Running head: Inspiring Stories through Content

Inspiring Stories through Content

Caitlin Kelleher

Washington University in St. Louis

Abstract

Through user testing of Storytelling Alice, we found that users' ability to find and develop story ideas was important in maintaining their engagement with programming in the system. In this paper, we describe the design process behind creating a gallery of characters and scenery that helps Storytelling Alice users to find and develop story ideas as well as lessons learned about successful and unsuccessful strategies for scaffolding the process of finding story ideas through content. We analyze thirty-six stories created with Storytelling Alice and examine the relationship between story complexity, users' attitudes towards Storytelling Alice, and their programming behavior.

Storytelling Alice is a programming environment designed to make the process of learning to program more appealing to middle school aged girls by focusing on the activity of storytelling (Kelleher, 2007). A recent study comparing girls' programming behavior using Storytelling Alice and a version of Alice without storytelling support (Generic Alice) found that girls who used Storytelling Alice spent 42% more time within the system programming (as opposed to doing non-programming tasks such as using the mouse to position objects in the 3D scene) (Kelleher, 2007). Further, where only 17% of Generic Alice users snuck extra time to program, 51% of Storytelling Alice users snuck extra time (Kelleher, 2007).

In early user testing of Storytelling Alice, we noticed that users' ability to find a story idea they were interested in pursuing seemed to be an important in maintaining their engagement in the process of programming. Further, the characters and scenery that girls added to their Alice worlds often had a substantial impact on their ability to find a story idea, their success in creating a program, and on their continuing interest in using Storytelling Alice.

The potential impact of girls' choices of 3D objects was illustrated by a pair of girls who came in to user test an early version of Storytelling Alice. One of the two girls chose to add a dinosaur and a person to her world. She then proceeded to build a simple story in which the dinosaur scared the person and the person ran away in fear. Having accomplished that, she added a mouse character and continued her story by having the dinosaur be frightened of the mouse and run away. In this case, the dinosaur's potential to be frightening provided inspiration for a simple story.

The other girl was drawn to a collection of amusement park models, in part because it was one of the only cohesive spaces available in the gallery at the time. She spent a long time carefully arranging the rides in her amusement park and then added a man into the park. She began by having the man ride the merry-go-round but quickly ran out of ideas she wanted to pursue. Lacking a goal she wanted to pursue, she quickly lost interest in interacting with the system.

In response to our observations that the content users chose for their stories could contribute to their success or failure at finding a story, we began to examine how to design content for a storytelling system that helps users find and develop ideas. In this paper, we describe the design process behind creating a gallery of characters and scenery for Storytelling Alice as well as lessons learned about successful and unsuccessful strategies for scaffolding the process of finding story ideas through content. Based on an analysis of thirty-six stories produced with Storytelling Alice, we found that story complexity correlates strongly with the percentage of time users spent within Storytelling Alice on programming tasks (rather than 3D scene layout tasks).

Related Work

There has been extensive past research on creating storytelling systems for children. The goals of these systems range from entertainment to improving literacy to enabling self-expression.

One family of storytelling systems helps users to improve their literacy skills. StoryMat (Cassell, 2004) and Rosebud (Cassell, 2004) encourage children to tell stories and, based on their stories, play back related stories. User studies of StoryMat have found that children incorporate

elements of stories they hear into their own stories (Cassell, 2001). Sam (Cassell, 2004) is a virtual peer who listens to a child's story and replies with a more complex story that models language skills the child has not yet mastered. SAGE allows children to create virtual storytellers, a task which requires that they both listen to and tell stories. Using TellTale (Glos, 1997) and FamilyBlocks (Glos, 1997) children can rearrange stories and pieces of stories with a set of physical props, enabling the exploration of different story progressions. Through encouraging children to reflect on their own and others' stories, these systems help children to become better storytellers.

Researchers at the University of Maryland working in inter-generational design teams have created several storytelling technologies. KidPad (Druin, 1997) is a spatial storytelling system in which children can draw a series of pictures and connect them together using hyperlinks in a zoomable interface. StoryRooms (Alborzi, 2000) are interactive story spaces in which the actions of Story Room visitors can gradually reveal a story. In the process of creating StoryRooms, the authors found that props could be helpful in getting an inter-generational team to tell a collaborative story. This observation lead to the creation of "idea cards" which can depict an object, setting, or an event and are intended to inspire story ideas (Alborzi, 2000) in the StoryRoom space. To enable children to create their own StoryRooms, researchers have prototyped a rule-based programming system (Montemayor, 2001).

Commercially available programs such as American Girl Premiere (Learning Company) and Barbie StoryMaker (Mattel) allow children to create short animated movies using pre-made animations. Programming systems that enable users to create animations such as ToonTalk (Kahn, 1996), EToys (Kay), Scratch (Maloney, 2004), and StageCast Creator (Smith, 1994) can

be used to create animated stories, but do not contain explicit support for finding or developing story ideas.

While our work was inspired by an observation similar to the StoryRooms observation that props can help users to find story ideas, our goal in this research was to develop an understanding of how the attributes and presentation of content can influence users' success telling stories.

Formative Testing – Story Kits

To begin investigating how content can help users generate ideas for their stories we decided to explore the space of Story Kits. We define a Story Kit as a themed set of characters, scenery, and animations designed to help inspire story ideas. Initially, we envisioned three ways in which a Story Kit could be presented to users: 1) in a folder in the Alice gallery of characters and objects (Users of Storytelling Alice construct the cast and setting for their stories by selecting objects from a gallery of pre-made 3D objects).; 2) as a Storytelling Alice program that contains a scene, characters, and an initial animation; or 3) as a combination of a Storytelling Alice program and a supplementary folder of content that users can add through the Storytelling Alice gallery.

We chose to focus on Story Kits as a starting point for two reasons:

1. Girls in our user tests were often attracted to coherent sets of objects within the gallery. For example, they frequently selected the models and characters from Egypt, Japan, and the Amusement Park, the only coherent sets in the original Alice gallery.

2. Story Kits provide a low-cost way to experiment with different ideas. Making rapid, large-scale changes to the full Storytelling Alice gallery which contains more than 350

models was not feasible. Story Kits provided the opportunity to identify promising approaches by quickly developing and testing smaller sets of models and animations.

Thirteen undergraduates who had prior experience with Alice participated in the Story Kits seminar. The undergraduate students worked in teams of three to four students to create and test a series of Story Kits. Over the course of the semester, we created and tested a total of 16 Story Kits in four rounds with each round taking two to three weeks. Each team functioned as a small research group; they were required to propose a mechanism for scaffolding story generation and describe how that mechanism would be realized in their Story Kit. Then, each team created the 3D geometry and textures for all characters and scenery elements in their Story Kit and animated their 3D models in Storytelling Alice. At the beginning of the next round, Story Kit creation teams were shuffled so that the undergraduate students were working with a different team on each Story Kit that they built. This approach of two-week long projects and shuffling teams for each project was inspired by the Building Virtual Worlds course (BVW, 2008). By completing four full rounds of development and testing, we hoped to facilitate the exploration of a wide variety of potential strategies for scaffolding story ideas. The motivation behind shuffling the groups for each round was to enable the Story Kit teams to more fully incorporate lessons learned from the previous rounds. By creating new groups we helped to ensure that each of the Story Kit team members had a unique perspective on the problem of inspiring story ideas, based on his or her experience with past kits. To enable evaluation of a new pair of Story Kits each week, we staggered the team deadlines.

Participants

Throughout the semester, a group of 10 local children came to Carnegie Mellon to participate as informants (Druin, 2002) in the design process. The children ranged in age from 10

to 15, 7 were female, and 6 were African-American. 4 attended public or private school and 6 were home-schooled. The weekly sessions with the participants were 1.5 hours long. During the first session, we explained that we were trying to understand how to build Story Kits that could help middle school students to find ideas for stories. We also introduced the participants to the basics of Alice, concentrating on the features that we felt would be useful in creating stories. During the subsequent Friday sessions, we asked the children to work in pairs to create a story using one of our Story Kits. Occasionally, because of absences or disagreements, children created stories individually. To focus our attention on each of the Story Kits, we instructed our participants to use only the content in the Story Kit to which they were assigned each week. To supplement the capabilities of the Story Kits, participants could use any of the standard Alice 2 animations. These include the ability to move and rotate characters or their body parts in space as well as say, think, and play sound animations that can be used to communicate the action of a story.

While worked with a Story Kit, undergraduate Story Kit designers observed the process and recorded notes about what the participants did and said while creating their stories. To get the most objective information about the success of each Story Kit, we ensured that observers were not involved in the design or development of the Story Kit being tested. Observers recorded the process that participants went through in creating their stories, paying particular attention to suggestions of plot lines or character actions and the context in which those suggestions occurred. Further, the observers studied how engaged participants were in the process of creating a story through looking at cues such as the amount of off-topic conversation, verbal comments like “cool,” frustrated sighs, etc. At the end of each session, we asked the participants to offer suggestions on how to improve the Story Kits. The observations, user’s comments and

suggestions, and the programs that the participants produced were used to provide insight into what attributes of a particular Story Kit contributed to its success of failure. By mixing the Story Kits teams for the next round, we helped to ensure that each of the teams had a more complete view of the strategies that had or had not been successful in the previous rounds.

Example Story Kit

The Secret Agent kit takes its inspiration from the spy stories genre. The goal of the kit was to leverage users' familiarity with these good vs. evil stories, but allow users to customize the struggle. The kit is presented as a folder in the Alice gallery that includes two secret agents (Agent Ajunt and Amme Leep), a villain (doctor Dahkter), and his sidekick (Henchman). The kit further includes a secret lair complete with a missile that can be launched, a computer, piranha tank with animations to enable participants to lower a victim into the tank or rescue someone from it, and a laser poised above a table. Each character is augmented with animations designed to suggest or support different story lines. Doctor Dahkter can laugh maniacally and adjust all of the instruments in his secret lair. The Agents can fight or get caught in one of Doctor Dahkter's many traps. Participants who used this kit immediately recognized the conflict between the agents and the evil doctor and developed stories in which the agents must thwart a variety of evil plots.

Lessons Learned – Story Kits

Through our explorations of Story Kits, we experimented with several strategies for inspiring stories. In this section, we briefly describe the successful and unsuccessful strategies. We believe that these guidelines will be helpful to the designers of other systems based on storytelling.

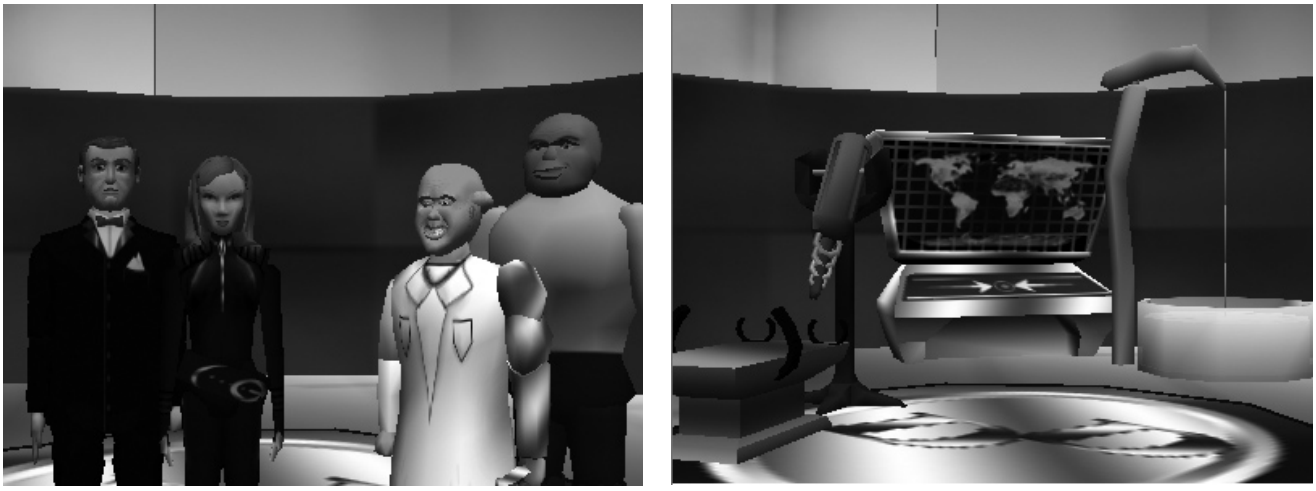

Figure 1: The secret agents (Agent Ajunt and Amme Leep), Doctor Dahkter, and his sidekick Henchman (left). Scenery for the Secret Agent Kit (bottom). The Death Laser and Piranha Tank include animations that provide users with potential evil deeds for Doctor Dahkter (right).

Successful strategies for inspiring stories

Providing characters with specific, visually identifiable roles supplemented b y supporting animations. One of the first round Story Kits was based on Robots and included four teenage robots: Biff is an athletic character who has animations that include flexing his muscles and doing the moonwalk. Gina wears a cheerleading-style skirt and can talk on the phone, dance, and cheer. Harold wears glasses and is a little clumsy as illustrated by his trip and fall animation. Tami wears a sports jersey and can punch and do karate. These characters proved to be exceptionally popular and enabled participants to write stories that exaggerate some of the dynamics that occur in school settings. In participants' stories Harold got teased for being a nerd but saved the day by fixing a broken machine. Biff and Gina fell in love. Based on the characters' appearances and capabilities, users were able to start piecing together ways in which the characters might interact.

Providing animations that require explanation within the story. In the Robot kit described above, the robot Harold had an animation entitled “crazyGoNuts” which proved to be a very rich starting point for stories. Participants wrote stories ranging from Harold’s girl friend breaking up with him to his parents expecting perfect grades and Harold realizing that he had failed a test. These stories all culminated with Harold going crazy.

Initially we believed that the success of “crazyGoNuts” was due to its unexpected nature. To test this hypothesis, kits in later rounds incorporated a variety of unexpected animations. One restaurant themed kit included a set of anthropomorphized animals who, in addition to their restaurant duties, had the ability to “rock out.” This animation was not nearly as successful in helping participants to find story ideas. Through our explorations of different single animations to inspire stories, we found that an important attribute of these animations is that they imply a question (e.g. why would Harold go nuts?). As participants tried to answer that question, they constructed a wide variety of different narratives to explain the behavior.

Providing characters from familiar genres. The characters in the Secret Agents kit do not represent any specific secret agent, but using a recognizable genre allowed users to draw on their experience of other stories or movies that incorporate secret agents for story inspiration. Similarly, a Mixed Fairy Tales kit incorporated characters from two familiar fairy tales: Little Red Riding Hood and The Three Little Pigs. While participants often began by re-creating some portion of one of the two tales, their stories quickly diverged from the traditional fairy tales. These divergences can be facilitated by the animations each character can perform. In the fairy tale, Little Red Riding Hood is rescued by a woodsman. However, because the Story Kit version of Little Red had a “matrixKick” animation, many of the participants chose to have her rescue herself and sometimes the three little pigs as well.

Objects can suggest a goal. Hoping to explore the potential for characters with exaggerated personalities to help spark story, the designers of the Aquarium Story Kit designed a kit that included several anthropomorphized sea creatures. The characters names and animations supported their intended personality: Angela Snobbington, Hyper Henry, Active Ali, and The Dreaded Duchess of Pebbleville. The designers of this kit created an aquarium object and included a cave and a treasure chest, props that are often put into aquariums. Although it was intended as a simple background object, many of the participants centered their stories on a treasure. In one, the Dreaded Duchess of Pebbleville had stolen a fellow sea creature's treasure and the other sea creatures had to work together to get it back.

A Fairy-Ogre Story Kit which featured an ogre's home in the swamp similarly used environmental cues to suggest a story. Next to the ogre's cooking pot is a sign that read "No Faeries Allowed." The participants readily understood that the ogre and the fairies were not friends, but this knowledge was not as effective in helping participants to develop story ideas as the treasure chest in the aquarium kit. The combination of the clearly evil character (The Dreaded Duchess of Pebbleville) and treasure chest in combination suggest both a tension between characters and a potential end-goal for the story. However, even within stories that share a common tension and end-goal, there can be tremendous variation in the ways that participants choose to develop the story.

Unsuccessful strategies for inspiring stories

Providing the beginning of a story. One natural strategy for inspiring stories is to provide the opening of a story that introduces the characters and the conflict and allow users to complete the story to resolve the conflict. The creators of the Spider in the Sink kit provided participants with given a pre-constructed Alice world. When users' played the initial world they saw an

animation sequence showing the spider falling from the edge of the sink into the basin, struggling, and ultimately failing to get out, suggesting a goal for the story. The kit included a gallery of anthropomorphized toiletries that had animations such that they that could either help (e.g. Dan, a roll of floss, could throw the spider a floss line and help her out of the sink) or hurt (e.g. the toothbrush could turn on the faucet) the spider. Few of the participants were interested in completing a pre-created story.

This may be partially attributable to the fact that a set conflict reduces the ability for users to create stories that relate to issues in their own lives. When users could choose their own conflicts, they created stories that addressed a range of important issues including dating, academic performance, trouble with parents, and dealing with bullies. In order to use story beginnings to inspire stories, participants would need to be able to select from several different story beginnings for each kit.

Providing animations that suggest a character's goal. Because items such as a treasure chest or a trophy can suggest a goal for a story, the designers of the Jewel Thief Kit elected to experiment with providing animations that can suggest a particular character's goal or motivation. Each of the characters in the Jewel Thief kit had a fantasize animation which displayed a thought bubble with a picture representing their internal motivation. For example, the butler fantasized about being royalty and saw himself with a crown. Nina the Ninja, on the other hand visualized jewels that she wanted to steal. Where many of the stories created with the Jewel Thief kit did involve the ninja trying to steal the jewels, few of the participants explored any of the fantasize methods. To successfully suggest a story goal, the suggestion cannot be hidden in an animation. Providing an animation for the butler entitled "fantasize about becoming king" would likely have been more effective in providing a possible story direction.

Embedding puzzles in the animations. The designers of the Mosquito Man Kit incorporated a simple logic puzzle into a set of super-hero characters. By combining the talents of the super-hero and side kick, the users could defeat the villain. While this is an appealing concept, it suffers from the same problem as providing the beginning of a story. Because the users have to combine the super her and his side-kick's powers in a specific way, there is relatively little latitude for adapting the story to include issues that are relevant to the user.

Formative Testing – Storytelling Gallery

Based on early user testing with the Alice 2 gallery we found that users were attracted to sets of related characters and scenes such as the Egypt themed models. This observation inspired the initial focus on story kits. To enable rapid exploration of how the Story Kit space and the most effective strategies for inspiring stories, we instructed our participants to create stories using a specific story kit. However, this is an unrealistic requirement in open-ended use of the system and we felt it was critical to perform a second set of user tests in which participants were not restricted to using content from a particular Story Kit.

To facilitate this, we constructed a new gallery in which each Story Kit had a separate folder. A Story Kit's folder included both the characters and scenery objects associated with that kit. We constructed a new version of Storytelling Alice that included the Story Kits gallery. During this round of testing, participants were asked to create stories. They were given no restrictions or suggestions about what gallery content to use in their stories.

Participants

Our second set of user tests included 31 participants, 13 boys and 18 girls, from two local home-schooling groups. Through these groups, we organized two series of user testing sessions.

The sessions were a total of 8 hours, divided into 1 or 1.5 hour sessions. The participants ranged in age from 10 to 16. Most said that math and/or science were their favorite subjects. More girls than boys listed language arts, arts, or history/government related subjects as their favorite subject than boys. Where 9 of the 13 boys listed computers as a hobby, only 2 of the 18 girls did. Girls most commonly listed arts (13 of 18) and sports (13 of 18) as hobbies. According to self reports, the home-schooled boys were more frequent computer users than the girls. All but one of the boys reported using their computer daily. Among the girls, fewer than half of the girls reported using the computer every day.

Lessons Learned – Storytelling Gallery

When users were not instructed to use a single story kit, we found that participants rarely selected all of the characters from the same Story Kit. Instead, they would often choose a setting from one kit and assemble a cast of characters from several different kits. When using the Story Kit based gallery, users lacked a good model for where they were likely to find appropriate characters for their stories. As a result, users often searched through nearly every Story Kit looking for a particular type of character (e.g. a girl , a dog, or a mean character). In contrast to users' tendency to select characters from multiple Story Kits, users frequently used a whole setting from a single Story Kit.

During our initial Story Kits user testing, we found that environmental cues (e.g. a "no fairies allowed" sign in the Ogre's forest) and positional cues (e.g. a fairy character appearing inside the ogre's cage when she is added to the world). Because users tended to assemble a cast from multiple Story Kits, these kinds of techniques which depend on having characters and settings from the same Story Kit are no longer appropriate.

Final Storytelling Gallery Design

Based on our user testing, the process of selecting content for a story can be divided into two steps: selecting a cast and selecting a setting. The high-level organization of the Storytelling Alice gallery corresponds to this pattern: the top-level folders are "characters" and "scenery." Because users tended to select cohesive scenes we created folders representing different scenes such as a classroom, a bedroom, or a forest. Each folder contained content that could be used to create that scene. For example, a classroom scene might contain a room with a chalkboard on the wall, a teacher's desk, and student desks.

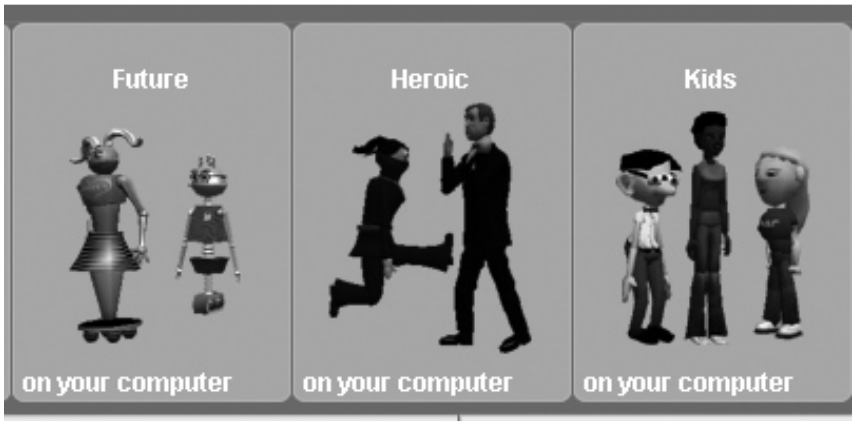

Figure 2: A few of the character folders by organized by role in the Storytelling Alice Gallery

We chose to organize the characters by the roles that they typically play in users' stories. Many of our users chose to use kids as the protagonists in their stories, so we have a folder of "kids." The rest of the characters are organized into groups like "adults," "heroic," or "scary" (see Figure 2). In our user tests, we observed that the non-protagonist characters are typically used as devices to move the story along, introducing a challenge or help: an adult character is often an authority figure, a hero might rescue a character in distress, and a scary character might play the role of a villain. Although this organization arose from the needs of user testing, it

suggests story patterns similar to those described in Joseph Campbell's mono-myth (Campbell, 1949).

In addition to reorganizing the Storytelling Alice gallery, we revised the set of animations that characters in the gallery perform. We incorporated as many animations that support character's roles or require explanation within the story as possible. A lunch lady character was revised to include a "scold" animation which helps to reinforce her likely role as an authority figure and an "attempt to brainwash" animation designed to encourage users to explain why the lunch lady would want to brainwash someone through their stories.

Evaluation – Storytelling Gallery

We began this work with a hypothesis: helping users to find story ideas will help keep them engaged in programming in Storytelling Alice. To examine this hypothesis, we conducted a study in which we asked girls to build programs using Storytelling Alice. In particular, we were interested in two questions:

1) Do users incorporate elements from the storytelling gallery in their stories?

2) Are users with stronger stories more engaged in programming?

Participants

Thirty-six girls were recruited from local Girl Scout troops. The average age for the participants was 12.5 years and nearly all participants were in grades 5-9, with the majority in the 7th and 8th grades. To encourage broad participation, we made a $10 donation to the Girl Scout troop for each girl who participated. Many of the troops mentioned using participation in our study as a way to earn money for trips and other special activities.

Study Details

During the study, participants had two hours and fifteen minutes to complete the Storytelling Alice tutorial (30-45 minutes for most participants) and create a program (during the remaining 90-105 minutes) to share with other study participants at the end of the session.

Data

Storytelling Alice programs. We collected the programs that participants created to get a qualitative picture of what participants build.

Storytelling Alice logs. We instrumented Storytelling Alice to record all of the actions that users took within the program. These logs include both programming activities (e.g. adding, deleting, moving, or modifying a line of code, creating a method, adding a loop) and non-programming activities (e.g. adding, deleting, or positioning characters or objects within the 3D scene). Using these logs, we can recreate the state of the program code at any point in time. Additionally, we can use the logs to examine trends in how users spent their time over the course of the session.

Programming quiz and attitude survey. At the end of the session, participants took a seven question programming quiz that asked them to predict the behavior of short blocks of Storytelling Alice programs. The quiz questions covered sequential execution, parallel execution, loops, methods, parameters, and events. The attitude survey asked participants to answer questions related to their how easy and entertaining they found Storytelling Alice, their intended future use of the system, and their interest in pursuing computer science.

Story complexity. Trabasso proposed the goal-action-outcome (GAO) narrative coding scheme as a tool for understanding the complexity of narratives (Trabasso, 1992). Trabasso's

coding scheme enables analysis of the coherence stories both locally (the connection between a goal, action, and the result of that action) and globally (the connection between local coherent structures). We have labeled the goals, actions, and events in the stories created by our participants and categorized them according to the following scheme:

- 0: No story is present.
- 1: One incomplete GAO sequence.
- 2: One complete GAO sequence.
- 3: Two or more GAO sequences, not globally coherent.
- 4: Two or more GAO sequences, globally coherent.

For each of the stories, a text-version of the story was automatically generated using the log-files. Two coders independently labeled the goals, actions, and outcomes within each of the stories and then classified them according to the rating scheme presented above. Based on the initial coding, the raters agreed on 57% of the story classifications. The remaining stories were each discussed. Each of the two raters presented the rationale for their assigned score. The discrepancies in the initial scores were caused by two things: 1) one of the two raters missed a story element in labeling the goals, actions, and outcomes and 2) the procedure for handling casual conversation within a story was unclear. In our initial instructions to the raters, we did not explicitly address how conversation should be handled. Consider a conversation in which one character asks another character “How are you doing?” The other character answers “fine.” This could be interpreted as an information-seeking GAO sequence. The question “How are you doing?” is both a goal (determine how the character is doing) and an action (ask) and the answer “fine” is an outcome. Unless the information-seeking GAO leads to information necessary to

help the story progress, we chose not to classify these sequences as GAO sequences. Once the raters incorporated missed elements and excluded casual conversation as a potential GAO, they agreed on all of the story ratings.

Results

Table 1: Programs grouped by story complexity.

Story Complexity	**Number of Programs**
No Story	6 programs
1 GAO (incomplete)	5 programs
1 GAO (complete)	10 programs
>1 GAO (not coherent)	1 program
>1 GAO (coherent)	14 programs

Table 1 shows the number of programs created in each complexity category. Most of the users were able to find and develop a story idea (at least one complete GAO sequence). It is difficult to precisely quantify the extent to which users incorporated ideas from the storytelling gallery into their own stories. However, the majority of stories appeared to incorporate ideas from the storytelling gallery. To illustrate how participants incorporated ideas from the Storytelling gallery into their stories, we discuss examples of how character roles and animations requiring explanation provide the inspiration and support the action of stories.

Character roles and their supporting animations

Character role as a central theme. One participant wrote a variation on the traditional Three Little Pigs story. In her story, the Big Bad Wolf confronts the three little pigs with the intention of befriending them but secretly plans to eat them for lunch. The pigs, though afraid of the wolf, do not run away. Instead a ninja comes, frightens away the wolf, and saves the pigs. Here the role of the Big Bad Wolf provides the inspiration for the story conflict.

Character role as a story support. In another story a father and his two children are on vacation in the snow. While hiking to their hotel, they get lost. Despite the father's assurances that everything will be fine, the son uses a cell phone to call his mother and tell her that they are lost. She arrives a little bit later. Frustrated with the father for getting lost with the kids (as he has apparently done before), she spanks him. As a reward for calling her, the mother pats her son on the head, using another character animation. Both the "spank" and the "pat on the head" animations reinforce the mother's role as an authority figure, in this case for both the father and the son.

Animations that require explanation within the story

Explanation-requiring animations as a central theme. Often the stories inspired by an animation that requires explanation consist of a series of events that culminate in the use of an explanation-requiring animation. For example, a story in which Harold the robot went "crazyGoNuts" began with his girlfriend breaking up with him. However, explanation-requiring animations can also occur at the beginning of a story in which case the story seeks to explain what happened and why. In one such story, a magical tree waves hello. A boy named Leon standing nearby sees the tree move and comments to his friends. Leon's friends are skeptical and tease him. The tree, witnessing the teasing, speaks up and tells the children that he can hear them.

Explanation requiring animations as a story support. Another story features parents in the midst of marital strife. The father has lost his job and, in his wife's opinion, is not finding a new one quickly enough. The participant who created this story used the LunchLady as the mother figure. To underscore the mother's displeasure with her husband's unemployment, the LunchLady screams. Later, when the mother finds out that her husband has not been actively searching for a job, she "attempts to brainwash" him.

While the character roles with supporting animations and the animations intended to require explanation within the story are potential sources for story inspiration, it is important to note that users do not have to incorporate these elements. Storytelling Alice includes basic human motion animations including walk, sit on, and say that enable users to construct the kinds of stories they envision (Kelleher, 2006). Animations that enable users to control characters' limbs provide the ability to create arbitrary motions (Kelleher, 2006).

Other Sources of Inspiration

Tutorial themes. Although we focused on helping users to find story ideas through the gallery, we found in classifying the stories that there was an additional source of inspiration: the tutorial. In the second tutorial, users of Storytelling Alice are guided through the process of building a simple story in which a fairy seeking mischief casts a spell on a boy named Trevor who then falls in love with an Ogre. Two of the thirty-six users created stories that used a theme from the tutorial. In one, the mischievous fairy, Petal Beamweb, declares an intention to "make trouble" in a school. Some of Petal's fairy kin resolve to stop her.

Independent ideas. While many of the users incorporated elements from the storytelling gallery to support or even anchor their story line, it is notable that there were several stories in which users created independent stories in which they defined their characters and the

relationships between them in ways that were not suggested by cues within the storytelling gallery. While the storytelling gallery can help users to find ideas, users who have stories in mind already can still create them.

Unsuccessful Stories

Eleven of the thirty-six study participants did not create a cohesive story. However, many include scenarios which establish a clear relationship established between two characters. For example, unsuccessful programs included exchanges in which one character asked another out on a date or a secret agent fought with the evil Doctor Dahkter.

In user studies of StoryMat, researchers found that when StoryMat users heard audio recordings of other children telling stories that were related to their own stories that StoryMat users often incorporated elements of these stories into their own stories (Cassell, 2001). Identifying stories that include characters with similar relationships and providing those stories as inspiration for struggling users may help to jumpstart the storytelling process.

Story Complexity and Programming Behavior

Table 2: Correlations among variables (* p< .1, **p<.05, ***p<.005)

	Story Complexity	% Time Programming	Quiz Score	Entertaining	Easy	Future Use	CS Interest
Story Complexity	1.00	0.53***	0.23*	0.24*	0.11	0.28*	0.02
% Time Programming		1.00	0.10	-0.08	-0.18	-0.13	-0.02
Quiz Score			1.00	0.15	0.10	0.29**	0.29**
Entertaining				1.00	0.51***	0.80***	0.61***
Easy					1.00	0.46***	0.33**
Future Use						1.00	0.64***
CS Interest							1.00

Because we cannot directly influence the complexity of the stories that users build with Storytelling Alice, we can only examine the correlation between the complexity of users' stories, their programming behavior, and their attitudes about Storytelling Alice. Story complexity correlates strongly (r=.53, p<.005) with the percentage of time that users spent programming (rather than laying out scenes) within Storytelling Alice. It also weakly correlates with better performance on the programming quiz (r=.23, p<.1), users' perceptions of Storytelling Alice as entertaining (r=.24, p<.1) and their intention to use it in the future (r=.28, p< .1).

It is interesting to note that amongst Storytelling Alice users who participated in this study, the percentage of time programming was not significantly correlated with either programming or attitudinal benefits. On the surface, this is surprising. In general, it is reasonable

to expect that more time on task will lead to learning benefits. However, Storytelling Alice users across the board spent a significant amount of time on programming. While the ones with strong stories seem to spend more time programming, the users who created the strongest stories (>1 Gao, coherent) only spent twelve minutes more on averages than those who created the weakest stories (0 GAO) over the course of the session. A previous study comparing the programming behavior of Storytelling Alice and Generic Alice (a version without storytelling support) found that users of Storytelling Alice spend 42% more time programming. And, the users who spent more time programming performed significantly higher on the programming quiz. Over a longer period of use, the difference in the amount of time spent programming is likely to lead to greater programming expertise.

Story complexity weakly correlates with users' performance on the programming quiz. One possible explanation for this is that as users develop concrete story ideas, they develop concrete programming goals. In pursuing those goals, they master some basic programming concepts along the way. However, there is a broad range of programming complexity within the participants' stories. Some have used parallel execution, created methods, and used loops and parameters. Others have created programs that are mostly simple sequences of instructions.

Additionally, users who developed stronger stories felt that Storytelling Alice was more entertaining and expected to use it more frequently in the future. This finding provides some support for our initial hypothesis: having a story idea increased users' interest in working with Storytelling Alice. However, many of the users who did not find a story idea to pursue also had a positive attitude towards Storytelling Alice, suggesting that support for story creation may contribute towards users' interest in Storytelling Alice, but clearly other factors also contribute. Within the weak story programs, there is heavy use of social interaction between characters: one

character might taunt another, kick them, or kiss them. The space of social interaction may be compelling because it provides a freedom middle school students often do not have in real life or allows students to recreate their impression of real life. For example, recreating the experience of being taunted by a bully may not require a full story arc if the one being bullied feels believes the situation to be hopeless.

Conclusion

We began our research on supporting users in finding story ideas with a hypothesis: users who can find and develop stories within Storytelling Alice will have a more positive attitude towards the system and learn more about programming. In support of that hypothesis we developed the storytelling gallery based on user tests in which we asked participants to build stories and observed the process, placing particular emphasis on how users found and developed story ideas. The storytelling gallery was incorporated into Storytelling Alice which provides a more motivating introduction to programming than the same environment without the storytelling support (Generic Alice). In this study, we examined how the complexity of the stories that users develop relates to their programming success and interest in using Storytelling Alice. Users who developed stronger stories spent more time programming, performed slightly better on the programming quiz, and had a slightly more positive attitude towards the system. However, many of the users who did not develop a strong story performed well on the programming quiz and had a positive attitude towards the system. At the beginning of this effort, we believed that the ability to craft stories would motivate users to interact with the system. While that appears to be true for some users, it is clearly not true for others. As we continue to develop Storytelling Alice, it will be important to continue to research which other aspects of interacting with Storytelling Alice are compelling to users. However, this raises an interesting

point in the design of compelling education spaces. Currently, we do not have reliable models to predict what will be compelling to users. When we design educational games and play-spaces, the pieces of software themselves embody the designers' theories about how to motivate users to participate in a given activity. The fact that the resulting game is successful in engaging users does not necessarily imply that it is successful because the designers' theory about how to motivate users is completely correct. Looking carefully at the behaviors and experiences of users can help to shed light on what elements of the system are motivating.

REFERENCES

1. Alborzi, H. et al. Designing StoryRooms: Interactive storytelling spaces for children, in *Proceedings of DIS 2000.* ACM Press, 95-104.

2. Building Virtual Worlds. Available at http://www.etc.cmu.edu/bvw/.

3. Campbell, Joseph. *The Hero with a Thousand Faces.* Princeton University Press, Princeton NJ, 1949.

4. Cassell, J. and Ryokai, K. Making Space for Voice: Technologies to Support Children's Fantasy and Storytelling. *Personal Technologies 5,* 3 (2001), 203-224.

5. Cassell, J. Towards a model of technology and literacy development: Story listening systems. *Applied Developmental Psychology* 25 (2004). Elsevier, 75-105.

6. Druin, A. et al. KidPad: A design collaboration between children, technologists, and educators. in *Proceedings of CHI* (Los Angeles, CA 1997). ACM Press, 463-470.

7. Druin, A. The Role of Children in the Design of New Technology. *Behaviour and Information Technology 21,* 1 (2002), 1-25.

8. Glos, J. and Umaschi, M. Once upon an object…: computationally-augmented toys for storytelling. in *Proceedings of Computational Intelligence,* 1997.

9. Kahn, K. ToonTalk: An Animated Programming Environment for Children. *Journal of Visual Languages and Computing*. 7, 2 (June 1996). Academic Press, 197-217.

10. Kay, A. Etoys and Simstories in Squeak. Available at: http://www.squeakland.org/author/etoys.html

11. Kelleher, C. and Pausch, R. Lessons Learned from Designing a Programming System to Support Middle School Girls Creating Animated Stories, in *Proceedings of VL/HCC 2006* (Brighton, UK, September 2006), 165-172.

12. Kelleher, C., Pausch, R. and Kiesler, S. Storytelling Alice Motivates Middle School Girls to Learn Computer Programming, in *Proceedings of CHI 2007* (San Jose, CA, May 2007), 1455-1464.

13. Learning Company, The. *The American Girls Premiere*.

14. Mattel, *Barbie StoryMaker.*

15. Maloney, J., Burd, L., Kafai, Y., Rusk, N., Silverman, B., and Resnick, M. Scratch: A Sneak Preview. in *Proceedings of Creating, Connecting, and Collaborating through Computing* (Kyoto, Japan 2004). 104-109.

16. Montemayor, J. Physical Programming: software you can touch. in *Extended Abstracts of CHI* (Seattle, WA 2001). ACM Press, 81-82.

17. Smith, D.C., Cypher, A. and Spohrer, J. KidSim: programming agents without a programming language. *Communications of the ACM*, 37(7), 1994, 54 - 67.

18. Trabasso, T., Stein, N., Rodkin, P., Munger, M., Baughn, C. Knowledge of goals and plans in the on-line narration of events. *Cognitive Development,* 7 (1992), 133-170.