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## Interpersonal expression in the special educational needs classroom: An experience-centred design case study

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## ABSTRACT

This paper describes our Experience-Centered Design (ECD) enquiry into the current and potential role of digital photography to support interpersonal expression in a class of children (aged 11–15 years) at a mixed special education needs school. Presented as a case study, we describe five classroom-based creative workshops that engaged pupils with a broad range of complex special needs, and classroom staff. From these workshops, we generated a set of qualitative considerations for the design of digital photographic tools to support interpersonal expression in this setting. Additionally, we present the evaluation of a photo-sorting system we developed in response to our workshop findings and evaluated in the school over a period of 12 months. Our case study demonstrates how an ECD approach can guide a creative interaction design process in a special education needs setting, supporting interaction designers in empathising and responding pragmatically to the complex and dynamic interactions at play between the stakeholders. We further discuss design research approaches to user groups in such settings, and consolidate our insights about conducting research through design for social inclusion.

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### 1. Introduction

Increasingly, special needs schools in the UK are using Information Communication Technology (ICT), including digital photographic tools, to support the delivery of their curricula and everyday expression in teaching and learning [1]. Such schools are therefore a relevant but currently underexplored setting for interaction design research [2]. In this paper, we report on a case study led by an interaction design research team that explored how photographic practices can support and enhance interpersonal expression amongst pupils and teachers at a UK school for children with a broad range of special educational needs. A central aim of this study was to generate qualitative considerations for the design of novel digital photographic tools for use by teachers and pupils in this kind of setting. A key concern within the research team was to use practice-based design methods to develop a tacit understanding of the 'real-world' needs, desires and experiences of our stakeholders in using photographic tools on an everyday basis.

The study formed part of a project funded by the Research Councils UK, exploring how digital technology may deliver social benefits to support and sustain communities that may otherwise be marginalised (<http://www.side.ac.uk>), with stakeholders in special needs schools being identified as a relevant community to engage with. The Special Education Needs (SEN) Code of Practice (2001) [3] defines children as having special educational needs if they have a *learning difficulty* which calls for *special educational provision* to be made for them. The broader term of *disability*, as defined by UK Government legislation (The Equality Act 2010), is having a physical or mental impairment with a substantial, long-term adverse effect on a person's ability to perform normal everyday activities. For the purpose of this paper, we draw upon the term Special Education Needs and Disability (SEND), used within this legislation, to describe the research population engaged in our study.

The *social* function of digital photography to support and enhance communicative environments, including educational ones (e.g. [4–6]), leisure (e.g. [7–9]), and even healthcare (e.g. [10]) is well documented in research fields relating to the study of Human–Computer Interaction (HCI). The social function of photography as a means of expression in *SEND classrooms*, however, is a currently underexplored setting for HCI and related research

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[2,11]. Interaction design research for SEND settings has only recently been reported in the related literature [12–17]. The SEND classroom arguably poses particular design challenges relating to the complex needs of pupils as well as the resources and strategies that teaching staff members use to support them, and the *practical* constraints necessarily imposed by the SEND school as an institution. Also, as we emphasise herein, it is important to ensure that pupils and staff can contribute to the research and design process, both to support their self-advocacy as stakeholders and ensure that any subsequent designs are effective and responsive to the setting and population for which they are intended.

Our case study sought to explore this challenging design space. Over the course of five ‘Creative Photography’ workshops, our research team employed an Experience-Centred Design (ECD) [18] approach to understand how photographic tools may be developed to support and enhance interpersonal expression between pupils and staff in a SEND classroom. In this paper, we report the qualitative findings of this study, demonstrating in the process how our ECD method was efficaciously put into practice to develop a novel ‘Photo-sorting System’ for use in a SEND school. We further report on our evaluation of this prototype to empirically ground our research understanding and design insights. A key proposed contribution of interest to the child–computer interaction research community is the account of our tacit understanding, as a design research team, of the SEND setting, guided by ECD. Furthermore, our case study contributes a set of wider considerations for interaction designers interested in developing photographic tools for SEND classrooms and related learning contexts.

## 2. Background

Before describing our case study, we first set out the rationale for why photography, conceptualised in terms of technologies and practices, has social value in SEND settings. We highlight some of the previous work that has explored the use of digital interactive technologies in the lives of children with SEND, and discuss previous approaches to designing for the SEND classroom.

### 2.1. Digital photography for the developing self

In recent years, HCI researchers have given increased consideration to children as a distinct user population [5,14,19–23]. Children are rapid adopters of emerging technologies, including photographic tools, and are pioneering their use in innovative ways [11]. When considering the *social* functions of these technologies, older children (8–18 years old) are a particularly interesting user group because they are at a key developmental stage for identity-formation and self-expression to others [24]. At this stage, their perceptions of self-image in relation to others may be a delicate concept mediated significantly by photography.

This social psychological phenomenon arguably gains new significance when considering the photo practices of older children with SEND [2]. These children often face difficulties in communicating their views, emotions, and experiences, leaving them with limited agency in decisions that affect their lives [ibid]. In such cases, photography has been found to serve as a useful vehicle for fostering self-advocacy and social understanding [25].

The concept of using photography to support social communication and expression – including storytelling – is also well established in the HCI literature [4,8,11,24]. It is also drawn upon more widely in clinical research to this end; for example, Levin and colleagues [10] describe the development of ‘Aphasia Talks’, a photography class designed to promote self-advocacy in stroke survivors with communication difficulties.

### 2.2. ICT design for children with SEND

There has been recognition in the past decade of the importance and benefits of ICT more broadly in the lives of children with SEND [2,12,13]. ICT is also found to have a clear social function for this population; the European Agency for Development in Special Needs Education’s 2010 review of innovative HCI practice in SEND defines the role of ICT as enabling people to learn social development skills to facilitate their full and equal participation in education [26]. This endeavour is most relevant to the social context of the SEND *classroom*, as reflected in the notion of the equitable classroom [27]. Adding to this complexity is the school policy on the production and distribution of photographs; in a SEND context, children’s vulnerability makes issues of privacy and disclosure a priority [28], with implications for ICT support.

Recent HCI studies that address design for children with SEND have tended to focus on specific forms of disability and impairment [9,15,16]. This can be seen in the ECHOES project [14]: whilst offering insights into the design of interactive systems for all children with SEND, the enquiry nevertheless focused on children in the autistic spectrum in a dedicated setting. In other work, Kientz and colleagues [29] discuss the benefits of pervasive technologies for children with autism from the perspective of caregivers. Mixed educational needs’ contexts have been considered, however; Foss and colleagues reveal the complexities of such contexts in their documentation of a Cooperative Design enquiry with older children at a school supporting mixed learning and communication needs [13].

Our case of the SEND mixed ability classroom focuses on teaching pupils with a *broad* spectrum of needs including combinations of both cognitive and physical impairments, including issues with mobility, dexterity, social, behavioural and emotional control, as well as profound communication difficulties [2]. Our case further engages staff *and* pupils as stakeholders, thus providing multiple perspectives on the context. By highlighting previous studies focusing on specific impairments, we demonstrate the relative novelty of our objective, aligned with [13], to explore a mixed ability SEND setting from multiple stakeholder perspectives.

### 2.3. Children’s participation in design research

There is a small but growing literature in HCI on the participation of children in interaction design processes. An early exploration of children’s involvement as such by Allison Druin suggested four potential roles for them, of User, Tester, Informant, and Design Partner [30]. Within Druin’s framework, the child as *User* involves their use of a technology being studied by an adult to inform its development. Within this role, the child has limited agency in the appropriation of the tool and its development, although their involvement in the research is most easy to manage. The other roles capture a greater degree of involvement from the child in design research and development. As *Tester*, the child may offer direct feedback on technology use to the researchers in response to direct questions. This is intended to be empowering, although the child remains uninvolved with the original design; they are responsive to it. Children act as *Informants* when they inform the original design process, with the adult researchers ‘in charge’. And as *Design Partners*, children are equal research stakeholders and involved in the design process throughout. Druin promotes the Design Partner role as one that is aligned with and broadly inspired by the values of Participatory Design (PD) [ibid].

More recent studies have addressed how different levels of ability, and the contexts in which they are located, determine the types of contribution a child with SEND can make [15,16], and how their orientation to the design process may be structured and interpreted [13–15]. For example, Guha and colleagues [15] take

up Druin's notion of a child as a Design Partner, but contend that the kind of involvement a child can have may be determined by the 'level' of severity of their disability combined with the level of support that the child can be offered by the design research team. This means that, in order to take on the desired role of Design Partner, a participant's disability must be compensated for in the research approach. This appropriation of the term is critiqued by Larsen and colleagues [7], who suggest that children's appropriate involvement should be guided by the "situated resources and potentials rather than deficits and diagnoses" per se [ibid, p. 38].

These studies form part of a wider discussion on 'children's voice' that aims to support children in contributing directly to the design and evaluation of technology whilst considering the 'real world' settings in which a technology will be deployed with all its practicalities and constraints [6,13,19–21,23]. Indeed, Foss and colleagues have most recently highlighted the rich scope of opportunities and challenges for SEND research 'in the wild' that attends to children's voice [13]. In line with these recommendations, we focused our study on a real world SEND classroom with an aim to engage inclusively, empathetically and pragmatically with our stakeholders. As we will describe in our account to follow, we were concerned, methodologically, with the day-to-day practical realities, contingencies, and lived experiences of staff and pupils in a UK SEND school. Moreover, our account reflects an orientation to designing for SEND that focuses on the social, expressive functions of technology within a classroom group, a focus that has been under-represented in HCI related studies to date [31].

#### 2.4. Experience prototyping for inclusive design

Any discussion about special educational needs' participation through design is arguably a political one. Those practising Inclusive Design (or Universal Design as it is known in the US) acknowledge how the affordances of designed artefacts may include and exclude people from their use, and envision mainstream products that are accessible to a broad range of people, including those with SEND, without the need for special adaptation [32]. As captured by Graham Pullin [ibid], this design perspective recognises that any population has a *broad spectrum* of capabilities to interact with things. Pullin has further emphasised the value of creative and artistic input to such a design process to enrich the aesthetic experience of use, and how this should be achieved through qualitative approaches to prototyping that focus on experience and an active engagement with users. From this perspective, felt experience comes to the fore: "the acceptability of design for disability depends not just on its functionality and usability but also on how using it makes an individual feel" [32, p. 153].

This foregrounding of individual experience for Inclusive Design is further emphasised by De Couvreur and Goossens, who propose 'horizontal innovation networks'; designs developed in response to detailed and specific considerations of context and need are used to inform broader patterns of innovation [33]. The significant value that Pullin attributes to creativity felt experience, and social engagement, and the ideographic focus of De Couvreur and Goossens, align with our motivations as design researchers, and reflect a design discourse that we intend herein to connect with child-computer interaction.

#### 2.5. Paper aims

The specific context of our case therefore presents interaction design challenges that are relevant and new for the child-computer interaction community relating to research in sensitive settings with mixed ability groups that have individual communication needs. Herein, we offer up an illuminative account of how a team of interaction designers understood and responded to a

complex and sensitive setting, drawing upon creative resources to foster aesthetic and social engagement with the research subject grounded in tacit experience [18]. We aim to contribute a set of qualitative insights about the social value of photography as a means to support SEND, and considerations for the design of digital photographic tools to support interpersonal expression in this setting. An additional aim, in turn, is to draw attention to the potential rich outcomes of doing research *through creative practice* for SEND.

### 3. Study design

We now turn to describe our study, working with staff and pupils at a UK SEND school, which began with a series of 'Creative Photography' workshops to understand the design space of our interests. This workshop series was the first of many linked design studies with this school, forming a longitudinal empirical engagement that has been documented in part elsewhere [34] and continues to date.

#### 3.1. Methodological approach

In keeping with our orientation to the research subject, just described, we adopted an Experience-Centred Design (ECD) methodology for our case [18]. ECD is grounded in observed, tacit, and phenomenological understandings of the setting—the SEND classroom. ECD shares some values with PD and Cooperative Inquiry, (which have previously been explored by the child-computer interaction research community [13,21,22,30]), such as aspiring to a form of democracy that affords voice to all stakeholders in the research process in order to guide it. We distinguish ECD from these and other approaches as it places special emphasis on *fostering empathy, dialogue and aesthetic engagement* between stakeholders in order to *support the pragmatic goal of designing to improve the lived experience of technology users*. To this end and in contrast to PD, ECD allows the designer latitude to design for a community. ECD also shares values with Inclusive Design [32] acknowledging that the latter is more of a general approach and attitude than a methodology.

ECD determined our inductive and ideographic method. As a design research team seeking to understand a specific context, we focused on our subjective experiences of the context as we explored it with our participants, not on responding to general pedagogical requirements associated with SEND. Given this positioning, our study design was informed from the outset by our unfolding, *empathetic* dialogue with the school as our research partner. In turn, our design process was grounded in the *pragmatics* of engaging pupils with mixed special needs as much as 'Design Partners' as was possible whilst respecting the school's organisational structure. As we go on to describe, our ECD approach enabled us to flexibly adapt *how* we invited pupils to engage with the research activities, as – drawing on Druin's framework [30] – either Users, Testers, Informants or Partners, depending on what was deemed appropriate.

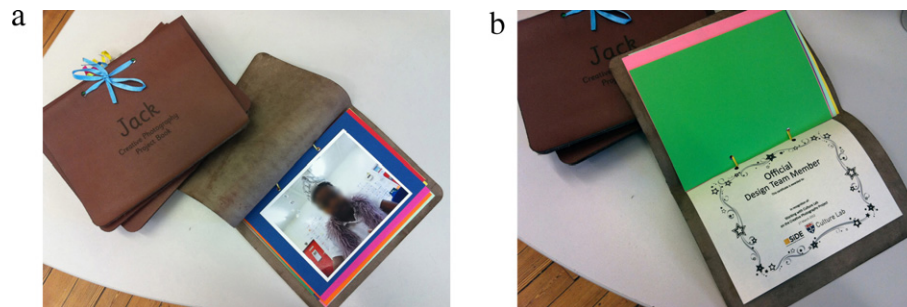
Our method was also informed by the interdisciplinary knowledge within our research team, which included developmental social psychology, speech and language therapy (SLT), computer science, and fine art, alongside interaction design. This interdisciplinarity enabled us to bring multiple and different expertise to the setting (e.g. clinical expertise on SEND, creative, technical expertise on photography and computer programming, and social scientific expertise on processes of identity formation) for knowledge exchange and sense making. Our team found common ground through phenomenology and an analytic focus on subjective experience; the shared understanding that we generated is reflected in our collective account on process and outcomes to follow.



**Table 1**

Sample of pupils with a broad spectrum of needs.

Ingrid	Epilepsy and learning difficulties
Duncan	Epilepsy, learning difficulties, shows behaviours consistent with being on the Autism Spectrum Disorder (ASD) continuum
Holly	Cortical visual impairment. Also has epilepsy, encephalopathy/developmental delay; hemiplegia—left side (Leg & arm weakness) due to near cot death
Jack	Cerebral Cortical developmental delay; communication difficulties
Luke	Epilepsy, mild cerebral palsy; learning difficulties
Cass	Cerebral palsy; associated special educational needs relating to motor skills, language development; a range of learning difficulties
Janine	Learning difficulties; visual impairment
Tamas	Language, learning & social difficulties
Philip	General development delay; medical difficulties
Peter	Duchenne Muscular Dystrophy (DMD)
David	Medical, behaviour, emotional & social difficulties
Phoebe	Difficulties in expressive language fine & gross motor co-ordination, delayed general learning & the maintenance of appropriate behaviour
Gabi	Developmental delay in most areas & low muscle tone with motor development delay, brought on by trauma at birth

**Fig. 1.** Creative photography project books.

### 3.2. Sample and sensitising work

Drawing upon established contacts within our research programme, we partnered with a school in the local area accommodating pupils with SEND (aged 2–19 years). We approached this school in Autumn 2011 with an intention to form a longitudinal engagement. In advance of conducting the study, we organised preliminary school visits, to introduce our team members and meet the headmaster, staff and pupils to be involved (through self-selection). We intended for our study design to be informed by our unfolding dialogue with these stakeholders and by our experiences of visiting. Indeed, our decision to conduct workshops was shaped by the headmaster's recommendations on how we could engage his staff and pupils. In initial discussions, he suggested utilising a regular hour timeslot in the school curriculum, over the course of a term, hence workshop 'series'. He then recommended that we worked with a class of Key-stage Three children (aged 11–14 years) with SEND, their teacher, Jane, and teaching assistants (TAs), Sarah and Philippa. The class comprised 13 pupils. For ethical reasons, all participants' names have been replaced with pseudonyms. The pupils' broad spectrum of needs is illustrated in Table 1, using Jane's descriptive terms.

We were also invited to sit in and observe classroom activities during the preliminary visits, and were given a tour of the school during which we observed how photography was drawn upon – ubiquitously – by the staff and pupils in display making for social communication (i.e. in classrooms and corridor spaces). We gained early insight from these visits about the school's strategic foci and broad management structure, learning how it flexibly accommodated the complex needs of individual pupils.

## 4. Workshop series

Five workshops exploring different aspects of photography took place over the school's Spring Term 2012. The first workshop facilitated pupils in reflecting upon and demonstrating how photography was currently used at the school, drawing upon existing school resources including cameras, photos and photo

displays. The remaining workshops aimed to creatively explore stages within the photographic process, including technical aspects and creative practice about camera and photo use.

### 4.1. ECD practice

Our exploration of the setting was supported by design practice. Activities for each workshop were inspired and developed in response to output from the previous workshop, in dialogue with school staff. In between each workshop, we designed bespoke (tailor-made) props, of varying fidelity (from sketches to prototypes) in response to issues and ideas raised in previous workshops.

We also made a 'Project Book' for each pupil; again, bespoke by design and leather-bound, these aimed to serve as albums containing photos that the pupils had taken (Fig. 1). Also, information about each workshop activity could be added to the Books incrementally. We intended for these Books to invite pupils to reflect back on what they had done at each workshop to be informative for our research. Digital cameras were also provided at each workshop for the pupils to use as part of activities.

Prop-centred activities reflected our ECD method of enquiry. They were intended to inspire creative, aesthetic engagement: allowing pupils to engage with aspects of photography via embodied interaction that has been previously found in pervasive computing for children's literature to foster creativity [20]; and through novel, aesthetically rich experiences [23]. Through this we aimed to understand how design might support, extend and mitigate the social interactions and power relationships between staff and pupils in the classroom setting. Making further reference to Druin's framework for participation [30], we broadly oriented to the pupils as Informants in workshop planning.

### 4.2. Our workshop procedure

In this section we summarise our workshop procedure, which evolved as we gained experience of the setting in dialogue with our participants. Further details about this procedure are documented elsewhere [34].

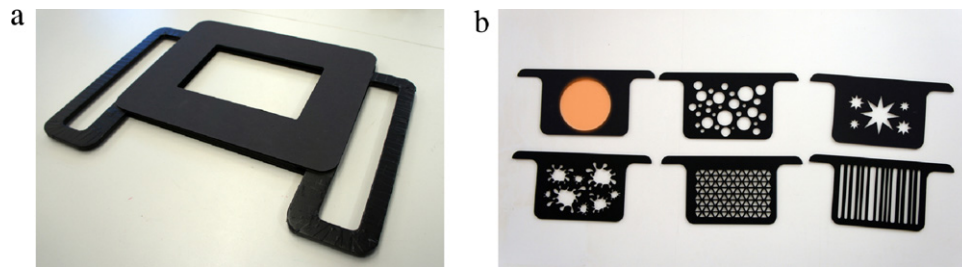


Fig. 2. Magic frame and filters.

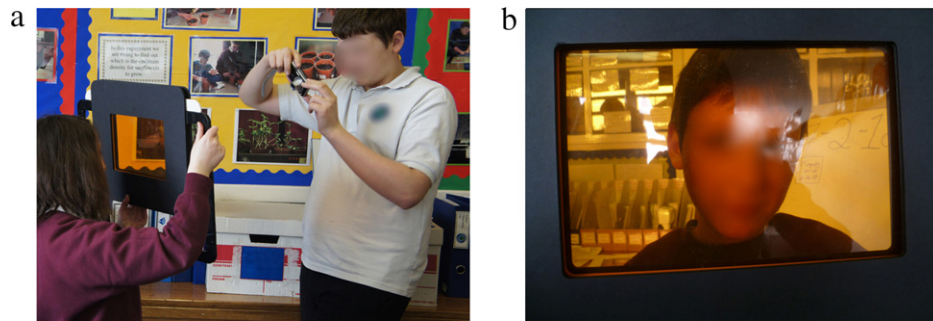


Fig. 3. Magic frames in use.

#### 4.2.1. Workshop One: introduction

For the first workshop we devised a 'Photography Portrait Task', intended to frame the series as being 'fun' as well as informative. It centred around a 'Costume Box' prop. In pairs, pupils were invited to select one or two costumes from the Costume Box. Each pair was given one digital camera and allocated an adult facilitator. In pairs, pupils were invited to take three photos of each other in costume. We paired pupils by proximity—'by the person sitting next to you'. The activity lasted for 15 min after which each pupil was tasked with selecting a favourite photo out of those captured. At the workshop's close, we presented an example Project Book and explained that we would give one to each pupil at the next workshop, each containing a print of the pupil's favourite photo (see Fig. 1).

At this first workshop we experienced, first-hand, the practical challenge of managing a group of children with diverse, complex needs. We also observed how Jane and her assistants responded to this challenge. When discussing our experiences with Jane after the session, she described how staff members typically learn about each child and how to manage them by analysing the interaction and response in class, over time. One such means of management is strategically pairing up pupils to complete classroom tasks. At Workshop One, we had arbitrarily paired pupils up; and Jane said she observed, resultantly, social tensions arising within certain pairings, leading to disruption from the task. She reflected that, for subsequent workshop tasks, she would proactively orchestrate pairings as part of the in-class management of needs.

Analysis of Workshop One involved a combination of round-table discussions between the research team, in which our experiences were reviewed, and supported by field notes and observational (audio-visual) data. This activity took place at the school following the session, and then later at our lab. Our analytic focus at this stage was on physical accessibility issues, centred on physical interaction with the provided cameras in the Portrait Task, in particular to use of their 'Zoom' function.

#### 4.2.2. Workshop Two: ways of looking

Workshop Two involved a reflection activity followed by a task. We first invited the pupils to look at their individual Project Books

and their 'favourite' photo from the previous Portrait Task. Building on our analysis, we invited discussion on 'ways of looking' as part of photographic practice, including composing images and using the 'Zoom'. The task involved the pupils working again in pairs – this time orchestrated by Jane – and taking photos of each other. Each pair was invited to utilise the bespoke prop that we had designed for this task, called a 'Magic Frame' (Fig. 2a). This prop was intended to help the pupils compose photos and, specifically, draw attention to the practice of 'framing' a subject to capture. Magic Frames were accompanied by 'Magic Filters' that could be slotted in to the Frames to change 'ways of looking' for capture (Fig. 2b).

The Magic Frames and Filters were intended to help us critically explore initial insights about the pupils' apparent difficulties with understanding how to use the Zoom function and related issues of physical accessibility when handling the cameras. These props also helped us further observe pupil collaboration in pairs. The Frame extended the functionality of the cameras by affording an additional 'Zoom' lens that worked by being moved backwards and forwards in front of the camera. This physical gesturing for composing photos required collaboration between at least two pupils, 'taking turns' to either handle a Magic Frame and Filters, or a camera (Fig. 3).

Subsequent analysis focused on the collaborative work between the pupil operating the camera and their partner holding the Frame to achieve different 'ways of looking'. In some cases we found that this involved getting the camera view to 'fit' with the view through the Frame. Sometimes, the pupil holding the Frame became a 'human zoom', physically moving with it to where their partner wanted it, in order to compose a shot.

Jane instructed us to take the Project Books away from the pupils after each class, and add photos to them after each workshop *on behalf of each pupil*. Pupils could only handle the Books and the photos they had taken *during* the workshop sessions. This was organised to address any issues of ethical sensitivity surrounding the unwarranted distribution of photographic content outside the classroom.

During Workshop Two, a couple of pupils and Jane drew attention to the tactile quality of the Project Books. So afterwards we discussed with Jane the apparent importance for this class of having tangible materials to accompany activities. We also

discussed the pupils' literacy capabilities and the use of photo-annotation and storytelling. Jane described how tutors and TAs typically become pupils' 'personal secretaries', taking dictation to write descriptions on their behalf. Jane also described using other Audio Books in the class and their efficacy as expressive tools; these were paper books with pages embedded with electronics to enable audio recordings to be made and played back on a small speaker (Talking Photo Album, Talking Books Ltd). This discussion informed how we used the Project Books in the workshops as the series progressed, and how we analysed their handling.

#### 4.2.3. Workshop Three: capturing photos

Workshop Three opened with a reflection on the previous session, with each pupil invited to review previously 'favourite' photo-prints in their Project Books. Open questions were then used to explore different ways that a camera could be triggered to take a photo. Pupils worked in pairs with Trigger Card props that we had designed. Each Trigger Card depicted an action to be 'acted out' and captured on camera. Whilst one partner in the pair was to select a Card to act out, the other should capture the action on camera. Partners were instructed to take it in turns to adopt one of these roles (i.e. Actor or Photographer). After this, the class regrouped to discuss the activity. Again, the Card prop was designed to encourage in-task collaboration, this time focusing attention on temporal aspects of photographic expression. The actions encouraged physical gesturing and impersonation in posing for photos (e.g. 'Jump' and 'Be a Lion'). This posing in turn created a playful challenge for the photographer in the pairing to capture a moving subject. At the session's close, pupils selected personal favourite photos using the cameras' Review function, for us to print and include in their Books.

In our post-hoc discussion with Jane she reflected on how this task revealed an important feature of photo capture for this class: "seeing the achievement of taking a photo needs to be instant", she said. In other words, the pupils placed value on the experience of immediately reviewing photos they had taken. She stressed the importance of seeing the output as an *accomplishment* and, to scaffold this, suggested that we design a certificate to present to each pupil at the last workshop, rewarding them on their completion of the series (see Fig. 1b).

#### 4.2.4. Workshop four: display and share

The fourth workshop focused more heavily on the *social* aspects of photography, moving from 'how' we take photos to 'why'. This involved using the Project Books again to reflect on the previous session as well as using them to explore different ways of *displaying* and *sharing* photos. We also presented a slideshow of selected workshop photos, utilising the school display resources including the classroom computer (PC) monitor and pupil Tamas' personal iPad. We also led the pupils and staff to congregate outside the classroom at the corridor wall display board and discussed its use and significance. Towards the end of this session, Jane led a discussion about how photo displays support remembering, talking through 'Memory Books' that were kept on display in the classroom, each containing photos of previous pupils who no longer attended the school.

#### 4.2.5. Workshop five: store and keep

At the final workshop, we held a discussion on how our participants store and keep photos for posterity. We presented the pupils with their Project Books to keep, which now included a certificate marking their participation in and contribution to our research team (Fig. 1b).

### 4.3. Analysis and reflections

We now turn to discuss our analysis of the workshop series, and how the insights we generated helped us design for the

SEND classroom of our real world case. Our analytic framework was phenomenological in nature and therefore focused on understanding how the participants made sense of the workshops, grounded in experiences and observed interactions with cameras and photos, between pupils, staff, and, ourselves—the researchers. Our analysis included participant accounts of broader experiences of practising photography.

Our analysis began after each workshop, and after the pupils had left, when our team remained in the classroom and reflected on the proceedings with Jane, then after Jane left, we the researchers shared and made sense of our personal experiences whilst reviewing video, audio and photographic data captured at the workshop. Field notes were further captured of this initial analysis in the classroom.

Later at our research lab, we each analysed the data generating phenomenological themes and then regrouped to collectively select extracts, deemed significant in light of our research concerns, for further analysis. We discussed multiple researcher interpretations and established consensus, deriving a consolidated set of themes and design considerations. This process inspired creative ideation and round-table sketching and evaluation of design ideas based on the themes.

Our findings are partly documented elsewhere [34]; herein, we consolidate our insights and inspirations into a summary that addresses our aims to explore, firstly, the potential social value of photography as a means for interpersonal communication in this SEND context to demonstrate, secondly the methodological value of conducting ECD for studying SEND.

#### 4.3.1. Representing the developing self

First we reflect upon the insights gained about the social function of photos in pupils' self-presentation. Pupils reported their general use of photos to demonstrate *personal achievement*, both to themselves, in a reflexive act, and to others in and beyond the classroom. Pupils described having supervised access to digital cameras at school, for capturing projects and demonstrating learning milestones. With assistance from TAs and our SLT expert to communicate, they all described using cameras outside of school too, albeit less frequently, and occasionally brought photo-prints, taken of them or by them, into class to relay interesting things they had done. Whilst the PC with monitor afforded screen interaction with photos, photo-print displays were salient in the classroom. In line with this, pupils and staff said that they liked the Project Books as a *tangible* record of achievement and of doing the workshops, a function that may be illustrated with Jane's idea to incorporate the certificate.

We also observed how photography was drawn upon for sharing stories of school and broader life experiences. Over the course of our visits, pupils and staff drew attention to the corridor wall display as significant for demonstrating the collective achievement of the class. Jane had cleared space on this board to document the whole workshop series, adding new printed photos each week along with paper label annotations denoting tasks that the photos captured. During Workshop Four, Peter explained that this display served "to show people what we've been doing, the work that we've been doing". Jane had also displayed information on who was involved. David pointed out the importance of these annotations: "so we know who's taking part". Whilst standing at the display, a couple of pupils highlighted the value of photomontage for creating stories around events and affording a richer narrative expression. As David noted, "If you've only got one picture, you can't tell nothing what you've actually being doing"; to which Luke added, "And it would be less boring as well". Pupils expressed differing ideas for where they would like to display photos. Some said that they didn't want certain photos displayed in the corridor for all at the school to see, preferring more intimate displays to particular others, or to the class only. This sentiment is perhaps not surprising to hear given the sensitivity over identity formation that emerging adolescents feel [24,28].



#### 4.3.2. Working together

The workshops also produced insights on interpersonal dynamics between pupils mediated by photography, observed during the collaborative tasks. We found these dynamics to have a significant impact on the class' creative engagement.

Some pairings were seen as constructive for nurturing friendships. For example, Duncan and Ingrid were paired for the Trigger Cards task of Workshop Three because they were good friends. One Card they worked with invited them to perform and capture 'Dance!', which was enjoyable, and entertaining; the photos taken by this pair were valued for reflecting the fun they had working together. Other pairings were constructive because one pupil shepherded the other. In Workshop One, Luke was positively engaged in showing his partner Cass how to use the camera's Zoom function. He demonstrated patience as Cass tried to use the Zoom, and seemed pleased to be able to teach her something.

However, social competitiveness was also expressed between pupils, and friendship did not always make for constructive pairings. Tensions arose when Luke and David used the Magic Frame and Filters; Luke was keen to remain in possession of the camera, saying he was "the best photographer". Jane noticed this and took David aside to ask him to "be patient with Luke". Another time, using the Trigger Cards, Peter showed similar competitive behaviour, asking his peers: "How many cards have you done?" Some responded with mild annoyance indicating that Peter was being disruptive.

Pupil behaviour differed between pairings for different workshops. As just described, Luke was patient with Cass; but he tried to assert himself in a different way when working with David; in the latter instance, David demonstrated patience with Luke. We observed that this differing behaviour related to the differing special needs of the partner within the pairing. In another instance, of David pairing with Phoebe, he was disruptive rather than patient during proceedings. Jane later reflected that the differing behaviour was not about how pupils were engaging with each different task per se but rather within a *particular pairing*. So, the pairing of particular pupils was significant for how they worked together to do photography; pairings could be hugely constructive for interpersonal expression within the learning context [27], but they needed to be carefully orchestrated by those facilitating.

#### 4.3.3. Managing a group of individuals

As the workshop series progressed, the relationship between staff and pupils was recognised and foregrounded as most significant for our research; as such, Jane's voice became more salient in the data we collected and in shaping our insights. We became centrally interested in how staff were drawing upon resources and strategies – such as sharing tools in collaborative tasks – for managing and enhancing the learning environment for their pupils, and how the pupils drew upon these resources in response.

When Jane discussed, generally, the design of ICT for the SEND classroom, she described how the real world challenge of managing "a group of individuals" with mixed needs who share school resources must be kept in mind. She stressed that *each* pupil in her class has a mix of conditions and broad-spectrum issues, some of which are diagnosed in the course of being at the school; "so", in her experience "designing for a *particular* special educational need is a moot point". Each pupil, Jane added, was supported by staff to follow their *own* learning trajectory, and each pupil raised a distinct set of pastoral concerns (i.e. concerns for looking after his/her overall well-being).

We characterise Jane's management of this broad spectrum of needs in terms of the complexity and contingency that she faced in everyday class activities, mediated by photography in interesting ways. One poignant example was found in her reference to the

Memory Books in Workshop Four. Jane described how pupils had joined and left her class over months and years for reasons relating to their special needs, including behavioural issues and illness. In some cases, leaving involved moving to join a different class or school, and in other cases was due to death. When showing pupils the Memory Books, Jane chose her words carefully to explain their social function, to manage the presence and absence of "pupils who are no longer with us" and those "who we don't see as often as we would like to".

Staff management of complexity and contingency was also found in the practical handling of expressive classroom resources including cameras and photos. As set out above, the SEND context produces heightened ethical sensitivities and protocols concerning child protection that present challenges for preventing visual identification through photo displays [28]. Addressing this in our case, Jane was found to supervise the handling of all photos by the pupils as well as by us researchers. Such challenges were brought into acute focus for us in relation to one pupil Janine, who was in foster care at the time of our study. Janine's status required us to carefully review all photos captured after each workshop to ensure that none of hers left the school grounds, a time-consuming task of considerable significance.

#### 4.3.4. Representing others

We also gained insights about researcher–staff–pupil interaction with photos and specifically on tensions surrounding photographic representations of pupils by others that impacted interpersonal expression. Tensions were illuminated by the work with the Project Books.

Recall how Jane instructed us to remove the Books from the pupils after each workshop. In keeping with this rule, Jane and ourselves would triage photos on the pupils' behalf and decide, in-between each workshop, which photos to print for inclusion in the Books. However, whilst we were guided by pupils' voiced preferences about photos, we found that the selections we made and presented back were often not what the *pupils* would deem representative. This was the case with Peter, who on multiple occasions rejected prints for his Book, which made him "feel silly" or "not like me". We reflected that the *necessary arbitration* of photos by staff and facilitators on behalf of the pupils produced tensions over representation; in many cases, a pupil's sense of self-efficacy was negatively impacted. Peter's response here, alongside others', highlights the significant role of photos in the expression of self to others in the emerging adolescent mind-set of these pupils. In turn, pupils clearly wished to have more say than was currently afforded to them on how photos captured by them or of them were to be displayed to others or stored for posterity.

#### 4.4. Design considerations

Our findings capture the *social complexity* of our research context whilst highlighting *social tensions* within it, with design implications for supporting interpersonal expression. Orienting to pupils as 'a group of individuals', staff strategically 'paired' mixed needs and abilities for constructive group work, benefitting individual learning trajectories and addressing pastoral concerns. This kind of arbitration determined *power relations* so that staff also, necessarily, managed school photo displays on behalf of their class. During our workshops, however, pupils expressed strong feelings and opinions about how they wished to reflect their individual and collective achievements through photos; these views and wishes were not always known about or met by staff. Leading from this – and with a pragmatic, empathetic mind-set – we reflected: how may Jane and her TAs manage the special needs of their pupils, which include pastoral concerns for their



Fig. 4. Photo-sorting console with RFID card & reader.

### 5.1. Photo-sorting console

The first of these elements, the Photo-sorting Console (Fig. 4), controls a software application running on the pupils' classroom PC. This application shows pupils a collection of photos on the PC monitor screen, which are loaded from an SD card, USB stick or CD-ROM inserted by their teacher. The physical controller, designed to afford both individual use and visible, *collaborative use* in small groups or pairs, consists of a number of physically accessible arcade-style buttons for browsing, sorting and annotating photos. The Console was prototyped using Microsoft .NET Gadgeteer physical computing components [35], and is housed in a chassis made from plywood and Perspex. Using Gadgeteer enabled us the flexibility to rapidly render, test, and experiment with different configurations of interface and functionality in the lab and at the school, before arriving at the final design.

#### 5.1.1. Browse and sort photos

A user or group of users is associated with an RFID card, which they place on the RFID reader to 'log in' when they want to start using the Console. This RFID card quickly identifies them (important for group work) so that their opinions about photos can be recorded and, subsequently, differentiated. Names can be written directly onto these cards using markers, or they can be labelled with stickers, to associate them with pupils' identities. Pupils – the anticipated users – can navigate through the photo collection by pressing the yellow ('Left') and blue ('Right') rectangular buttons (see Fig. 4). Pressing the circular, 'Rotate' white button will also rotate photos, which were taken in portrait. Pupils can use another set of three circular buttons to express their opinion about a photo: the orange 'Display' button lets a pupil ask that a photo is shared with others in the school; the purple 'Keep' button asks for the photo to be kept for personal consumption, but not shared with others; and the grey 'Delete' button asks for the photo to be deleted. Upon pressing one of these three buttons, the pupil or group of pupils' opinion about how a photo should be displayed within the school is captured. When this is done the photo is given a corresponding coloured border, to indicate the decision. Pupils can easily change their annotation of any photo by pressing a different button.

Whilst designing the Console to elicit pupils' feelings and opinions, we also intended to support the teacher's existing practice of pairing pupils to scaffold collaborative participation in a learning activity. In response to this challenge, we tailored the Console, and accompanying interface, so that it might be used collaboratively by small groups. The Console was given a sizeable and simple physical form factor that could be easily controlled by many pupils at once, while large arcade-style buttons were chosen to make pupils' interactions visible to others when working together. Furthermore, we designed the lightweight card-based approach to logging into the Console, to allow pupils to quickly switch between who's opinions are being recorded when working in groups.

#### 5.1.2. Record audio-stories

In order to support pupils in telling photo-stories to their class, and to the rest of their school, the Console also enables pupils to record sounds and associate them with photos, through the incorporation of two additional buttons and an omnidirectional microphone. The aim through this feature is to enrich photo-mediated communication. Pressing the red 'Record' button records audio through the microphone and associates it with a photo. Pressing the green 'Playback' button plays back sound through a speaker. The associated audio-story may describe the photo's referents (content), describe an opinion or comment about the

protection, whilst at the same time supporting them through photography to develop the means to express themselves?

Based on our workshop experiences and their analysis, we generated a set of experience-centred design considerations, framed as sensitising concerns, for developing photography-related ICT to support the SEND classroom context of our case, attending in particular to its social dimensions.

(1) Support a 'group of individuals' to accommodate pupils' wide-ranging, complex needs and the active management of the class.

(2) Support photo annotation and storytelling around photographs for recognising personal achievements.

(3) Support collaboration around groupware, accommodating the constructive pairing of pupils.

(4) Support dialogue in display making at school to give pupils an active involvement in media handling by staff.

(5) Ensure support for staff arbitration of media display.

To further explicate our ECD approach, we now describe how we put these considerations into practice in the next phase of our research.

## 5. Photo-sorting system

Our ECD approach enabled us to give our stakeholders voice in the design research process whilst allowing us to respond creatively and empathetically to the above considerations. In doing this, a new design concept emerged: a Photo-sorting system for the mixed SEND classroom. This system allows pupils to express their views and feelings about *how* photos taken of them or by them should be displayed to others in and beyond the classroom (specifically on the classroom wall, on a corridor wall display or a personal album—akin to a Project Book). The system was designed to broadly support *the democratisation of display making* at our partner school and, therefore, open up these displays as sites for pupils to express themselves to their peers, teachers and school visitors. We developed the system as part of our continuing engagement with our sample, envisaging it as also deployable in future studies with other schools, and with our broader research population.

Its design comprises three key elements that function in a networked device ecology: (i) a photo-sorting tool that allows pupils to express their opinions and record audio stories about photographs, controlled using a bespoke annotating Console and RFID reader; (ii) a separate desktop application that allows teachers to review pupils' photo annotations and prepare photos for print; and (iii) an interactive wall-based display area further leveraging RFID technology for multi-media interactions.



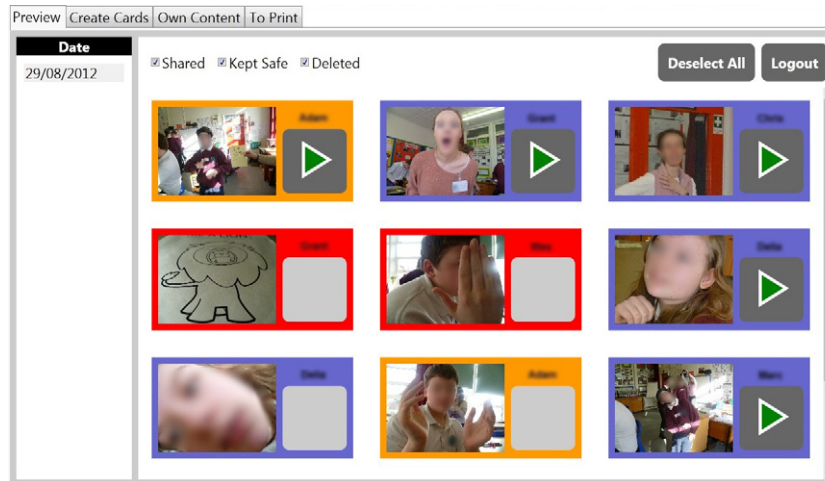


Fig. 5. Teacher's application user interface.

photo, or could be used to enrich the content with, for example, ambient sound or music.

When a pupil or group removes their ascribed RFID card from the reader, they are logged out from the Console. All of the photo-sorting and audio-story creation is saved so that the pupil or pupils are presented with the same interface and content when they next log in. When nobody is using the Console, the PC displays a slideshow of photos already nominated for 'Display'. Whilst the design of the Console affords flexible appropriation, we intended for this part of the Photo-sorting system to be predominantly used by pupils.

## 5.2. Teacher's application

The Teacher's Application (Fig. 5) is the second key element of the system. It is designed to enable nominated teachers to review their pupils' thoughts, views and stories about photos and take these into consideration when handling the photos and making displays at the school. This includes reviewing audio-stories associated with photos. Essentially, this application affords a teacher editorial control over what is finally included in displays, whilst addressing a need to afford their pupils greater 'voice' in how photos captured 'of' or 'by' them are handled. In addition, the Teacher's Application enables the teacher to have recorded, and print selected photos for displaying on a wall—all recorded on the corresponding RFID card.

### 5.2.1. Arbitrate photowork

We designed this application to address the need for Jane and her colleagues to remain the arbiter of all photo display creations representing her class. In our design, we were conscious to meet and balance two considerations: to afford pupils greater 'voice' in how their photos are handled; and to afford staff members the necessary degree of control over what is voiced. In response, the Teacher's Application was designed to provide the teacher with editorial control over what is finally included in the display.

We were also mindful that our system should work to utilise the existing wall displays in the school that placed a significant role in communication, and accommodate the existing staff practices of display making. These displays were found to offer Jane and her colleagues an opportunity to document and present the work and activities of their classes to the rest of the school and, to this end, staff invested substantial effort to make them interesting, informative and visually compelling.

The teacher logs in to the application by placing a special teacher card onto the RFID reader. Once logged in, the interface

displays pupils' expressed opinions on photos made using the Console. Each opinion is represented as a rectangular element that shows a photo, the pupil's name and a coloured border that indicates the decision made. Pressing the 'play' button on-screen plays sounds associated with each photo. Opinions are grouped by photo, so that the teacher can view pupils' contrasting opinions. These can be filtered by the date of photo capture.

### 5.2.2. Print for audio-photo wall display

After browsing annotations and audio-stories, the teacher can select a number of photos to print. If printing photos associated with audio-stories, a Wizard is generated that enables these sounds to be linked with their printed copies. The Wizard displays each photo in turn, instructing the teacher to stick an adhesive RFID tag onto the back of its printed copy and then place it onto the RFID reader. This simple sequence allows the system to make connections between printed photos and sounds.

The Teacher's Application also includes administration functionality intended to support potential longitudinal use in the classroom, such as erasing old photos. This interface includes a mechanism to easily create and personalise RFID cards for individuals and small groups of pupils, affording staff the flexibility to use the Console and annotated media to support the classroom activities that they design.

## 5.3. Audio-photo wall display

The third key element augments traditional corridor wall displays outside the classroom. The teacher adds photos to the display that are printed from the Teacher's Application. Unlike a traditional paper-based display, however, pupils, teachers and visitors to the school are able to hear the sounds that the pupils have associated with photos by moving a wireless RFID reader over the display. This reads tags attached to the displayed prints and instructs playback of associated sounds from a nearby PC.

## 5.4. Evaluation sessions

Continuing our ECD process, the Photo-sorting system was evaluated with our research participants over the course of six hour-long sessions at the school during a year-long period (June 2012 to June 2013). Our key aim through this evaluation was to gain critical feedback about how the key functional elements of the system may serve the *real-world classroom*, and how it may empirically ground the design considerations of our case that were

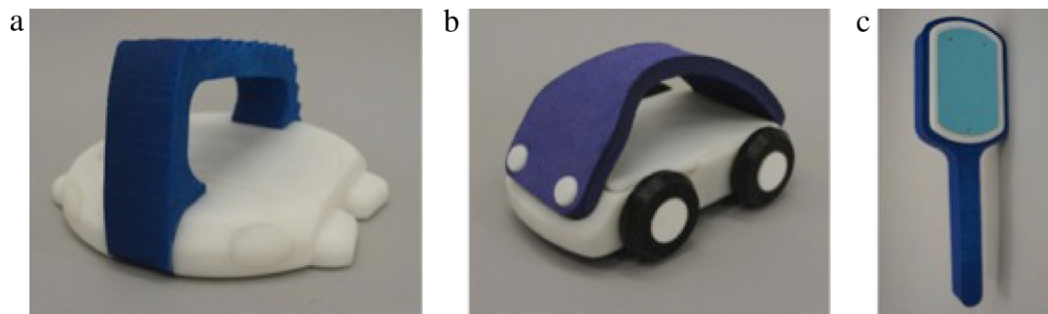


Fig. 6. Magic wands.

generated from the workshops. Our ECD approach enabled us to re-orient flexibly to the staff and pupils in this evaluation as ‘Testers’, ‘Informants’ and ‘Partners’ [30], whilst retaining an empathetic dialogue with them. Each session was video-recorded for later group analysis by the research team, and data was coded using the same analytic framework described above.

#### 5.4.1. First group evaluation

The first evaluation session took place three months following the workshop series. In this session, the Console was installed on the classroom PC. The session followed a format similar to that of our workshops. During an hour-long class, the pupils were introduced to the system, given an opportunity to experience using it, and then asked to relay their reflections on use. Two pupils volunteered as Testers to operate the Console. One of our team then talked the class members through a scenario of using the system with photos captured during the workshops. Within this scenario, photos were viewed, opinions and feelings expressed and, finally, audio-stories recorded. We asked different class members, and then the class as a whole, to decide if particular photos should be ‘Displayed’, ‘Kept Safe’ or ‘Deleted’ and to record accompanying sounds. Further pairs of pupils were then invited to use the Console and test its functionality. The pupils were then taken to the corridor and shown a demonstration of the Audio-photo Wall Display. Using a photo collection prepared prior to the session, the pupils were shown how the wireless RFID readers could be placed over photo-prints to play sounds and invited to interact with them.

Towards the end of this session, the pupils and staff reassembled around the Console and we invited a critique of the tools. Both pupils and staff responded positively, raising minor usability issues. We observed that all of the pupils were able to use both parts of the system during the session. Some did so independently, whilst others interacted with the assistance of their peers. Some pupils suggested design ideas for enhancing the system. Philip and Peter collectively suggested that the Console should be made *wireless* so it could be passed around the classroom in group activities. Also during this session, the term ‘Magic Wand’ was introduced by the pupils to describe the RFID reader. David, Gabi, Luke and Phoebe then suggested ways in which the Magic Wands could take novel forms, and be made customisable by them and their peers. David for example, suggested that a ‘Wand’ take the form of a car.

Once the pupils had left the classroom, we conducted a demonstration of the Teacher Application with Jane, and invited her critical reflections on its potential role and impact. She did not suggest any major revisions to the design but emphasised how important it was that it allowed her to remain ‘Arbiter of photos’. She further highlighted how important it was that the system did “not allow pupils to *actually* delete photos”, reiterating her need to keep and print photos that the pupils do not necessarily deem significant or representative, for her own purposes. Finally, she emphasised that she, alongside her other colleagues, would like to use the system to handle other kinds of media within the classroom and wider school activities.

#### 5.4.2. Second group evaluation

In response to the feedback from this session, we refined our design of the Photo-sorting system and presented a new iteration of it at a second evaluation session, a month later. A significant addition was the development of three novelty ‘Magic Wands’ (Fig. 6), each of these aiming to inspire a different way of interacting with the Wall Display and be useable by subsets of pupils with differing physical needs. As the pupils had effectively *partnered* with us in developing the Magic Wand concept, and had conceived of original designs for how they may be realised, we oriented to them variously in the second evaluation as Partners and Informants. Both staff and pupils were inspired to see how we had responded to their previous comments, and how their design concepts had been realised and explicitly incorporated into the system (e.g. David’s ‘car’ in Fig. 6b). Another key addition was to the Teacher’s Application interface, to afford Jane and her colleagues, a comprehensive view of all the pupils’ decisions on photos made through the Console. At this second evaluation, Jane and the headmaster also said they would like to experiment with appropriating the system for different functions beyond photo sorting, specifically for communication around school timetables.

Following this second evaluation, we iteratively refined the Console design to resolve the usability issues that were newly revealed, resulting in a revised prototype. Firstly, the Console buttons were reconfigured to alleviate an observed issue with them, at times, not being pressed down enough by the pupils to sense input. This was attributed to ‘tentative interaction’ (i.e. less confident button pressing) in some cases, and in others to physical and/or cognitive impairment. The issue resulted in a user experience of ambiguity about the system capture of input, compounded in the group work and in particular in turn taking. Feedback from button pressing was enhanced in the refined prototype to address this: when either the ‘Record’ or ‘Playback’ buttons are pressed, an LED bulb (positioned next to the button) lights up (Red for Record, Green for Playback). Another design revision resulted in a button being held down to either record or playback sound for the duration of the recording, and releasing the button to stop Record or Playback. Again, through the lighting up of LEDs, we aimed to make button interaction clearer to users and to better support social interaction in Console use.

Secondly, the PC photo-browsing application that accompanied the Console was revised to better guide and cue up the recording of audio-stories, similarly, to address the ‘tentative interaction’ issue and to resolve ambiguity in the system function. When a user presses the Record button in the refined prototype, a graphical animation appears on-screen, to count down over three seconds (“three; two; one”) to start the recording function. This revision addressed another usability issue, of the Console recording function starting after the user had already started telling their audio-story; the ‘countdown’ provided a cue to start when users could see and hear that the device was ready.

#### 5.4.3. Evaluation sessions with pairs

Further three evaluation sessions were conducted with this new prototype, again in the classroom setting at the school (March to June 2013) to continue exploring our design considerations through practice. These sessions were run by three of the project team researchers (the speech therapist, social psychologist and interaction designer), and held during an 'IT and study' time in the curriculum with pupils from a subset of the class (now aged 12–15 years) who are non-swimmers and typically engaged in private study with the Design and Technology teacher, named Paul. An hour in duration, each session focused on evaluating the use of the Console for doing photowork. Pupil Luke created a photo collection on behalf of his peers for use in the sessions, which captured them on recent trips and at special events (e.g. Olympic Torch parade, School Sports Day). This collection was already intended to be sorted for display in the school, so was appropriate for use in the evaluation.

In order to obtain more in-depth feedback from a number of individuals (complementing our previous group evaluations), and to pull focus on the consideration of design to support collaborative work in pairs, we decided to run *each* session with *one pair* of pupils. All participating pairs were self-selecting on the day of the session. The three pairs involved were: Holly and Cass; Phoebe and Duncan; and Luke and Gabi. At each session, the researchers, facilitated by TA Philippa and teacher Paul, reintroduced each pair to the Photo-sorting system and described again how the Console worked, and let the pupils informally explore the Console functionality (accompanied by a glossary of functions), before stepping through a set of short tasks for editing and annotating the provided photo collection.

All of the pupils learned the Console button functions swiftly during the session (some before others), even those who were visually impaired. Indeed, the changes in the Console design and accompanying application proved effective for holistically addressing usability issues with the system. With this resolved, what was foregrounded as an interesting phenomenon in Console use was the expression of social dominance within the pairings, whereby one pupil guided the other who was less confident in creating audio-story annotations. For example, Holly and Cass were both shy and quiet at first, but over the course of the session, Holly became increasingly vocal and directive within the tasks.

Holly: "Cass, do you want to do this one? What do you want to say? ... This is Fay doing—what was it Cass? ... Ready? (Presses Record:)"

Cass: "Fay is doing discus".

This was also found with the other two pairs, with Phoebe and Luke directing and prompting Duncan and Gabi respectively.

This observed dynamics was couched in constructive terms, as something akin to shepherding. Extending the example just given, Holly encouraged Cass to annotate a photo to highlight (and celebrate) her peers' achievements (such as discus-throwing at Sports Day) and then praised her for successfully recording the audio story. Cass became increasingly vocal towards the end of the session and the dynamics within the pairing shifted to reflect something more playful; the annotation process was a prompt to talk, play, and joke together. Towards the end, Cass hovered her hand over the Record button, playfully threatening to record a joke message: "I'm gonna do it!" Holly replied: "Don't you dare press the red button!" At the session's close, the girls were both laughing together, and clearly both enjoying what they were doing. Hitting the Console buttons formed highly expressive gestures as part of the fun. Thus, the Console use effectively supported playful collaborative work grounded in shepherding by one pupil in the pair.

Significantly, we found the audio-story mode of interaction, to combine annotation and storytelling into one performative activity, was highly engaging for fostering interpersonal expression.

The process of composing audio annotations within the pairings sparked performative acts of individual and collective remembering. This included remembering *others'* activities and achievements at the school, and sharing these recollections. We found that all the pupils needed to rehearse what to say for the audio recording, and *how* they would say it. This was no mean feat, as Philippa pointed out: "It's hard when you're recording your voice, you have to think about what you say". In such an instance, we found that those gathered around the Console to facilitate – i.e. Philippa, Paul, us researchers, and the other pupil in the pairing – helped with articulation and delivery, which, in turn transpired – perhaps counter-intuitively – to be a fun collaborative activity. The small group facilitation of this work seemed essential.

Within this performative activity, the creation and rehearsal of audio stories was found to challenge teachers' and pupils' assumptions about the meaning or value attributed to certain photos and which portrayals people wanted to keep from display or delete. As such, we found the Console design to properly address a central consideration (above) about giving the pupils voice to shape display making, and in turn fostering shared understanding between staff and pupils.

#### 5.4.4. Staff evaluation

We conducted a final evaluation session with the Design and Technology teacher Paul (June 2013), to gain an additional staff perspective on the Photo-sorting system. This formed a semi-structured interview, during which we demonstrated the networked device ecology of the Console, Teacher's Application and Audio Wall Display, and then invited Paul to use the system and offer reflections on use. We also invited him to reflect on the previous three evaluation sessions with the Console, which he had helped facilitate.

Paul liked the incorporation of audio photography to address the design considerations we had elicited.

"I think it's great. You look at a photo and it kind of tells you something, but a running commentary is different. It *tells* a story. I think it is also relevant. You do get a lot of the kids looking at the displays in the school, so better to have something interactive."

The telling of a story draws out the relevance of the captured subject from the photo, using sound technology that appeals. Paul thought that the Photo-sorting system provided a means to get the pupils interested in the process of display-making, even if, for the staff, the 'democratisation' of the process created *more work* for them: "the process of making the display is much longer with this device, but in reality is better". And he thought the system supported teacher accountability: "You can say 'Look, you (pupil) marked it as orange', you chose for it to go up on display".

We asked Paul if the Console would be something he had envisaged being installed at the back of the class, for walk-up interaction, (which was how it was configured for the evaluation sessions with pairs). He replied that he instead envisaged it being used as "part of the class, used for collaborative learning", building on Philip and Peter's suggestion that it could be wireless and passed around. Paul added that "collaborative learning is perfect for that Console", also highlighting that using it to create a photo display (e.g. for a class trip) could constitute a discrete collaborative task by which the pupils could demonstrate key citizenship and problem solving skills in-class, and in turn gain a special qualification.

Our dialogue with Paul also challenged assumptions we had made as a design team about who would use different aspects of the system. Paul critiqued the Teacher's Application by suggesting it be renamed to reflect intended use by staff including teachers and TAs.



"I would avoid saying teacher. You could say Editor Suite. Yeah I wouldn't identify a group to use it as specific as teachers. Even if we'd made that decision that it was staff, then yeah, it riles the TAs. In fact you mean just staff."

Discussion on use of this application prompted Paul to briefly consider if a relatively higher-functioning pupil, like Luke, could, after all, be given access to it—a consideration that surprised us (researchers), given Jane's comments in earlier evaluations. This prompted a more focused dialogue with Paul about the key social affordances of the system for balancing classroom management with children's voice. The need to *ensure staff arbitration* of display was subsequently reinforced with a demonstration of existing in-school technology: accompanied by Philippa, Paul showed us the use of RFID technology in programmable audio-display buttons on walls in the school corridors, which play sound recordings upon pressing to assist with the reading of signage and other labels. Paul and Philippa pointed out that many of these buttons had been hacked by pupils and, in such cases, staff had removed components to be reprogrammed. Paul commented: "those (RFID) readers are good but they're too easily changeable". Paul pointed out that this hacking issue is diverted with the Photo-sorting system by having the Teacher's Application act as a conduit to ensure staff arbitration; specifically, key devices in the ecology – for reprogramming the RFID stickers – would be locked away when not in supervised use.

#### 5.4.5. Evaluation summary

In summary, our four-part evaluation sought to use the Photo-sorting system to 'put into practice' the design considerations (or sensitising concerns) that we elucidated in the workshop series, and empirically grounded a design response to this mixed SEND context. Consequentially, pupils' and staff reflections on their 'experiences of use' at the evaluation sessions have deepened our research insight, as we will describe in the closing sections of this paper.

## 6. Discussion

Reflecting on our experiences of running the workshops and prototype evaluations, we now return to address both our research objectives and the paper aims herein, and consolidate a number of transferable insights about how experience-centred and inclusive design may leverage the social value of photography as a means to support interpersonal expression in a mixed SEND classroom setting. In doing so, we hope to contribute to a discourse of considerable interest to the child-computer interaction research community.

### 6.1. Develop ICT for SEND classrooms with appropriation in mind

A core motivation in this case study had been to use our shared *tacit understanding* of the classroom activities at the SEND school to drive our design process. This tacit understanding revealed an active management of in-class contingencies by staff, scaffolded by the appropriation of flexible resources and techniques. This translated to the *need for the design team to support this affordance for staff*, and was realised in the photo-system design with its simple, clear functionality that can be configured for purpose within an ecology of devices and class groupings. Paul and Jane's evaluations of the system reinforced that its design afforded this, and necessarily so. Developing this insight beyond our case, we may suggest that ICT for SEND and wider classroom settings be extendable and networkable for additional and more complex functionality as required by different use scenarios. ICT should support staff, through its design, to actively manage their class.

Thinking more broadly, the need to support to a 'group of individuals' in the mixed needs setting may guide design thinking towards creating *open* tools with functionality that is accessible by a range of users for *appropriation* in multiple, different use contexts.

Our focus on how design may support social inclusion in the mixed SEND classroom has brought the Inclusive Design agenda [32] to the fore. We have embraced the 'design for all' ethos in our practice by developing the Photo-sorting system as something that can be used both in the SEND classroom and also in other contexts; this is not a tool for exclusive use in a SEND context, but *a tool with functionality that can be appropriated efficaciously for SEND*—and is widely accessible by a relatively broad range of users. Indeed, it would be interesting in future work to evaluate the Photo-sorting system design with pupils and staff in a non-SEND setting.

### 6.2. Promote research through design for SEND

In reflecting upon what we have designed, we suggest that our insight on appropriation has been, to no small degree, shaped by *how* we approached the design space in the first place, that is, not to respond to pedagogical or other formal requirements of SEND per se, but with a creative, exploratory mindset, responding pragmatically and empathetically to our experiences in the classroom setting and our dialogues with stakeholders and participants in the study.

This approach has demonstrated the use of design practice guided by an ECD methodology [18] to drive research in a mixed SEND setting. ECD collectively afforded our research team the scope to engage creativity, aesthetics, and felt experience within the remit of our project. More specifically, ECD gave us *latitude for the creative interpretation* of both the setting and participant dialogues, to form ideographic design responses. The design artefacts that were made – e.g. Magic Frame props, Photo-sorting Console – were *placed back into the setting as catalysts* for consolidating research understanding as they emerged, as part of a creative dialogue between people and technology.

Leading from this, we highlight in this discussion the potentially rich outcomes of conducting *research through design* practice as an ideographic, "generative endeavour" [36]. ECD is relatively new and currently under-represented in the literature related to interaction design for children, and therefore a proposed methodological contribution of this paper is to inform the emerging discourse on research through design in HCI [ibid] as it connects to doing co-design with children, grounded in tacit experience. Our descriptive account of the ECD process may be useful to interaction designers and researchers interested in using creative processes for conducting research with children [21]. We further promote the potential value of creative and aesthetic engagement when designing for social inclusion [32]. Our ECD approach determined the small sample of our case, intended to contribute to a growing number of qualitative cases about SEND [13].

### 6.3. Support active engagement in representation

Our study aimed to tacitly understand how to leverage the social value of photography for design. ECD enquiry led to an exploration of audio-photography [11] for supporting social engagement, and we found in turn that the *performative aspect* of this mode of interaction, combining annotation and storytelling into one activity, proved to be an efficacious means to spark active collaboration and interpersonal expression in the context of our case. This potential application of audio-photography for SEND connects with recent studies about its potential more generally

in the transition to digital photography, and the consideration of associated cultural practices [ibid].

Expanding this point, we found that the ICT support provided through the Photo-sorting system had a positive impact on self-expression and self-advocacy – within communicative exchange – because it enabled pupils to foreground personal achievements and *display these achievements to others*, and also say when they felt that a photo did *not* portray them as they wished. In particular, the Console enabled pupils to voice their opinion on *how* they wished for media to be displayed. The *triaging* feature of our design was arguably the most effective for promoting self-efficacy through photography, a technique that may be considered by designers working in related contexts to extend understanding on children's voice in relation to HCI [5,7–10,19–23,25,28,32].

The active engagement that we describe, afforded through these design features, was supported significantly by structuring interaction into small groups of pupils and facilitators. This insight complements the recent findings of Foss and colleagues about the importance of small group interaction for doing co-design with children [13]; in alignment, we also found the small group structure to afford greater facilitation, flexibility and informality in orienting to class activities, in turn fostering pupil interest and participation. This insight may help inform the child-computer interaction community about the development of methods in future empirical studies on co-design in SEND settings.

#### 6.4. Negotiate children's and adult's voices in participation

Reflecting upon our study outcomes, we hope to have raised a new discussion about the definition of and approach to SEND user groups in child-computer design research. It is already established in the related literature that engaging children with special needs in co-design is a constructive and valuable endeavour [7,13,15–17]. Our findings offer up new insight about the social complexity at play in this endeavour when working with a broad spectrum of interpersonal communication needs reflected by a diverse 'group of individuals'. Again, ECD enabled us to flexibly navigate this complexity; we have referred to Druiin's framework [30] as a way to frame and illuminate the *differing* ways in which we oriented to our participants in the course of our ECD enquiry and how this was determined by our distinctly creative approach and our analytic focus on the real-world pragmatics and contingencies within classroom activities. SEND settings arguably present unique challenges for co-design; pupils in our study were engaged in different roles (e.g. Partner or Informant) at different times based on their complex individual needs and states; and for example within the collaborative pairings described above, particular power dynamics between pupils, and between pupils and staff, were found to shape the nature of their participation in the design process.

We have further come to understand that ICT tools for the SEND setting must be designed to *negotiate* the promotion of children's voice with the organisational management needs of others, including school staff, for providing support to social functioning. This has been demonstrated through a system design that supports both pupils' and staff voices in creating photo displays at a SEND school. We highlight the broader – and non-trivial – interaction design challenge for SEND and related learning contexts to flexibly *afford*, in ICT systems, this 'negotiating' of children and adults' voices.

#### 6.5. Challenges for doing research in a SEND setting

We established in the Introduction to this paper ways in which SEND settings are understood to be ethically sensitive [28]. In our study, by further attending to *socio-political concerns* about

'children's voice' and the democratising potential of ICT in a real-world SEND setting, our research team had to address and negotiate both ethical and political sensitivities raised both by researchers and participants. As mentioned above, the handling of media data generated in the study, in particular with respect to viewing and storing in different geographic locations, presented logistic challenges and involved the use of encryption technologies and the careful situating of data analysis sessions (e.g. at the school). Participants – in particular, staff – were often concerned about 'going on record' about the practical reality of managing classroom activities, resulting in many discussions being captured post hoc in field notes rather than in video or audio recordings. And finally, our University Ethics Committee had to commit to an extended study timeframe to accommodate the availability of our sample to take part within their school curriculum, and to create time and flexibility for developing a relationship of trust given the sensitive setting and population. In concluding our discussion, it is worth noting that these various challenges significantly shaped our procedure and the trajectory of our design process; and the phenomenon of 'managing contingency' that was so central to our participants' classroom experiences was also found to be a key feature of our shared 'researcher' experience of doing research in the SEND setting.

## 7. Conclusion

Through presenting our case study of ECD research in a mixed SEND school context, we have sought to explore a relatively new and challenging area of concern for the HCI and child-computer interaction communities, that is, a mixed special educational needs setting. Over the course of a 'Creative Photography' workshop series in a SEND classroom, followed by a design prototyping exploration and a series of design evaluation sessions, our research team has gained tacit understanding of how digital photographic tools may be developed to support and enhance interpersonal expression between pupils and staff.

In this paper, we have provided a descriptive account of a creative, design-led enquiry, inspired by and grounded in empirical experiences of running the workshop series. We have thus presented a case of *ECD in practice*, demonstrating its real-world efficacy and social value within the research endeavour at hand, as voiced by both the stakeholders and by us as a research team. ECD has enabled our research team, in the course of responding to their experiences of the SEND setting, to foreground and negotiate the social complexities found within it, and to engage multiple stakeholders towards a pragmatic goal. As such, the pupils and staff were engaged in the research *in different ways at different times*, for example, as 'Partners' in co-producing design concepts and as Partners, Informants and Testers of prototypes in the evaluations that followed. We have also demonstrated the potential transferability of the workshop findings by describing how we developed a novel 'Photo-sorting system, thus 'putting into practice' a set of considerations and sensitising concerns for the mixed SEND context.

In the spirit of the Inclusive Design attitude [32], we suggest that the design considerations captured herein may have wider applicability in related learning or mixed special needs settings, or indeed in mainstream education, where photography may be used in conjunction with ICT to support interpersonal expression, and, in turn, participation. We hope that the considerations set out in this paper will be taken up by interaction designers who are interested in developing photographic tools both for SEND classrooms and for learning contexts beyond.

### 7.1. Follow-on studies

These insights are informing follow-on studies. The newest prototype is now deployed with the school of our case, for an ethnographic study of the Photo-sorting system in everyday use. In this continuing work, we are interested to understand how the Console may be appropriated for communicative purposes beyond photo display making, in the school more widely. We are also planning future studies to deploy the system in another mixed SEND school and in a non-SEND setting to study its use and appropriation. In pursuing these further studies, we aim to deepen our empirical understanding of what it means to address an Inclusive Design agenda. In related work building on the findings documented herein, members of our research team are also exploring a design space for creating toolkits that enable children with additional mixed needs to make their own expressive ICT devices [37].

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