7.4 Workshop series section of this chapter. Semi-structured and informal interviews were also conducted after each session with the class teacher, the school's interaction designer and the class's teaching assistants. Throughout the sessions I constantly worked with and talked to students about their ideas, work and thoughts on the prototypes. Whilst they were not directly interviewed, this interaction

between the students and myself is reflected in the 7.4 Workshop series section of this chapter.

In addition to the semi-structured interviews I conducted with staff, I also worked closely with the class teacher and the school's interaction designer to develop the sessions and prototypes each week. This was done through conversations over email, on the phone and in person. These conversations I would define as *design conversations* rather than more formal interviews and are discussed in 6.2.2 Methods in the previous study. I found that this constant conversation not only led to a closer relationship with the staff and students but also enabled me to manage my expectations, and those of the staff, of what the study would achieve. The interviews and conversations I had with staff were either recorded with an audio recording device or as hand written notes and were subsequently transcribed and coded as close to the time of conducting the conversation as possible.

I used grounded coding as an on going analysis tool throughout the study. As with the other studies in this thesis I attempted to code my empirical data as and when it was collected in order to then iteratively inform the next stage of the research, which included my questions for participants, the design of the prototypes and my approach to the delivery of the design sessions. Whilst I tried to code all of the data as the study progressed I found that at times the amount of work it took to build, develop the prototype session and liaise with the school meant I would sometimes miss a week before coding my data. The final insights presented at the end of this chapter are the result of this iterative coding and focused analysis of the material I gathered during the study.

Once again I worked with the same colleague I worked with during the previous studies to code small sections of my data three times during the study and to discuss my coding decisions and memos. This was invaluable in developing the final insights but also in checking my coding throughout the study process.

7.2.3 Dates

This study was conducted before the study discussed in Chapter 6 this year I have.. I have done this as the previous study fitted thematically after the study discussed in Chapter 5 My photos, your photos and so I made the decisions to present the studies in this thesis thematically rather than chronologically.

The following are the dates of both the full days spent with the class as a teaching assistant (TA) and the explorative design sessions.

Date:	Session:
9th, 10th & 11th January 2012	Working as a teaching assistant
16th, 17th & 18th January 2012	Working as a teaching assistant
23rd January 2012	Session 1: Paper prototyping session
30ththth January 2012	Working as a teaching assistant
6th February 2012	Session 2: Phonics session
	HALF TERM
13th, 14th & 15th February 2012	Working as a teaching assistant
20nd February 2012	Session 3: Storytelling session
27th February 2012	Working as a teaching assistant
6th March 2012	Session 4: Video mixing session | RFID
7th March 2012	Session 5: Video mixing session | Controller large
13th March 2012	Session 6: Video mixing session | Controller small
20nd March 2012	Focus Group Session: All staff meeting and demonstration

7.2.4 Participants

Teaching staff

I worked once again with Nick the class teacher I have worked with for the duration of this research project at Delmore School. There were also two main teaching assistant Amanda and James both of whom I had worked with in the previous studies and in my time working at the school outside of my research.

Students

In order to provide the reader with a clearer understanding of the students that participated in the study I have provided a short narrative style paragraph about the six students I spent most of my time working with. There were around twelve students at any one time in the class I worked with. Most of these students at some time had worked with me as a TA or during the prototype sessions. Whilst most students joined in at some point with the prototype activities, I have listed the six students I worked closely with and refer to in my observation sections. This is a comparatively small sample of students but providing this much detail about each student is done in order to help the reader understand what happened and why within the design sessions and the range of abilities and impairments of students that were in the class. A narrative style is used in order to support the observations made about the students within the study in terms of their abilities and needs without focusing on their impairments and medical diagnosis.

William – Male, 11 years old

This student is an engaged and friendly student who takes care to support his fellow students when they struggle with a particular task. He becomes excited when anything to do with technology is mentioned.

He has a degenerative physical condition, which means he requires the use of crutches if standing for a long time. His condition can affect his fine motor skills depending on what he has been doing physically that day. He uses switches for some computer and communication tasks. He has some moderate learning difficulties, which become more apparent when asked to do more pressured tasks such as demonstrating skills or ideas to others.

Emily – Female, 10 years old

She is a lively and energetic girl who is always very keen to talk about what she and others are doing and achieving. She presents some serious emotional blocks to learning and moderate learning difficulties, which can affect her behaviour particularly when working in group situations. She is physically able and able to work well independently when needed.

Jacob – Male, 11 years old

This student is very engaged with and excited by how digital technologies and interfaces work. He is always ready to pick up a piece of technology and take it apart to see what's inside and what's connected to it. He will quickly try every button, switch and interface and keep using it until he gets some kind of effect. He works well with others and is happiest when engrossed in a task or working collaboratively with a friend. He uses a zimmer-frame and crutches to walk and a special chair, which helps him to sit upright and work at a table. His gross and fine motor skills are affected by his impairment and he can get frustrated when this prevents him from working in a way he wants. His frustration can manifest itself in negative behaviour but he will return to a task having had some time to calm and centre himself. He uses switches for some computer and communication tasks.

Dan – Male, 11 years old

He is a playful student who is able bodied but has complex emotional issues, which means that whilst he is high functioning, he often displays disruptive behaviour and ignores instruction from facilitators and staff. This has meant that on more than one occasion he has been excluded for a time from participating in a task. He shows a clear interest in working with video as a means of expression but struggles to focus on tasks that he is less enthusiastic about.

Oliver – Male, 10 years old

This student is quiet but very observant and will only participate in an activity once he is sure that he understands the task and what is expected of him. He works well with others though when partnered with more outgoing students he can become passive and unengaged in the task.

Mark – Male, 12 years old

A very friendly and likeable young man who is very enthusiastic about any task you set him. He has some serious difficulties with literacy, which means he is unable to read and write without a lot of support from others. He has moderate learning difficulties, which can cause his focus to drift from the task at hand but can be brought back with some encouragement and time. He is able bodied but his terminal illness sometimes requires that he leave the room for coughing fits and in some severe situations to spend time with the school medical team.

7.3 Design rational

As discussed in the previous chapter, the design rational for the prototypes used in this study's workshop series were informed by literature on: interaction design for children, AAC for children with special educational needs, wider HCI discourses and Tangible User Interfaces. My main considerations for the initial prototype designs were that they were appealing to participants (Light & Drager, 2007b), safe and robust, and were simple and quick for me to make and alter so as to minimise the attention demands of the system for the participating students (Blackstone et al., 2007; Light & Drager, 2007b).

To begin with I wanted to develop a simple system that would allow the user to trigger a media event using a physical action that had a clear conceptual link between the action of triggering the device and the resulting action. This was informed by the insight raised in *Chapter 5 – My photos, your photos* of the importance in user experience of connecting a child's action to the resulting event. When choosing the technology to use I avoided using touch screens. This was in response to Treviranus and Roberts' contention that touch screens are less suitable interface modes for children with special educational needs than tangible buttons and objects which provide clear kinaesthetic feedback {Treviranus:2003w p231}. I chose to create a simple RFID system and interface that could then be used and adapted for a range of prototypes and situations. The RFID system that is used in the majority of the sessions consists of an RFID reader encased in coloured acrylic and RFID reading software that identifies a tag placed on the reader and triggers a media event. The RFID tags I used are very durable and can be attached to and within a range of materials.

Figure 31 - Early prototype RFID reader designs (left and middle) and final design (right)

I wanted to develop aesthetically engaging objects that would appeal to students so they would be more likely to use them. I attempted to unify the aesthetic qualities of colour, shape and symbols across the different software and hardware interfaces I created and use in this study. As discussed in the previous chapter, colour in UI design for children plays an important role in how appealing the device is. Careful use of colour can also support children's visual processing and in particular plays an essential role in designating different functions in interactive systems for children (Wilkinson & Jagaroo, 2009). I used a small palate of colours that have been shown to be appealing to students (Garth & Porter, 1934; L. M. Walsh et al., 1990; Zentner, 2001) (red, yellow, blue, green, pink, white and black) in the interface and hardware I developed as a means to link particular functions between tags and readers and between software elements and hardware functions.

I used the Infant Sassoon font as with the previous study for my hardware, software and associated paper resources. The font is designed with a focus on readability and has the quality of being able to be copied by children learning to write. It has been shown to increase reading speed and comprehension for children, including children with special educational needs over more typically used fonts. (S. Walker & Reynolds, 2003; A. Wilkins et al., 2009) I also decided to use a raised font by cutting letters out of 3mm acrylic offering an additional sensory mode for the participants.

The materials I used for the physical interfaces needed to be durable, hygienic, and have a minimal risk of shattering or having sharp edges. I used food grade acrylic, which is strong, cheap, non-conductive, light weight, and waterproof and can be wiped clean. It is also available in bright matt colours and can be laser cut which was used to develop prototypes quickly and accurately. This meant I could cut the acrylic with rounded corners thus preventing potentially sharp edges.

The symbols system I used on the hardware and for the AAC sorting boards was the Picture Exchange Communication System (PECS) developed by Lori Frost and Andy Bondy at the Delaware Autism centre in 1985 and used with students in the majority of special needs schools in the UK. (Overcash, Horton, & Bondy, 2010)

Figure 32 - Examples of PECS boards taken from http://www.pecs-unitedkingdom.com/ (accessed 12th June 2015)

I used MAX/MSP to develop my software, which allows for rapid development of software integrated with hardware systems. The issue with using this package is that it is not intended for long-term use and can develop bugs. It also clashes with different configurations of hardware and software.

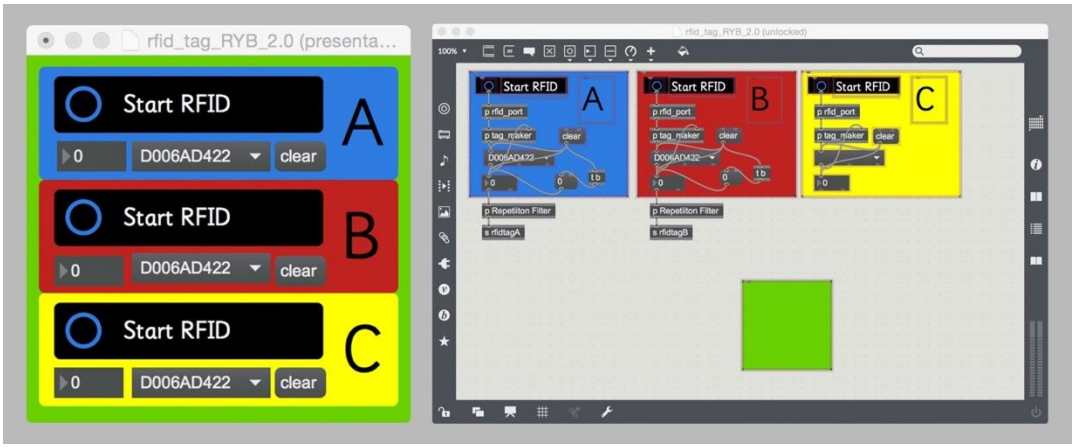

Figure 33 - The MAX/MSP RFID Tag reader patch created by the researcher

The only exception to this was my use of the Modul8[6] live video mixing software, which offered a stable and wide range of functions for the video prototypes that would otherwise have needed many months to program. I used my own laptop throughout the study instead of the classroom computer that had severe restrictions on installing software, plugins, and specific media formats. I did however use the classrooms audio and video projectors when needed.

7.4 Workshop series

The following section describes a series of design-led workshop sessions carried out with children in a mixed ability SEN classroom. Each workshop introduces a tangible interface which uses digital media (sound, video, images) to compliment and extend classroom based teaching activities. For each of the sessions I provide a description and rational for the prototype used, a descriptive account of the session and an initial reflection on the understandings that arose from each of the sessions. The empirical evidence and initial insights gathered during the workshops are then used alongside pertinent literature to form a grounded analysis which is discussed in the *7.11 Discussion* section of this chapter. This workshop series and the teachers' focus group are part of the design-led, embedded and grounded methodological approach taken in this study.

7.4.1 Preliminary work

As in the previous study, *Chapter 6 – This year I have…*, I worked as a teaching assistant and workshop facilitator with a single class in Delmore school. This follows my

[6] See http://www.modul8.ch/

research approach in this context that emphasises the importance of developing m*eaningful emotional encounters* (Wright & McCarthy, 2010)with staff and students as a means to incorporate their perspectives and lived-experiences into the design process(Frauenberger et al., 2010; Hammersley & Atkinson, 2010; Read et al., 2002). Working in the school during this study and my previous experiences working with staff and students, directly informed the choice of activities that I would incorporate into my prototype and workshop sessions.

7.5 Workshop 1 – sorting boards

In this first workshop session I introduced a simple, tangible AAC communication board which used digital media to augment each AAC symbol represented on the board by triggering a media event (sound, video, image) when placed on the RFID reader. The purpose of this session was to introduce the basic functionality of the RFID reader kit to the students and staff in the class and see how the tangible interface could be used to extend the simple paper AAC boards that were extensively used in the class.

In my interview with the head of the school's speech and language therapy department, we discussed the extensive use of AAC boards within the school. Teachers and students with a range of abilities and impairments used these in a number of different situations. AAC boards are used as the main tools for communication, planning and understanding the day or weeks ahead, as a teaching tool for teachers introducing ideas and for discussing how students are feeling or what they have achieved.

I had seen a range of different designs for these boards working in the school and the speech and language specialist showed me several designs as well. The simplest and most widely used was a 5 x 5 grid printed and laminated on cardboard. Each square on the grid has a Velcro tab on which a square with an image or symbol can be placed. This might be used as a timetable with each square representing a period of time during the day at the school or might show a series of different objects or adjectives that the student can select for communicating non-verbally with others. What was notable about this version was that it was very cheap and easy to construct and share using PDF templates.

The speech and language specialist then showed me an Accent (brand name) digital sorting board**,** which the school had been using with non-verbal students for the past few years. The system consisted of a Windows tablet with a ruggedized touch screen overlaid with a raised plastic grid. The tablet ran proprietary software that allowed the

user to select from a select range of images that would then be placed in the specified grid position. When a square was touched the tablet would play a corresponding sound, a word or sound effect. In contrast to the initial design, the speech and language (SL) specialist discussed the large cost (several thousand pounds) and inflexibility of the system. She also talked about the difficulty of setting up the system and changing the images on the screen.

Working in the school over the past two years I had seen the range of uses for picture/ AAC boards and thought that this combined with the simple RFID reader I had created in the previous study would be an interesting starting point to introduce to the class.

There were a number of constraints to the design that informed my initial session. The interface should use the Velcro tag system from the basic board system so that it was recognisable to students and simple to change. It should allow the teacher to use the system without the digital component. It must be simple to setup for the teacher and simple to use for students should also be adaptable for different tasks and useable by the majority of students in the class regardless of their physical and cognitive abilities. I also wanted the system to be inexpensive and rugged enough to survive the knocks and spills that occur in a SEN classroom.

7.5.1 Prototype Overview

RFID Communication Board: The prototype for this session consists of a reader, nine RFID tags with images on, and an acrylic board that holds the reader and tags in place. Each tag has a Velcro strip that allows different images to be placed on the front. When a tag is placed on the reader an image is displayed on screen with an accompanying sound.

Figure 34 - RFID communication board

The software consists of two simple parts. The first part allows the user to choose an image and sound to be associated with a particular tag. The second part displays an image and sound associated with a tag when placed on a reader. The user was also able to print out the image on each square as a PDF with a musical note denoting a square that had a sound but not an image.

7.5.2 Observations

Length: 25 minutes

Students: Eight students including William, Jacob and Emily - **Staff:** Amanda (TA), James (TA), Nick (CT)

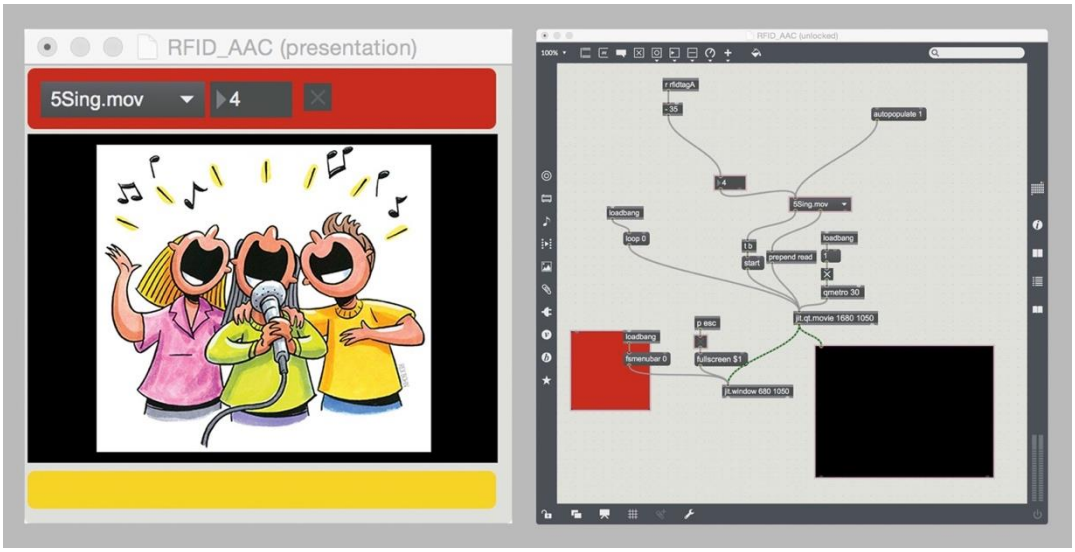

Figure 35 - MAX/MSP patch for the RFID communication board

The week before the session I had worked with the class teacher to decide on a range of images and sounds that would make up the different squares on the AAC sorting board. We selected symbols that were both exciting and had a clear corresponding action or sound.

I set up the RFID pad and tags on a table near the centre of the room with the laptop sitting to the left and the white board in front. The setup required some moving around of tables and chairs and the use of a long VGA lead to connect to the white board at the front of the class. The class teacher introduced the task and me. I began by talking to the class from the front about the visual timetables used by the students. I then used this as a means to introduce the RFID communication board. All of the class seemed eager to use the reader and two students had to be asked by the teacher to sit down as

they started to pickup and play with the reader and disrupt the class before they had been invited to use it.

Students were asked to select a tag and place it on the reader. Each student was asked to come up and try out the system and was invited to comment on what they had done. Each student smiled when they tried the system for the first time and there was laughter when the 'silly face' video was played.

Two of the students, Williams and Jacob found it difficult to place the cards on the reader due to their poor motor skills. Emily placed two cards on the reader and seemed to become frustrated when both images and sounds were not displayed.

William said that it was just like the cards they used with the teacher to talk about how they felt when they found it hard to describe their feelings. The teacher later showed me the board with emoticons that was used to discuss feelings with students.

At one point the software crashed on the laptop and so I had to spend time resetting the computer and software. The teaching assistant supporting me then asked the students to each choose a square and to either act out or make a sound for the image that was on it. This proved to be a fun task, which had most of the class including me laughing. I was able to reset the software quickly but decided to continue the task that the TA had set so that every student had a chance to show the group their action or sound.

7.5.3 Reflections

The design of the AAC sorting board meant that students quickly recognised the function, having all used AAC sorting boards before. As designers creating digital resources in this context we can make use of existing tools and strategies which teachers and students are already familiar with and use regularly as a basis for our designs. Using existing tools as a starting point allows us to use the qualities that make the tools successful for the context and to reduce the learning requirements for teachers and students.

The interface was a draw for students, which meant that they were attracted to using it but also disruptive as was evidenced by the behaviour of the two students at the start of the session. This may have been due to the novelty of working with a staff member that wasn't the class teacher or a teaching assistant or possibly the introduction of an unknown piece of computer equipment.

In regards to my initial rationale for the session, the ability for the device to be used without the augmentation of sound and video proved to be useful when the device failed. Indeed, the session became more focused on the students' actions and sounds rather than the trigged media responses. This shows the importance for designers of creating tools that support teachers to use contingent strategies when the augmented, digital functions fail or require adjusting.

The design proved to be accessible for most students but there were obviously two students who struggled to use it. This meant I needed to adapt the design so that the cards could be placed on the reader with less need for precise placement. I had thought that the range the RFID antennae gave would give a wide enough contact area but it showed that I needed some kind of guard to prevent that cards from slipping off. The session did show however that the use of rugged acrylic was a sensible option.

7.6 Workshop 2 – Phonics

For this session I created two prototypes which focused on phonics and literacy. The prototypes and workshop session were based on teaching activity from the week before and the insights I had started to develop during that session. These were; the importance of considering and using qualities of existing resources and activities as a basis for the prototype designs and using augmented objects to support literacy activities through the use of sound and images.

In the week between the workshop sessions I worked with the class on a phonics lesson. The use of the phonics learning system is central to the literacy skills component of the students' learning plan for that year. During the session the teacher started the session by reviewing five letter and five blend sounds from the previous week. Each student was given a set of the plastic letters that corresponded to the five letters. The students then took it in turns to sound out single letters, blends and words, which they then wrote on the board with help. The class teacher explained that this was a technique to reinforce the letter shapes through a tactile sensory mode alongside the visual and audio modes.

In the second part of the session the class teacher split the class into four groups depending on their reading and writing level. I was asked to work with one of the groups with the support of Amanda. We used a pair of dice, one yellow and one red. The yellow die had a single letter on each side and the red die a selection of letter blends. Students took it in turn to roll the two dice and write on the white board the resulting word. They were then asked as a group to decide if this was a real word or not. If the group decided it wasn't a word, then it was wiped from the board.

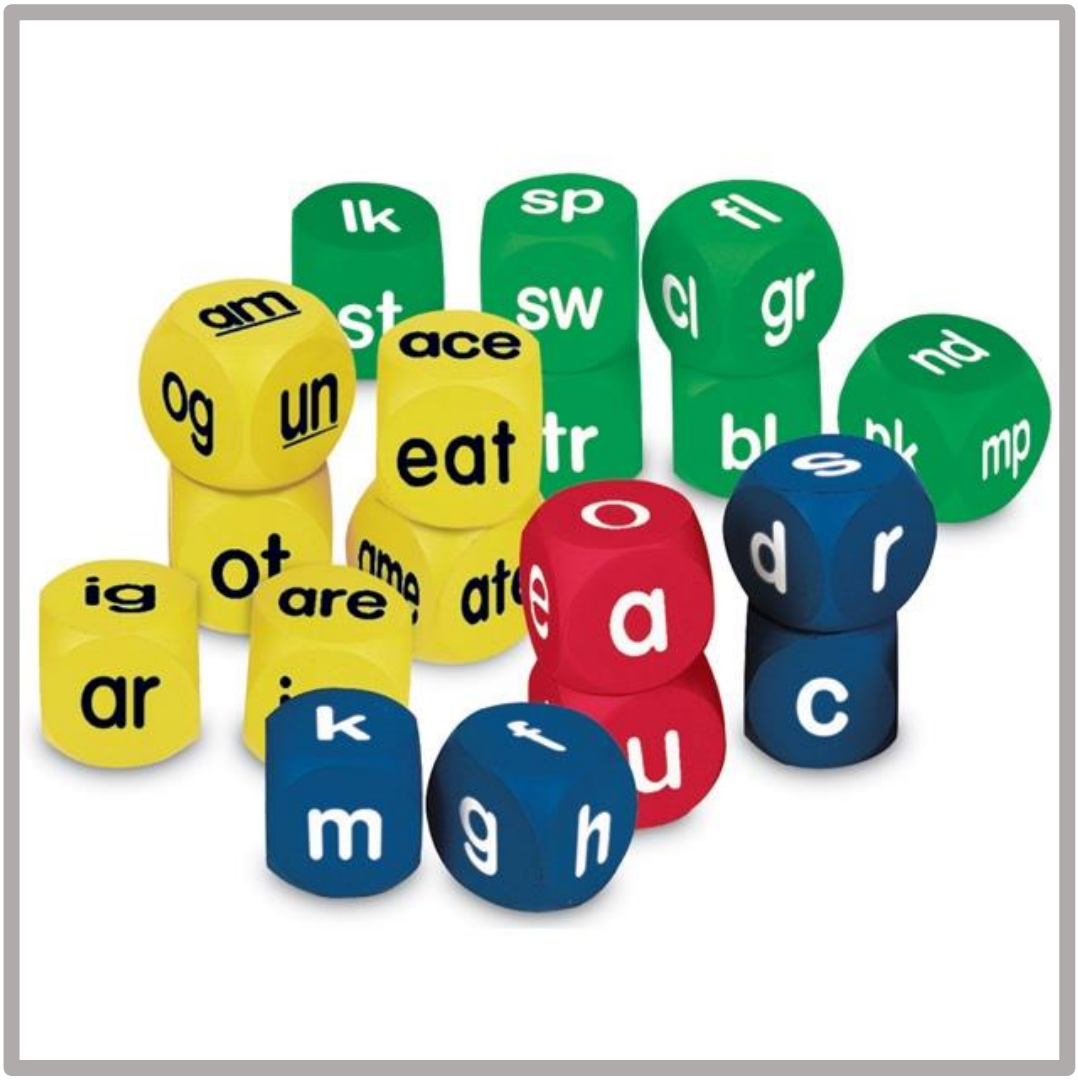

Figure 36 – Image of Phonics Dice from http://www.creativeacademics.com/ (accessed: 12th June 2015)

I decided to use this session as a model for the next prototype session. I was interested in the idea of creating tactile forms of the letters, augmented with projected images and sound, as a means to reinforce the learning of sounds and ways of writing letters. I also wanted to create ways for students to check on letter sounds quickly and easily without having to ask a staff member for support. In the design I was interested in the colour

coding that was used to distinguish the letter blends from the single letters and wanted to replicate this in my design. I also used colour to distinguish on the alphabet board between vowel and consonants. Both the prototypes I created all had raised letters that allowed students to feel and see the letters they placed on the readers and used colour to denote the different vowels.

7.6.1 Prototype Overview

This session used two different prototypes that were based on the RFID reader. The first was an RFID reader and 26 tags with tactile cut outs of the letters of the alphabet. When a tag is placed on the reader a video is triggered with an actor reading the particular sound.

Figure 37 – Phonics, alphabet sorting board

The second consists of two RFID readers: one pink and one yellow and two sets of cards in yellow and pink. When placed next to each other the cards spell out common word blends commonly used in phonics teaching. The yellow cards have single letters on them and the pink cards are two or three letter endings. When a yellow card is placed on the yellow RFID reader and the pink on a pink RFID reader they spell out a word. The word is then displayed on screen and the student is asked if this is a real word or not. The yellow and pink cards have distinct sounds that are played when placed on the reader.

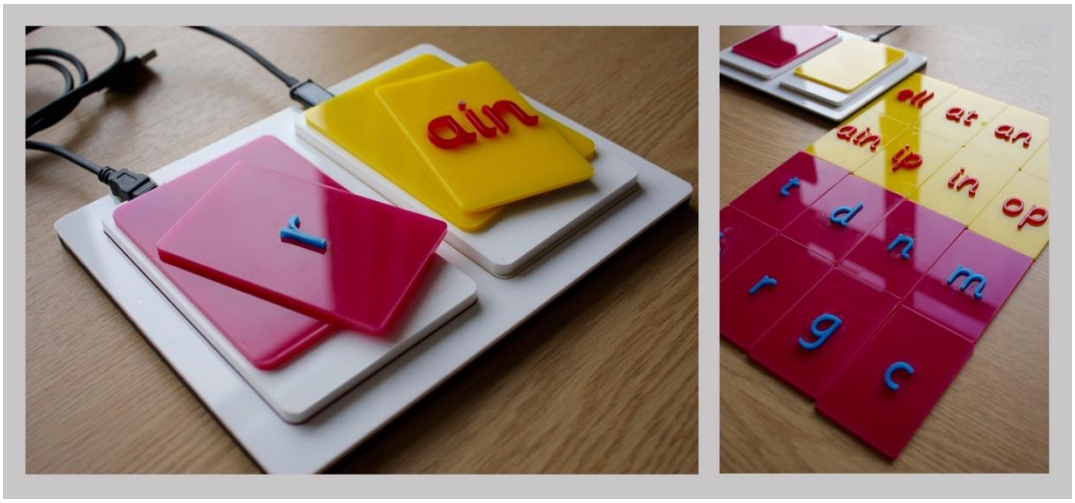

Figure 38 - Phonics game cards and readers

7.6.2 Observations

Length: 35 minutes with setup time

Students: William, Oliver, Emily, Jacob **– Staff:** Nick, Amanda

For the prototype session I worked with three students who took part in the previous session plus one student who was absent the week before. The initial setup took about ten minutes, which I did whilst the class was engaged in another activity. This was distracting for the students and Nick and Amanda and James had to repeatedly ask for students to focus on what they were doing and not on me.

The students and researcher sat around a small table with the two RFID systems placed in the centre of the table. I first reminded the students of the activity from the week before. Nick had mentioned on more than one occasion that almost all of his students had memory retention problems, which meant that they required clear and multi-sensory reminders in order to refresh their memories about activities even within a single day. In light of this I showed them the phonics dice and played a couple of rounds of the activity from the week before in order to remind them of the previous week's activity. Once we'd established this, I introduced the first of the two prototypes; the phonics sorting board. I explained how it worked then asked the students to take turns placing a token on the RFID reader.

Williams and Jacob both took it in turns to place the tokens on the board. William placed multiple tokens on the RFID reader and I explained that this would confuse the system. Emily quickly swapped the tokens creating a broken set of sounds and video that whilst

being less useful for understanding the letter sound created an interesting sound track that made everyone in the group laugh.

I then introduced the second prototype, which mimicked the dice from the previous week. All four of the students quickly understood the system and took it in turns to play with it and get used to how it worked. Both William and Jacob had motor skill issues that meant that they found it hard to place the cards on the reader without them falling off or being close enough to register. This they clearly found frustrating but Emily helped by placing the cards for them when they had an issue. Replacing the letters on the alphabet sorting board however seemed to be better suited for William and Jacob as they would slot into a specific shape and be less likely to slide off the reader.

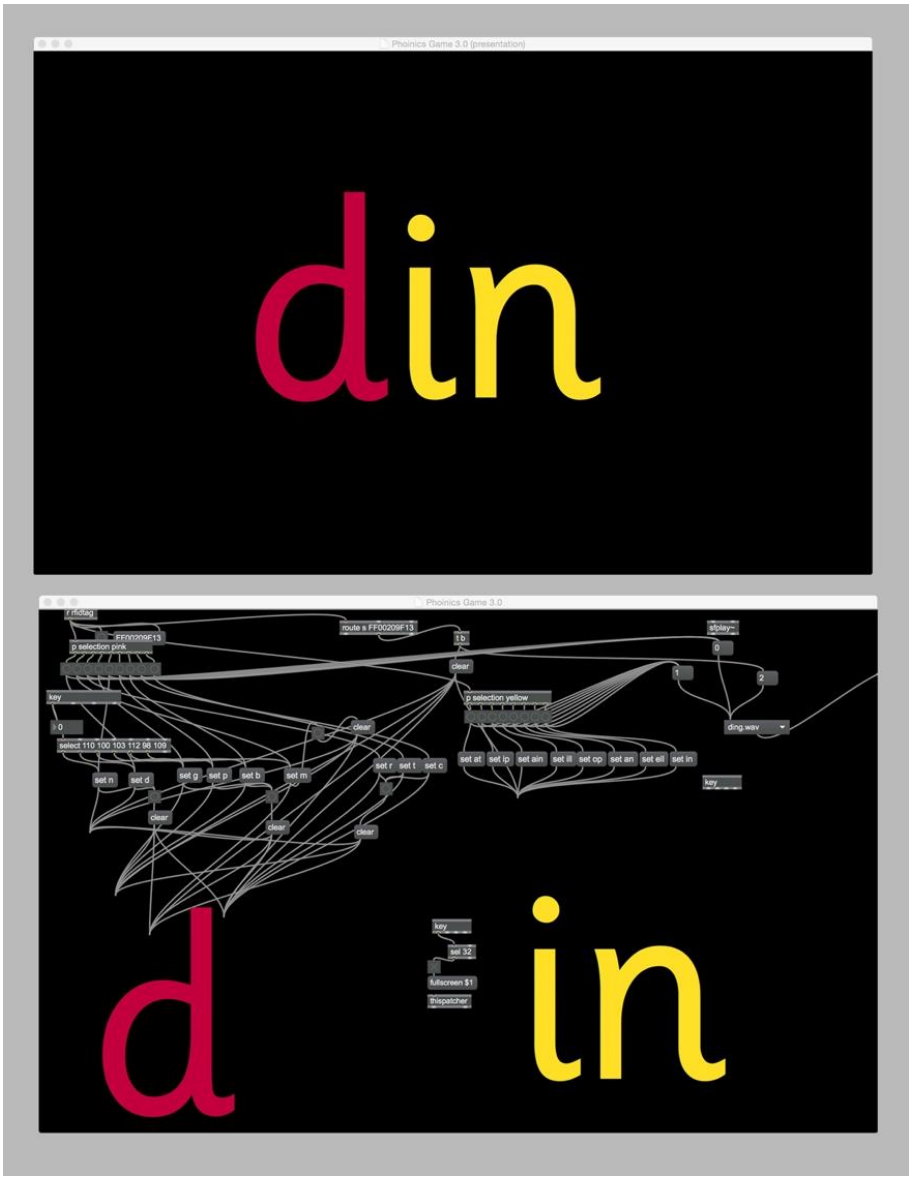

Figure 39 - MAX MSP Phonics game patch

The group played the same game from the previous week using the RFID prototype but used the separate phonics sorting board to sound out letters they didn't know. The students seemed very keen to use the system and had to take turns so that they were able to each get a turn. The function of displaying the letters on the screen as the students changed the cards meant they were able to try different combinations quickly and discuss as a group if they thought what was being displayed were words or not. As a group we ended up with a list twice as long of actual words, which the students had formed in the same amount of time as the week before. The alphabet sorting board proved useful to some extent for the single letters and it was noticeable that students would use the board before asking a member of staff if they had correctly sounded out a single letter. The setup time and packing away of the equipment however took far longer than with the dice.

I talked with Nick after the session and he commented that the students were excited by the tactile and audio feedback from the letters and that it was clear that it helped them in sounding out and thinking about the different letter combinations. He also said that we needed to consider the motor skills of students as this had been a problem as well as the extended time needed to setup and pack down the system.

Reflections

The setup time for the equipment meant that the participating students were disruptive to the rest of the class. At the start of each teaching session Nick was able to calm and focus students. I had to refocus the students once I had setup the interface, which took some time. For designers and researchers, it is important that we consider setting up time when planning session as teachers do. If possible have resources setup and tested before sessions start will minimise the disruption to the flow of the session and other activities going on in the room.

Using the same format as the previous week for the session meant students were able to understand what they were meant to do quickly once they had calmed and refocused. This again raises the importance of incorporating existing strategies', activates and resources with the design process and session planning as a means to reduce the learning requirements of devices and to bring the useful qualities of existing resources.

The students were quick to test out the limitations of the system this was useful both in terms of design but also in creating a convivial atmosphere to work within. Allowing students to test the limits of our designs allow us to see where those limitations lie but

also helps students to familiarise themselves with the functionality and potential uses of our designs.

The students would also handle and touch the letters when attempting to sound out individual letters, blends and words. One student went so far as to stick several letters in their mouth! When they were recovered from their mouth we were able to quickly use a wet wipe to clean them and they still worked straight away. This shows the rugged nature of the design as well as potentially the extra tangible sensory mode that it allows for.

Once the students understood they could use the sorting board to check the sounding of individual letters they would ask me and Amanda noticeably less than in the previous week. The accessibility was again an issue with the flat RFID readers, though the sorting board seemed easier to use as students could locate the tags onto the holes in the main board.

7.7 Workshop 3 – Storytelling Interface

In this session we explored as a class the use of a tangible interfaces to support creative story telling as a group activity. In this session I handed over the responsibility of using the system to the teacher and teaching assistants as a means to consider how it functioned when used by its intended users.

This storytelling prototype was based on the storytelling work I conducted during my MSc research detailed in *1.4 Previous work* and a group storytelling task done with the class by Nick the previous week. An issue during storytelling sessions with the levels of abilities presented in this class was that a majority were unable to write anything more than single words or short sentences in a session. This meant that for creating more complex stories Nick relied on spoken word, performance, photographs and dictation when creating and recording stories involving students in the class.

I used the RFID system that was developed in the other sessions but modified it so that the RFID readers had a slot that the cards would lie in to address the issue in previous weeks with cards slipping from the reader. I also continued the colour coding system by making the RFID readers and tags three different colours to distinguish the different story components and make it clear on which reader each card should be placed.

In the first session I was interested to see that when the technology broke down the teaching staff devised an activity that focused on the student's actions, sounds and ideas. Using this I wanted to create a session that used images, sounds and video as a starting point for students to create their own ideas and stories.

Having also run the previous two sessions I wanted to hand over responsibility for using the interface to the teacher and teaching assistants. This was to see how affectively the design worked with the teacher rather than designer using the system.

7.7.1 Prototype Overview

The system consists of three RFID readers with an acrylic board to hold them in place, three sets of five RFID cards with corresponding images Velcroed to the front of each card. The cards were split into three categories: Animals, Landscapes and Sounds.

Figure 40 - Story game sorting board

The three cards, when placed on the RFID readers, create a scene for a story projected on the classroom white board. The animal is overlaid on the landscape and a sound is played when placed on the reader.

Figure 41 - Story game RFID readers. One reader for background image, one for the character and one for the sound effect

7.7.2 Observations

For this session I intended for the teacher and students to use the prototype with as little intervention from me as possible. I arrived early at the school and spent 20 minutes working with Nick, Amanda and James to show them how the prototype worked and to develop a classroom activity for the literacy session later in the day. The session was to be run by the teacher while I acted as teaching assistant and to help if the system stopped working.

I set up the system in the centre of the classroom on a table with the students' tables placed around the space in a horseshoe shape. Nick introduced the session and explained that they would be creating stories based on pictures that the students would be making with the RFID system. At this point all of the students had used the RFID for a task and so were familiar with the idea of placing cards on the reader.

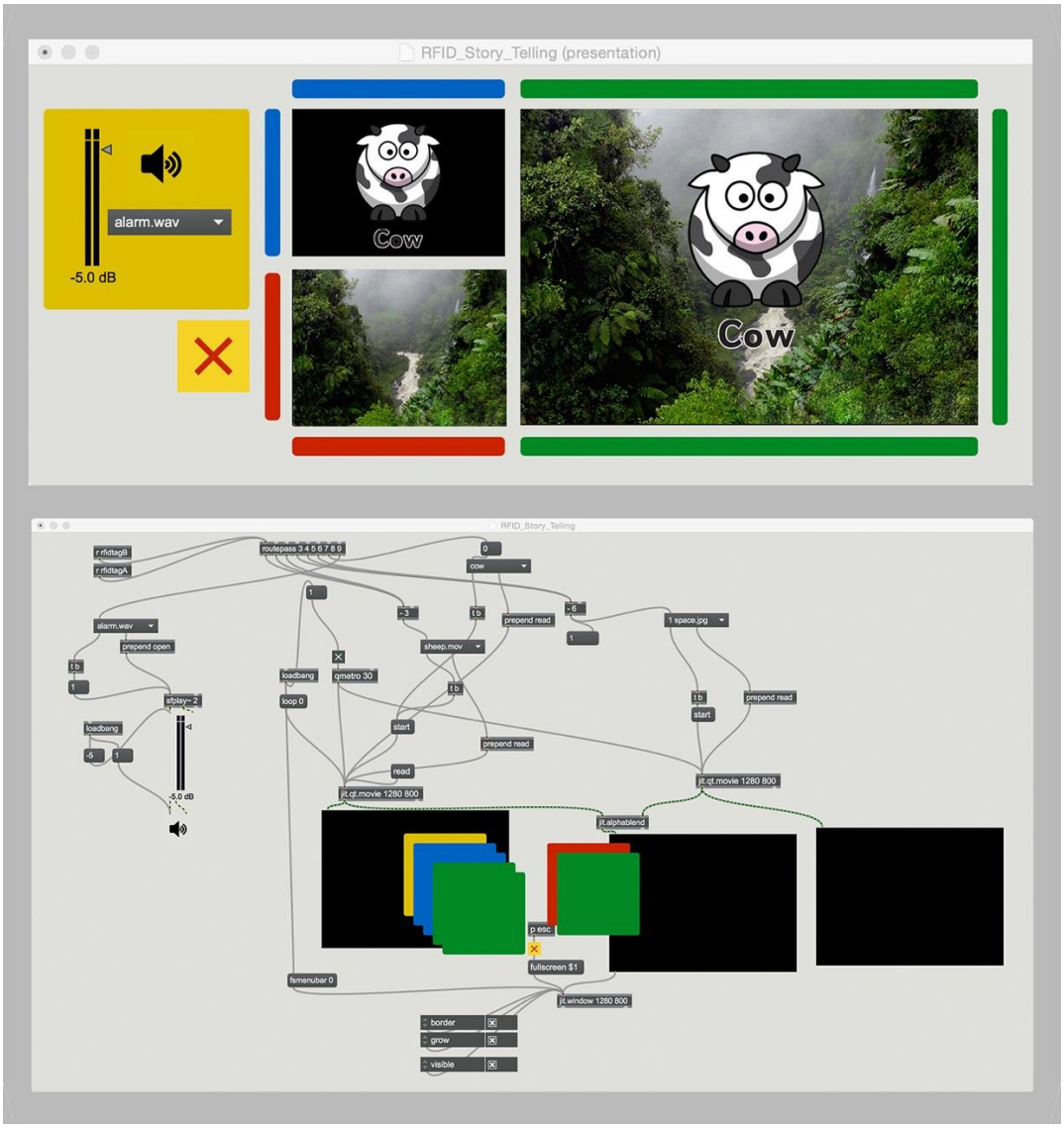

Figure 42 - Story game MAX/MSP patch

Nick started the session by selecting a card from each stack and creating an image on screen with an accompanying sound. Once the basic function of the system had been demonstrated, Nick invited different students to create a scene by selecting a card from each stack. For each of the scenes students created, the teacher would ask the class a set of questions in order to develop a simple and quick story about the scene. These included:

What do you see? What does the place look like? Who do you meet? What do they look like? What do they eat and drink? Where do they live? What does the character sound like? Smell like? Feel like? How does it walk and move?

Nick used the prototype as a means to engage the class as a group in an imaginative storytelling task. After the initial group storytelling task the students were asked to each make a story in pairs by selecting three cards that made up a scene. Each student was given a printed card with the three aspects of the scene to help them remember their idea. Nick, Amanda, James and the researcher worked with the groups to come up with a story they could present to the class. They were given 10 minutes to come up with the story and were then asked to present their story to the class. The stories were funny, weird and short. One interesting moment was when a student had forgotten what their main character was doing until the second student placed a sound effect card on the reader. The sound prompted them to remember and finish their story.

At the end of the session the teacher talked with the researcher and TAs about the session. The system remained stable throughout the session and didn't require any intervention from me. Nick said that it would have benefited from a function that would allow the teacher to print out the scene as a sheet with room for text below so that students could then create individual stories. Amanda mentioned that a recording and playback function would have been useful for students who struggled with writing.

7.7.3 Reflections

The session highlighted the importance of the teacher's use of the technology as a tool. This may seem an obvious point but the way the class teachers used the device to illicit responses from students showed that it is not an innate quality of the technology that enables students to learn but rather the way in which the teacher uses that technology to encourage students to think and learn. This puts the onus on to the teacher and relies on their skills to see the possibilities for how a technology can be used to encourage students in the particular class to think and respond.

The interface allowed students to very quickly devise and present their stories to the rest of the class using sound and images to complement their ideas. They were in some ways limited by the selection of media they could use but this meant they did not have to spend time preparing and ordering the media. Interestingly the digital media acted as a memory prompt for at least one group. This illustrates the role of digital media in supporting children with special educational needs to create stories using a range of modes, image, sound, tactile and the written word.

The storytelling interface complimented and to an extent enhanced the existing storytelling practices used by the teacher and teaching assistant in the class. The

structure of the sorting board; character, place and sound provided a loose structure for the stories and the overlaid images projected on the screen reinforced the need for each of the student's stories to have three different elements. The individual sorting tokens offered a small, constrained selection of materials which the students and teacher could use to construct their stories and acted as trigger points for their imagination. The addition of sound and image provided an extra sensory dimension to the process. Whilst the storytelling activity would have worked without the augmented digital media function, the system provided additional material which the teacher could use with their students to create and tell stories.

7.8 Workshop 4, 5, and 6 – Video Mixing Sessions

The following section discusses three individual workshop session that I conducted with students from the class. I have included all three workshops together as they are all concerned with interfaces that support students to play and mix video. For each of the sessions I introduced a new prototype interface which the experiences of each workshop directly informing the next prototype design.

I have a background in mixing live video for music events, festivals and in advertising. I have also used live video mixing with groups of children with SEN in various play and arts settings. A quality of live video mixing is that you can quickly create impressive and unique mixes that children find engaging and exciting. In my *MSc work* previous to the work in this PhD at the school I developed a simple video mixing system for Nick's class at the time using an MIDI keyboard and custom MAX/MSP patch. This allowed students to play and manipulate their digital stories during a live performance.

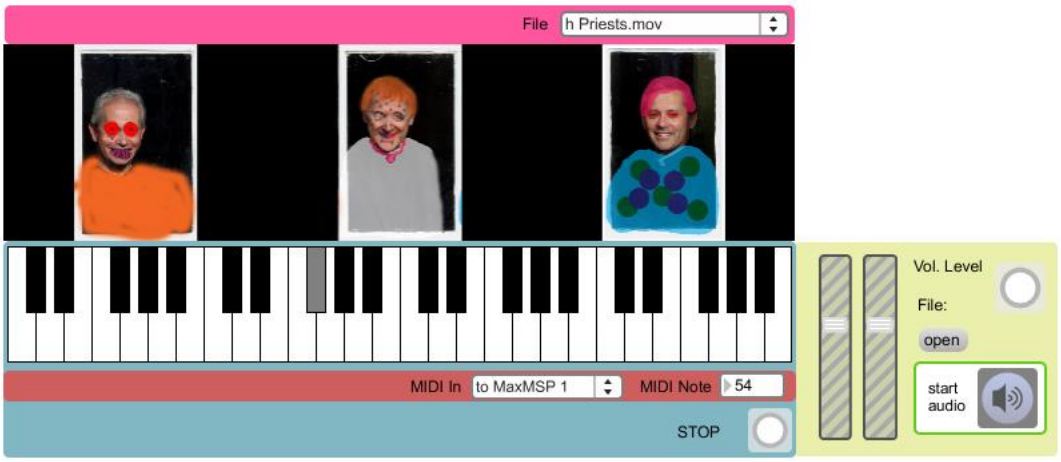

Figure 43 - Video MAX/MSP patch from my MSc research project

In our discussion at the start of the second term, Nick suggested that I create a simple system using the RFID system for the students in his class who had been really engaged in the work I had done over the two terms. I decided to create two different systems one using the RFID system and a second using a custom controller with arcade style buttons and sliders. I used the RFID system as it was the basis for all of these previous sessions and I thought students would be familiar with the way the system worked. I chose to try the arcade style controller, as I was aware that many of the students in the class had computer game systems such as Xbox and PS3 at home. I also wanted to use a system that had a high quality tactile response to being pressed, slid and moved. Arcade style buttons and joysticks are designed to be extremely reliable, durable and simple to use, all qualities that would be useful for the students in the class.

7.8.1 Prototype Overview

For each of the three video mixing workshops I created a new interface design: there was an RFID based sorting board, a complex arcade style mixing interface and a much simpler arcade style mixing interface.

7.8.2 Session 4: Video Sorting Board

The first interface consisted of an RFID reader, nine RFID cards and a custom MAX/MSP Patch. Four of the cards when placed on the reader will trigger a short loop of video associated with that card. The other five cards change the video in the following way: Play video forward, Play video backwards, Toggle video Slow Motion, Toggle Bump Distortion, Toggle Inverse Colour.

Figure 44 - Video Sorting Board

7.8.3 Session 5 - Large video arcade controller

For this session I created a large arcade style controller consisting of eleven arcade style buttons, six rotary potentiometers, and five slider potentiometers. This is then mapped to the commercial live video mixing software Modul8. This allows two channels of video to be mixed and multiple effects to be added using the controller. The central fader allows the user to cross fade between two pieces of video. The top six buttons select different videos, the middle three add distortions and the bottom three add other image effects to the selected video channel. The potentiometers act as RGB controls for the two different video channels.

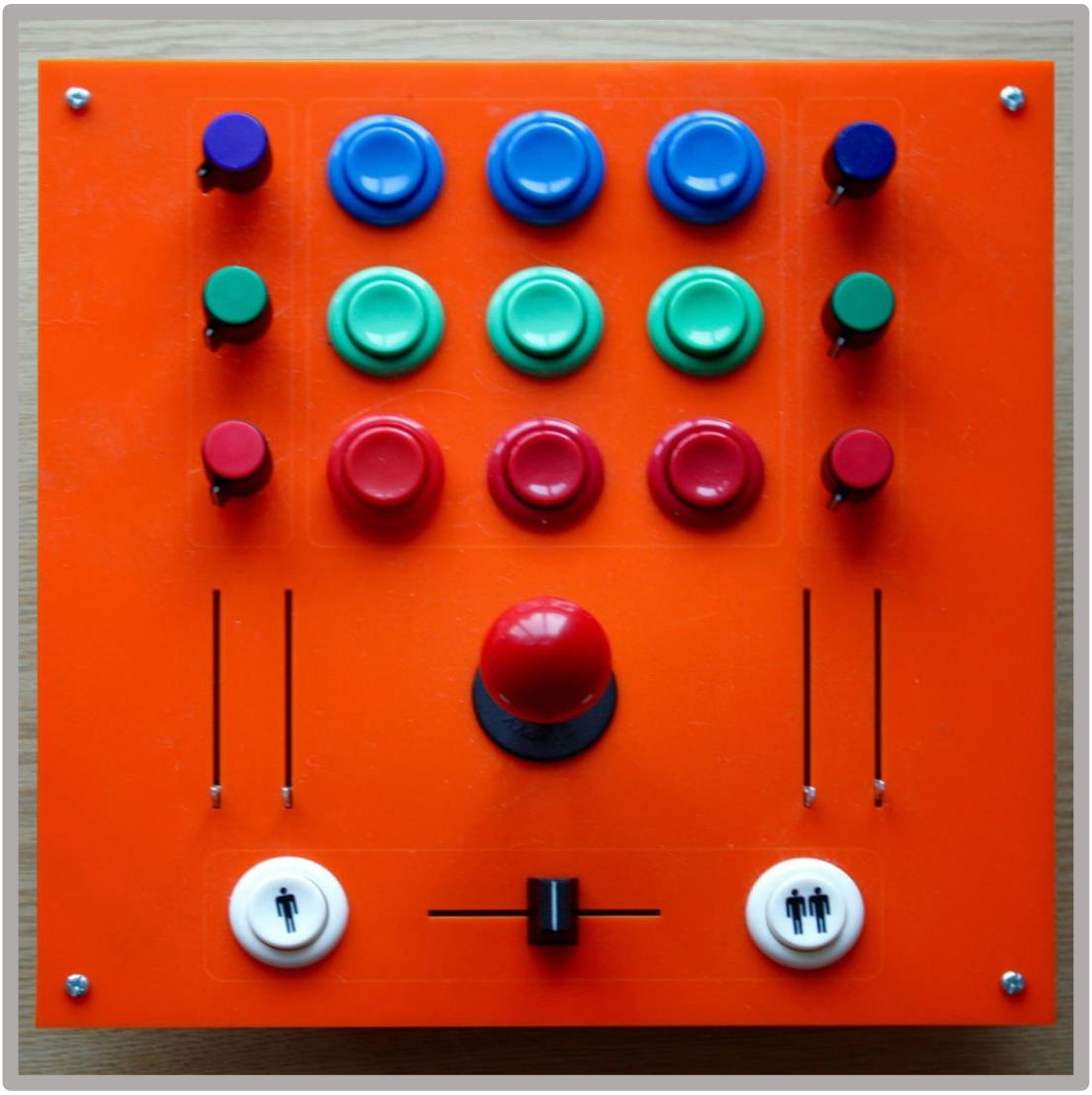

Figure 45 - Large video arcade controller

7.8.4 Session 6: Small video arcade controller

The interface for the final session consisted of a small arcade controller with a multi-axis joystick and four different coloured arcade style buttons. This was mapped to Modul8 but uses a webcam as the image source. The joystick adjusts the colour of the webcam through an RGB colour space and the four buttons add four simple image effects and distortions. The arcade controller deliberately did not have any labels but rather used colour to denote functions (see *7.3 Design rational)* so that each button and slider could be mapped to different functions depending on what was needed during a session.

Figure 46 – Small video arcade controller

7.8.5 Observations

Session 4: RFID video mixing interface

For this session I worked with three students William, Jacob and Mark. I set up the RFID system in a corner of the room before the session. Nick had already told the students that they would be working with me in the morning session and they came straight over to the table when they entered the room. Having checked that this was ok with Nick I asked them if they remembered using the RFID in previous weeks. Mark said, 'Yeah I remember, are we doing the storytelling thing again?' I explained that we would be doing something else but that I wanted them to try it out and see if they thought it was fun.

I started by giving them each a different card associated with a video and asked them to place the card on the reader in turn. Again William found it hard to place the card directly on the reader but resisted help from me. I then swapped the cards around and asked them to try it again. They were then allowed to try different cards and to see how the video changed between the different channels. At this point I introduced the distortion cards and the speed and effects cards and asked them to see what happened

to the video. All three students struggled to use these cards and when asked whether they were aware that they had some effect on the video being played they quickly became disengaged. Within five minutes of introducing the cards two of the students become agitated and began to stack the cards on top of each other and spread them over the reader. They then asked to join the rest of the class who were doing a quiz on the digital white board with Nick. The remaining student Mark stayed with me and played with the different video cards but ignored the manipulation cards. Again he struggled to manipulate the cards and place them on the reader. After around five minutes Mark became disengaged to the point that he walked over to a different part of the room. I asked if he would like to join the rest of the group and he decided that he did. At the end of the session I was unable to talk to the TAs or Nick as two students had to be removed from the class for fighting leaving neither Nick nor any TAs were available to talk.

7.8.6 Session 5: Large arcade style video mixing interface

I developed an arcade style controller at the same time as the RFID patch in order to create a more tangible and adaptable system for students. The interface offered far more functions than the RFID system and so potentially more scope for experimentation for the students.

I set up the system in the same way as in Stage 1 with the controller placed in the middle of the table and the screen raised on a box behind. I worked with the same three students as before. I introduced the interface and showed them the basic functions then asked them to play with the system to see what they could make. Mark was the first to use the interface and I observed that he was able to select individual buttons with greater ease than with the RFID card system. He pressed every button and slid every potentiometer but without any sign of understanding the difference in their functions. William played with the controller in a similar manner, pressing all the buttons. After his initial button pressing he focused in on the video changing buttons and cross fader, pressing these quickly and seemingly at random. He smiled throughout but after two or three minutes offered the controller to the last student saying he was 'done with it'. The last student again tried most of the buttons and potentiometers then focused on the six colour controls. He repeatedly turned these and quickly became frustrated when he was unable to see their effect. This was due to the video he was effecting being on the non-visible side of the cross fader. At that point I attempted to show him how the cross fader worked but it was clear that all three students had disengaged from the

task. At this point I asked if the students wanted to return to the rest of the class as they were clearly distracted and bored. William and Jacob returned to the rest of the class and Mark stayed to play with the controller for another five minutes before also asking to return to the rest of the class.

7.8.7 Session 6: Small arcade style video mixing interface

I redesigned the console creating a far simpler version of the arcade type interface. I reduced the number of options constraining the interface to a joystick and four buttons. I worked with three of the students I had worked with the previous week.

I set up the interface and laptop and webcam on the same table as the previous week and instead of taking the more explorative approach from the previous week introduced the session as a storytelling activity.

The console was mapped to the commercial Modul8 software. The webcam took a continuous video of the student's face. The joystick adjusted the colour of the webcam through an RGB colour space and the four buttons added four simple image effects and distortions. The students were asked to try out the system. Jacob was first and quickly learned to use the joystick to manipulate the colour of the video with the two students and the researcher laughing at the resulting images. Where previously he had struggled to use the different interfaces he seemed comfortable with the joystick and was able to choose with precision the different colours I asked him to find.

Figure 47 - Alien Passport ready for print

I explained that I wanted the students to turn themselves into aliens using the interface. Once they had create an alien they were happy with we would take a picture (screen grab) and then we would use that picture to create an 'alien passport'. Though each student took it in turns to create an alien portrait the students not using the interface were ready to make suggestions to the student whose turn it was and at times press buttons when they hadn't been asked to.

Once we had an image for each student I had to then place those images onto a premade alien passport template in Adobe Illustrator and print the sheets off for them to work on. This proved difficult, as I needed the laptop I was using to do this and had to close down the video program and put the interface away whilst keeping the students engaged. The students were reluctant to let me put the interface away and became agitated to the point that William grabbed the interface from my hands. At this point Amanda came over to the group and asked the two students if they could help him with gluing a wall display he was preparing on the other side of the classroom. This left me the time and space to quickly add the portraits to the templates. I then placed the images onto a USB so they could be printed on the class computer. This became a problem as I had to interrupt Nick and ask him to log me onto the class computer so

that they could be printed. This all took around ten minutes and required at least one other member of staff all of which I hadn't factored into the session.

Once the sheets were ready the students came back over to the table we had been working at and looked at the images I had printed. All of the students were excited by the images and laughed at their own and each other's portraits.

TA Amanda had joined me at this point and between us we worked with the students to fill in our alien passports. At the end of the session each of the students presented their aliens to the rest of the class. Amanda suggested to the students that we create a small wall display with them and they seemed pleased and agreed.

7.8.8 Reflections

Session 4: RFID video mixing interface

Initially students were excited to work with the controller and me. After using the system for a short period the students became quickly disengaged which led to them being disruptive. There were a number of reasons for this. There was a lack of clarity in the functionality of the interface. Whilst they could understand the idea of triggering video using the different cards, the use of distortion, colour and direction control was too abstract for them to understand. This may have been due to the design of the cards and the complexity of the concepts but also the facilitation of the session by myself. There was no clear task for the students to achieve and when they began to misuse the system by stacking cards on top of each other there was no serendipitous results only a blank screen. If the layering of cards had say set off a layering of effects this may have been more exciting and engaging for the students. This shows the importance for designers of considering the correct mapping and interface style for particular tasks. Whilst using the existing structure offered by the paper sorting boards used in the school working well for the AAC sorting board in the first session, using it to mix video was not. Finding what works comes from careful design thinking on behalf of the designer but also thorough testing and use in the classroom context they are designed for.

7.8.9 Session 5: Large arcade style video mixing interface

The layout and tactile feedback of the controller made the console easier to use for the students. As with the previous session the students started engaged and excited to use the system but quickly became disengaged. The range of functions meant that the

students had more opportunity to play and discover different qualities for their video. However, the system was overly complex and offered too large a range of functions, which seemed to overwhelm them. Importantly it was the facilitation of the session that also led to students disengaging from the task. There was no clear task set for the students other than to 'explore' the console and its affects. Whilst this meant they tried to push, slide and pull every control they quickly become directionless and then disengaged.

As designers then we must make sure that we acknowledge the cognitive abilities of students and rather than including every possibility and function in a design we must consider what is actually needed and how we can avoid 'feature creep' which Boone and Higgins note can be as problematic for children as not having enough features. (Boone & Higgins, 2015)

7.8.10 Session 6: Small arcade style video mixing interface

This session was conducted a week after the first sessions and it gave me time to reflect on the problems. The intention for this session was to take the positive aspects of the arcade controller; the ease of use and tactile feedback from the controls and create a session with a constrained choice in the functions of the controller and a clear outcome.

What I found was that the limited affect options and clear change in the video led students to spend more time experimenting and learning what they could do to their web cam image. Having set the task of creating an alien passport, the students had an aim, in this case to create the weirdest looking image of themselves they could. This also meant other students contributed their own suggestions and ideas. The format of the session meant that we could facilitate a writing task in which they added their names, favourite food and home planet to the passports. At the end of the session the students shared their finished passports with the class. This again shows the importance of designing to support facilitation and that it is helpful to consider the systems we make as tools that support activities beyond the functionality of the device.

The main issue with this session was the time it took to transfer the images onto the passports, which involved disrupting the class teacher and asking the TA to occupy the students whilst I added their images to their passports and printed them.

7.9 Teachers' Focus Group

At the end of the second term I used the school's all staff meeting as a platform to run a focus group session with a range of teachers and teaching assistants from the school. The all staff meeting is held once every term at the school and all teaching staff and some support staff are expected to attend. The sessions are used to discuss administration issues, for training and for teachers to share teaching methods and projects. Using the staff meeting meant that teachers were already used to the discussion format and so would be potentially more willing to talk and share ideas with each other and me. Also the time constraints of individual staff meant that it was one of the only occasions during the term that I would be able to work with more than one teacher at the same time.

This session supported the reciprocal relationship I had with the school as a research partner. It enabled Nick to share our work together with the rest of the school and allowed me to introduce myself and work with the majority of teachers at the school. It also served as a training session to help teachers think about how they might incorporate technology within their classroom teaching.

The aim of the focus group session was to:

Discuss the interfaces I had created during the design sessions with a wider group of teachers who were both potential users and expert informants.

Consider how the interfaces that I created might be adapted for students with a broader range of needs than were present within the single class I had been working with.

7.9.1 Session structure

The session was held in the Sixth form common room at the school and of the nineteen secondary and primary class teachers thirteen were present plus five teaching assistants and the school's access management co-ordinator.

Figure 48 - Screenshot of the presentation to teachers

I limited the talk to only 15 minutes to ensure that the group remained engaged. I began the session by briefly introducing my previous research at the school then talked through the current design sessions I'd been working on with Nick's class. I started by discussing the participatory approach I had taken before giving an overview of the sessions and the interfaces that we worked with. This included a brief discussion of the adaptations I had made in response to the needs and suggestions of the students and teaching staff. At the end of the talk I gave an overview of the RFID technology that I used in the majority of the interfaces. Refreshments were then provided and teachers were given an opportunity to try out three of the interfaces I had used with Nick's class and to talk to me and Nick about the project. (The sorting board, phonics game and the final video-mixing console.)

At the end of the break the teachers were asked to break into groups of two or three and to work with teachers from the same year group. They were set the task of thinking about the interfaces they had been shown and the basic principle of the RFID technology (essentially a contactless button triggering a media event) to come up with suggestions for how they might be used with the students they teach. They were also asked to consider any potential problems that the technology might present to their teaching.

At the end of the session each of the smaller groups were asked to report back to the main group. They were asked to explain the age and abilities of the students they worked with, how they might appropriate the system into their teaching and finally to give any suggestions, ideas or observations about the system I had been using.

This then led onto a wider discussion about the use of digital media and tangible interfaces in special educational needs classrooms. The results of this focus group are summarised below.

7.9.2 Teachers' responses

The following are the teachers' responses to the task they were set. These short summaries of teachers are provided to give the reader a sense of the range of potential uses and problems that the teachers discussed. The recorded discussion was used as part of the empirical evidence for the grounded analysis I conducted in this study and informs, alongside the other empirical evidence, the discussion of the conceptual categories in the *7.11 Discussion* section of this chapter.

For each of the groups, the age of the cohort they work with and the kind of needs that students in the class present, are given. The level of detail for each of the groups varies and was dependant on how much each group reported back and on the feedback that each group's response generated.

The following are used as abbreviations for the generalised level of needs of the students the teachers work with.

SLD = Severe Learning Difficulties

PMLD = Profound and Multiple Learning Difficulties

MLD = Moderate Learning Difficulties

ASD = Autistic Spectrum Disorder

Group 1: 14 -16 years old | MLD

Literacy and Drama

This group thought that using the RFID function combined with tokens that could be drawn or written on would be great for students developing and performing stories to

the class. In particular, they were interested in how to use both materials made by students such as drawings, sounds and videos and those found online.

Group 2: 12-14 years old | ASD, PMLD, SLD, MLD

Personal, Social and Health Education (PSHE)

The teachers identified PSHE as an area of teaching that could be supported by the use of an adaptable interface for making choices combined with video and sound. They identified this as being particularly useful for students with SLD given the level of risk involved in certain life skills activities that include crossing roads, being independent shoppers and life skills that require sequencing such as getting dressed, personal care and other skills such as boiling a kettle etc.

Group 3: ASD, PMLD, SLD, MLD | 6 – 18 years old

Music

Potential for using the RFID interface for music composition using different loops that are acoustically sympathetic and share the same tempo

Group 4: 16 – 18 years old

All areas of curriculum

These six-form teachers talked about using the simple video interface and RFID tags as a way to answer multiple choice questions in quiz and exam situations. They then talked about how this developed into the idea of using the system for advocacy purposes such as in elections, making choices about learning and care for both individuals as well as in a group context.

Group 5: ASD, PMLD | 9 – 11 years old

Drama and Sensory

The group concentrated on the use of the RFID system in multi-sensory sessions. The two groups of students require robust, tangible interfaces that can easily allow them to trigger a range of sensory responses e.g. smoke, bubbles, lighting, vibrations, visual and sound effects. They also mentioned the need for switch compatibility for students that require them.

Group 6: ASD, PMLD, SLD, MLD | 11 – 13 years old

Modern languages and PSHE

The group discussed the use of the sorting board system for vocabulary building using picture matching. This could then be extended to simple sentence building. They then talked about the use of the simple video console as a means to make decisions about certain social situations and their consequences using video triggered by different buttons. This group's response developed into a discussion around the benefits and drawbacks of creating content with students and using pre-existing video.

Group 7: ASD. PMLD, SLD | 7 – 10 years old

Developing a sense of self

One of the targets for the teachers working with a severely disabled cohort is to support them to recognise themselves as individuals. They saw an opportunity to assign images and specific sounds to individuals using the system. They also saw it as a way to give students a sense of agency through control over choice of outcome, be that turning on a light, triggering a sound or making a specific yes or no choice.

Group 8: ASD | 8-10 years old

AAC development with reward

All of this group's cohort present as being on the Autistic spectrum. As such they saw this as an opportunity for developing pictorial exchange communication work using the sorting board as a means of reward. For example placing the correct counter on a reader triggers bubbles or a Mr Tumble video clip.

Group 9: ASD, PMLD, SLD, MLD 17 – 18 years old

Assessment and advocacy

This group focused on the use of tokens for teachers as a means of working with students to assess their own progress. This then developed into a discussion around the use of the interface for students as a presentation tool for their work and to express their opinions during care assessments.

Group 10: ASD, PMLD, SLD, MLD 14 – 15 years old

Building / sequencing stories about a student's life

This was a single teacher and teaching assistant who work together with a class. They thought that the sorting board concept would be useful for sequencing real experiences for students, particularly on school visits when returning to the classroom.

Group 11: ASD, PMLD, SLD, MLD | 7 – 9 years old

Role play, treasure hunt

This group thought that if you could expand the system so that it was plug and play on the school network you could develop treasure hunt activities which made use of location and screen and audio systems all around the school.

Group 12: ASD, SLD,

Family and relationships, organising days

This group saw this as a way to sequence and order days for students who require clear and careful structures in order to function fully within the school environment. They saw the ability to associate hand drawn and written tags with images and sounds as a useful way to reinforce and sequence days that would engage their cohort of students.

7.9.3 Reflection

The use of the pre-existing session for discussion and collaboration between teachers allowed me to work with a group I would otherwise have been unable to work with. The participants were already used to the structure of the session if not the content.

As an approach I focused on the function of the technology I had presented, that is the triggering of a media event when an object is placed on the reader and shared potential designs for an interface. This led to a diverse set of potential uses with a range of students that went beyond the cohort I worked with during the design sessions with the ideas being generated grounded in the perspective of the teachers. Whilst this technique generated many ideas it should be seen as a means to generate new avenues for the system I created rather than as an evaluation of the system itself. This approach also generated a useful debate around the use of digital media in teaching at the school, which again was based on the experiences of teachers using (or not) different technologies in their day-to-day practice. For designers and researcher working in this

context this focus group session shows how sharing research with teaching staff beyond your main participants can lead to new avenues for work and can further inform your design processes.

7.10 Workshop Series Summary

This workshop series section has provided a descriptive account of the six design-led workshops. These have focused on the development of simple interactive interfaces for supporting existing teaching activities in a mixed ability SEN classroom. It has also provided a detailed account of a focus group session held with a range of teachers from the school that considered potential uses for the RFID interfaces that I had created in the workshop series. The workshop series demonstrates that researchers and designers in this field can use existing teaching and classroom management techniques and structures to inform and create suitable designs for SEN classroom contexts. As with the previous studies, this study demonstrates the importance of acknowledging and tackling the social complexities and tensions that exist within a SEN classroom, in the design process.

The first workshop demonstrated how we as designers can use and augment classroom tools, in this case AAC sorting boards, as a means to reduce the learning requirements for students by providing familiar layouts, symbols and actions but with the additional multi-sensory modes offered by digital media. It also discussed the importance of creating tools that teachers can use to enact contingent strategies when digital functions fail or require adjusting. In the discussion of the second workshop I highlighted several important issues for designers; the need to consider setup time when planning research sessions and allowing participants to test the limits and break our designs as a means to understand the devices limitations, and for participants to familiarise themselves with the functions of the device. This session also demonstrated the benefits of borrowing from existing classroom resources and activities in our designs.

The third workshop showed that as researchers and designers we must be aware of how a teacher will use the resource with their students. It is not an innate quality of a technology that supports students but rather the careful, professional application of that technology as a tool. The final three workshop sessions (workshops four, five and six) showed the importance of providing functions that are suitable for the cognitive levels of the students you are designing for. It also revealed the importance of testing

different configurations of physical interfaces to find the most suitable one for the device and activities it is used for. Finally, it reiterated the need to consider the tools we create as resources that can support activities beyond the functionality of our device.

The focus group at the end of the workshop series allowed me to present my work to other staff in the school and gather their perspectives on the devices I had designed. As designers and researchers working in this context sharing our work with staff outside of our main participant groups can lead to new and unexpected avenues for our research and designs.

7.11 Discussion

This chapter has provided a descriptive account of a design-led, embedded, research study in a mixed ability special needs classroom. Through a series of design-led workshops using novel, rapidly developed prototypes I gathered a range of empirical evidence about how we as interaction designers develop digital tools that compliment and extend existing teaching activities and strategies in a mixed ability special educational needs classroom. In the following section, I discuss the conceptual categories and resulting design insights that arose from my grounded analysis of the gathered empirical evidence; observational notes, transcribed interviews with staff and the shared and meaningful experiences of working with my participants. My grounded coding process resulted in two conceptual categories: *Existing Classroom Practices* and *Reflections on Approach* both of which are discussed in relation to wider literature. These categories result in design insights which speak directly to those in the interaction design community concerned with developing technologies for mixed ability SEN classroom environments.

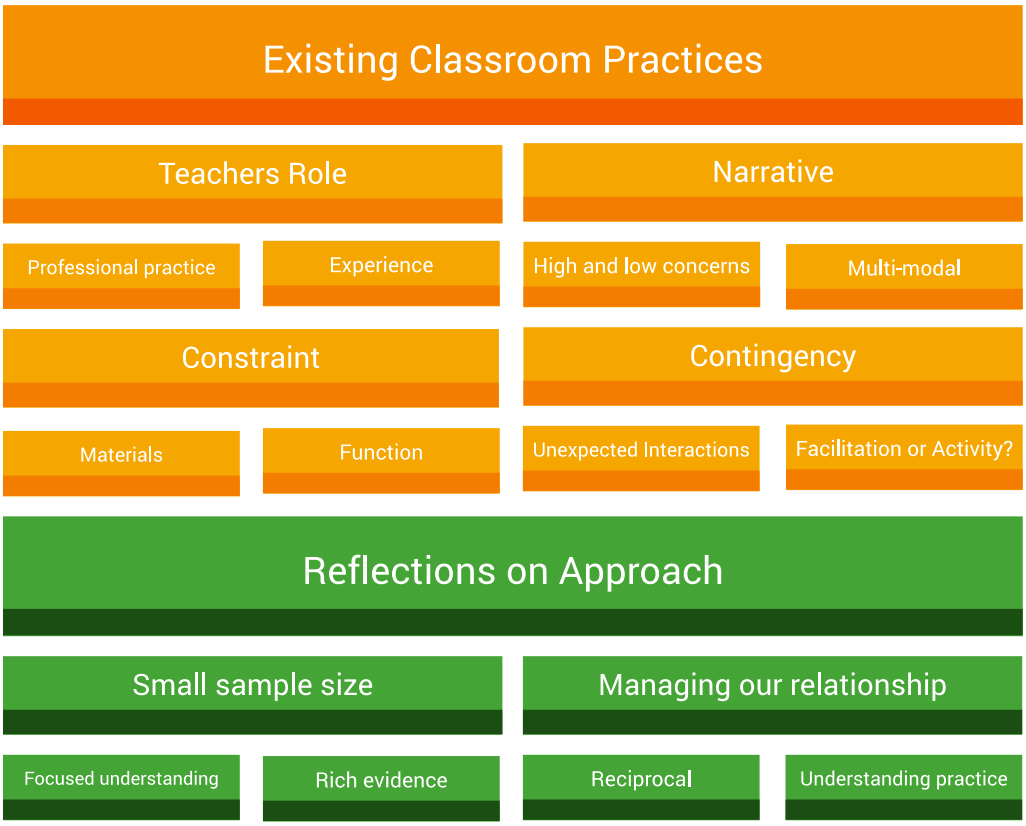

Figure 49 - Stories and sounds final code map

7.11.1 Category 1- Existing Classroom Practices

This category considers how existing classroom practices can be used to inform the design of digital resources to support the work of students and teachers in mixed ability classroom environments. This is considered in terms of; the use of narrative and thematic structures to provide context and meaning for the technologies that are introduced, and conversely the use of technologies to support student narrative structure and composition, the role of the teacher in using the technology, the importance of constraint when designing tools and learning activities for children with special educational needs and designing for contingency in the tools we as interaction designers create for this environment. This category offers designers and researchers working in SEN classroom contexts transferable insights about how the existing teaching practices they encounter in a classroom can be used to inform and support the resources they create.

Narrative and thematic structures

In this study it has been shown that narrative and thematic structure provide context and meaning to the use of the technologies introduced. Conversely the use of technology has provided a structure to support students' *high* and *low order* literary concerns. The Alien Passports narrative activity provided a much needed structure and goal for students during the final video mixing workshop session. This narrative activity allowed students to play with and learn the functions of the simple arcade mixing console by providing them with a concreate goal that the technology would help them achieve. In the Workshop 3 – Storytelling Interface session the use of narrative provided an opportunity for students to work together, through the teacher's facilitation, to build simple and funny stories which they could share with their peers using the multiple sensory modes of digital project and sounds.

Multimodal story composition is intrinsically linked with the tools and ways of working that digital media and related technologies offer (Bruce et al., 2013). Keh et al. conceptualise writing as consisting of *higher order* and *lower order* concerns. Lower order concerns relate to the mechanics of writing such as syntax, spelling, phonics and handwriting, while higher order concerns are skills such as idea formation, sequencing and argument construction (Keh, 1990). Within this study, many of the design interventions that were introduced to the participants offered a form of scaffolding for storytelling and narrative construction. This scaffolding addressed lower and high level concerns discussed by Keh et al. (Keh, 1990) . The mechanics of writing such as syntax, handwriting and spelling, pose a consistent challenge for many students with special educational needs (Troia, 2008). Multiple studies have found a range of benefits for children with special needs of the high level aspects of storytelling and composition. This includes language development, abstract reasoning, the development of personal identity (Bonsignore et al., 2013; Melzi & Caspe, 2007; Reese et al., 2010) and the development of imagination and creativity (Polkinghorne, 1991).

The range of prototypes introduced in *Chapter 7 - Stories and Sounds* study addressed low and high level concerns for writing and story composition. The phonics and sorting boards enabled students to develop an understanding of the phonetics of letters in much the same way as the 'phonic dice' on which the interface was based but with the added motivation of having a projected image and ability to self-check the sound of individual letters.

This use of narrative and thematic structure was derived from the practice of the class teacher and teaching assistants in non-technology related tasks. Technologies that enable students with special educational needs to work with digital media help them to take ownership of their learning, story composition and modes of expression by offering modalities in addition to those offered by text. For this to happen the tools that the technology provide need to be used by skilled and engaged facilitators to ensure that students are using tools that support their individual needs whilst at the same time functioning within mixed ability groups. This is a key idea that I have highlighted in my literature review, that technology cannot and should not replace sensitive and skilled teaching. (Buckingham, 2007; Cuban, 1986; Englert et al., 2007; Selwyn, 2011)

The Role of the Teacher

The storytelling prototype in workshop 3 also highlights the fundamental role that the teacher has in how much a technology can support students. This session was the only workshop where the teacher used the prototype I developed unsupported. The teacher in this case used the different pieces of digital media as prompts to get students to offer ideas for scenarios and characters. The teacher started with a piece of media and asked questions: What do you see? What does the place look like? Who do you meet? What do they look like? What do they eat and drink? Where do they live? What does the character sound like? Smell like? Feel like? How does it walk and move? The technology in this example provided a starting point from which the teachers and students could develop creative, narrative elements for their later storytelling.

It is not an innate quality of the technology that enables students to learn but rather how the technology is used as a tool and the suitability of that tool for the situation that matters. As interaction designers we must understand how teachers can or might use our interactive resources with their students. This position, as the previous study's *Chapter 6 – This year I have…*, talks directly to the those of Cuban, Buckingham and Selwyn in calling for technological interventions in the classroom that start from the teacher's and students' needs and the social context of the classroom environment (Buckingham, 2007; Cuban, 1986; Selwyn, 2009) This position is in opposition to a techno-determinist approach typified by that of Mark Prensky (Prensky, 2001; n.d.) that would ideally remove the teacher from the processes and allow the 'innate' qualities of the technology to enable students to learn alone (Prensky, 2008b).

Contingency

Technology fails and children become disengaged no matter how meticulously you plan a session. This may be due to factors independent of the task you are presenting or may be due to a fault in your planning. Teachers are constantly revaluating and adapting their teaching. As discussed, it is the facilitation and use of digital technology that ultimately will support students' and teachers' learning. Teachers understand that variations in mood, ability and other factors that affect classroom behaviour will impact on their carefully planned sessions. An important observation of the class teacher when working with students throughout the studies in this thesis was that they would often have to adapt and change activities in response to the changing needs of their students and the availability of resources.

An interesting example of this was during a session where the class teacher Nick was working with his students to practice hand writing the shapes of individual letters. The session wasn't going well with the majority of the students in the group becoming disengaged and distracted. He suddenly asked the students to get up and get their coats on. We then went outside and Nick got the students to use their fingers to draw the letters on the ice that had formed on the classroom windows. This spontaneous activity reengaged the students and revealed the importance of developing designs that allow for surprise, serendipity and flexible changes to teaching activities.

How do we then support this kind of spontaneity and flexibility as interaction designers in this context? By attending to the everyday social interactions between students, teachers and the environment in which they work and by sharing and observing in those interactions. In terms of design qualities, the teacher needs to be able to understand the basic functionality and constraints of a device in order to make a professional and creative decision about how the device can be used given a set of particular factors. We can also design resources that can be used without the digital element of them working, as seen in Workshop 1 – *Sorting boards*, where the sorting board RFID system failed and so the teaching assistant used the plastic sorting tokens to run a fun activity that was directly related to the session's aim without the augmented digital media function of the boards.

Constraint

In the seminal *Design of everyday objects*, Norman provides us with three distinct forms of behavioral constrains that affect how we understand and interact with everyday objects and tools (Norman, 2013, pp. 123-162): cultural constraints; learnt, artificial restrictions that reduce the set of likely actions, physical constraints; the physical limitations of the actions that can be performed with the object and logical constraints; how naturally the action of an object maps to its function. Norman shows us that by acknowledging constraint when understanding interactions between people and objects, it can be used by designers as powerful design tools. (Norman, 1999).

Meckin in his longitudinal study on the use of context and constraint in the design of novel music technologies for children with special educational needs found that constraining the possible interactions a child can have with a digital device resulted in a low point of entry for accessibility in terms of learning requirements and physical needs by providing an immediacy between the interaction and the response from the system. This in turn allowed children to start to rapidly learn the possibilities of the system and develop their own style (Meckin, 2015, p. 217). Building on Norman's work, Gurevich, Stapleton and Bennett (Gurevich, Stapleton, & Bennett, 2009) show in their design experiments with novel electro-acoustic instruments that creative play and style development is supported through the use of *physical constraints,* any device or object that is constrained in the physical world, and *perceived constraints,* those which are manifested in the mind of the user.

In this study the storytelling prototype constrained the choices of media that students could use to construct their stories but at the same time served as a starting point for the children's imagination without overloading them with too much choice. The VJ consoles showed that too much choice and unsuitable interfaces demotivated students, leading them to disengage and even leave activities. The final VJ prototype showed that having a constrained and clear set of functions with an underlying narrative goal (the alien passports) led the students to engage and create weird and wonderful character personas.

As designers then we need to be careful not to make our digital resources do too many things at once. In the Workshop 5 – *Large Arcade Mixing Console* we can see that what would be a very adaptable and useful tool for a professional VJ becomes unsuitable and

difficult to use. This was due to the large amount of functions which became overwhelming for both the participants and the facilitator. By constraining what a device can do both physically and logically it is more likely that teachers and students will be able to understand how to use the device and develop their own uses for that device. In order to do this then we must again understand the existing practices and constraints of the context we are designing for. Donald Foster puts this eloquently:

Cultural constraints and conventions are about what people believe and do, and the only way to find out what people do is to go out and watch them—not in the laboratories, not in the usability testing rooms, but in their normal environment. (Norman, 1999, p. 41)

7.11.2 Category 3 – Reflecting on Approach

This study intentionally focused on a specific context and group of participants. Whilst this was narrow in scope the study provides a deep and rich set of information. The insights gained through this study should be considered as useful but provisional and importantly part of a wider set of insights that this chapter presents at the end of the thesis.

A major factor in developing and delivering the study was managing my relationship with the school as a research partner. This involved not only coordinating with the class teacher and teaching assistants but also with school management staff about ethical considerations and child protection training. An important part of developing my relationship with the school was ensuring that both the class teachers and I clearly set out our expectations for the project and our commitment in terms of time and resources. This management of expectations was constantly re-evaluated and discussed throughout and even after the end of the project. The maintenance of the relationship ensured that not only would this study progress but also that future studies with the school would be possible. The development of this close relationship with my participants also led me to develop an understanding of some of the existing strategies and practices that were used in the school to support students. This in turn led to both the focus for this study, developing interfaces to support existing classroom activities using digital media, and some of the insights discussed in the previous category.

The reciprocal nature of the study was ensured by my commitment to facilitating and supporting teaching beyond the research sessions that are detailed here. A single

researcher without the aid of a wider research and design team conducted this study in contrast to the study described in *Chapter 4*. This meant that I needed skills as a designer, researcher and project manager to ensure its success. As a single researcher however I was able to integrate myself and observe everyday interactions without dictating or influencing every activity that I was part of.

The study was conducted over a significant period of time and was reliant on the prototypes and approach taken by the researcher within a single classroom context. This extended and embedded approach led to a deeper understanding of the context being studied and to becoming part of the everyday activities and interactions of the students and staff, which in turn informed the development of my prototypes.

It is unlikely another researcher could duplicate this study in its entirety. This study however provides a rich and detailed account of the context, participants and design process which elucidates the research process and offers other researchers a rich body of information to consider.

7.12 Summary

This chapter, through an embedded and grounded approach to research has considered how as interaction designers we can develop digital interfaces to incorporate digital media into existing teaching activities in a mixed ability special educational needs classroom. The study resulted, in the workshops series section, in a discussion of how the design methods used and the resulting prototypes work within the constraints of this classroom setting and provided for the interaction design community a descriptive account of a design-led research study in a mixed ability SEN classroom. In *7.11 Discussion*, through a grounded analysis of the empirical evidence, I developed a set of qualitative design insights for those in the interaction design community about the importance of attending to existing classroom practices in our design processes in this context.

8 Discussion

8.1 Introduction

This chapter begins by providing an overview of the content in this thesis to place the following discussion in context. It then continues with a section detailing the key insights and resulting guidelines for the interaction design community on the use and design of systems for using digital media in a mixed ability special educational needs classroom. This discussion is based on a grounded analysis of all the evidence gathered in the four studies of the thesis and is illustrated as a final conceptual map at the start of the section. Each key insight and guideline links to concrete examples and more detailed literature and explanation in the main body of the thesis. The chapter then turns to a reflection on the methodological approach and methods used throughout the studies in this thesis. It finishes by detailing the specific contributions to wider research and design discourses and sets out avenues for future research and design work based on this thesis.

8.2 Thesis overview

Chapter 1 – Introduction introduced the motivation and aims of this thesis, outlined the contributions it makes to the wider research community, details how the thesis is organised and discusses my previous work that informed the subsequent studies. *Chapter 2 – Position,* began by setting out and discussing the methodological positions and methods of inquiry that were used to conduct the four design-led research studies in this thesis. In *Chapter 3 - Background and Literature Review*, I situated the theoretical and empirical work conducted within this thesis within relevant fields of study.

The first study discussed in *Chapter 4 – The Scented School* provided a research case study that detailed the processes and challenges of designing and using interactive digital tools in a special needs school from the perspective of four key staff members. Through an extended visual arts project I embedded myself within a UK special educational needs school as a means to collect a range of rich, empirical evidence. This evidence was analysed in an iterative, grounded analysis resulting in three theoretical categories: *Accessing Education*, *Classroom Management* and *Reflections on Approach*. These categories are discussed and result in a set of insights and personas for those in the interaction design community working within the context of a special educational needs school. This study provides us with a high level understanding of the role of institutional staff in the interaction design processes in the school.

The next study, detailed in *Chapter 5 – My photos, your photos* continues the thesis research by moving to a mid-level view of an interaction design process in a SEN school. This is done by considering the social role of digital media in a mixed ability classroom context through the use of a design-led workshop series. The study consisted of five design-led workshops which were first analysed as a team with the resulting design considerations used to inform the design of a photo-sorting console for students and teaching staff. I then conducted an individual, grounded analysis of the empirical evidence from the workshop series and design process which resulted in three theoretical categories: *Digital Media and Representation, Classroom Management* and *Reflections on Approach*, which were discussed and led to insights for the interaction design community.

Through an embedded design-led and experiential research approach, *Chapter 6 – This year I have…*, builds on the findings around digital media and representation and classroom management presented in *Chapter 5 – My photos, your photos*, by introducing a set of photo-sorting console prototypes through a series of workshops. The consoles

provided a means for students to self-advocate in a 'real world' presentation of their achievements in a UK special educational needs school. This study was conducted within a mixed ability special needs classroom. This chapter resulted in a descriptive case study and a grounded analysis of the empirical evidence and led to three qualitative categories: *Designing for Self-Advocacy*, *Design Concerns* and *Reflections on Approach*, which are discussed in detail in relation to wider literature.

The final study, *Chapter 7 – Sounds and stories*, turns from introducing new novel digital systems that support teachers and students to use digital media, to introducing systems that support existing classroom practices through the use of digital media. This is considered through an embedded and inductive approach to the research. Through a grounded analysis of the empirical evidence the study results in the discussion of two conceptual categories: *Existing Classroom Practices* and *Reflections on Approach*, and a set of qualitative design insights for those in the interaction design community working in mixed ability special educational needs classroom contexts.

8.3 Digital media in a mixed ability SEN classroom: key concepts and guidelines

This is a discussion of the key concepts and guidelines that were iteratively developed through an inductive, grounded analysis of the empirical evidence gathered through four design-led research studies. This was carried out from my perspective as an interaction designer and researcher. This thesis has considered the social interactions that occur within a mixed ability special needs classroom and how these affect and in turn are effected by the design and introduction of interactive systems for working with digital media. This final discussion draws together the array of individual phenomena that occurred within the broad range of research experiences represented in this thesis. The phenomena that arose and are categorised in the grounded coding maps presented throughout the thesis are fluid, dynamic and chaotic. Any representation will only ever be partial. The participants, including myself, are all unique but share enough commonalities with others in similar contexts to make the research presented here useful for others. The categories and guidelines presented here are thus points of departure which researchers, designers and educators can use to apply and adapt to the specific people, context and place that they find themselves working within.

The following discussion of key insights and resulting guidelines was developed through a grounded meta-analysis of the findings of each of the studies detailed in this

thesis. This was done to thematically draw together the insights from across all of the studies and to outline a set of key design guidelines for the wider interaction design community.

The analysis process went as follows. I began by reading through all of the findings of the four studies and from this I created a single focused code map of all the categories and sub-categories developed in those studies. I drew out pertinent themes from the code map and when combining sub-categories, I would return to the concrete examples that informed them to iteratively support the development of the final thematic category formation. Through this process three key thematic categories appeared which describe the findings of this thesis relating to the design and use of digital media in a special educational needs classroom. The 'Digital Media in a Mixed ability SEN classroom thematic map' shown below illustrates the results of these processes and is used to structure the key insights and guidelines section in this chapter.

Each of the categories is summarised, based on the more detailed discussions that have been presented in the individual study chapters. These discussions in the main body of the thesis are signposted for more detailed review and are considered in relation to other categories in the final grounded coding map. For each of the categories a guideline is presented in order to clearly support researchers, designers and educators working at the intersection of digital media, mixed ability special educational needs classrooms and interaction design.

The studies that have been presented in this thesis have all been focused on the potential uses of digital media to support learning and social development in the context of a mixed-ability SEN classroom. As the literature review shows, technologies that support the use of digital media can offer a number of benefits for both teachers and students with special educational needs; identity formation, communication, literacy skills and self-advocacy. (Bonsignore et al., 2013; O'Mara et al., 2000; Polkinghorne, 1991; Reese et al., 2010).

Cuban, Buckingham and Selwyn (Buckingham, 2007; Cuban, 1986; Selwyn, 2009) have all argued that it is not the technology that brings about change in itself but that changes occur within the social interactions in the classroom that accompany its use. In order then to discuss the design of digital media technologies in a SEN classroom setting we must also consider the social context in which they are used.

In the following sections I use the thematic map, developed from the empirical evidence and analysis of the four studies in this thesis, as a structure to present key insights and guidelines relating to the design and use of interactive systems to support the use of digital media in a mixed ability classroom. There are three main thematic categories which represent three important aspects of the research conducted in this thesis.

In *supporting self-advocacy*, I set out important insights and guidelines that we as interaction designers must attend to when understanding and designing systems that aim to support students to self-advocate using digital media. This is considered in terms of the wide matrix of skills and opportunities required for children with special educational needs to self-advocate, the choices students make about how, when and where they are represented through digital media and the emotional blocks and pedagogical issues of risk and confidence that must be supported in order for students to *access education* that is suitable for their needs.

It then turns to *classroom practice* within the context of the mixed ability SEN classroom and considers how existing classroom practices can inform and in turn be informed by the design of novel interactive systems. This is considered in terms of:

- *The teacher's role* in introducing and using digital resources in a classroom
- *Classroom management* issues that must be addressed in our designs and research studies
- The importance of designing for *contingency* in the resources we create and the role of *narrative* as a form of structure in classroom sessions
- The role digital media can play in *narrative* formation.

In the final section *design processes,* I discuss the design processes that I and the wider interaction community need to engage with when designing novel interactive systems to support staff and students in mixed ability classrooms. This is considered in terms of how we design for the particular physical *environment* of a mixed ability SEN classroom, how we *design with teachers* in our development processes and finally how we can design novel digital resources that are *appealing* to both students and teachers.

The following insights and guidelines have been developed directly from the research conducted in the four main studies in this thesis. For each of the insights I link to the corresponding discussion and examples in the relevant studies.

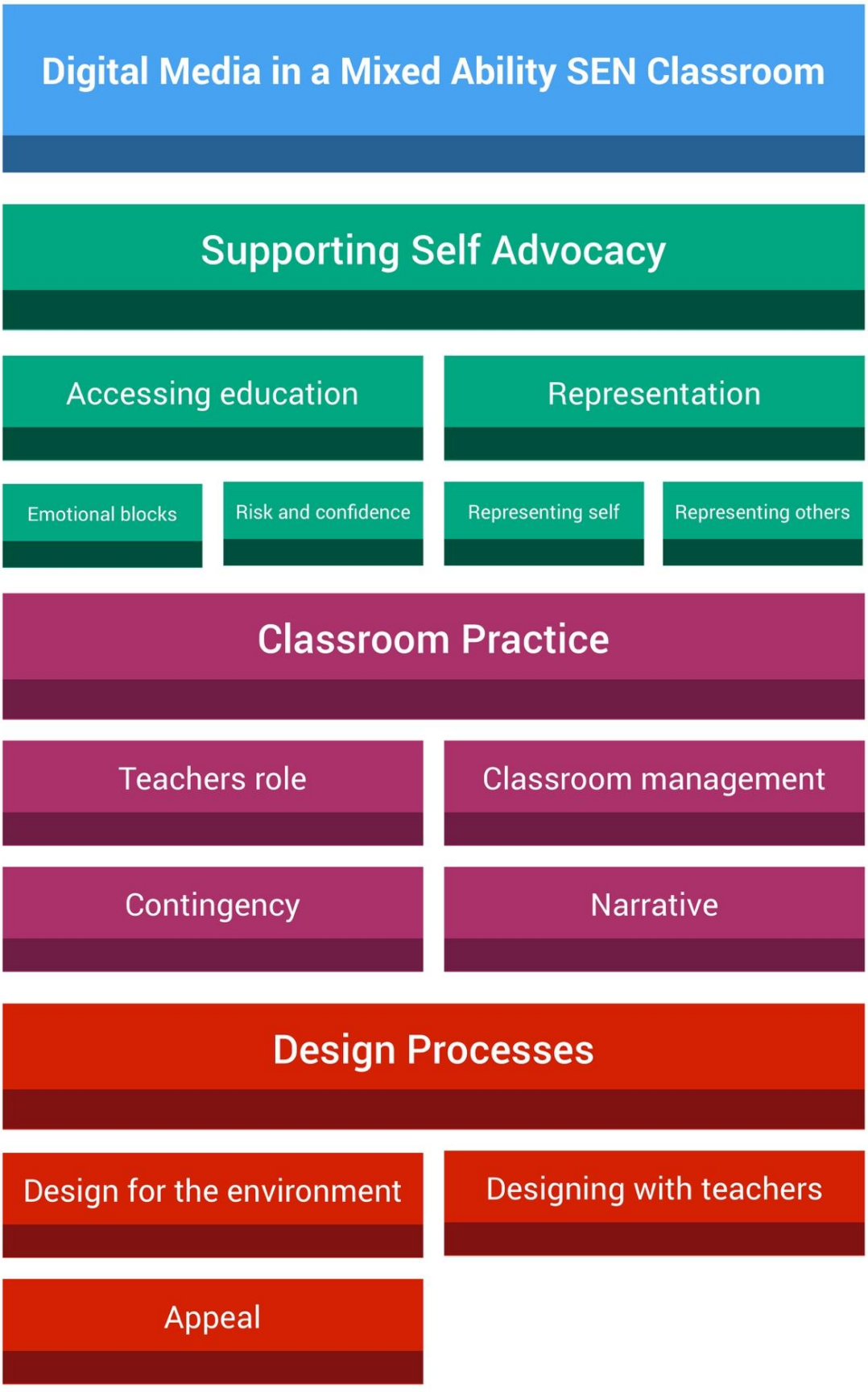

Figure 50 – Digital Media in a mixed ability SEN classroom thematic map.

8.3.1 Supporting Self Advocacy

In *Chapter 3 - Background and literature review*, we have seen that children with SEN are often devalued and disempowered by the social attitudes and expectations of their abilities, which can lead to low self-esteem and learnt helplessness. Children with SEN are less likely than their typically developing peers to be consulted about changes that affect their lives which may include medical, educational and pastoral provision (D. Miller, 2002; 2003) (Lewis et al., 2008)**.** The inherent power imbalance between children and adults is emphasized for children with SEN due to both socially constructed factors that disable them and the impairments that require support to mitigate (Alanen, 2001; Auslander, 2008; Sandahl & Auslander, 2005). **Link to position in the thesis:** 3.2.4 - *Challenges in special education research*

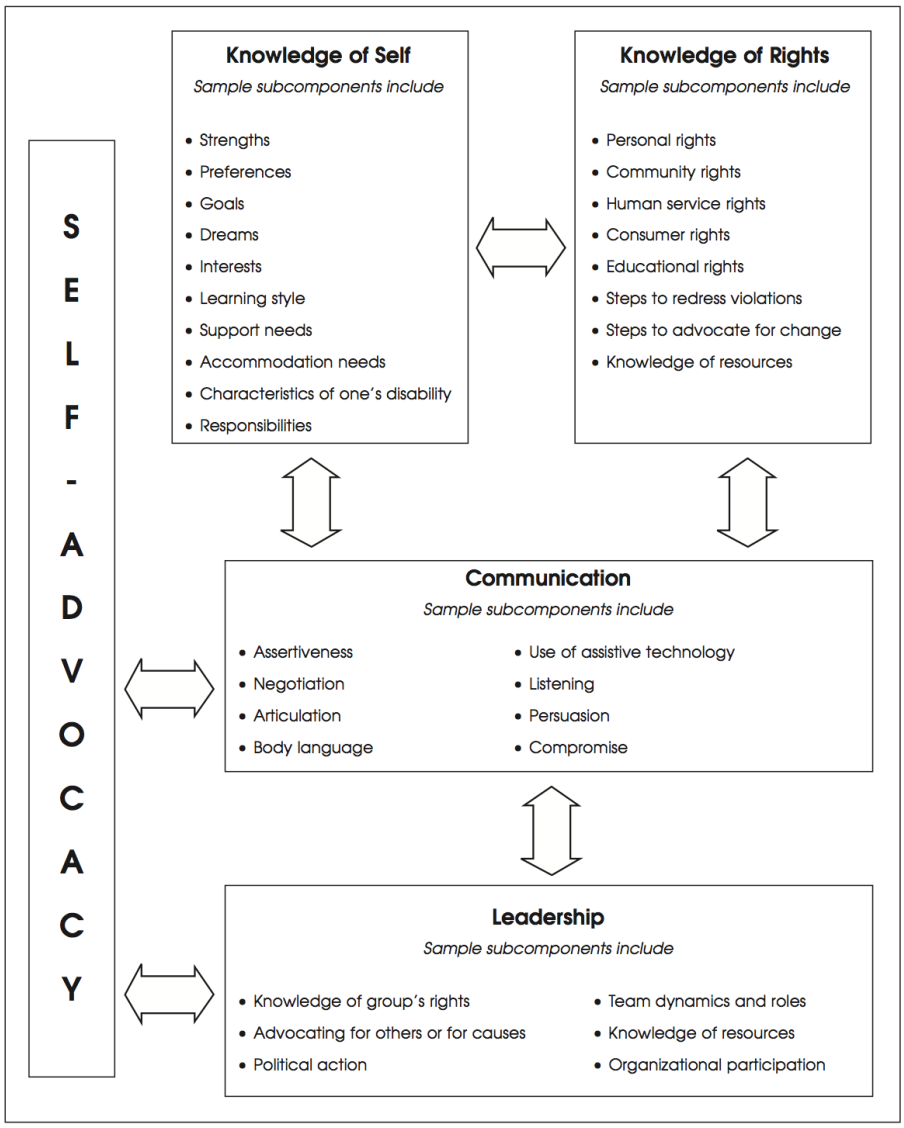

Figure 51 Conceptual framework of self-advocacy (Test 2005 p. 49)

There is a wide range of literature that calls for children with SEN to self-advocate in matters that concern their lives and those of other people with disabilities, 'nothing for us without us' (Department for Education Department of Health, 2015; Williams:1984wg in Test et al., 2005, p. 47)**.** This call for self-advocacy can be found in the literature concerning the design of interactive technologies for children with SEN in the methodologies that are used to research and design new technologies (Benton, Vasalou, Khaled, Johnson, & Gooch, 2014a; Druin, 2002; Frauenberger et al., 2011; Guha et al., 2008) and the effects of using the technologies themselves (Liu et al., 2007).

If we consider the conceptual model of self-advocacy that is put forward by Test et al., (Test et al., 2005) we can see that there is a matrix of skills, tools and opportunities that must be developed in order for people with SEN to self-advocate. Self-advocacy is an important concept that we, as designers and researchers, should support children with SEN to achieve but it would be hard to claim that any research or technological design on its own can be said to enable students to self-advocate.

As Pia Christianson (Christensen, 2004) argues, children exist within complex social situations where disclosure and the power relationship between adults and children are of acute importance. Working to mitigate this when trying to enable students to express their needs will not be achieved through technology on its own but rather through wide ranging social pedagogical change on which new technologies may or may not have some affect.

Accessing Education

Chapter 4 – The Scented School showed that providing the tools, training and opportunities for students to share their preferences, interests and achievements with people of significance to them was a strategy used by the school to support students' emotional and educational development. This was considered through two conceptual categories, *emotional blocks* to learning that children with special educational needs face and the need as facilitators and designers to manage the *risk* of sharing ideas and achievements with the *confidence* it can bring. **Link to position in the thesis:** 4.6 - *Category 2: Accessing education*

This issue of *risk and confidence* was then further explored in *Chapter 5 – This year I have…* through a shared, meaningful experience of developing an audio annotated slide show with students to share their opinions and achievements in a 'real world' context.

It reinforced the need for designers and researchers to take into consideration how we *balance risk,* develop *platforms* for children to advocate, create *safe spaces* in which to do it by providing *reliable tools* and *positive reinforcement* for the achievements they share. **Link to position in the thesis:** *6.12.1* - Risk and Confidence

Representation

This conceptual category of a*ccessing education* and *risk and confidence* then informed the next two research studies presented in *Chapter 5 – My photos, your photos* and *Chapter 6 – This year I have…* which focused on designing a console to support students to use digital media as a form of communication and more specifically to share their interests, preferences and achievements. If we return to Test et al.'s model of self-advocacy we can see that this speaks to two of the main categories *Communication* and *Knowledge of Self*.

Chapter 5 – My photos, your photos demonstrated that digital media in the form of photographs and short videos were used by students to *represent the self* by talking about sharing their personal achievements and activities in school with people of significance to them through the use of wall displays, photo books and screen based slideshows. It also found that students were rarely consulted regarding which media was selected to represent them and how it was shared by teaching staff. This was found to stem from a need by teachers to arbitrate in the process due to legitimate issues of child protection and pastoral care by teachers. However, it also became clear that this was also due to a lack of available tools and strategies to enable students to engage in the process of choosing and sharing digital media. **Link to position in the thesis:** 5.7.1 - *Digital Media and Representation.*

In *Chapter 6 - This year I have…* I showed that there are a number of *structures* that need to be developed and considered when creating systems to support children to make choices and share their achievements and opinions through digital media. This includes the use of *narrative* to structure children's ideas, addressing the *existing goals* of students and those that teach them, the need to design for *contingent* strategies in our interaction design. **Link to position in the thesis:** 6.12.1 - *Structures*

8.3.2 Guidelines for designing to support self-advocacy for children with special educational needs using digital media..

Empirical evidence was gathered, analysed and discussed in detail in the individual studies that make up this thesis. The conceptual categories that resulted, which are summarised in each of the category discussions in this section, have led to a series of guidelines for those in the interaction design and educational community concerned with developing digital interventions to support the use of digital media in mixed ability classroom contexts. The guidelines concerned with the development of systems to support self-advocacy through the use of digital media are set out below:

1. **Support students to become confident and competent learners:** An important area for interaction designers to focus on in future research in the context of special education is to support children with special educational needs' social and educational development by helping them to become confident and competent learners. There is no single strategy, tool or solution to do this. It is a matrix of skills, opportunities, social attitudes and tools that must be changed and developed. As designers and researchers we can contribute to this matrix by creating supportive and accessible environments and tools with which students can develop their communication and creative skills and demonstrate those abilities to others. Students must be able to access appropriate learning activities, be supported to take risks and have people that are willing to listen and appreciate their achievements. As a designer then we must see where we can support, mitigate or offer alternatives to the tools and strategies that are used by teachers and the students themselves to support and demonstrate student's confidence and abilities.

2. **Support student's self-advocacy through active engagement with digital media:** This work in this thesis has shown the social value of using a design-led research approach and creative design process to support students to actively engage in the representation of their ideas and achievements using digital media. If we consider Test et al.'s conceptual model of self-advocacy, (Test et al., 2005) we can see how the photo-sharing consoles in *Chapter 5 – My photos your photos*, and *Chapter 6 – This year I have…* used ICT and digital media to support interpersonal communication and expression. This fits with the matrix of skills, tools and opportunities for supporting students with SEN to self-advocate. The photo-sharing tools supported students to *articulate* their *strengths* and *interests* by

enabling them to express their *preference* about how they were represented to others.

For researchers and designers then this demonstrates that we can support students with special educational and those that work with them to self-advocate through the development of systems that actively engage them in creating, choosing and sharing digital media that represents them and that this is an important and fertile area for future interaction design research. We must ground our design processes in the social and pragmatic complexities of a mixed ability special needs classroom through design-led, cooperative research approaches.

3. S**upport students' and teachers' voice:** Designers and researchers must balance the right of children to use and have their voice heard in the research and design process within the institutional and management requirements of the school and teacher. Whilst there has been a focus in literature on the promotion of the child's voice through interactive systems, the work in this thesis demonstrates the challenge for developing interactive systems in a SEN classroom that incorporates the negotiation of both the student and teacher's voices in the design process.

   The photo-sharing console in *Chapter 5 – My photos your photos*, and the insights that informed its design demonstrate the effectiveness, in supporting students with SEN to self-advocate, of designing a tool that enables them to be actively engaged in decisions about how images representing them are to be shared, stored or deleted. The triaging technique used should be considered by other designers working to develop digital media tools and practices to enable expressive and creative communication for children with SEN and speaks directly to the research that seeks to understand the role of children's voice in the interaction design processes (Druin, 2010; Frauenberger, Good, & Alcorn, 2012a; Iversen & Smith, 2012; Read et al., 2002; 2014).

4. **Attend to existing and potential structures for supporting self-advocacy:** As researchers and designers working in this context we must consider not only the functionality and user experience between student and system but also the social and learning structures that our systems will sit within and create. By tackling both the pragmatic 'situationally constrained choices' that teachers, designers and researchers must make in the day-to-day interactions with children (Cuban, 1986) in a classroom environment and the structures we use to develop shared

experiences (Wright & McCarthy, 2008) we can develop digital tools and approaches that are not only useful but are also used in a mixed ability SEN classroom context.

8.3.3 Classroom Practice

Cuban, Buckingham and Selwyn (Buckingham, 2007; Cuban, 1986; Selwyn, 2009) have all argued that it is not the technology that brings about change in itself but that any changes occur within the social interactions in the classroom that accompany its use. In order, then to ground interaction design processes in the 'social reality' of a school environment(Selwyn, 2011), the existing teaching practices being used (Buckingham, 2007) and the 'situationally constrained choices' of teachers (Cuban, 1986) we must actively acknowledge existing classroom practices and consider how our interventions will compliment, mitigate or interfere with those practices. This is in opposition to the techno-determinist position typified by Prensky in his call for teachers to get out of the way of the innate pedagogic qualities of new technologies.

> If we can agree that the role of technology in our classrooms is to support the "new" pedagogy of kids teaching themselves, then we can all move much more quickly down the road of reaching that goal. (Prensky, 2008b, p. 3)

The work in this thesis has shown that it is vital that we consider not only the functions and user experience that occurs between student and system but also the social and learning structures that our systems will sit within and create. By attending to both the pragmatic 'situationally constrained choices' that teachers, designers and researchers must make in the day-to-day interactions with children (Cuban, 1986) in a classroom environment and the structures we use to develop shared, meaningful research experiences with our participants (Wright & McCarthy, 2008) we can develop digital tools and approaches that are not only *useful* but are also *used* in a mixed ability SEN classroom context.

The participatory approach taken in this thesis has allowed us to develop an understanding of the social context and social effects of digital media in a mixed ability classroom. This understanding directly contributes to the wider interaction design community by providing, at the end of this section, guidelines about how to deal with the social complexities that affect and must be considered in our design processes when working in a mixed ability special educational needs classroom.

Teacher's Role

The work in this thesis and in particular the findings in *Chapter 4- The Scented School* and *Chapter 7 – Sounds and stories*, has highlighted the important role of the teacher in choosing, using and modifying digital resources to suit their professional and 'situationally constrained choices' as a means to support their students. It is not an innate quality of the technology that enables students to learn. It is how the technology is used as a tool and the suitability of that tool for the situation that matters. As interaction designers our design processes must address how teachers can and will use our interactive resources with their students. **Link to position in the thesis:** 7.11.1 - *The Role of the Teacher*

The personas presented in *Chapter 4 – The Scented School* are useful guides for designers, researchers and educators as to the role that teachers and other staff in SEN schools can have in an interaction design process. **Link to position in the thesis:** 4.5 - *Personas*

Classroom Management

The studies carried out in *Chapter 4 - The Scented School* and *Chapter 5 – My photos, your photos*, led to a discussion of the importance of supporting active classroom management when designing and conducting research in the context of a mixed ability SEN classroom. A central theme that arose from both studies was how teachers and staff use existing strategies and practices in the classroom to manage and include all students in learning activities, and how students respond to those strategies and practices with the teacher and other students.

These discussions identified three important categories of classroom management that are pertinent to the design and understanding of the social role of digital media: *individual achievement, adapting activities, a group of individuals.*

Jane, the class teacher in *Chapter 5 – My photos, your photos*, discussed the challenges of managing 'a group of individuals'. That is ensuring that the shared teaching resources and activities are suitable for the range of needs and abilities presented by her students. She went on to say that as every student in the school has an individual learning and care plan 'designing for a particular student's special educational need is a moot point.', that is when designing for a mixed ability classroom context we must tailor resources and activities for the needs of individuals whilst still considering the group context in which they work. This is also reflected in the insights of Rosa, the

Delmore school's curriculum access coordinator, that whilst a teaching approach that supports and is accessible to every child is desirable it must be tempered within the needs of the class as a group. **Link to position in the thesis:** 5.7.2 - *Classroom Management*.

In *Chapter 4 – The Scented School* I identified two strategies that Rosa and the schools' teaching staff use to manage 'a group of individuals': *adapting activities* and *individual achievement.* When a teacher is attempting to address the individual needs of a student in the class, they are encouraged to consider how a particular lesson, resource or activity will fit within the wider educational and care plan for the pupil. It is then up to the teacher and other supporting staff to continually assess the suitability and accessibility of resources and lessons for a particular student. They must *adapt their approach* in the planning and delivery of activities in response to the plurality of needs within a class. As interaction designers and researchers we must then turn out attention to the importance of creating systems and devices that support both the individual needs of students and at the same time work for groups of students with mixed cognitive and physical needs. **Link to position in the thesis:** 4.6.2 - *Classroom Management*.

Contingency

The conceptual categories arising from a grounded analysis of the empirical evidence in *Chapter 6 – This year I have…* and *Chapter 7 – Sounds and stories*, led to a discussion of the importance of *contingency* as a strategy used in the classroom by teachers and therefore an essential approach to consider in our research and design.

The term contingency relates to classroom management issues around the planning and structure of sessions in terms of student behaviour and the fluid nature of timings in a classroom context. Teachers must adapt and change activities, approaches and the resources they use with students in response to the ever changing social complexities of a classroom context. Ensuring they can use and create contingent strategies whilst teaching is an integral part of a teacher's professional practice. **Link to position in the thesis:** 7.11.1 - *Contingency*.

As a researcher and designer in this context we must also be prepared to make changes to our plans, approaches and resources in response to the demands of our participants and the environment in which we work and design, to support contingent strategies in

the resources we create for teachers and students. **Link to position in the thesis:** 6.12.1- *Structures*.

Narrative

The work in *Chapter 6 – This year I have…* and *Chapter 7 – Sounds and stories*, demonstrate that narrative and thematic structure provide context and meaning to the technologies that were introduced. Conversely the introduction of resources to use digital media has been shown to help students handle *high* and *low order* literary concerns (Keh, 1990). The design interventions introduced in both chapters offered participants a form of scaffolding for storytelling and narrative construction. This use of narrative and thematic structure was derived from the observed practice of the class teacher and teaching assistants in using narrative in their teaching.

The student presentations in *Chapter 6 – This year I have…*used narrative as a means to structure and reflect on the achievements that each student had made that year. The photo-sorting console supported higher-level literary concerns by enabling students not only to reflect on and make decisions about how the photos that they were in or had taken would be used, but also to reflect on the aspects of their life that the story represented. The image sorting and audio annotation functions of the story-sorting consoles also enabled students with cognitive and physical impairments to mitigate issues around the mechanics of writing by offering two modes; using images and voice recordings, to tell stories that did not require the literacy and fine motor skills needed for handwriting or typing. **Link to position in the thesis:** 6.12.1- *Structures*.

The range of prototypes introduced in *Chapter 7 - Stories and sounds* also addressed low and high level concerns for writing and story composition. The video mixing workshops and storytelling workshops all used narrative as a basis for the classroom activities. The phonics and sorting boards enabled students to develop an understanding of the phonetics of letters in much the same way as the 'phonic dice' on which the interface was based but with the added motivation of having a projected image and ability to self-check the sound of individual letters. **Link to position in the thesis:** 7.11.1 -

Narrative and thematic structures.

8.3.4 Guidelines for attending to exisiting classroom practices in interaction design processes.

1. **Design for active classroom management:** As designers and researchers we must take into consideration the social and pragmatic issues of managing a class that consists of students with multiple abilities and needs within the institutional restraints of a SEN school. Any interactive systems that we introduce must become a tool within that active management process. This means developing tools that are adaptable, robust and accessible to students and teachers who have a range of abilities and needs. As designers and researchers concerned with the design of interactive systems to support social inclusion in SEN contexts, we must not only design for social interaction but understand how interactive systems disrupt and complement existing classroom practices.

2. **Support contingency and spontaneity in the classroom:** Creating discrete digital tools with clear functions that can become part of a wider constellation of resources and strategies allows teachers to use and adapt them to their teaching practice. A teacher needs to be able to understand the basic functionality and constraints of a device or system so that they can make a professional and creative decision about how the device or system can be used given a set of particular factors. We can also support contingency by creating resources that can still be used without the digital element of them working.
3. **Acknowledge and support the use of multi-model narrative construction using digital media:** Interfaces that enable students with special educational needs to work with digital media help them to take ownership of their learning, story composition and modes of expression by offering modalities in addition to those offered by text. For this to happen the tools that the technology provide need to be used by skilled and engaged facilitators to ensure that students are using tools that support their individual needs whilst at the same time functioning within mixed ability groups.

8.3.5 Design Processes

This third category considers the design processes that I and the wider interaction community need to engage with when designing novel interactive systems to support staff and students in mixed ability classrooms. It covers the importance of *designing with teachers* to ensure both the interaction designer and participants are attuned to the needs of one another. It continues by highlighting the need for interaction designers

to consider the physical aspects of their design and the environment in which they work to ensure that the tools are suitable and *appealing* for the users they are created for.

Designing with teachers

The work in *Chapter 4 – The Scented School,* showed the importance of developing dialogues and meaningful, emotional encounters between interaction designers and teaching staff as a means to enable each side to consider the needs of the other. As interaction designers we need to be aware of the social complexities and professional practice of teaching staff in our designs and not simply expect teachers to conform to our design requirements. Teaching staff need to have the time and training to consider the potential use of the digital designs we introduce but more importantly must be able to contribute as an informed participant from the beginning of the design process. **Link to position in the thesis:** 4.4.2- *Designing with teachers*.

If our aim as designers and researchers is to develop systems that are not only *useful* but are also *used* in the environment they are intended for then we must find ways to understand the needs of our users and enable them to make informed decisions about what they require of our work. The 4.5 - *Personas* section in *Chapter 4 – The Scented School* provides a detailed set of personas of three key members of staff in a UK based SEN school. This is presented to support those in the interaction design community working in this context by providing an overview of staff roles that designers and researchers are likely to encounter in this context. **Link to position in the thesis:** 4.5 - *Personas*.

Designing for the environment

Chapter 6 – This year I have… demonstrated the need as interaction designers to tackle several important *design concerns* relating to the specific attributes of the mixed ability classroom context. In particular, it considered the role of tangible user interfaces for working with digital media to provide multi-modal tools for communication and as points of reference and meaning for constructing narratives. **Link to position in the thesis**: 6.4 - *Design rationale,* 6.12.2 - Category *2 – Design Concerns.*

Chapter 6- This year I have… and *Chapter 7 – Sounds and stories* also showed the importance of considering design elements such as material, colour, shape and texture as a means to support the range of accessibility needs found in a mixed ability SEN classroom. **Link to position in the thesis:** 7.3 - *Design rational*.

Appeal

Much of the work in this thesis has considered how to design systems that support and engage with teachers' professional practice. If our goal is to make systems that are *useful* and *used* by children as well as teachers, then we must consider how to make our system appealing to them. *Chapter 6 - This year I have…* and *Chapter 7- Sounds and stories* both carefully considered the use of colour, material, fonts and shape as a means to make the prototypes appealing to students. **Link to position in the thesis**: 6.4 - *Design rationale,* 6.12.2 - *Category 2 – Design Concerns,* 7.3 - *Design rational.*

8.3.6 Guidelines for conducting interaction design in a mixed ability special needs classrom context.

1. **Design with teaching staff to promote more effective design:** As an interaction designer working in the context of a special educational needs school we must develop a mutually understandable dialogue between designer and teacher. We must work with teaching staff to ensure we understand the needs of the teachers and their students and conversely that teachers understand the abilities and needs of the designer and their work. In order to do this, we must incorporate what Wright and McCarthy call 'emotional and meaningful' encounters (Wright & McCarthy, 2010) between designers and participants. This results in a mutual understanding that grounds designs in the lived experiences of both designers and participants and was enabled through the use of an intermediary; the curriculum access coordinator in the work described in this thesis. The 4.5 - *Personas* section provides interaction designs and researchers with useful insights into how particular members of staff might help support their work and the priorities they have for interactive technologies in their teaching.

   The work in this thesis has shown that another strategy for developing useful design is providing training for teachers. **Link to position in this thesis:** 4.4.2 *Training teachers***.** By incorporating training for teachers into our design strategies we can ensure that those designs will compliment and extend teachers' practices. As seen in the Scandinavian inception of participatory design (Asaro, 2000; Bjerknes & Ehn, 1987) teachers need to not only learn how to use the functions of a particular artefact but also how to express themselves publicly, to evaluate their own and other's decisions, and to absorb information as a means to develop strong participatory structures. This results in technologies that are not only *useful* but are also *used* by teachers in their everyday practice.

2. **Attend to the multi-modal qualities of your designs to promote appeal and reduce learning demands for students:** Students with special educational needs require teachers to use a range of multisensory modes of communication in order to engage with the differing needs and learning styles of students. Using digital media in the special educational needs classrooms offers the potential to use audio, olfactory, tactile, audio and visual modes of expression in teaching and to re-appropriate media that represents pre-existing meanings. As designers and researchers working in this context we must pay attention to the aesthetics and material choices we make to ensure that the children we design for are willing and eager to use the systems we create.

8.4 Reflections on Approach

In *Chapter 2 –Position*, I started from first principles to explain my research approach as being both empirical and phenomenological; an inductive approach that starts from phenomena, which then builds knowledge and understanding through interpretation, analysis and explanation. I have been concerned in this thesis with the consequences, intended and unintended, *of* and *for* the use of digital media as a form of social action and interaction within the institutional space of a UK special education school.

The epistemology, methodology and methods of inquiry used in this thesis are not put forward as a general method of sociological enquiry for design research but were chosen for and were appropriate for the studies in this thesis. The methodological approach adopted in this thesis has not strictly followed any one formal methodology but rather has used the appropriate tools and ways of thinking about the phenomena understudy offered by grounded theory and the range of participatory design methods to build a coherent and useful account.

Not all the methods used in this thesis have been appropriate or successful. Over the duration of the research, different methods have been used, adjusted, abandoned and rediscovered as new insights, lines of enquiry and practicalities of using those methods in a real world context become clear. The social interactions within the schools I have studied are contingent on the interaction of multiple processes over time. By constantly evaluating and being flexible in my methods of enquiry, I was able to learn from and adapt those methods in response to my understanding of those processes over time.

In *Chapter 2* - Position I put forward an approach, following from Neil Selwyn (Selwyn, 2011), to researching and designing technology in schools that engages with the school

context as it is, rather than as we would like it to be. In order to do this, I took an embedded, longitudinal approach to conducting my research. This enabled me to gain a deep understanding of the relevant parts of the school context in which the design interventions I created were situated over time and in response to my experiences of interacting within the social contexts of the schools.

In the following section I will reflect on my approach to research and design in this thesis using both the accounts set out in my studies and relevant arguments within the wider literature.

8.4.1 Methods

The embedded, longitudinal approach taken during this research borrowed methods from grounded theory and different forms of participatory design. Grounded theory was the principal method used to collect and analyse data about the context of this research. It provided a rich and detailed understanding of the context through a combined analysis of participant's views, observations and video data. By using grounded analysis throughout the research I was able to compare results from my different studies to further refine the categories and themes for each study. This detailed understanding of the context did not develop into a full grounded theory, as this would require a significant amount of work and resources that is beyond the scope of this research project.

I devoted a large amount of time to collecting and analysing my data in order to follow the reciprocal, grounded analysis approach. The amount of time this took went far beyond what I had planned for in my research schedule**.** Learning the skills to gather and analyse my data as a post-graduate student took time. Over the duration of the research project I learnt techniques and methods of evidence gathering that sped up the analysis process. The coding, analysis and iterative gathering of information for analysis is however innately time consuming, particularly when the data is gathered over a significant amount of time and when working without a wider research team (Charmaz, 2006)**.**

A criticism that can be levelled against the methods used in this research project was that student views were only elicited briefly in some of the studies. Ann Lewis would describe this as a *weak* position (Lewis et al., 2008) as the participants were involved in the research but not as equal partners in the process. Lewis says that we must adjust our research in order to take into account the context and abilities of participants to

engage with the research process. Larsen and Hedvall (Larsen & Hedvall, 2012) argue that researchers start from children's capabilities rather than compensating for their impairments and advocate for the use of observation, design intervention and discussion with adult participants as a form of participation which they call *voice by proxy.*

Why then did I choose not to include the views of participants through formal interviews or other PD workshop methods? The participants in this study presented a wide range of communication abilities and many students required support from staff in order to understand or communicate even simple ideas and needs. Other students were capable of understanding and communicating their views but this range of abilities over the different classes of students I worked with left me with a difficult choice regarding balance. I decided that instead of partially representing the views of students whom I could interview directly, as seen in (Garzotto & Bordogna, 2010) where typically developing children were used as proxy voices for children with SEN, I would rely on the observations, design interventions and experience of embedding myself within the classrooms as a form of voice by proxy described by Larson and Haedvall. (Larsen & Hedvall, 2012).

Though I did not use formal interviews with children throughout the research project I did build strong relationships of mutual trust and understanding with many of the participants. Christensen (Christensen, 2004) argues that we can never fully understand or be part of a child's world as an adult and so must take time to negotiate and mitigate some of the inherent imbalances in the adult/child relationship whilst understanding our limitations. During the project I spent a long time with students and dealt with issues as a teaching assistant and lead artist that included peer relationships, bullying, and the other day-to-day concerns of children in a school. Building these relationships with children meant that I was able to meet parents and siblings and get to know about their outside interests and aspirations for work and life outside of school.

Developing trust and taking time to get to know children is, I argue, as important as using more formal participatory methods as a means to illicit the views of children. The methods I used are in line with the qualities that Wright et al. contend are essential when conducting design research:

The development of a relationship between the participant and designer that enables both parties to be attuned to one another's needs.

A focus on the emotional qualities and effects of both the participant's and researcher's experiences.

A compassionate approach to the users.

(Wright & McCarthy, 2010)

These qualities as Lindsay et al. (Lindsay et al., 2012) contend, help the researcher and participants bridge the gap between their day-to-day experiences to work towards a form of shared understanding.

An issue with using a proxy-user method was the over-representation of some adult participant's views. In order to address this, I would share my observations and insights and interviews with other adult participants (with permission from the interviewee) and discuss my interpretations after and during my sessions in the school. Balancing the voices of young people with special needs, their carers and teachers with my own observations is a difficult and nuanced task that required me to be open with participants and to rely on a balanced analysis using multiple points of evidence.

Buckingham, Cuban and Williams et al. amongst others have called for research in educational technology to consider the low level of the interactions within classrooms and schools within which this research study is concerned but also higher level socio-political processes such as the local authority, government initiatives and wider political and industrial processes (Buckingham, 2007; Cuban, 1986; P. Williams et al., 2006). Research on literature concerned with these high-level factors helped to shape the methods and approach to research in this project but was not the focus of the applied research. These levels are beyond the scope of the research project itself but are germane to developing a fuller understanding of the role of interactive technology in special needs schools.

The inductive methods of empirical data collection and analysis used in this research project, combined with taking an extended amount of time working and researching in schools, resulted in a complex body of information and experiences that proved very hard for me to articulate clearly and in a way that is fair to the participants involved. Qualitative research is inherently subjective and relies on the researcher's experience and knowledge and awareness of their own subjective view in order to present an

accurate account of their research. Working with children with special needs is a privilege and places a great responsibility on the researcher to convey their findings in a manner that not only includes their successes but also their failures and problems so that others can learn from and develop the work that has been done. Working closely with adult and child participants and other experts in the field and having adult participants check and discuss my insights has helped to define and validate the outcomes of the research present in this thesis.

8.4.2 Methodological approach

As I have made clear previously, whilst this research project made use of participatory methods and principles, I do not claim that this project has taken a Participatory Design (PD) approach. I align the approach taken in this thesis to the work of Guha et al.'s 'inclusionary model' (Guha et al., 2008) (itself based on the seminal work of (Druin, 2002)) for designing interactive technology with and for children with special educational needs. The children participants in my studies had the role of 'informants' in the design process. This was due to the wide range of abilities, age and communication difficulties among the participants I worked with. There was a possibility that some could be become design partners but as not all the students could I decided that it would be unfair to exclude others and this would be against the schools directive of providing education and access for all.

The design-led, longitudinal and embedded approach I took in this research project aligns with research projects such as (Avramides et al., 2010; Guha et al., 2008; Keay-Bright & Gethin-Lewis, 2011), all of which are considered in the literature and background chapter of this thesis, but differs in some important aspects. Whilst these projects place an emphasis on the importance of rapid development and short participatory workshops my research approach was concerned with a more involved long ranging engagement with participants and context. There is an implied hierarchy of participation that can be found in many research projects concerned with the design of interactive technology for children (Yarosh et al., 2011). This hierarchy places full participation or children as co-designers as being best practice for design with and for children. The issue this raises is that researchers can approach their research and subsequent dissemination with an emphasis on what (Heeks, 1999) describes as the 'indicators of participation', to the detriment of the project's resulting designs and insights (Iversen & Smith, 2012; Yarosh et al., 2011).

I argue that making claims that children can become co-designers and full participants in the design process and removing adult/child power imbalances is unfair to both the research and participants. As Christianson has argued, we cannot fully mitigate the power imbalance between children and adults. These claims of equality in the design process result in the interesting position that children have the same design, creative and research skills as a highly trained adult. It airbrushes out students' impairments and conversely does not give enough consideration to the valuable contribution that students can make through direct participation and the observations of their actions by the research and adult participants. I would align myself in this regard with Armagno and Benton et al. (Armagno, 2012) (Benton, Vasalou, Khaled, Johnson, & Gooch, 2014b) who call for the researcher to start from more progressive constructions of disability, such as the social model (Sandahl & Auslander, 2005; Swain, 2004; Worthen, 1998), that considers the strengths of participants and how to mitigate the socially constructed disabling issues that prevent them from participating. This means thinking about how participants might contribute to research beyond directly giving opinions, rather than compensating for their failures to contribute as a typically developing child might.

The approach I have taken has allowed me to gather a detailed and rich understanding of the context within which I have been situated. It has been participatory and inclusionary in that I have spent an extended time working with and understanding the social interactions of the participants that make up this research project. Heeks, Yarosh, and Iverson et al all contend that researchers must share their values and aims in using participatory design methods so that the readers can evaluate the research in light of this (Heeks, 1999; Iversen & Smith, 2012; Yarosh et al., 2011). My aims in pursuing a participatory approach were twofold: to develop suitable and usable designs for special educational needs classrooms and to understand through an inductive method the context I worked within and where and how I might introduce design interventions. I do not claim that my methodology was emancipatory in line with the democratic principles of PD but it did benefit both the participants' and my work through a reciprocal approach based on building trust and delivering positive outcomes for staff and students in my partner schools.

I was able to gather close observations, interpretations of children and adult participant's actions which resulted in a set of insights that were then used to develop design interventions which in turn informed further insights in a grounded and iterative manner. The design interventions I developed were in line with (Larsen &

Hedvall, 2012) in being propositions or questions that were explored through the use of the artefacts in the school.

The artefacts can be seen as basic questions as well as materialized hunches and understandings relating to the design program. They are continuously being reshaped and reinserted and in a sense giving form to designerly dialogues (Larsen & Hedvall, 2012, p. 39).

Two important reflections about my longitudinal, embedded approach emerged from conducting the studies in this thesis; time and the roles that I played as a researcher. Gathering, collating and analysing all the different evidence in my studies took a large amount of time. Whilst it resulted in a rich body of information and insights the time needed to conduct it may be unfeasible for many other researchers.

During the project I had to take on a wide range of roles: researcher, lead artist, teaching assistant, designer, classroom facilitator, technician and workshop leader. These roles both benefited the research by providing a means to build relationships and be exposed to experiences and skills that I might otherwise have missed. It also meant however that I struggled at times to maintain both my research and my responsibilities to the schools that I worked within. An important example was the issues around negotiating my role and the expectations of staff during the first study. Beyond the insights and accounts that I have set out in this thesis I have learnt a range of skills in managing my roles, developing positive relationships with partner institutes and resource management that will enable me to continue my work in this challenging and exciting field.

8.5 Contributions of this thesis

This thesis makes three main contributions to the community of researchers, designers and educational practitioners who are concerned with the use of digital technology with children and more specifically working within the field of interaction design for children with special educational needs. These contributions are:

1. A set of key insights and guidelines for the interaction design community on the design and use of digital media to support students and teachers in a mixed ability special needs educational context. The guidelines were developed through an iterative, grounded analysis of the empirical evidence gathered and analysed in the four studies

of this thesis. **The key insights and guidelines are presented in** 8.3 - *Digital media in a mixed ability SEN classroom: key concepts and guidelines*.

2. A discussion of the research approaches taken in the four studies in this thesis: **This discussion is presented in:** 8.4 - *Reflections on Approach*.

3. A set of design personas, developed in *Chapter 4 – The Scented School*, for three key members of staff who interaction designers are likely to encounter when working in a UK special needs school and set out: their role in the school, their priorities for the use of interactive technologies in their work, their role in the interaction design process and the challenges for designers and researchers in this context. **These personas can be found in:** 4.5 - *Personas*.

8.6 Future Work

This thesis has provided detailed accounts of four major studies in special educational needs schools in the UK. There are several avenues that could be pursued in my and other's future work on the design and use of tools to work with digital media in a mixed ability SEN school environment. The work conducted in this thesis provides a foundation for conducting interaction design research in this context. The qualitative methods used have provided an understanding and guidelines for design processes that take into consideration the social complexities and social impact of digital systems in a SEN school in the UK.

A subsequent stage in this research will be to develop design interventions, using the guidelines that arose from this thesis, which can be handed over to teaching staff for long term use and evaluation in multiple contexts. It is at this stage that a combination of qualitative observational work and quantitative methodological approaches can be used to evaluate the impact of interventions on the teaching practice of staff and the learning and social development of children with special educational needs.

An example of how you might use one of the guidelines in this thesis for future work might be to start from the guideline: *Support student's self-advocacy through active engagement with digital media*. This could be used as the basis of a longitudinal research project with a single group of children with special educational needs, that supported the participants to create a range of novel digital systems for them to use to self-advocate. These could be developed through a co-operative design practice in order to provide feedback and make changes to how they access a particular institution

or service, for example, a museum, play centre or theatre. This would then allow the research to consider and discuss the effectiveness of the research and design processes used, provide a real world platform for children to self-advocate and result in a set of novel digital interfaces for use in other contexts.

Another fertile area of investigation will be to develop guidelines and techniques for carrying out co-operative and participatory design processes with a group of children with mixed cognitive and physical abilities based on the social model of disability and the emancipatory approach of the Scandinavian inception of Participatory Design. This needs to be investigated through practical research with children with special educational needs and the adults who support them in the play and learning contexts in which they work.

8.7 Closing Remarks

This thesis has demonstrated the role that digital media can have in supporting students with special educational needs to learn, build self-confidence and to share their achievements with people of significance to them. It has been a pleasure and honour to work with the children and adults in the participant schools and has led not only to the experiences and insights detailed in the thesis but also moments of happiness, delight, humour and sadness that I will never be able to convey in writing. I have been humbled by the patience, strength and integrity of the children and adults that I have worked with. We as researchers and designer must continue to focus on research that enriches the lives of children with special educational needs, the people that support them and the contexts in which they learn, love and play.

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