Exploring Performative Authoring as a Story Creation Approach for Children

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Abstract. We propose performative authoring, an approach for children to author digital animated stories using pretend play or story enactment. Using a systematic methodology, we designed and developed DiME, a prototype system to explore how children may make use of performative authoring to create stories. Findings showed that children greatly enjoyed the authoring approach, and that DiME supported the child's imagination of characters, objects and environments during enactment. However, enactment for authoring lacked narrative structuring and the affordance for rapid iterative editing that is critical to creativity. We conclude that performative authoring has great potential to facilitate and even improve children's storytelling.

Keywords: Storytelling, Authoring, Children, Creativity, Enactment, Pretend play.

1 Introduction

Story authoring interfaces for children remain tied to the traditional GUI-based paradigm of the mouse and keyboard, even as other types of interactive systems, such as games, are moving towards the emerging paradigm characterized by broader use of embodiment for interaction, i.e., using broader sets of body motion or embodiment as the user interface. Unlike interfaces for consuming pre-defined content where users' actions are mostly predetermined (e.g., platform games, interactive books, etc.), or at least bounded by rules (e.g., role-playing games, sandbox games, etc.), story authoring interfaces are, by definition, engaged in the production of novel and creative output. As such, story authoring interfaces provide greater design challenges.

In the consumer arena, recent developments in story authoring interfaces for children include touch-based 'apps' such as *ToonTastic* [1], which allows a child to record an animated story by moving 'sticker-like' cartoon characters around on the tablet screen. We are not aware of any commercially available story authoring interfaces that have attempted to go beyond the display-centric interaction of the computer or of the tablet. The closest interaction approach that uses body movements for 'authoring' is the use of full-blown motion capture in the entertainment industry to enable actors to create content for animation. In the research community, a few projects have proposed prototype systems that make use of embodied motion for story authoring. We shall provide an overview of those later.

A. Mitchell et al. (Eds.): ICIDS 2014, LNCS 8832, pp. 61–72, 2014.

This paper explores *performative authoring*, an enactive approach that allows children to create animated cartoon stories using embodied enactment. The approach to storytelling for children is motivated by the numerous benefits of children's pretend play. Pretend play has been advocated as a basis for imaginative thinking, creativity, and combinational flexibility, as well as for other skills such as reductions in egocentricity, improvements in perspective-taking, and cooperative social problem-solving (see [2] for a review). To situate performative authoring in the space of existing designs, we first present a review of story authoring systems within a framework of embodiment. We then describe the design and development of an exemplar performative authoring system: the DiME (*Digital Micro-Enactment*) system. Finally, we describe an exploratory study of how DiME was used by children, aged 8 to 10. Findings inform further development of our prototype system, and contribute to the understanding of how embodied enactment may be used to allow children to author stories.

2 Embodied Story Authoring Systems

Figure 1 classifies representative embodied story authoring systems into three types: (i) *Direct manipulation* – the child manipulates story elements onscreen through the mouse pointer or finger touch interaction; *(ii) Puppeteering* – the child controls story characters through manipulation of external physical objects; *(iii) Enactive* – the child performs the role of story characters. Each of these approaches possesses different characteristics by which the child expresses her imagination. Figure 2 illustrates the problem of digital story authoring. Essentially, storytelling is an idea-driven process founded on creativity that may be defined as a process of recombination of bits drawn from real-life experiences [3, 4]. Say, the child wants the hero of her story to wave goodbye, and walks away from his village, sad that he is leaving his parents. She now needs to translate this into actions by a *graphical representation* of the hero character. Figure 2 summarizes distinctions of how the child may realize this in the three types of authoring interfaces. For both the *direct manipulation* and *puppeteering* interfaces, the child will have to know that waving can be decomposed into a series of repeated movements of an upraised arm tracing an arc, and that 'walking sadly' may translate to 'walking slowly with hunched shoulders and dipped head'. For a *direct manipulation* interface, the child will further need to know the appropriate

Interface Type	Tool	Focus	Perspective
Direct manipulation	Mouse cursor	Graphical object	Allocentric
	Finger	Graphical object	Allocentric
Puppeteering	Puppet	External proxy	Allocentric
Enactive	Self	Idea	Egocentric

Fig. 1. Story authoring interfaces

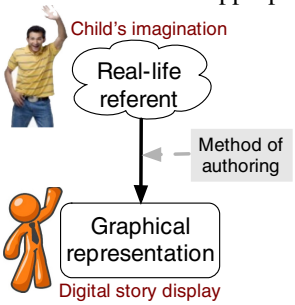

Fig. 2. Story authoring

actions to realize these movements in the graphical avatar using the mouse and keyboard. With *puppeteering* interfaces, the child may be aided by the affordances of an appropriately-designed puppet to, for example, execute the waving motion by moving the puppet's upraised arm back and forth using the natural joint constraints.

In the *Enactive* interface, the child neither engages in motoric decomposition nor in the mechanics of a particular tool use. The instrument is the child's own body, an instrument with which she already has experience 'in her body' (from an egocentric point-of-view). Her focus is on the story idea itself, making storytelling the idea-driven process it is meant to be. This is in distinction to the requirements of both *direct manipulation* and *puppeteering* to construct the necessary decomposition from an allocentric perspective before overcoming the operational burden of executing the constituent actions. Thus, authoring through the *enactive* is perhaps the most intuitive and seamless for the child. Quoting Pederson et al. [5], the child's imagination (in storytelling) is effectively supported when she can move "from action in response to objects present in the perceptual field (e.g., the graphical object, the external proxy) to action generated and controlled by ideas".

Wayang authoring [6, 7] is a *direct manipulation* interface that enables children to author stories in the form of shadow puppetry, a traditional Indonesian storytelling art. The child composes a story using a web-based graphical user interface by clicking and dragging objects on a 'stage'. The system records the direction and speed of the dragging movement as 'the story being told'. The authors reported that "the visual appearance and the implemented work flow were first uncommon but easy to handle for most of the children". However, only informal testing of the system was reported.

Video puppetry [8] allows children to tell stories through *puppeteering* with cut-out-style animations. After drawing and cutting out the story elements using paper and scissors, the user moves the paper-based elements in front of a camera. The software processes the input frames from the camera by detecting the 'object' drawn and tracking it as the user moves the cut-out element around, and removes the user's hands from the video. Although the system was not specifically designed for children, it was showcased at several public events where it was used by children. The authors reported that "the system is easy to learn and use. All users were able to control the onscreen puppets with minimal instruction because the interface is so transparent."

We did not find any *enactive* interfaces that were designed specifically for children to author stories. *Handimation* [9] maps the movement of a 3D virtual character to a user's movements by requiring the user to use three wiimotes (one in each hand, and one attached on the top of the head), but the interface follows a music sequencer metaphor and is rather complex to use. The system was developed for animators. The approach of performative authoring that we present in this paper is an 'enactive' method that simulates children's role-playing or pretend play to enable children to author digital stories. The following sections describe the theoretical foundation of the approach, and the principled design of a system based on the approach.

3 Performative Authoring: Pretend Play for Digital Storytelling

We focus on children between the ages of 8 to 10 as they undergo significant socio-cognitive developmental changes. Changes include the emergence of strong social

awareness [10], the beginning of the development of logical and hypothetical thinking [11], and the need for competence and the formation of one's self-concept [10]. The child in this phase thus is in critical need of support and scaffolding. Pretend play (sometimes also called make-believe, imaginative play, or story enactment) has been shown to be beneficial not only more generally as a 'zone of proximal development' [12] for the development of cognitive skills such as problem-solving, but also more specifically for the budding literacy and storytelling skills. Comparing the recall of narrative structures after 4- and 5-year-old children engaged in conditions where they either pretend play enacted stories or only listened to stories, Kim [13] found that over short time periods, pretend play can facilitate narrative recall and expression. Chu et al. [14] also described a study that showed that the story quality in terms of richness and coherence was significantly better when children enacted story scenes with physical objects than when they simply viewed a narrated video of the story, especially when the enactment of the children involved imagination beyond a certain threshold.

According to Lillard [15], the necessary and sufficient components for pretend play to take place include: *1) A pretender* (i.e., the child) ; *2) A reality* – the real world in which we are constantly immersed (i.e., the bounded space within which the pretend play takes place); *3) A mental representation that is different from reality* (i.e., the idea of a story character, or of a non-visually present story object); *4) A layering of the representation over the reality, such that they exist within the same space and time* (i.e., the child imagining herself as the story character, the child projecting on a visually-present object); *5) Awareness of the pretender of components 2, 3, 4*.

These components are integrated for use in pretend play across three subparts:

Character Play: The child takes on the role of someone who she is not. Pretend play by children is a key contributor to the development of what cognitive psychologists call the 'theory of mind', the human ability to "explain people's behavior in terms of their thoughts, feelings, beliefs, and desires" [16]. Being able to associate and interpret observed behavior with underlying mental states is essential for character playing. Theory of mind has also been related to perspective-taking.

Object Substitution: The child imagines an object to be something else (E.g., a stick becomes a horse). Much imaginary object substitution involves 'projection', defined by Kirsh [17] as "augmenting the observed thing, of projecting onto it".

Fantasy Worlds: The child imagines a surrounding environment that is not present. The creation of mental imagery that specifies an ambient 'world' has been called the ability for 'broader imagination by Chu et al. [18].

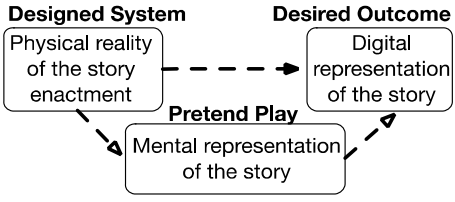

Fig. 3. Performative authoring

Within each of these subparts, the child has to simultaneously engage with the *physical reality* in which she is acting, and her own *mental representation*. However to make use of pretend play to author digital stories, an additional layer of representations is required: the *digital representation* of the story being created. The layering of these elements is at the core of our proposed approach of performative authoring. Fig. 3 illustrates it conceptually. The end goal of performative authoring is to produce stories in a digital form, which can be text-, graphics-based, animation, or multimodal in nature. The environmental structures extant during performative authoring are critical, as it shapes the reality of the child while she engages in the creation of stories. Within this setup, performative authoring asks the child to overtly enact her imagination of character roles and to imagine object props and surrounding worlds.

Practically therefore, a system based on performative authoring needs to consist at the minimum of: **i.** A setup that enables a child to create a digital story through pretend play/enactment; **ii.** Structures that support a child's imagination or mental representations as she enacts; **iii.** A way for the child to view and edit her digital story.

A performative authoring system embodying these specifications can be designed in a myriad of ways. In the next section, we lay out the design pathways and rationale for the prototype system that we developed to explore the authoring approach.

4 Designing *DiME*: A Digital Micro-Enactment System

Design Methodology: In order to avoid losing the wood for the trees, we followed the *Finding-NEVO* 'design-oriented research' methodology proposed by Chu et al. [19] to design DiME to exemplify performative authoring. The approach "articulates a methodology to select design ideas that yield prototypes that are faithful to a conceptual rationale and seed idea". As such, it ensures the validity of both a research prototype and the scientific process that employs the prototype for testing and inquiry.

Finding-NEVO specifies that a set of 'idea-defining characteristics' should be produced arising from the seed idea for the system (in our case, using pretend play for story authoring). We used the 3 core requirements (i) - (iii) listed in Section 3 as our guiding list of idea-defining characteristics. In a 'gatekeeping process' that precedes each system development cycle, every prospective design feature is evaluated against

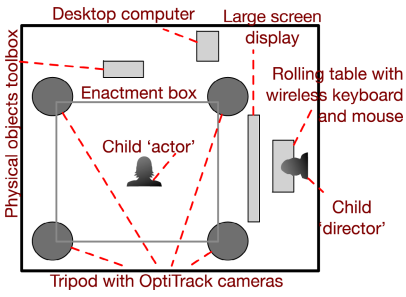

Fig. 4. DiME setup

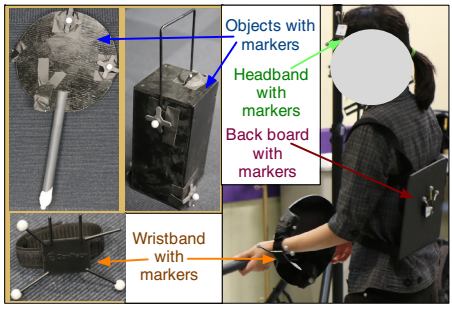

Fig. 5. Reflective markers

the idea-defining characteristics list. The rationale for key design decisions included consideration for the abilities of children in our target age range, technical possibility and feasibility, time constraints, study findings from prior literature, etc.

System Description: DiME captures the movements of a child using a physical object, and mirrors the actions in real-time through an animated cartoon character with a graphical prop. To capture children's enactments, we used the OptiTrack [20] motion-capture suite to track body and physical object movements, and an external microphone to capture sound effects or any narration that the child may make while enacting. Figure 4 shows the setup of DiME. Reflective markers are embedded in props for acting and in wristbands, headbands, etc. worn by the child (Figure 5).

The main interface consists of a series of frames set in a filmstrip-like visual metaphor (see Figure 6). The child creates a story scene in each frame using either text or enactment. Figure 6A shows the text editor interface. If the child chooses to enact a story scene/frame, she is first asked to choose a 2D cartoon character. She can then choose to act with a prop from a library (Figure 6B), or without one. After the child selects the graphical prop, the system directs her to pick up a corresponding physical object to use in her enactment. DiME maps the available 3D graphical props to 'generic' physical objects according to 'affordances'. The mapping is one to many where each physical object is mapped to several graphical props with similar interaction affordances. For example, the racket-like physical object in Figure 5 can be a graphical tennis racket, guitar, frying pan, fan or stop-sign prop.

During enactment, the cartoon character and the graphical prop (if selected) are shown against a white background. As the child 'actor' moves around in the tracked space with the physical object, the cartoon character follows her movements in real-time. When the 'actor' is ready to start the enactment, the child 'director' starts the recording of the cartoon animation by pressing the spacebar on a wireless keyboard.

DiME was pilot tested for usability with two children (one girl and one boy aged 8 and 10 respectively) in a laboratory setting. The updated version of the system after bug fixing was used in the exploratory study.

5 Exploratory Study with DiME

Study Description: We ran a study to investigate the use of DiME by children at a local 'Boys and Girls Clubs of America' afterschool program. The participants were 7 children (4 girls, 3 boys), all aged between 8 and 10 years old. Parents voluntarily signed up their children for the study, and completed a consent form. Verbal assent was also obtained from each child for her willingness to participate. The study ran over a period of two weeks. The children used the system in pairs on certain weekdays from 4 to 6 pm. Study activities included a i) familiarization session consisting of an ice-breaking game with the researchers, the researchers explaining to the children how to use the system, and practicing creating stories with DiME; ii) story creation session based on a given theme, and iii) post-study interview. The story theme given to the children for the story creation session was 'An adventure in the jungle'. The children were told that their story had to contain *at least* two enactment frames and two text frames. Figure 7 and Figure 8 show the use of DiME during the study.

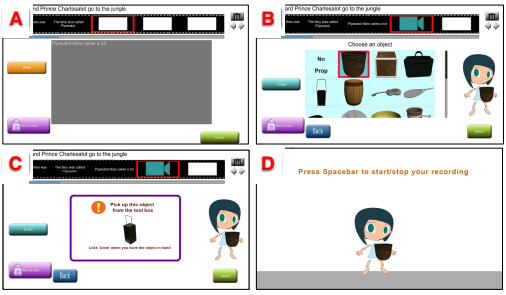

Fig. 6. DiME user interface

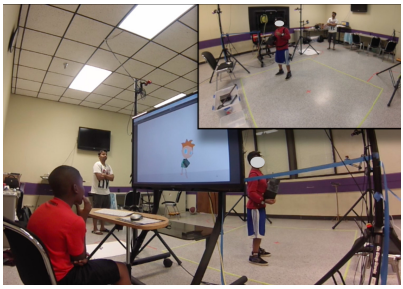

Fig. 7. Children using DiME

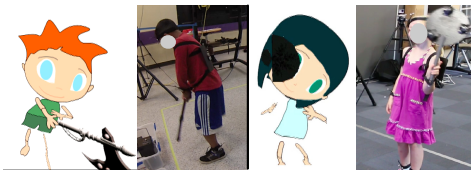

Fig. 8. Enactment Mapping

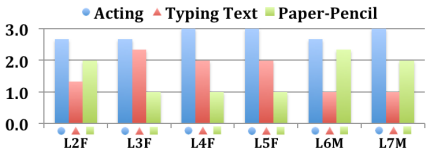

Fig. 9. Fun Sorter *(Y-axis: coded ranking)*

In the post-study interview, a questionnaire was administered to the child to assess her experience of storytelling via enactment, via text, and via the approach of paper-and-pencil typically used at school. We used survey methods from the Fun Toolkit [21] developed specifically for use with children. These include the smileyometer (5-point Likert scales from 'Awful' to 'Brilliant'), the Fun Sorter (ranking of storytelling methods on 'I like', 'Is fun', 'Makes me happy'), and the Again-Again table (choice of 'yes', 'maybe', 'no' for motivation to do it again).

The amount of time allocated to each activity of the study was not restricted since we were interested in exploring system use and study protocol with the children. Table 1 summarizes the pair groupings of the children (M: Male, F: Female) and the full stories produced. All sessions were audio and video recorded.

Data Analysis. Answers to each question in the post-study questionnaires were numerically coded and entered in a spreadsheet for statistical analysis. We used both the animated cartoons created, as well as the actual video of the children's enactments for story enactment analysis. Children's narrations in the enactment videos were transcribed with speaker labels (actor, director), and a text summary of each story scene was produced to facilitate analyses.

Findings: Children's System Evaluation. The results of the children's assessment from the post-study questionnaires were overall very positive. Mean ratings on the 5-point Likert-scale smileyometer were: Acting ($\mu = 4.3$); Paper-pencil ($\mu = 3.7$); Typing ($\mu = 3.2$). However, examination of the individual scores showed that some children gave the same ratings for at least two of the methods. Results from the Fun Sorter, which required children to rank order the methods, were more conclusive.

Table 1. Children pairs in our study

Children IDs	Story IDs
1M, 3F	A
3F, 5F	B
2F, 4F	C
6M, 7M	D

Table 2. 'Again-Again' results

	Acting	Typing	Paper-Pencil
Yes	6	1	2
Maybe	0	5	2
No	0	0	1

The method ranked 'Best' was given a score of 3, and the one ranked 'Worst' was scored 1. Combined mean scores for the three dimensions of the Fun Sorter are shown in Figure 9. Similarly, results from the 'Again-Again' question, in Table 2, showed that children were overwhelmingly motivated to continue using DiME.

Findings: Children's System Use. There were a total of 11 enacted story frames and 7 text frames across 4 stories. Enacted story frames lasted on average 50.18 seconds. We describe ways in which the children used the system under three headings:

i) Actor-Director Collaboration Strategies: We identified three main approaches used by the children to author stories collaboratively during enactment. Collaborative actions were seen at 2 levels: in terms of the actual content of the story and at a meta-level management of the storytelling process (enactment recording, timing, etc.):

A. The *director's initiative* was especially evident in Pair D (ref. Table 1). The director allows the actor to make up the story, but decides to terminate the recording of the enactment by himself when he notices long pauses or repetitions in the actor's acting. E.g., the actor acts out repetitively fighting against a lion until the director says "Alright" and stops the recording. In this case, story content is determined by the actor while the meta-level is controlled by the director; **B.** *Co-creation in real-time* was an approach used by Pairs B, C and D. The director frames the story on the fly or reads off a planned script, that the actor acts in response. E.g., the director announces: "She's looking for her friend Mary." The actor acts out searching around and calls out "Where are you?". Here, the director and the actor co-create both the story content and the meta level; **C.** *Communicating through acting* was seen in Pairs A and C. The actor indicates to the director that she wants to terminate the enactment by acting out the story character exiting the scene in some way. E.g., while acting out hitting on a cave wall, the actor calls out still in-character "I'm tired. I'm going to take a rest." In this case, the actor determines both the story content and the meta-level.

ii) The Role of Text Story Scenes: The children did not seem to understand the concept of continuous story frames represented by the filmstrip metaphor that we used in the story creation interface of the system. The filmstrip is a series of frames that the user 'fills' either with text or an animation to construct the scenes in her story (ref. Figure 6). The children used text frames in four ways:

A. To express a *summary of the enacted story scenes* that precede it. E.g., after an enactment of using an 'axe' (virtually) to hit around the space, Pair A typed in the following text frame: "once there was a boy and girl named Mary and John and they lived in a cave. one day they got an axe and hit there cave and hit it. and rebuilt it and it looked like the best cave ever."

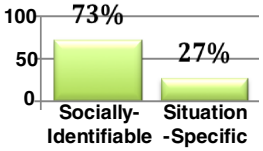

Fig. 10. Role identification

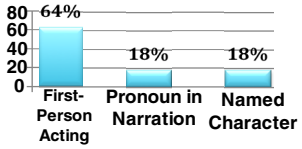

Fig. 11. Methods of character identification

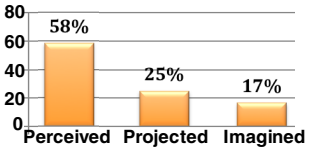

Fig. 12. Pretend play with object

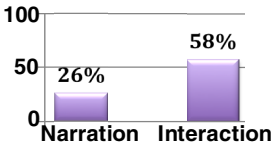

Fig. 13. Expression of environmental elements

B. To construct *disconnected, self-contained stories*. E.g., Pair B enacted a story about two friends being separated in the jungle in the first two frames, and then started another story about two sisters getting bitten by a dog in the text frame.

C. To *contextualize the enacted story*. E.g,, Pair D used the text frames to set the overall topic of their story ("this story is about this boy finding some gold") and to provide an epilogue after all their enacted scenes ("well that was a good aventure i found gold thats good now im rich and played my catar [guitar] and it was good.").

D. To *continue enacted story* scenes. This was the approach that we expected the children to use for the text frames, but it was surprisingly used consistently only by one pair. E.g, Pair C used two frames to enact a girl falling off a plane into the jungle and being attacked by a tiger, and continued the story using text, writing about a gang of monkey that came to harass her next.

iii) Extent of Imagination: We analyzed how DiME supported the child's imagination during story enactment in terms of the three components of pretend play:

I. *Character play.* We coded for the roles that the children created during story enactment. 73% of the enacted scenes contained roles that were socially or culturally identifiable (e.g., pop star, baseball player, gold miner). The other 27% (Figure 10) acted story roles that were situation-specific (e.g., losing a friend in the jungle). We also looked at how the children made explicit the various roles in their story scenes (Figure 11). Most acted the roles in the *first-person* with no explicit referencing (64%), some used *third-person pronouns* (18%) such as "she lost her friend" especially in the director's narration, and some *named the characters* they were acting (18%).

II. *Object substitution.* We coded the stories created for objects that the story characters used. We classified the objects according to Kirsh's model of 'thinking with external representations'. His model specifies three types of representations: *Perception* – entirely dependent on the physical stimulus present (i.e., the physical object used for enacting, the graphical prop onscreen, and the imagined object in the child's mind all align. E.g., in Figure 8, the physical stick object is the digital axe, and is imagined as an axe by the child); *Projection* – anchored to the physical stimulus but not entirely dependent on it (i.e., the physical object and the graphical prop align,

but the imagined object does not. E.g., the physical stick object controls a digital axe, but is imagined as a baseball bat); and *Imagination* – entirely not anchored to any physical stimulus (i.e., an object is imagined, but no physical object is used and no graphical prop can be seen. E.g., the child imagines picking up gold nuggets that have no physical representation in reality). Figure 12 shows the distribution of objects.

III. *Fantasy worlds.* We coded each enacted story scene for environmental elements, i.e., objects, characters and animals that the child imagines in the story setting as she enacts. Across all enacted scenes, 73% had some degree of setting imagined by the children. There were on average two environmental elements evident in the enacted scenes. Figure 13 shows the manner in which environmental elements were manifested. Most of the environmental elements were made evident through *enactment of interacting with the element* (58%), e.g., targeted picking-up action of a gold nugget, looking around at the "real beautiful flowers" in the jungle. The rest (26%) were evident only through *narration by either the director or the actor's speech*.

6 Discussion

The goal of performative authoring is to enhance the creativity, coherence and richness of children's storytelling by tapping into the imaginative power of pretend play to provide children with the freedom to imagine and the transparency to translate their imagination into actual story-products. We used the DiME prototype system in an exploratory study to understand its impact on children's story creation. Our results show that children had a positive response to the system, as compared to the traditional story authoring techniques of keyboard typing and pen-and-paper writing.

Children showed great flexibility in how they collaborated within DiME's director-actor framework to create the story content and the meta-level management of process through the director's initiative, co-creation, and in-character acting. All of the three collaboration methods were spontaneous, a lot more like improvisational theater rather than a scripted play. DiME itself did not enforce/integrate story planning as part of the system interface. Instead, we allowed children to plan their story using large drawing sheets and markers before enacting, but few of them used them. When used, the children wrote out the enactment scenes in their planning sessions. We posit that performative authoring as a storytelling method may lead to holistically better stories when narrative structuring is also supported through the system, or external means.

We expected text in the story enactment system to be used to describe scenes that advance the story. Instead, text in a performative authoring system was integrated in several ways, e.g., as summary textboxes, story scene textboxes, encapsulation textboxes (for prologues and epilogues). This also shows that the filmstrip metaphor that we decided to use to convey the idea of a story as a series of animation frames in DiME may be hard to grasp in the mental model of some children. A filmstrip is common knowledge for an adult with a basic understanding of movies. For a child however, authoring a story by creating a collection of scenes may not seem intuitive. This runs counter to our intention of extending and sustaining the child's story imagination, and suggests the need to investigate appropriate visual interface metaphors

that can convey the connectedness of an animated storyline to children. Moreover, the tendency of children to use a single frame to enact whole, self-contained short stories may also be counter to the quick editing and iterative process that is critical to creation or authoring. While using frames for whole stories may not be a problem for consumption-oriented storytelling systems, the capability for quick editing is important in creativity-oriented systems. The problem is that long and continuous enactment segments are unwieldy, and not amenable to the kind of iterative/rapid editing that support creative manipulation. We may need to study features that from the child's perspective, allow the system to encourage and support the creation of shorter, micro-enactments that can be edited quickly and constituted into larger story arcs.

The support of the layering of imagination over reality through DiME in terms of character play occurred mostly through first-person acting. Taking the role of a character in their story from an egocentric point-of-view required children to engage in perspective-taking and the development of a theory of mind. Object imagination was satisfactory with a good proportion of perceived, projected and imagined props used. However, children were less engaged in the imagination of story environments. One reason may be our design decision of having the animated character against a white background instead of a contextual picture. Research is needed to understand design factors to support children's imagination of fantasy worlds during story enactment.

7 Conclusion

We proposed an enactive approach called performative authoring for children to author digital stories using pretend play or body enactment. We used a systematic design methodology to develop DiME, a prototype system that embodies the authoring approach, and conducted an exploratory study to understand how children use such a system and approach to create stories. Pretend play brings with it many benefits in terms of cognitive and social development for the child. In mapping pretend play to a story authoring approach, we seek to preserve these benefits while investigating factors to support the child's ability to tell stories. Based on our study results, performative authoring appears to have great potential for children's storytelling.

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