Multisensory storytelling: A co-design study with children with mixed visual abilities

Clare Cullen
University of Bristol
Bristol, UK
c.cullen@bristol.ac.uk

Oussama Metatla
University of Bristol, UK
Bristol, UK
o.metatla@bristol.ac.uk

Abstract
This paper presents the preliminary findings of a co-design study with children with mixed visual abilities to create a multisensory joint storytelling platform. Storytelling is a valuable way for children to express their imagination and creativity, and can be used as tool for inclusive learning. Children with visual impairments are typically educated in mainstream schools, and often encounter barriers to learning, particularly in group settings. To address some of these issues, we have been working with a group of children with visual impairments, their Teaching Assistants (TAs), and sighted friends, to design and develop multisensory storytelling technologies. This paper presents the findings of the first five design sessions. We also present the outcomes and challenges of working with mixed stakeholder, mixed visual-ability groups in participatory design.

Author Keywords
Inclusion; Education; Co-Design; Children; Collaborative Storytelling; Visually impaired.

ACM Classification Keywords
H.5.2 User Interfaces: Prototyping, User-centered design; K.3.1 Computer Uses in Education: Collaborative learning;

Figure 1: Images from the field visit to The Story Museum, Oxford.

K.4.2 Computers and Society: Social issues - Assistive technologies for persons with disabilities

Introduction

The majority of children with visual impairments in the UK are educated in mainstream schools [18], which is in line with trends in other countries worldwide [16]. Issues surrounding accessibility and inclusion can often make group work challenging for children with VIs and difficult for their educators to support and facilitate [17]. In the UK, Teaching Assistants (TAs) are increasingly responsible for the academic progress of these students and are often tasked with creating learning materials with little planning or preparation time. In this research, we look at the potential for multisensory, digital technology to overcome some of these challenges and improve opportunities for peer learning and peer interaction for children with VIs, whilst also supporting their TAs.

We conducted a field study to research storytelling in UK primary schools and museums through interviews and observations. Alongside this, we ran a series of five preliminary workshops to establish the main requirements and ideas for a collaborative, multisensory storytelling platform for primary school children. Using participatory design techniques, we included both adults (TAs, Special Educational Needs Coordinators) and children in the design activities, to determine the key ideas to be implemented in the device. Here, we outline the initial findings from the workshops, including ideas for a hybrid digital and physical grid-based story system.

Related Work

Interactive Storytelling

Storytelling is a valuable learning activity which can promote imagination and creativity, build confidence, and improve memory and sequencing skills [8]. Storytelling has the potential to be a social and collaborative activity in the classroom, which can engage children of different abilities and increase motivation to learn [9]. There has been a growing interest in interactive storytelling in the field of HCI over the last ten years [9, 11]. In the recent literature, tangible storytelling systems illustrate how children can collaborate to create and share stories using physical objects embedded with digital capabilities [13, 20]. Examples of other types of systems include online story editors and virtual environments [5], mobile devices [6] and robots [19]. However, this is still an emerging field and more work needs to be done to establish how digital storytelling tools can be used effectively in collaborative learning activities. Additionally, there is very little research on making storytelling accessible and inclusive of both children with and without visual impairments.

Co-Design with Children with Mixed Visual Abilities

Existing research shows that taking a participatory approach to designing learning technologies for children and young people with visual impairments and SEN leads to better design and more successful adoption [4], with more positive outcomes for the participants involved [8, 20]. There is also a growing interest in designing with adults and children with mixed abilities [2, 16]. We build on this research and previous work using innovative technology for supporting and empowering visually impaired learners [3, 10] in our

Figure 2: The modified "box of multisensory stuff" (above) included crafting materials that provided different affordances in different modalities in-line with children's interest, e.g. pronounced visual appearance, unusual tactile experience, audio recorders, flavours and scents. A compartmentalized organization of materials made it easier for both children with and without visual impairments to access the materials independently during the workshops (below).

preliminary research on designing a joint storytelling tool for mixed visual abilities.

Methodology

Co-Design Workshops

Five participatory design sessions have taken place so far in cooperation with a local primary school. The school is a mixed, mainstream primary (4-11 years) with specially resourced provision for students with special educational needs relating to physical disabilities and visual impairments. Students with a statement of special educational needs are supported by dedicated Teaching Assistants. In the initial co-design session, three children with VIs, four sighted children (all aged 7-9 years), three Teaching Assistants (TAs) and one Special Educational Needs Coordinator (SENCo) took part. In the subsequent four sessions, two of the children with VIs, three of their sighted friends, two TAs and 1 SENCo participated.

The aim of the workshops have been to establish requirements for a joint storytelling platform and begin designing and prototyping possible design options. The workshops have so far involved a combination of low and high-tech prototyping and we have explored a range of established and modified participatory design techniques to facilitate participation from both children with mixed visual abilities and mixed stakeholders (children, TAs and researchers). Techniques have included the future workshop technique, fictional inquiry [14] and *bag of stuff* [7], presented here in a more accessible format as a "box of multisensory stuff" [16] (Figure 2).

Field Study

In parallel to the design sessions we conducted a limited field study, with the aim of finding out more about the impacts and outcomes of storytelling for individuals and groups, and gaining insight into how collaboration can be encouraged in a storytelling context. To date, one local primary school and a museum in Oxford have been involved in the field study, and three interviews and two observations have been carried out. The interviews have involved two class teachers of the children with VI participating in our co-design study, and one storytelling practitioner from The Story Museum in Oxford. The observations include a literacy lesson in a mixed classroom with one of the children with VI, and an observation of a whole-class storytelling workshop for sighted children at The Story Museum (Figure 1). The findings of the field study were used to inform the structure and content of the co-design workshops.

Preliminary Findings

The five workshops have covered: i) augmenting traditional storybooks; ii) future schools and storytelling tools; iii) story mapping with an initial prototype; iv) characters; v) story sequencing with a second prototype. The first and second workshops established the design space and conceptual overview with our participants. During the first workshop, the participants explored how traditional storybooks could be made more engaging and inclusive by using different sensory modalities (hearing, touch and smell). Each group was given a storybook and asked to explore how it could be augmented with the multisensory craft materials. In the second workshop, participants were tasked with thinking about future technologies for

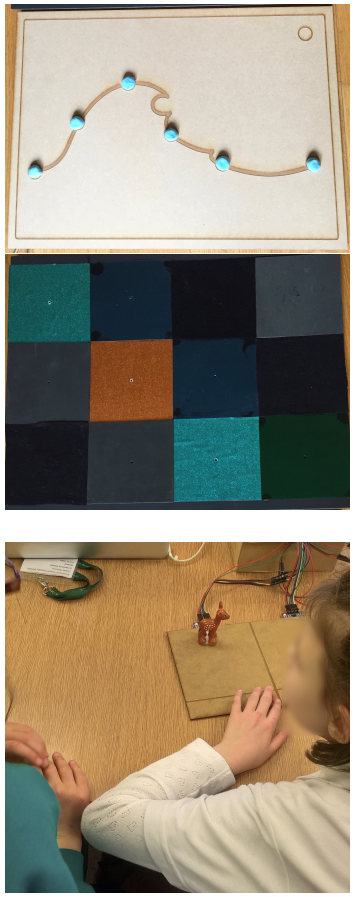

Figure 3: Top: The story-wave prototype for recording and playing narrative segments; Middle: Tactile grid using different textures; Bottom: The grid prototype with characters

collaborative storytelling. Following a discussion, participants took part in a crafting session in which they designed these future tools using the multisensory craft materials from the previous workshop.

In the most recent three workshops we have started to develop ideas and introduce prototypes, which focus on the auditory input and output of the system. In the third workshop, the participants were asked to think about story structure and we introduced two prototypes, a high-fidelity storyboard for recording and playing back a short narrative, and a lo-fi grid tactile grid, to explore mapping out narrative in different ways. In the fourth workshop, participants were asked to think about the role of characters in stories and start to explore tactile representations of character. In the fifth workshop, we introduced a second prototype of a story grid, using buttons to record audio, and RFID to enable participants to move a tactile character along the grid to playback auditory segments of the story (Figure 3).

Through the workshop sessions, the children and educators outlined a design for a three-dimensional joint storytelling system, which uses a grid for navigation, has pop up characters and props than can be coded to speak and move, and programmable grid squares which can emit smells and sounds. Overall, the system should be able to capture and play back narrative and also print out a copy of the story in both print and braille.

During the sessions we explored character in more detail, thinking about types of characters, (e.g. "superheroes", "robots" and "animals"), the capabilities of characters (e.g. talk, move), relationships of characters to each other (e.g. "enemies" and "friends"), and different forms and physical representations of characters in a tangible system. We also discussed levels of detail, from abstract representations (shapes) to direct representations with high-levels of detail (playmobil figures) and thought about which might be better for supporting imagination and creativity. We found that the child with VI demonstrated imaginative thinking with all of the props, with the duplo shapes morphing into "a megatron monster" and promoting the most creative ideas, whereas for the sighted child, the dinosaur figures were best at facilitating generation of story ideas. Throughout the workshops, we focused on non-visual materials for both the design of the activities and the selection of materials. We used sound as much as possible, for example with soundscapes and audiobooks, to engage non-visual senses and promote imaginative thinking and creativity. Using the multisensory box of stuff, the children also started to think about incorporating tactile and olfactory experiences into the design of the system.

Discussion

We used several PD techniques, for example, the bag of stuff technique, fictional inquiry and future workshops [7, 14], with some modifications to accommodate the needs of our participants [1]. We also designed activities to be engaging and encourage imaginative play, using scaffolding and embedding learning objectives so that children could learn about the subject matter being explored.

This research builds on previous work exploring the need to adapt and extend techniques depending on the participants' levels of design expertise for children with and without SEND [1, 7, 8, 16, 20], for example the adaptation of the bag of stuff to the box of

multisensory stuff as a more appropriate technique for our visually-impaired participants. We also leveraged participants' individual abilities and interests [1], including a focus on audio recording, which one child with VI particularly enjoyed, and incorporating the colour red into activities to appeal to another child with low light perception.

We have encountered some of the issues which have been raised in the prior literature, for example structuring activities so that they address the main design questions for the session, whilst still providing enough scope for creative exploration [15], as well as problems with turn-taking and one child dominating discussion [1]. Additionally, we found that in some instances, the sighted children saw the sessions as more about their friend with VI, and thought of themselves as secondary in the process. With this in mind there is a need to make the sessions and design activities more inclusive and appealing to both sighted participants and those with VI.

We have reported on the first five workshops for co-designing a multisensory collaborative storytelling platform with educators and children with mixed visual abilities. Future workshops will explore other important aspects of the multisensory storytelling tool: integrating audio i/o and effects for narration and dialogue, the use of sound effects and soundscapes, olfactory arrays, tactile aspects (texture, form, vibrotactile cues), and visual aspects (lights, colour). Additionally, a main focus for future work will be investigating different ways to better involve educators (particularly TAs) in the design activities, in order to facilitate more genuine participation with mixed-stakeholder and mixed visual ability groups in the design and development of the storytelling platform.

Acknowledgements

We would like to thank all participating schools and support services, educators, children and parents, and acknowledge the support of EPSRC Fellowship Grant EP/N00616X/2 Crossmodal Interactive Tools for Inclusive Learning project.

References

1. Laura Benton and Hilary Johnson. 2014. Structured approaches to participatory design for children: can targeting the needs of children with autism provide benefits for a broader child population? Instructional Science 42, 1 (2014), 47-65.
2. Stacy M Branham and Shaun K Kane. 2015. Collaborative accessibility: How blind and sighted companions co-create accessible home spaces. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 2373–2382.
3. Emeline Brulé and Christophe Jouffrais. 2016. Representing Children Living with Visual Impairments in the Design Process: A Case Study with Personae. In Proceedings of the 8th Cambridge Workshop on Universal Access and Assistive Technology. CWUAAT, 23–32.
4. Erin Buehler, Shaun K. Kane, and Amy Hurst. 2014.ABC and 3D: Opportunities and Obstacles to 3D Printing in Special Education Environments. In Proceedings of the 16th International ACM SIGACCESS Conference on Computers & Accessibility. ACM, 107–114.
5. Nicoletta Di Blas, and Paolo Paolini. 2014. Multi-User Virtual Environments Fostering Collaboration in Formal

Education. In *Journal of Educational Technology & Society* 17, 1 (2014): 54-69.

6. Jerry Alan Fails, Allison Druin, and Mona Leigh Guha. 2010. Mobile collaboration: collaboratively reading and creating children's stories on mobile devices. In *Proceedings of the 9th International Conference on Interaction Design and Children* (IDC '10). ACM, 20-29.
7. Jerry Alan Fails, Mona Leigh Guha, Allison Druin, and others. 2013. Methods and techniques for involving children in the design of new technology for children. Foundations and Trends in Human–Computer Interaction 6, 2 (2013), 85–166.
8. Christopher Frauenberger, Julia Makhaeva, and Katharina Spiel. 2017. Blending Methods: Developing Participatory Design Sessions for Autistic Children. In Proceedings of the 2017 Conference on Interaction Design and Children. ACM, 39–49.
9. Franca Garzotto. 2014. Interactive storytelling for children: A survey. International Journal of Arts and Technology 7, 1 (2014), 5-13.
10. Stéphanie Giraud, Philippe Truillet, Véronique Gaildrat, and Christophe Jouffrais. 2017. "DIY" Prototyping of Teaching Materials for Visually Impaired Children: Usage and Satisfaction of Professionals. In *International Conference on Universal Access in Human-Computer Interaction*. Springer, 515–524
11. Timo Gottel. 2011. Reviewing children's collaboration practices in storytelling environments. Proceedings of 10th International Conference on Interaction Design and Children. ACM, 153-156.
12. Mona Leigh Guha, Allison Druin, and Jerry Alan Fails. 2008. Designing with and for Children with Special Needs: An Inclusionary Model. In Proceedings of the 7th International Conference on Interaction Design and Children. ACM, 61–64.
13. Daniel Harley, Jean Ho Chu, Jamie Kwan and Ali Mazalek. 2016. Towards a Framework for Tangible Narratives. In Proceedings of TEI 2016. ACM, 62-69
14. Ole Sejer Iversen and Christian Dindler. 2008. Pursuing Aesthetic Inquiry in Participatory Design. In Participatory Design Conference . The Trustees of Indiana University, 138–145.
15. Andrew Large, Valerie Nesset, Jamshid Beheshti and Leanne Bowler. 2006. "Bonded design": A novel approach to intergenerational information technology design. Library & Information Science Research. 28 (2006) 64-82.
16. Oussama Metatla and Clare Cullen. 2018. "Bursting the Assistance Bubble": Designing Inclusive Technology with Children with Mixed Visual Abilities. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2018)
17. Metatla O. Uncovering Challenges and Opportunities of Including Children with Visual Impairments in Mainstream Schools. Proc BSC-HCI'17. 2017.
18. RNIB. 2013. Key statistics on the prevalence and population of children and young people with vision impairment. (2013).
19. Kimiko Ryokai, Michael Jongseon Lee, and Jonathan Micah Breitbart. 2009. Children's storytelling and programming with robotic characters. In *Proceedings of the seventh ACM conference on Creativity and cognition* (C&C '09). ACM, New York, NY, USA, 19-28.
20. Jamie Sanchez. 2007. Science learning by blind children through audio-based interactive software. Annual Review of CyberTherapy and Telemedicine. 5 (2007) 184-190.
21. Sharma and SJ Salend. 2016. Teaching Assistants in Inclusive Classrooms: A Systematic Analysis of the International Research. Australian Journal of Teacher Education 41, 8 (2016), 118–134.