Developing the Story: Designing an Interactive Storytelling Application

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ABSTRACT
This paper describes the design of a tabletop storytelling application for children, called TellTable. The goal of the system was to stimulate creativity and collaboration by allowing children to develop their own story characters and scenery through photography and drawing, and record stories through direct manipulation and narration. Here we present the initial interface design and its iteration following the results of a preliminary trial. We also describe key findings from TellTable's deployment in a primary school that relate to its design, before concluding with a discussion of design implications from the process.

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Interface design, storytelling, interactive tabletop, tangibles, children, photography, drawing.

ACM Classification Keywords
H5.2. User Interfaces

INTRODUCTION
Stories play a central role in the world of children [6]. The telling of them is one means by which they can make sense of their world, learn how to communicate and play collaboratively. Furthermore, telling stories is fun. It encompasses creativity, allows for the imagination of exotic places and strange characters, and permits the placing of oneself, one's peers, or one's heroes into different worlds.

Given the importance and ubiquity of storytelling, it is no surprise that there have been many attempts in HCI to support it for children. Some of these, such as StoryMat [4], are designed to support children engaging in storytelling alone, and through "mediated collaboration" with children learning from their peers through replaying their stories. Other systems support multiple co-present children to create stories together in various ways: Pogo [5], for example, allows objects (including the children themselves) to be captured using photography or video, augmented through drawing, and then manipulated in the story using a physical proxy. While the various elements of the interface may inspire different children to take on specific roles, this is not inherent within the design. In contrast, KidPad [1] is a drawing application that makes available additional features, e.g. new colours, only when children perform a joint action, therefore "encouraging" collaboration. Despite this, children did not always collaborate when using KidPad, which was implemented using a PC with multiple mice. More easily shareable technologies, such as interactive tabletops, may offer a way forward. StoryTable [3], which utilised DiamondTouch technology, attempts to "enforce" collaboration again through cooperative multi-user operations, although when tested, researchers reported that they needed to adopt a rather active role in guiding the storytelling process.

Figure 1. TellTable being used by children.

We introduce an application called TellTable (Figure 1), which was similarly motivated by a wish to foster child-driven creativity and collaboration. The approach we took in trying to meet this goal was one of supporting flexibility; we wished to develop a system that would support collaboration, could be used without guidance, and that would allow children to use all kinds of objects from the everyday world. Like Pogo [5], children using TellTable can capture physical objects using photography and augment these with digital ink. Like StoryTable [3], we use a multi-touch tabletop that allows children to directly interact with TellTable using their fingers. However, unlike StoryTable or KidPad, we did not explicitly emphasize special features as a means of enforcing collaboration. Instead, we wanted to explore how children might negotiate collaboration amongst themselves by creating an application that was extremely simple to use. In this paper, we focus on the design process that was undertaken in developing the user interface of TellTa-

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ble, including aspects of the software and of the physical devices used with the interactive surface. We report how the user interface was iterated following an initial user trial, and discuss implications that were drawn out of the design process and a field deployment.

INITIAL DESIGN

In order to stimulate imagination and to enable children to combine the physical and digital worlds in creating their story characters, TellTable incorporates photography and a Microsoft Surface interactive tabletop. This allows children to directly capture content using a camera and then cut out the object of interest using their fingers, or to create content from scratch using drawing tools. They can also use both of these functionalities in combination. Thus, photos of objects can be combined to make a single new object, and then augmented with scribbles in order to customise them for the story in question. Following the creation of characters and scenery, children can trigger the recording function while they tell the story, during which the children's voices, the characters' movements as controlled using multi-touch interaction, and the introduction of new characters or changes to the background scenes are all recorded. These stories can be replayed later by the same or other children.

Initial Design of the Interactive Software

The initial design of the software interface (Figure 2) provided a single workspace for interacting with captured content, creating new content, and recording and replaying stories. Its design was very basic, comprising a grey background and rectangular buttons labelled with text. Buttons along the bottom side of the screen triggered system-level functionalities including taking photos, starting sketches from scratch, accessing previously created story elements, recording new stories, accessing recorded stories, and accessing the recycle bin that contained discarded content.

Figure 2. Initial software interface. Top left: a cut-out mug; middle: a photo of a toy robot being edited.

When a new image was captured with the camera, the photo would simply appear on this work surface. By double-tapping on the photo, the user could reveal editing options (draw, erase, cut and paste), depicted as buttons along the sides of the photo. Pressing one of the buttons entered the relevant editing mode. A "Done" button completed the edit and hid the options. Story elements could be freely moved, rotated, and resized using multi-touch operations for both editing and storytelling purposes. After the user created all story elements, they could immediately press the "Record" button to start recording the story using the elements already present in the workspace.

Design of Physical Devices

To enable children to flexibly photograph objects, we designed a capture tool as a tangible extension to feed into the tabletop system. In order to provide a tool that would be easy and cheap to set up and that would permit exploration of different design possibilities, we created a modular solution, comprising a generic camera module (Figure 3a) that could be snapped on to several interchangeable "bases". The three bases that were created were chosen to emphasise playfulness and simplicity, being a "magnifying glass", a "telescope" and a "magical frame" (Figure 3c, d, e). We deliberately chose to use large rectangular frames as "live" viewfinders instead of digital viewfinders to keep the system setup as simple and low-tech as possible.

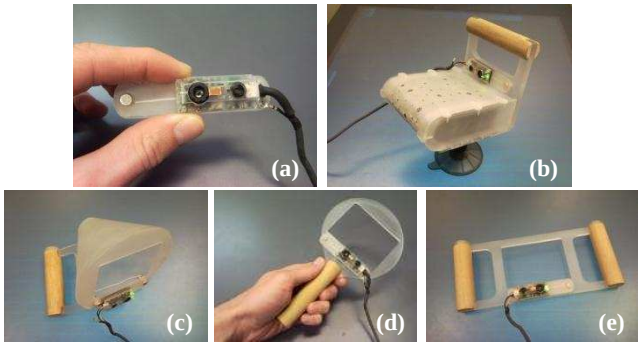

Figure 3. (a) Camera module (b) Situated base. (c) Magnifying glass (d) Telescope (e) Magical frame.

Apart from the telescope, which was specifically designed for individual use, we envisioned the large rectangular viewfinders in the other two bases as a means of encouraging children to use and frame objects cooperatively, and to swap between bases in order to support different capturing situations, e.g. a nonspecific capture of the surroundings using the magical frame, vs. a more precise capture of an image from a book using the magnifying glass. The camera module was equipped with two magnets that allowed it to be connected to the different bases, and which also acted as the electrical connection to the button(s) located on each base, triggering photo capture. This setup generally allowed the capture device and its interaction possibilities to be adjusted without changing the computational elements.

In addition to the camera module and the three handheld viewfinders, an additional base was designed to attach to the surface itself so that pictures could be taken "hands-free". This base allowed the camera module to be mounted onto the table using a suction cup (Figure 3b), as well as encapsulating a speaker and microphone used for recording and playing back stories. All of the bases were designed with similar aesthetic qualities in order to provide a common interaction language.

Initial trial

An informal trial was run in which two separate pairs of boys (aged 7 and 8, and 8 and 12) used the system for about two hours in our research lab. Our intention here was to

highlight obviously problematic design elements, and to gain some early feedback.

Even with only two pairs of users, it became immediately clear that the large amount of functionality available within a single workspace led to uncertainty about different system features; the fact that the creation of story elements and the recording of the story were represented in the same space seemed particularly confusing. These problems were further confounded by ambiguous button labels and the fact that buttons for very different features looked visually similar. An additional difficulty was the location of buttons along the bottom edge of the tabletop, which led to children accidently triggering these features when manipulating content (e.g. with their sleeves).

Regarding the camera devices, it also became evident that children had difficulties in framing their pictures. The location of the camera on the portable viewfinders (off-centre at the bottom of the frame) had been chosen because it was felt that children might sacrifice precision for playfulness in interaction. For example, the large viewfinder in the magical frame might allow children to look through the viewfinder together. However, the mismatch between the physical viewfinder and the camera image caused difficulties, especially for the "magical frame", where the perceived framing depended on the position and distance of the person viewing. In addition, apart from changing between one of the handheld viewfinders and the situated base (which was well suited for taking self portraits), there seemed little enthusiasm for swapping the camera to support different capturing situations.

REDESIGN

In redesigning TellTable we aimed to solve the issues raised in the initial trial by (i) creating a distinction between making elements for the story, and telling the story, (ii) creating new graphical representations for the interface elements and repositioning them, and (iii) resolving framing issues for the cameras.

Figure 5. Redesigned software interface ("Make" mode).

Introduction of Modes

In order to clarify the different system features, the single workspace model was replaced by two distinct system modes: "Make" mode and "Tell" mode. These were differentiated by their backgrounds (icons representing editing tools such as pencils and scissors populate the background in Make mode). Additionally, the interface elements of each mode were intentionally positioned on opposite sides (left versus right) of the tabletop, which had the extra advantage of diminishing the likelihood that features would be accidentally triggered when switching between modes. Figure 5 illustrates the redesigned software interface.

Re-design of Interface Elements

The graphical interface buttons were redesigned as large irregularly shaped "blobs", each containing a graphical icon plus supporting text (Figure 6).

Figure 6. Redesigned graphical interface buttons.

The different shapes of the blobs and the addition of various feedback sounds emphasised their different functions and instilled a sense of playfulness. On reflection, it was decided that the default interface layout and text should be oriented such that it naturally favoured children positioned along one side of the table. This was so that children on this "preferred" side would have more control over the current interaction status (e.g. switch mode, start recording etc.) to reduce conflict and confusion. At the same time, other children could freely join in from any side in order to create story elements, moving and rotating these elements to suit the children's position, as suggested by [7].

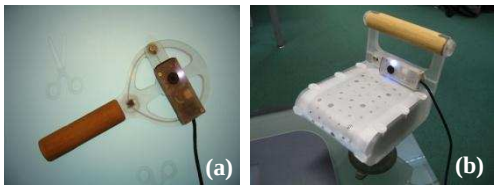

Figure 7. The final handheld and situated capture tools.

Capture tools

As our initial trial steered us away from having multiple handheld viewfinders, we decided to focus on the design of one handheld base. Given the fact that the use of the magnifying glass resulted in less viewfinder misalignment and at the same time supported multiple children viewing, we iterated further on its design and a new handheld base was created onto which the camera module, once attached, would form a crosshair. Now that the camera was more central, aligning the crosshair with an object would allow that object to be better framed (Figure 7a). In addition, two buttons were added on both sides of the handle of the situated base for triggering capture (Figure 7b). In addition, a digital viewfinder on the tabletop screen gave additional feedback (Figure 5 left side). This was then used along with the hands-free device containing the microphone.

FIELD DEPLOYMENT

Following the redesign, TellTable was deployed in the library of a primary school in the UK for two weeks [see

also 2], during which time 66 children used the system: 34 girls and 32 boys, ranging in age from 6 to 12 years old. It was notable that the redesigned elements had the desired effect of improving simplicity of interaction, with children giving broadly positive feedback about the system. We also noted very few of the usability issues we observed in the first trial of the system.

During the deployment it also became clear that children started to adopt interesting approaches to collaborating with one another. In particular, the affordances offered by the multi-touch surface, for tasks such as cutting out photos and drawing on them, were obviously different to those offered during tasks incorporating the capture devices. When undertaking activities that just involved the surface, children had to socially manage their collaboration. This was particularly necessary during the cutting out of photos, as this required one finger and could easily go wrong if two fingers touched the surface. Children often managed this verbally, directing one another not to touch the screen when this activity was unfolding. On the other hand, activities such as drawing could involve numerous children at once, and whole groups were observed working together to colour in large pictures such as background scenes. In addition, the orientation of the default interface layout favouring those who occupied one side of the table encouraged them occupying that space to take control, helping in the management and decision-making needed to plan the story.

As outlined in the introduction, we did not wish to enforce collaboration through the design of TellTable. Thus, no extra features were included that would reward children who were working together. However, the affordances offered by the camera were observed to successfully encourage the children to collaborate. Because the version of the capture device used in the field trial supported usage by one child at a time, it offered the opportunity for only one child within a group to take the role of 'photographer' at any one time. Interestingly though, the separation of the capture device from the depiction of the digital viewfinder meant that often children at the table would adopt the role of pressing the capture button on the surface, directing the child with the capture device to line up the image. This was despite the fact that there was also a trigger on the capture device. In fact, the taking of photos became one of the most obviously collaborative activities; often one child would hold the live viewfinder, one would watch the tabletop viewfinder, and another would hold a toy or actually serve as the subject of the photo itself.

DISCUSSION AND CONCLUSION

The iterative design process, in which we had children participating in a very early stage of the system's development, helped us to quickly steer the development of Telltable. Here, we found that valuable feedback was gained on the basis of only two pairs of children, feedback that demonstrably made significant improvements to the application. For example, while the initial design was in some sense quite unstructured, we found that adding modes (more structure) actually made for a simpler system, which also mirrored the stages that children normally go through when telling stories (first making, then telling).

This issue about how much one enforces structure also arose in other aspects of the design. As found by Rick et al. [8] as well as observed in the initial trial and field deployment of TellTable, children are less likely than adults to respect the rules of turn-taking. This poses a higher risk of interaction conflict, and raises the question of whether and how one enforces social order while encouraging collaboration In our case, this was through subtle means: we laid out the main interface around a preferred orientation so that children on one side of the table were more in the role of managers, while others could contribute on local content. This proved to work well for children, despite the intuition of making tabletop interfaces orientation-agnostic.

Another interesting attribute of our design was the integration and division of features which spanned both software and hardware enabling collaboration without sacrificing individual interaction possibilities. For example, having a physical handheld capture tool and a software viewfinder on the tabletop might suggest something which is both redundant and disorienting. However, in this case, we found that this disjunction of different aspects of the camera encouraged children to take photos collaboratively. Another example was that one child would steer the situated capture tool from behind to help taking portraits of other children. These showed that by decentralizing interaction and involving multiple physical devices toward a single goal, collaboration could be promoted.

As we continue to pursue new forms of interactive tabletop systems, we will continue to learn more about the impact of different kinds of design decisions on important issues such as creativity and collaboration. This short note presents a case study which helps to populate this research space.

REFERENCES

1. Benford, S., Bederson, B.B., Åkesson, K.P., Bayon, V., Druin, A., et al. Designing storytelling technologies to encourage collaboration between young children. CHI, (2000), 556-563.
2. Cao, X., Lindley, S.E., Helmes, J., Sellen, A. Telling the whole story: Anticipation, inspiration and reputation in a field deployment of TellTable. CSCW, (2010), to appear.
3. Cappelletti, A., Gelmini, G., Pianesi, F., Rossi, F. & Zancanaro, M. Enforcing cooperative storytelling: First studies. ICALT, (2004), 281-285.
4. Cassell, J. & Ryokai, K. Making space for voice: Technologies to support children"s fantasy and storytelling. Personal and Ubiquitous Computing 5, 3. (2001), 169-190.
5. Decortis, F. & Rizzo, A. New active tools for supporting narrative structures. Personal and Ubiquitous Computing 6, 5-6 (2002), 416-429.
6. Engels, S. The stories children tell. W.H. Freeman and Company, 1999.
7. Kruger, R., Carpendale, S., Scott, D. S., Greenberg, S., How people use orientation on tables: Comprehension, coordination and communication. Group, (2003), 369-378.
8. Rick, J., Harris, A., Marshall, P., Fleck, R., Yuill, N., Rogers, Y. Children Designing Together on a Multi-Touch Tabletop: An analysis of spatial orientation and user interactions. IDC (2009), 106-114.