Lessons Learned from Designing Children's Interactive Narratives

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ABSTRACT

Designing interactive narrative for children requires awareness of the cognitive abilities of young readers. In this paper, we propose design principles based on knowledge of children's cognitive psychology research. The principles demonstrate how a children's interactive narrative can allow for creative play and *avoid frustration*. Furthermore, we present an interaction design strategy aimed to *reduce memory load* and focus on story understanding. By using simple and encouraging discourse through short interactive prompts, electronic fiction can be used to craft delightful and interesting literature for children.

Author Keywords

Children, interactive narrative, storytelling

INTRODUCTION

Designing interactive narrative for children requires awareness of the cognitive abilities of young readers. There are many developmental stages necessary before children can understand narrative. Young children innately want to develop the ability to articulate themselves through choice of grammar, and construct logical sequences of events into a story. Socially, children learn about empathy and communication through realizing that narrative delivery affects people's perception and relationships.

Beginning at preschool age, children engage in oral storytelling and dramatic play to experiment with narrative variation. From kindergarten to 3rd grade, participant-led storytelling activities are a part of many classrooms [6]. Children often change narratives to explore alternate identities, reorder narrative events, and play with time within stories as part of pretend play. Adapting and altering narratives are an inherent part of how a child learns about social roles, logical thinking, and story construction. We observe that storytelling play is a primitive form of oral interactive narrative.

INTERACTIVE STORYTELLING FOR CHILDREN

In light of the informal use of interactive narrative by young children, it seems that the field of interactive fiction (IF) does not explicitly target works to young children. Although a few interactive fiction pieces claim to be suitable for children, we are interested in the audience of very young children. Works like *A Bear's Night Out* or *WishBringer* may reference childhood themes (e.g. teddy bears or postal mail; see http://www.ifwiki.org). These "children-oriented" works provide a simplified plot compared to what exists in adult-oriented pieces. A playful dialogue diffuses the sense of danger that normally surrounds interactive fiction. Although these adaptations are accessible to young audiences, we are interested in looking further at how to construct enjoyable interaction fiction experiences. In particular, we are interested in how to appeal to young children who are learning how to read. Our approach is to design around the cognitive limitations of young children ages 1-5 and examine the existing storytelling rituals at these ages.

Informed by Vygotsky's Zone of Proximal Development [9] framework, we believe that puzzles in the existing works are too sophisticated for young children to play. Children from 1 to 3 years have very short attention spans, and are easily distracted by sensory displays. The sequentially rigorous nature of solving problems in traditional IF prose requires the ability to perform sequenced operations on abstract items, navigate a multi-room map, and solve puzzles in order to "win" the game. These tasks require focus, memory and abstraction that very young children do not possess. An IF story that supports their shortened attention span and provides quick encouragement from small interactions would be better suited to their developmental abilities.

Another aspect of storytelling ritual is the explicit inclusion of social cooperation. Young children do not tell stories alone; they tell stories to other young children or adults. Quick, short pieces of dialogue and negotiation between people are a key part of storytelling for young children. Dialogue that references familiar everyday objects can make the topics less abstract. Furthermore, supporting vocally expressive dialogue (e.g. by using sound effects, alliteration or onomatopoeia) encourages the oral performance of the text. Using sensory references (e.g. such

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as referencing parts of the human body within the text) can make the experience enjoyable and educational. Young children are learning how to read, and they rely on their sight and sounds to scaffold learning. We believe that adult-supported storytelling using an IF narrative that incorporates these features will provide an enjoyable IF experience for young children.

TWO EXAMPLE INTERACTIVE NARRATIVES FOR YOUNG CHILDREN

We have designed two technologies specifically to reduce the cognitive load and increase dialogic interaction. In this section, we briefly present the lessons learned from two example interactive narrative systems, *Baby Duck Takes a Bath* and *A Little Quiz for the Little Hare*. Both works target young children in the early stage of learning story construction.

Baby Duck is a multi-sequential narrative where the user can explore how a duckling can become dirty or clean by interacting with its habitat. The state of the characters (including a mother duck and duckling) results from manipulating elements within the small story world. The narrative changes according to the user's interactions, allowing for change in perspective, agency and attitude in real-time.

The *Little Quiz* system aims to teach young children the concepts of physical measurement and comparison through the conversation between two characters. Based on players' intention of exploring the story world in different ways, the narrative dynamically changes using a commonsense knowledge database and reasoning techniques.

Our approach to designing children's interactive narrative considers how children experience interactive story content. The basic principles of this approach are to provide *small interactive, contextual interactive content*, and s*imple flexible inputs*.

Case 1: *Baby Duck Takes a Bath*

Baby Duck is a multi-sequential narrative where the user can explore an interactive story world. The story is implemented in the Curveship interactive fiction system [4] and can express a story using a range of narrative variations. For example, the narration can be prophetic, personal, or surprised. In this piece, interacting with different objects in the world can control the duckling's state. The duckling will become dirty or clean and have approval or disapproval from the mother duck depending on the actions of the user. There are two characters and four common objects (a ball, pebble, a red rose, and a flower). The story world is the pond, and the objects around the pond.

Interactive Process

The system is designed for parent and child to read together. Ideally, the parent would read the story aloud and ask a child to select the things to interact with. The story begins with a description of the setting.

You have arrived to observe the wildlife in the lush green wilderness. You examine the wilderness full of lush greenery.

- Wilderness full of lush greenery -

You see yourself standing in the wilderness full of lush greenery. The scene contains a mother duck, a red rose, a sparkling pond full of clean water, a flower, a duckling, a ball, a pebble, and a puddle of mud. What do you want to play with?

As the parent reads the lines, they can reference themselves in the real world (e.g. point at the child for "duckling"). The simple objects in the story can even be physically present in front of the readers. When the readers make a choice or command in the fictional world, the interaction can simultaneously occur in the real world. The parent may touch or point to the objects in the physical space.

The parent and child can explore picking up the different objects and examining them, using the narration as a script. The narrative text describes objects simply, but the parent might embellish during the reading ("the red ball" or "the shiny pebble").

(continued)

>look pebble

You look at the pebble.
 A small rock.

>look flower

You look at the flower.
 The pretty flower here is the kind often found in the wild. The flower is dirty.

The plot evolves as the users interact with these story items. The experience relies on the imagination of the parent to bring references out of the virtual world into the physical world. For example, in the story, the user can clean or dirty items by interacting with the different bodies of water. A parent might demonstrate a physical ball getting clean in a cup of water, and make splashing sounds as she narrates the cleaning.

(continued)

>put flower in water

You wash the flower in the the sparkling pond full of clean water.

>look flower

You look at the flower. The pretty flower here

---

is the kind often found in the wild. The flower is clean.

The duck characters can also go into the water, causing a change in the state. The moral impact of dirty or clean can be a topic of discussion between the parent and child. The small responses given by the system in response to a command allows children to make an immediate connection between cause and effect.

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                 (continued)
>look duckling
You look at the duckling.    Here is a little
duckling who seems to be your friend. Your
friend is dirty.

>put duckling in pond
You wash the duckling in the sparkling pond full
of clean water.

>look duckling
You look at the duckling.    Here is a little
duckling who seems to be your friend. Your
friend is clean.
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In this story, the mother duck has some agency in that you cannot put her in the water. In contrast, the little duckling happily goes in either the mud or the pond. The author leaves room for the parents to discuss the agency of the characters.

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                 (continued)
>look mother
You look at a mother duck.    You see a clean
mother duck, quite splendid and fine.

>put mother in pond
You wash a mother duck in the sparkling pond
full of clean water.

>put mother in mud
You decide not to dirty a mother duck in the
puddle of mud because she enjoys staying put
and watching over the ducklings.
```

Case 2: *A Little Quiz for the Little Hare*
In the *Little Quiz* system, our goal is to explore the design space of enhancing interactive narrative to understand players' intention and provide dynamic experience with tailored narrations using a general commonsense knowledge base and reasoning techniques. We especially aim to teach young children the concepts of measurement and comparison based on the children's story "Guess How Much I Love You" by McBratney and Jeram [3], which illustrates a younger character "Little Nutbrown Hare" who wants to express his love in a scale to impress the elder character "Big Nutbrown Hare" by comparing with physical conditions in the story world, such as how wide his arm can stretch, how high he can hop, how far the lane

goes, etc. In the original story, the two characters compare each other's expression continuously to greater measurements, and end with a relatively large scale: the distance to the moon (and back). This storytelling process inspires us to design an interactive system to allow readers to "brainstorm" a way to express themselves, interact with the narrative based on their interests, and learn from the exploration.

Interactive Process
The following shows how the system begins the narration:

```
----------------------------------------
You, Little Nutbrown Hare,
who was going to bed, held
on tight to Big Nutbrown Hare's
very Long ears.

You wanted to be sure that Big
Nutbrown Hare was listening.
"Guess how much I love you," you said.

"Oh, I don't think I could guess that,"
said Big Nutbrown Hare.
----------------------------------------

Now, Little Nutbrown Hare,
please ponder a little and tell
Big Nutbrown Hare how much you love him!

Try something you can do?
(hop, run, sing, etc.)
```

The system asks the user, as the younger character "Little Nutbrown Hare", to think about how he or she wants to express the love to the other character "Big Nutbrown Hare", which is commonly regarded as the father or mother who reads the story aside. Note that in order to engage the reader to take the role, we redesign the original piece to the second-person narrative. Furthermore, to assist the user in thinking about the comparison, the system suggests questions (e.g. "Try something you can do?") and the relevant concepts ("hop", "run", "sing") based on the defined story world. The user can freely type in one or few words to interact.

```
                 (continued)
>> hop
You try to hop.
You can show your love by...
*1* hop as fast as possible
*2* hop as high as possible
```

When a user inputs a textual word (e.g. "hop" or "flower"), the system understands the input, generates a short narration with actions (e.g. "You try to hop" or "You see flowers around"), and then provides 1-3 possible suggestions based on the input concepts to measure (e.g. "hop as fast as possible" and "hop as high as possible", or

"as many flowers you can find" and "as red as the flowers can be").

```
               (continued)
>> 2
----------------------------------------
"This much," said you,
Little Nutbrown Hare,
hopping as high as possible

Big Nutbrown Hare hops even higher.
"But I love YOU this much," he said.
Hmm, that is a lot, thought
Little Nutbrown hare.
I wish I could hop like that.
----------------------------------------


Now, Little Nutbrown Hare,
please ponder a little again and respond to Big!
Look around you. What can you find?
```

When the user makes a choice from the listed suggestions, the system dynamically generates the narration and shows how Big responds with a larger measurement compared to the user's narration, such as "hop even higher", "finds more flowers around"). The system also reasons the user input in a comparative scale and changes the suggestion such as "Look around you. What can you find?", "Do you see something far or large beyond there?", or "Try to raise your head: what do you see? Something shining?".

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               (continued)
>> look
Here, you can find many things: One big *tree*
is standing in the dark night, resting silently.
Your bed is right on the comfortable *meadow*.
Many fresh *flowers* are standing around, with
various kinds of colors.

What you can see nearby include: There is one
*forest* next to your home, but it looks so dark
at night and you can't clearly see what's in it. A
small *pond* is right next to your sweet home.
Frogs are singing.

Also, far far away, you see many things:
mountain, houses, farms, and river.
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The user can navigate the story world by simple commands including "look", "look around", "look up", etc. He can keep interacting with the system, until the narrative ends up when the user input is considered as a large scale in the virtual world. However, the purpose of this narrative is learning from the comparing process instead of solving the puzzle of winning the other character's arguments.

System Design Considerations
Our systems enable the readers to customize the experience of the story through its simplicity. In our examples, we

designed the parameters of the stories to have few items to keep track of:

- 2 actors (Mother and duckling) (Little and Big Nutbrown Hares)
- Small areas: 1 area (pond) or 3 areas (around, nearby, and far away)
- A small number of objects contained in each of the areas with different attributes (trees, flowers; hills, a pond, a house; stars, a moon, etc.). The objects are familiar items that a very young child would have encountered. The interactions are not complex (looking, taking, putting down). The author can narrate each object, and embellish the descriptions easily.

By designing the children's story to integrate easily into the real physical world of our lives, we aim to ease the efforts for authors to define the world explicitly and to allow the users to navigate the story world easily. Our approach is to leverage "common sense knowledge", which is the general knowledge existing between human beings. For example, a rabbit usually has long ears and strong legs that support it jumping high and far, and lives in the nature. We also use familiar objects and simple state changes that can be easily understood by young children.

In the *Little Quiz* system, we apply Commonsense tools including the ConceptNet semantic network [5] collected from the Open Mind Common Sense (OMCS) knowledge base [7], and AnalogySpace for concept understanding and reasoning [8]. In this way, when we obtain the user input words (such as "hop", "arm", or "flower"), we can associate the concept with possible comparative words like [hop, rabbit, high], [hop, rabbit, far], [stretch, rabbit's arm, wide], or [be, flower, red]) in the form of [verb, subject/object, adjective/adverb]. By doing so, we can create the tailored narrative sentences to match the user's intent, supported by Natural Language Toolkit (NLTK) [1] that includes the natural language processing (NLP) capability and WordNet [2], a large English lexical database.

The current systems are purely text-based, similar to interactive fiction or text adventure design that lets user play as a story character and input textual commands to navigate in a story world. Parents can help with the interaction between the system and the child by reading and personalizing the text to cater to the interest of their child. Our goal is to encourage children to focus on the objects in the story based on their knowledge, imagination, and observation. The two systems help parents introduce ideas about cleanliness and comparison through storytelling. We envision that parents will use the systems as a verbal script for storytelling interaction with their children.

DESIGN PRINCIPLES
Based on the above narrative systems, we propose design principles for how children can manipulate interactive content within children's interactive narratives. Three basic principles of this approach are as follows.

A Small Interactive World

The first principle is to design a small story world that is interesting enough to incorporate simple spatial relationships and story elements. A small map helps to ease the cognitive load of navigating a virtual space. Instead of building multiple story spaces to explore, we propose that having one or few spaces populated with a few interactive elements (such as actors and objects) supports children's cognitive understanding and learning through real-time interaction, rather than focusing on memory and spatial skills.

Contextual Interactive Content

The second principle is to allow players to communicate by means of short *questions and answers*. To engage children in the interrogative process, our systems prompt simple dialogue. The systems raise context-appropriate questions and show supportive information to both arouse children's interests and further assist them in thinking logically to achieve a task.

Simple Flexible Inputs

The third principle is to allow freedom of exploration on the content level. Real-time reactions to a wide array of inputs create a supportive environment for exploration. For example, allowing interaction with objects to happen in any order and suggesting a variety of commands encourage exploration by the user. In our systems, even when the input is out of the boundary of author's story model, we use commonsense computing or graceful error handling to fill the gap between the authors' story model and players' model. Finally, there is no "puzzle" to solve and win. The enjoyment of the system results from discussion during interaction with the content. Conclusions about the content (e.g. "being clean is good" or "the sky is larger than the valley") are left to the parent and child.

DISCUSSION

In this section, we discuss how our design principles may bring better reading and playing experience for young children.

Cognitive Limitations of Children

In general, we posit that prior works of interactive fiction for children do not take into consideration the cognitive limitations children have. In particular, very young children are unable to understand much abstraction. Having small interactive worlds, referencing common objects, and designing quick and small interactive dialogic loops can make IF more enjoyable for them.

Social Interactive Fiction

A key part of learning for young children is the social aspect of communication. Designing simple content that makes room for parents' creativity can provide much amusement to children. The use of the interactive narrative as a base script for storytelling is a new way to look at interactive fiction for children.

CONCLUSION

This research aims to make interactive narrative more accessible to young children by supporting learning, creativity and logical development. We proposed design principles based on knowledge of children's cognitive psychology research. The principles demonstrate how a children's interactive narrative can allow for creative play and *avoid frustration*. Furthermore, we present an interaction design strategy aimed to *reduce memory load* and focus on story understanding, rather than puzzle solving in traditional IF works. By using simple and encouraging discourse through short interactive prompts, electronic fiction can be used to craft delightful and interesting literature for children.

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