Design to Support Interpersonal Communication in the Special Educational Needs Classroom

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ABSTRACT
This paper describes our Experience-centered Design (ECD) inquiry into the current and potential role of digital photography to support interpersonal communication and expression in a class at a mixed special education needs school. Presented as a case study, we describe five classroom-based Creative Photography workshops that engaged pupils with a broad range of complex special needs, along with classroom staff. We further describe how, from these workshops, we generated a set of qualitative considerations for the design of digital photographic tools to support interpersonal communication and expression in this setting. Additionally, we present the preliminary evaluation of a photo-sorting tool that we developed in response. Our case study demonstrates how an ECD approach can guide an interaction design process in a special education needs setting, supporting interaction designers in understanding and responding pragmatically to the complex and dynamic interactions at play between the stakeholders.

Categories and Subject Descriptors
H.5.m [**Information Interfaces and Presentation (e.g. HCI)**]: Miscellaneous.

General Terms
Design, Human Factors

Keywords
Special education needs; digital photography; experience-centred design; interaction design for children

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 [2]. Such schools are therefore a relevant but currently underexplored setting for interaction design research [10]. 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 communication and expression amongst pupils and teachers at a UK school for children with a broad range of special educational needs. The 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 classroom setting. A key concern within the design research team was to develop a tacit, pragmatic understanding of the 'real-world' needs, desires and experiences of our stakeholders in using photographic tools on an everyday basis, to guide the design process.

The Special Education Needs (SEN) Code of Practice (2001) [5] 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 that has 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, is well documented in research fields relating to the study of Human-Computer Interaction (HCI) [e.g. 3, 6, 13, 20, 21, 24, 27]. The social function of photography as a means of expression in *SEND classrooms*, however, is a currently underexplored setting for HCI and related research [10].

Interaction design research for SEND settings has only recently been reported in HCI and related IDC literatures [1, 11, 14, 17]. The SEND classroom arguably poses particular challenges for interaction designers and researchers, who must consider the complex needs of pupils as well as the resources and strategies that teaching staff members use to support them. One such research challenge lies in the need to consider and be responsive to the broad range of cognitive and physical abilities of students and the *practical* constraints necessarily imposed by the SEND school as an institution. However, as we emphasise in this paper, it is equally important to ensure that pupils and staff can contribute to the research and design process, both to support the self-advocacy of stakeholders and to ensure that any subsequent design artefacts are effective and responsive to the setting and population for which they are intended.

Our case study sought to explore this interesting design space. Over the course of five 'Creative Photography' workshops, our

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design research team employed an Experience-centred Design (ECD) [32] approach to understand how photographic tools may be developed to support and enhance interpersonal communication and 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 tool' for deploying in the SEND school we've been working with. A key contribution of interest to the IDC 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 Self-expression

In recent years HCI researchers have given increased consideration to children as a distinct user population for ICT [6, 7, 25]. Children are rapid adopters of emerging digital technologies, including photographic tools, and are pioneering their use in innovative ways [21]. When considering the *social* functions of these technologies, older children are a particularly interesting user group because they are at a key developmental stage for identity-formation and self-expression to others [30]. At this stage, their perceptions of self-image in relation to others may be a delicate concept significantly mediated by photography.

This social psychological phenomenon arguably gains new significance when considering photo practices of older children with SEND [10]. 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 [24].

The concept of using photography to support social communication and expression – including storytelling – is also well established in the HCI literature [3, 21, 28, 30]. It is also drawn upon more widely in clinical research to this end; for example, Levin and colleagues [20] 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 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 [1, 10]. 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 enabling people to learn social development skills to facilitate their full and equal participation in education [9]. When considering the context of the classroom for SEND, concerns for social inclusion and equal participation are balanced by the practical, organisational constraints for managing the class; teachers may adapt traditional teaching techniques to support learners with differing abilities across a continuum, as reflected in the notion of the equitable classroom [4]. Adding to this complexity is school policy on the production and distribution of photographs; in a SEND school context the vulnerability of children makes issues of privacy and disclosure a priority [23].

Recent HCI studies that address design for children with SEND have tended to focus on specific forms of disability and impairment [16, 18, 22]. This can be seen in the work of the ECHOES project [11]: whilst offering insights into the design of interactive systems for all children with SEND, the inquiry nevertheless focused on children on the autistic spectrum in a dedicated setting. Additionally, Kientz and colleagues [18] discuss the benefits of pervasive technologies for children with autism from the perspective of caregivers.

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 [10]. Our case further engages both staff and pupils as stakeholders in this setting, thus providing multiple perspectives on the context. By highlighting previous studies focusing on specific impairments, we demonstrate the relative novelty of our objective to explore a mixed ability SEND setting from multiple stakeholder perspectives, which foregrounded specific research challenges and invited a particular methodological orientation.

There is a small but growing set of literature in HCI on the participation of children in interaction design processes. An early exploration of children's involvement as such by Druin suggested four potential roles, of User, Informant, Tester, and Design Partner [8]. 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 [14, 17], and how their to the design process may be structured and interpreted [11, 16]. For example, Guha and colleagues [15] take up Druin's notion of a child as a *Design Partner* [8], 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 [19], who suggest that children's appropriate involvement should be guided by the their '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 and which calls for research to consider the 'real world' settings in which a technology will be deployed [6, 7, 12, 25, 26]. 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 studies to date [29].

We recognise that the specific SEND context of our case presents a number of challenges for interaction design that are both relevant and interesting for the IDC community, relating to research in sensitive settings with complex and mixed ability groups that have individual communication needs. Herein, we aim

to contribute an illuminative account of our design process that describes how a team of interaction designers understood and responded to a complex and sensitive setting.

3. OUR CASE STUDY

We now describe our case study, in which we worked with staff and pupils at a UK SEND school, running a series of 'Creative Photography' workshops to understand the design space. We approached this workshop series as the first of many linked studies with this school that would form a longitudinal and on-going empirical engagement.

3.1 Methodological Approach

We adopted an Experience-centred Design (ECD) approach to our case [32], a methodology grounded in observed, tacit, and phenomenological understandings of the setting – in this case, a SEND classroom. ECD shares some values with Participatory Design (PD) and Cooperative Inquiry that have previously been explored by the IDC community [8, 14], 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 and aesthetic engagement between stakeholders in order to support the pragmatic goal of designing to improve the lived experience of users; to this end and in contrast to PD, ECD allows the designer latitude to design *for* a community based on this pragmatic, empathetic and aesthetic engagement.

The ECD perspective determined our inductive and ideographic method for fostering understanding with our research population, and for generating qualitative analytic insights. As a design 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 per se. Given this orientation, our study design was informed from the outset by our unfolding, *empathetic* dialogue with the SEND 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.

Our method was further informed by the interdisciplinary skills within our design 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 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. Our team found common ground through phenomenology and an analytic focus on subjective experience; the shared understanding that we in turn generated is reflected in our collective account to follow, in which we describe our interaction design process and its outcomes.

3.2 Sample and Method

Drawing upon established contacts within our research programme, we partnered with a school in the local area accommodating children with SEND (aged 2-19 years). In addition to providing a learning environment, this special school functions as an assessment centre, where pupils' needs are diagnosed and monitored, as well as managed. Our decision to conduct workshops was shaped by the headmaster's recommendations for how we could engage his staff and pupils. In our initial discussions, he suggested utilising a regular hour timeslot in the school curriculum, over the course of a term, hence workshop 'series'. He also recommended a particular class and age, so we worked with a class of Key-stage Three children (aged 11-14) with SEND, their teacher, Jane, and teaching assistants (TAs), Sarah and Phillippa. The class comprised 13 pupils. The pupils' broad spectrum of needs is illustrated in the following table, using Jane's descriptive terms. For ethical reasons, all participants' names have been replaced with pseudonyms.

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 delayed, brought on by trauma at birth

Our workshop planning was further informed by a tour of the school environment during which we observed how photography was drawn upon by the staff and pupils in display making for communication (i.e. in classrooms and corridor spaces). We were also invited to sit in and observe classroom activities across three preliminary visits to inform our study design.

Five workshops exploring different aspects of photography were planned to take place over the school's Spring Term. 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 surrounding camera and photo use.

3.2.1 Bespoke Props for ECD Inquiry

Activities for each workshop were developed in response to output from the previous workshop, in dialogue with school staff. In the intervening time between workshops, we developed bespoke props, of varying fidelity (from sketches to prototypes) in response to issues and ideas raised by previous workshop output.

Figure 1a and 1b. Creative Photography Project Books

Alongside these props, we 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, to be edited after each workshop (Figure 1). Also, information about each workshop activity could be added to the Books incrementally. We planned to use these Books to invite pupils to reflect back on what they had done during each workshop to inform our research. Digital cameras were also provided at each workshop for the pupils to use in conjunction with activities.

These prop-centred activities reflected our ECD method of inquiry. They were intended to inspire creative engagement in our study in two key ways: allowing pupils to engage with aspects of photography in an 'embodied interactional' way that has been previously found in pervasive computing for children literature to foster creativity [7]; and affording pupils the tangible means to experience the world in a new and alternative way. Through such engagement, 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.

3.3 Our Workshop Experiences

In this section we document our procedure as distinct from our method because it differed in ways that were significant for our findings. It is key to mention that our experience of co-organising and running the workshops with Jane – and reflecting upon each workshop with her separately from the pupils – greatly informed our method, more so than originally anticipated.

3.3.1 Workshop One: Introductions

For the first workshop our bespoke prop was a 'Costume Box'. With this we intended to frame the series as being 'fun' as well as informative and creative. The central workshop activity was a 'Photography Portrait Task': in pairs, pupils were invited to select one or two items from the Box. Each pair was given one digital camera and allocated an adult facilitator. In their 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 minutes after which each pupil was tasked with selecting a favourite photo out of those captured, after reviewing them on the cameras. At the workshop close, we presented an example of a Project Book and explained that we would give one to each pupil out at the next workshop, each with the pupil's corresponding favourite photo added in by us in the intervening period (see Figure 1).

At this first workshop we experienced, first-hand, the practical challenge of managing a group of children where there is a high diversity of 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 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 afterwards that, for subsequent workshop tasks, it would be constructive for her to proactively orchestrate particular 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, supported by field notes and observational (audio-visual) data. This activity took place both at the school immediately following the session, and later at our research 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.

3.3.2 Workshop Two: Ways of Looking

Figure 2a and 2b. Magic Frame and Filters

Workshop Two involved an initial reflection activity followed by a task. We first invited the pupils to each look at their individual Project Books and their 'favourite' photo from the previous Portrait Task (that we had inserted). Building on our analysis of Workshop One, we invited discussion on 'ways of looking' as part of photographic practice, including composing images and using the 'Zoom'. The subsequent 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' (Figure 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 (Figure 2b).

Figure 3a and 3b. Magic Frames in Use

The Magic Frames and Filters are further demonstrative of our ECD method, intended to help us critically explore initial insights that were centred on the pupils' apparent difficulties with understanding how to use the Zoom function and related issues of physical accessibility when handling the cameras. We were also interested to further observe pupil collaboration in pairs. The Frame was intended to extend 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 required collaboration between at least two people; pupils worked together in their pairings to compose photos, 'taking turns' to either handle a Magic Frame and Filters, or a camera (Figure 3).

Insights from Workshop Two informed our on-going procedure. Subsequent analysis focussed 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 work involved getting the camera view to 'fit' with the view through the Frame. In some of these cases, 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.

Significant for our findings, Jane had 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 of the classroom context of our research.

During Workshop Two, a couple of pupils and Jane had drawn attention to the tactile quality of the Project Books. After the session we discussed with Jane the apparent importance for this class of having physical (non-digital) materials to accompany activities. We also discussed the pupils' literacy capabilities and the use of photo-annotation and storytelling. Jane described how tutors and teaching assistants typically become pupils' 'personal secretaries', taking dictation to write descriptions on their behalf. She also described using other Audio Books in class and their efficacy as communication tools given the pupils' various literacy capabilities; 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). We kept this discussion in mind when considering how to add content to the Project Books as the workshop series progressed and analysing how the Books were received and handled in class.

3.3.3 Workshop Three: Capturing Photos

At Workshop Three we used the Project Books to reflect with the pupils upon the activities and photos of the previous session. To explore sense making in photo sharing, we invited each pupil to review *four* photo-prints that were previously dubbed their favourites and then select *two* out of the four to fix in their Project Book. Open questions were used to explore different ways that a camera could be triggered to take a photo. Pupils then 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 use the camera to capture the action. Partners were instructed to take it in turns to adopt one of these roles (i.e. Actor or Photographer). After, the class regrouped to discuss the activity. Again, the Card prop was designed to encourage in-task collaboration, this time drawing particular attention to temporal aspects of photographic expression. The actions encouraged physical gesturing and impersonation in posing for photos (e.g. 'Jump' and 'Be a Lion'). This kind of posing in turn created a playful challenge for the photographer in the pairing to capture a moving subject. At the session close, pupils were invited to review and select personal favourites using the Review function on the cameras, 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 also 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 and demonstrating their achievements (see Figure 1b with a certificate in a Book).

3.3.4 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'. In sum, this involved reflecting on the previous session with the pupils and discussing the images that we'd added in to their Project Books as well as using the Books 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 collections of photos of previous pupils who no longer attended the school.

3.3.5 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 (Figure 1b).

4. REFLECTING ON THE WORKSHOPS

In the remainder of this paper we report on tacit understandings that we generated from the workshop series and how these helped us design for the SEND classroom context of our real world case. In the continuation of our idiographic account to follow, we address our ECD research aims to explore, firstly, the potential value of photography as a means for interpersonal communication and expression in this context and, more broadly, the importance of studying the social dimensions of photography use for SEND.

Our collaborative analysis of the workshops was phenomenological in orientation and involved round-table discussions about our tacit, empathetic experience of interacting with pupils and staff at the school. The sessions involved recalling observations and experiences, reviewing the video footage and photographs taken, and hand-sketching design concepts on paper. Discussions took place at the school immediately following each workshop, and later at the research lab.

Our analysis focussed on the observed social interactions with cameras and photos, between pupils, staff, and, ourselves – the researchers – during the workshops. We included in this analysis participant accounts of broader historical experiences of practicing photography in-class. At the round table discussions, each researcher offered their own unique perspective on the experience and recordings, reflecting the differing specialist expertise brought to the study. These were analysed collectively by the interdisciplinary team.

In the remainder of this section, we present a summary of our findings. In line with our phenomenological approach and within the scope of this paper format, we have selected excerpts of data that reflect the key themes generated in the analysis.

4.1 Representing the Developing Self

First we reflect upon the insights we 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. At school, pupils described having supervised access to digital cameras, using these to capture school projects and demonstrate achieving various learning milestones. With assistance from TAs and our SLT expert to communicate, they all said they used 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. This function of the Books may be illustrated with Jane's idea to incorporate the certificate.

We also observed how photography and photos were used 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 material week by week. Each week she printed photos for this display along with paper label annotations denoting the 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.

> David: "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."

At Workshop Four, pupils each expressed differing ideas for where they would like to display different photos. Some said that they didn't personally want certain photos displayed in the corridor for all those at the school and its visitors 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 are found to feel [24, 30].

4.2 Working Together

The workshops also produced insights on interpersonal dynamics between pupils mediated by photography, observed during the tasks whilst collaborating in pairs. 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!' Whilst holding the camera, Duncan laughed and said to Ingrid: "Wiggle your bottom!" As well as enjoying the activity itself, and entertaining other pupils, the photos this pair took were valued for reflecting the fun they had working together.

Other pairings were constructive because one pupil shepherded the other. For example, in Workshop One, Luke was seen to be positively engaging in showing his partner Cass how to use the Zoom function on the camera. He demonstrated patience as Cass tried to use the Zoom and seemed pleased to have been able to teach her something.

However, social competiveness 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". In a different workshop, 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.

Also, pupil behaviour differed between pairings for different workshops. As described above, Luke was patient with Cass but tried to assert himself in a different way when later 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, David could not take the task seriously and was disruptive rather than patient during proceedings. When discussing our experience with Jane she reflected that the differing behaviour was not about how pupils were engaging with each different task per se but rather within a particular pairing. In sum, the pairing of particular pupils was significant for how they worked together to do photography; pairings could be hugely constructive for interpersonal communication and expression within the learning context [4], but they needed to be carefully orchestrated by those facilitating.

4.3 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 currently draw 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 draw upon these resources and respond to the learning environment, the teachers and each other.

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, she added, is supported by staff in following their *own* learning trajectory, and each raises a distinct set of pastoral concerns.

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. Photography was found to mediate this in interesting ways. One poignant example was found in her reference to the Memory Books in Workshop Four. Jane described how various pupils had joined and left her class at different times (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 the 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." Drawing on the material qualities of these books, Jane highlighted how they "are always just there" for easy access.

Staff management of complexity and contingency was also found in the practical handling of expressive classroom resources including cameras and photos. As set out in the Background section, the SEND context produces heightened ethical sensitivities and protocols concerning child protection that present challenges for preventing visual identification through photo displays [23]. Addressing this in our case, Jane was found to supervise the handling of all photos by the pupils as well as by us (the design research team). 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 her left the school grounds. This task, directed by Jane, consumed a relatively great amount of time and attention, and was a key feature of our shared experience of the workshops.

4.4 Representing Others

This section focuses on insights gained from researcher-staff-pupil interaction around photos and specifically on tensions surrounding photographic representations of pupils by others that impacted interpersonal expression. Tensions were illuminated by the creation and handling of photos for 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. When we asked him why he replied that they 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.

4.5 Summary and Design Considerations

Overall, our findings capture the *social complexity* of our research context whilst highlighting *social tensions* within it, with design implications for supporting interpersonal communication and 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 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 mindset - we reflected: How might Jane and her TAs manage the special needs of their pupils, which include pastoral concerns for their protection, whilst at the same time supporting them through photography to develop the means to express themselves?

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

(1) Support a 'group of individuals'; accommodating the wide-ranging, complex needs of each pupil and the active management of contingencies in-class.

(2) Support photo annotation and storytelling around photos 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 active involvement in staff photowork.

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

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

5. DESIGN OF PHOTO-SORTING TOOL

Our ECD approach enabled us to give our stakeholders voice in the design research process whilst allowing us to respond creatively to the above considerations; in doing this, a new design concept emerged. Our above findings inspired the design of a photo-sorting tool for the mixed SEND classroom. This tool allows pupils to express their opinions 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 the corridor wall display or a personal album – akin to a Project Book). The tool was designed to broadly support *the democratisation of display making* at the school and, therefore, open up these displays as sites for pupils to express themselves to their peers, teachers and school visitors. We developed the tool 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.

5.1 Photo-sorting Console

Figure 4. Photo-sorting Console with RFID card & reader

The first of these elements, the Photo-sorting Console (Figure 4), controls a software application running on the pupils' classroom PC. This application shows pupils a number of photos on the peripheral PC monitor screen, which are loaded from an SD card inserted by their teacher. The physical controller, designed for visible, *collaborative use* in small groups or pairs, consists of a number of physically accessible arcade-style buttons, that pupils can press to browse photos – by pressing the left (yellow) and right (light blue) buttons, and rotate photos – by pressing the rotate (white) button. Pupils can also express their opinion about a photo, by pressing: the orange button to ask for the photo to be

shared on a wall display in the school; the grey button for the photo to be deleted; and the purple button for the photo to be 'kept safe' for personal consumption, but not shared with the class. Upon pressing one of these three buttons, the pupil's opinion is recorded and the photo given a corresponding coloured border. Pupils can easily change their opinion about any photo by pressing a different button.

The Photo-sorting Console was prototyped using Microsoft .NET Gadgeteer physical computing components [31], and housed in a chassis made from plywood and Perspex. Use of Gadgeteer enabled us the flexibility to rapidly render, test, and experiment with various different configurations of interface and functionality in the lab and at the school, before arriving at the final design.

To start using the Photo-sorting Console, pupils place an RFID (radio frequency identification) card on an RFID reader. This card quickly identifies them (important for group work) so that their opinions about photos might be recorded. To support storytelling, pressing the red button records audio through an omnidirectional microphone and associates it with a photo. Sound is played back when the green button is pushed. When a pupil removes their card from the reader, they are logged out from the Console. All of a pupil's opinions and sounds are saved, so that they are presented with the same interface when they next log in. When *no* pupils are using the Console, the PC displays a slideshow of pupils' nominated shared photos.

5.2 Teacher's Application

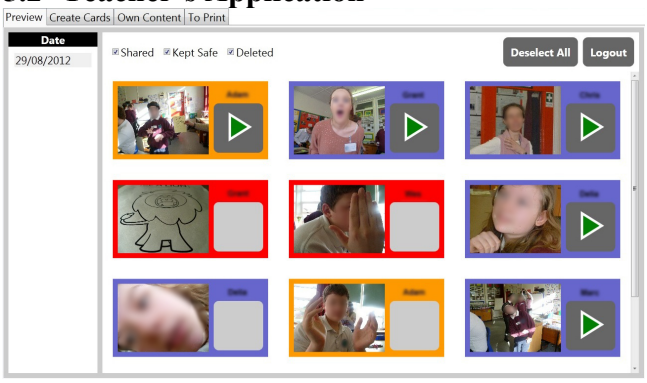

Figure 5. Teacher's Application user interface

The Teacher's Application is the second key element of the photo-sorting tool. It is designed to afford the teacher editorial control over what is finally included in displays whilst addressing a need to afford pupils greater 'voice' in how their photos are handled. We were mindful that it should support the existing classroom wall displays' significant role in communication, and accommodate existing staff practices of creative display making.

Using the classroom PC the Teacher's Application (Figure 5) allows a nominated staff member to view pupils' opinions of photos, preview sounds they have recorded, and print selected photos for displaying on a wall. The teacher is able to login to the application by placing a card ascribed to them 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.

After browsing opinions, the teacher can select a number of photos to print. If printing photos associated with sounds, a Wizard is generated that lets these sounds 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 tool 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 'Magic Wand' (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 Initial Evaluation Sessions

Continuing our ECD process, we conducted an initial evaluation of the photo-sorting tool with our participants. This took place over two sessions at the school. Our aim through this evaluation was to gain critical feedback about how the key functional elements of our tool may serve a real-world classroom, and how it may empirically ground the design considerations generated from the workshops. Our ECD approach enabled us to re-orient to the staff and pupils in this evaluation as 'Testers' of our prototype [8] whilst retaining an empathetic dialogue with them.

In the first session, the Console was installed on the classroom PC. Its evaluation followed a format similar to that of our workshops. During an hour-long class, the pupils were introduced to the tool, 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 tool with photos captured during the workshops. Within this scenario, a number of photos were viewed, opinions expressed and, finally, sounds recorded. We asked different class members, and then the class as a whole, to decide whether particular photos should be 'Shared', 'Kept Safe' or 'Deleted' and to record sounds to go with these photos. Following this, further pairs of pupils were 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 number of photos that had been prepared prior to the session, the pupils were shown how the novel Magic Wands could be placed over photo-prints to play sounds and given the opportunity to creatively play with them.

Towards the end of this session, the pupils and staff reassembled around the Console and we invited a critique of the tool. 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 tool during the session. Some did so independently, whilst others were able to interact with the assistance of their peers. Some pupils suggested design ideas for enhancing the tool.

Philip and Peter collectively suggested that the Console should be made *wireless* so that it could be passed around the classroom during a group activity. David, Gabi, Luke and Phoebe suggested ways in which the Magic Wands could take novel forms, and be made customisable by the pupils. David for example, suggested that the 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 tool's design but emphasised how important it was that it allowed her to remain 'arbiter of photos'. Leading from this, she highlighted how important it was that the tool did "not allow pupils to *actually* delete photos", reiterating her need to keep and print photos that the pupils don't necessarily deem significant or representative, for her own purposes. Finally, she emphasised that she, alongside her other colleagues, would like to use the tool for other functions or other kinds of media within the classroom and wider school activities.

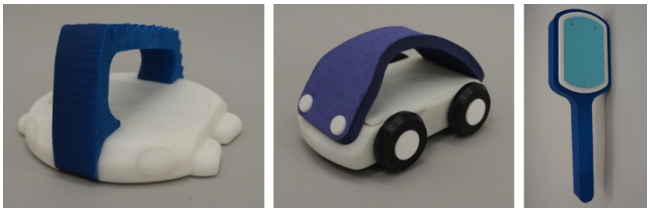

Figure 6a, 6b and 6c. Magic Wands

In response to the feedback from this session, we refined our design and presented a new iteration of it at a second evaluation session. A significant addition was the development of three novelty Magic Wands (Figure 6), each of these aiming to inspire a different way of interacting with the Wall Display and to be usable by subsets of pupils with differing physical needs. Both pupils and staff were compelled by this addition because their ideas from the previous session had been explicitly incorporated (e.g. David's 'car' in Figure 6b). Another key addition was to the Teacher's Application interface, to afford Jane and potentially her colleagues a comprehensive view of all the pupils' decisions on photos made through the Console. At this evaluation, Jane and the headmaster said they would like to experiment with appropriating the tool for communication around school timetables.

Following the second evaluation, we further refined the design to resolve the usability issues that our observations and testers' comments revealed. A further iteration has since been deployed in the school for a eight-month period, for further study. This deployment forms part of our on-going engagement with our case, again within an ECD process, to be reported in future work.

6. CONCLUSION

Through presenting our case study of ECD research in a SEND school context, we have sought to explore a relatively new and challenging area of concern for the IDC community, that of a mixed special needs setting. Over the course of five 'Creative Photography' workshops in a SEND classroom, our design research team gained tacit understanding of how photographic tools may be developed to support and enhance interpersonal communication and expression between pupils and staff.

In this paper, we've provided a descriptive account of our creative, design-led inquiry, inspired by and grounded in our empirical experiences of running the workshop series. We've 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. A key positive outcome of using this methodology for our team members was that it enabled them, in the course of creatively 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 considerations with the researchers, and as 'testers' of prototypes in the evaluation that followed [8].

We've also demonstrated the potential transferability of our workshop findings by describing our development of a novel 'photo-sorting tool' for deployment in the same research setting. In concluding this paper, we suggest that the design considerations emerging from this case may have wider applicability in related learning or mixed special needs settings where photography may be used in conjunction with ICT to support communication, expression and, in turn, self-advocacy.

6.1 Develop ICT with Appropriation in Mind

For example, the consideration of 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. Consider, for example, the support that was required (above) to the constructive pairing of pupils in-class, and the dynamic collaboration at play. Building on insights from our case study, ICT for this and related settings should be extendable and networkable for additional and more complex functionality as required by these different use scenarios. It should support teachers, through its design, to actively manage their class.

6.2 Promote Engagement in Representation

We found in our case study that the ICT support in the classroom provided through the photo-sorting tool had a positive impact on self-expression because it enabled pupils to both foreground personal achievements – and display these to others, and also say when they felt that a photo did *not* portray them as they wished. Moreover, the Console enabled pupils to voice their opinion on *how* they wished for media to be displayed. This *triaging* feature of our design was arguably the most effective for promoting self-efficacy through photography; this technique may be considered by designers working in related contexts to extend understanding on children's voice in relation to HCI [6, 7, 12, 25, 26].

6.3 Support Children's and Teachers' Voices

Our study findings illuminated practicalities taking place in the classroom that informed our design work; we understood that ICT tools for this setting must be designed to *balance* the promotion of children's voice with the organisational management needs of the school and the teachers' voice. We in turn highlight the broader design challenge for SEND to support the 'balancing' of children's and teachers' voices through the affordances of ICT.

6.4 Next Steps

We are currently applying these insights to follow-on studies. The Console is still deployed with the school of our case, and we are now conducting another design evaluation with the pupils and staff. This next evaluation focuses on understanding how the Console has been appropriated for other communicative purposes beyond photo sorting, in the classroom and, more widely, the school. In related work building on the study insights, members of our research team are now exploring a design space for creating toolkits that enable children with additional mixed needs to make their *own* expressive ICT devices.

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