Character Development to Facilitate Retention in a Storytelling Robot

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ABSTRACT

The purpose of this research is to further the innovation of education technology and education based on technological theory mediated through robotic storytelling agents. Through the development of robotic applications, the researchers create a tool to improve the story and literacy-based retention rates of elementary level students. This investigation seeks to analyze the effects of student retention while participating in story-time with a SoftBank NAO robot that delivers the narrative of multiple characterizations through pre-programmed voice variability, LED lights, and motions. It is the ultimate goal of this research to study the impact of agent character distinctions in storytelling as compared to human storytellers.

CCS CONCEPTS

• Applied Computing → Education → Computer-Assisted Instruction • Human-Computer Interaction (HCI) → Interaction Techniques

Keywords

Educational Technology; Human Robotic Interactions; Robotic Interaction Techniques

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1 INTRODUCTION

Prior educational literature shows that the combination of visual and verbal lessons has been of benefit to students' recollection of class content [10]. When students learn through the engagement of multiple sensory channels, it helps increase retention [8]. Providing visual aids while teaching a lesson verbally, helps to illustrate and crystalize intended learning outcomes. Additionally, storytelling is a common early literacy tool to increase child engagement and excitement toward reading, fluency and understanding [6,3]. Including robots in the classroom to intensify the visual and auditory aids could lead to higher rates of literary retention.

The introduction of NAO robots in the classroom happened within the past decade. Robots paired with specific software and curriculum are offering interesting new learning opportunities. These bots have been used to teach students simple math and literacy [4,12]. The company RobotLab has successfully developed and marketed a robotic curriculum that is used in grades K-12 classrooms across the world. This curriculum is enlightening and helps create a path for research in literary retention [9].

While the hands-on curriculum written by RobotLab offers lessons in reading, writing, math, pre-algebra, geometry, algebra, trigonometry, calculus and programming, the conduction of our research will help to validate if this method of teaching reading and is beneficial or not. In 2007, a study conducted by Bradley S. Barker and John Ansorge found that there was an increase in mean scores from pre- to post-test, indicating that robotics was effective at teaching youth about science, engineering, & technology concepts [12].

It is the researchers' hypothesis that this same result pattern will follow with literacy. It is important that we test students in this fashion because from an economic and a developmental standpoint, educational interventions that begin in early childhood are associated with longer-lasting effects than interventions that begin later in child-hood, and if these effects are positive and in fact do increase retention, the practice of introducing robotic agents into the classroom for story time would likely be implemented far and wide [5].

2 BACKGROUND

Over the past decade, there has been rapid change in the field of social robotics, with an increased focus on how robots can

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integrate into human environments in order to better interactively provide humans physical and cognitive assistance [2]. An important step in educational technology and its subsection of educational robotics is the social acceptance of robots in the education space. Humans gage how useful the technology may be if it is easy to use, and how easy it is to understand [2,7]. Educators are introducing robotic elements into the classroom because the method of robotic teaching is gaining so much popularity [1]. Previous work done on robots and human interaction, trough learning, and storytelling found that gestures and communication begin most if not all one -to-one interactions [11]. In our work, this is important because gestures and recognition of interactions and voice make up the factors that we suppose could increase retention.

This method of teaching is novel in that it implements multiple aspects of a single software to represent multiple dynamic characters. It engages students, while stimulating their ability to retain information. It is a multifaceted learning technique.

3 METHODS

Considering previous research that highlights the regard in which children hold robots, as the interaction with them has not yet been normalized, researchers consider the fact that students might be more willing to participate and engage because the story telling agent may be seen as exciting and impressive. Our research group seeks to understand more about how the novelty of robotic agents, not just as a tool to inspire technology exploration, but also as a means to increase engagement in literacy-based learning. Our research group also understands that as robotic agents appear more often and more frequently in the classroom, the novelty of learning through this agent may wear off and a new learning style be implemented.

3.1 Culturally Relevant Context

Culturally based stories and proverbs have been utilized for ages to characterize, archive and disseminate community knowledge. Often these proverbs and tales, distributed through orally transmuted channels provide the means to pass on historical, social constructs and societal virtues. In West-African communities, these story tellers were called Djeli among the Mande, Griot among many other ethnic groups. Here in the America's there is a strong tradition of African American storytellers who often refer to themselves as Griot as well. No matter the culture, storytelling is not just intended to entertain the listener, but also to insert the listener into a fantastical scene that provides relatable context and valuable life lessons. It is the work of this group to be able to develop a story-telling robotic agent that can provide the same robust 'edutainment' for the African American children of the local community.

3.2 Content Selection

The story selected for this work was "Mufaro's Beautiful Daughters: An African Tale", by John Steptoe.

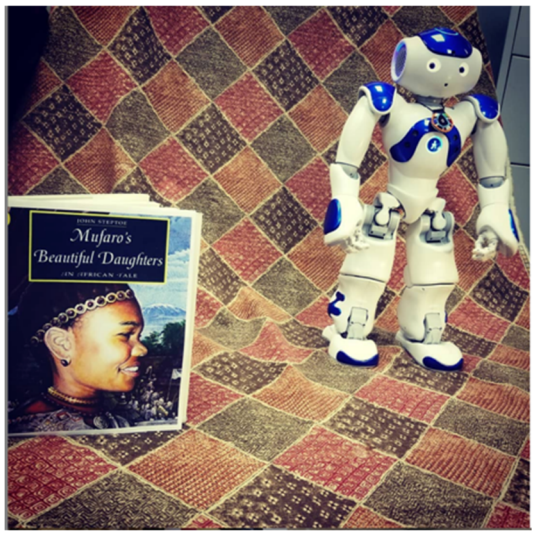

Figure 1: Storytelling Bot featuring Book and NAO Robot

The book was chosen because of the multiple character developments that are present in the narrative. The selection of a story rooted in a tradition African folktale was a culturally relevant 're-visitation' of the classic Cinderella tale that would appeal to the diversity of the African American communities served by the educational programs in the target community. As a Caldacott Honor and Reading Rainbow Book, this updated classic has been used in many classrooms throughout recent history.

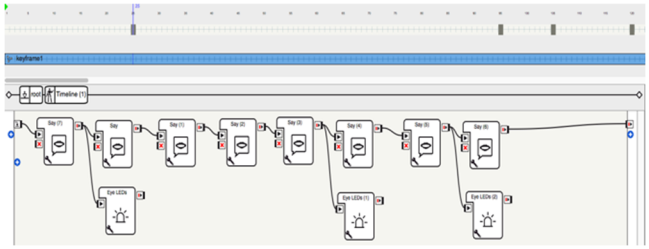

Figure 2: Choregraph timeline featuring a segment of the story

3.3 Character Implementation

To conduct this research, Softbank Choregraphe application development platform, and the NAO humanoid robotic hardware was needed. To program movements, voice, and LED lights the NAO's autonomous life was disengaged, which allowed for mobility. The entire book was transferred into separate speech boxes recognized by the NAO robot. Respective to each character, a voice shape was developed, and a color was chosen to represent them. Based on the scenes in the book each character was involved in, the robot's movements were also choregraphed to suit the projected actions.

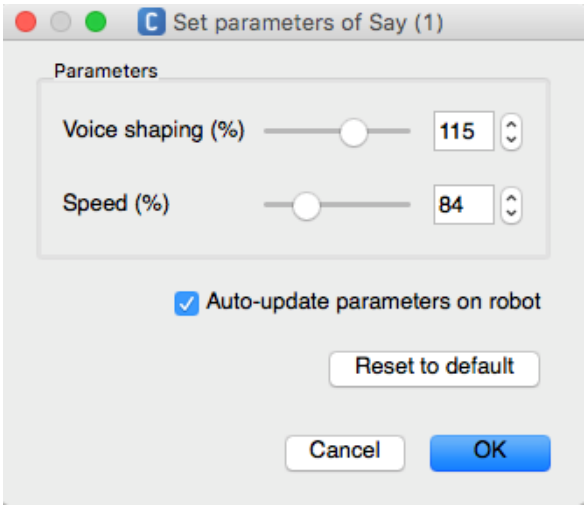

Figure 3: Voice Shaping Sample for Character Nyasha

What makes this program engaging for second grade students is the delivery. The difference between a robotic agent and a human delivering the same story is that the robot can do it statically. Each character the robot is programmed to represent will be the same throughout the narrative (See Table 1). The voice shaping, LED lights, and movements will map to a specific character, their behavior and gestures. This allows students the ability to differentiate between characters in the story while listening and visually seeing the robot's eyes change colors, their voice shift back and forth, and their actions adapt to the scene.

A human could only try to imitate the characters to the best of their ability each time they arise in the story. Although the voice augmentation may come close to sounding the same, it will never truly be identical each and every time. It would also be very difficult for a human to read the book while conducting movements to go along with the tale, along with it being impossible for them to represent each character through an LED color.

Table 1: Character Differentiation

Character	Voice Variability Parameters	Motion Characteristics	Visual Representation (LED Lights)
Narrator	Voice Shape: 100% Speed: 84 %	Informative	White – Omniscient, Goodness
Mufaro	Voice Shape: 50 % Speed: 84 %	Joyous	Gray – Intelligence, Old Age, Soundness
Manyara	Voice Shape: 80 % Speed: 84 %	Frantic, Standoffish	Red – Emotionally intense, Rage
Nyasha	Voice Shape: 115 % Speed: 84 %	Transitive, Gentle, Calm	Purple- Royalty, Wisdom, Dignity
Little Boy	Voice Shape: 90 % Speed: 90 %	Deprived, Begging	Light Blue – Softness, trust, Sincerity
Old Woman	Voice Shape: 90% Speed: 85 %	Warm, Inviting	Brown – Earth, Reliability
King	Voice Shape: 90 % Speed: 87	Subtle, Regal	Green – Traditional color of Peace, Nature

4 RESULTS AND FUTURE WORK

For this work-in-progress, we found that we were able to appropriately distinguish 8 different characters of the story dialogue. Additionally, distinct movements were coded to the agent to enhance the expression of the story to mimic that of a human storyteller, with the goal of improving the delivery, during the 11-minute narrative set in 8 chapters.

For the future activities of this work, researchers will begin with preliminary testing of the Storytelling Bot with two test groups made up of 2nd-grade elementary school students from the [redacted content]. Through an independent test group that receives the interactive story from a human and a dependent test group that receives the interactive story from a robot, the retention of materials and problems solved can be measured quantitatively. By administering a quantifiable test to both groups, rates of retention are gathered and analyzed with the expectation of higher levels from the dependent test group.
In the future, researchers' aim to administer the test multiple times to different independent and dependent groups to maximize data collection and results.

4.1 Retention

To test the retention of the second-grade students, a small test will be given to each group. Questions include things that are expected to be remembered once hearing the narrative, such as the main protagonist's and antagonist's name, their behavior traits, a description of the climax scene, etc. Sample text retention questions include:

1. What were the names of Mufaro's two beautiful daughters?
2. Which daughter was mean? Which was nice?
3. What three other characters did the king appear as?
4. Which of the king's characters appear first?
5. What did the king's messenger say to all of his subjects?
6. Who became the servant in the King and Queen's household?

Each question will be multiple choice with four possible provided answer choices. Students will have 15 minutes to complete a 10-question survey after participating in an 11-minute story time.

4.2 Character Shaping

Additionally, we intend to provide the users with questions related to the character shaping by providing short snippets of the story with sample voice and color content and having the subject identify to which character it belongs. Sample questions include:

1. Can you identify the character with this voice? [insert sample voice text]
2. How do you feel about the voice selected for this character?
3. Which character had the purple color?

4.3 Qualitative Feedback

Using open ended questions in an interview format, we will qualitatively assess student perception of the robot

characterizations, use of lights, voice shaping and length of story elements.

1. What did you think about the robot telling the story?
2. Did the lights help you tell what character was speaking?
3. Do you think story time was too long?
4. Would be interested in hearing another story from the robot?

5 CONCLUSION

The method of presenting a story through a robot with voice variability, motions, and LED lights is assumed to increase the memory retention rates of 2nd-grade elementary school students. This research hopes to further the innovation of education technology and education based on technological theory.

The main goal of this work is to study the impact of character shaping through voice, movement and visual representations as a means to increase retention of story elements. As a result of this work, teachers and engagement personnel can implement the Storytelling Bot in their classrooms.

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