

Robotic Learning Companions for Early Language Development

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ABSTRACT

Research from the past two decades indicates that preschool is a critical time for children’s oral language and vocabulary development, which in turn is a primary predictor of later academic success. However, given the inherently social nature of language learning, it is difficult to develop scalable interventions for young children. Here, we present one solution in the form of robotic learning companions, using the DragonBot platform. Designed as interactive, social characters, these robots combine the flexibility and personalization afforded by educational software with a crucial social context, as peers and conversation partners. They can supplement teachers and caregivers, allowing remote operation as well as the potential for autonomously participating with children in language learning activities. Our aim is to demonstrate the efficacy of the DragonBot platform as an engaging, social, learning companion.

Categories and Subject Descriptors

H.1.2 [Information Systems]: User/Machine Systems – *human factors, human information processing*; I.2.9 [Robotics]

Keywords

Education; learning; play; robotic learning companion; sociable robots

1. MOTIVATION

Research from the past two decades has revealed that a primary predictor for school-aged children’s learning and academic success is the early development of oral language knowledge and vocabulary skills [2,7]. Critical in developing these skills is early exposure not only to a rich set of words but also to a large volume of words [2]. The context in which these words are encountered is equally important – that is, language is inherently *social*. Infants can learn to differentiate phonemes when hearing a person speak, but not from an audiovisual recording [3]; similarly, children can learn some vocabulary when watching television, but they may not learn grammar rules or complex sentence structures [5]. Interactivity and the shared context of speaker and listener are crucial. Any

interventions targeting young children’s language development must account for this social context.

In our research, we have found that *sociable robots*, used as *robotic learning companions*, can provide the necessary social setting for language learning [1,4,8]. Sociable robots leverage the ways people already communicate with one another – that is, social cues that humans easily interpret – to create more intuitive interfaces for interaction. Their behaviors may incorporate speech, nonverbal behaviors such as mimicry, gaze following, and synchrony, movement, or expressions of affect. Combined with educational software, which can provide a student-paced learning experience, customized curricula, and more individual attention than teachers can allocate in a classroom setting, we argue that our robotic learning companions could provide an effective, engaging and scalable educational experience for young students.



Figure 1: Two social, interactive robotic characters, called dragonbots, used as language learning companions for young children.

2. ROBOT PLATFORM

We are using the DragonBot platform, designed by Adam Setapen and collaborators [1,6], as our robotic learning companion (Figure 1). The robot is based on “squash and stretch” principles of animation [9], creating more natural and organic motion and allowing for a range of expressive body movements, while keeping the actuator count low. A smart phone runs the software controlling the robot and provides a screen for the robot’s animated face. The phone’s web camera, microphone, speaker, and wireless capabilities are used to support remote presence

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interactions. A custom tele-operation interface that runs either on a tablet or laptop computer allows researchers, caregivers, or teachers to speak and act “as” the robot.



Figure 2: The tablet-based tele-operation interface for the dragonbot, which allows remote presence interactions.

The robots can display different emotions and internal states through their body motion and facial expressions, including agreement, disagreement, surprise, interest, confusion, and shyness, among others. They can follow or direct a child’s gaze by turning their bodies and moving their eyes. Speech is available through pre-recorded audio tracks or real-time voice streaming and voice pitch shifting from the tele-operation interface.

3. LEARNING COMPANION

The robots are versatile and could support a variety of interactions and curricula. For example, in upcoming work, we use plastic animals as well as tablet-based games as conversation props or play scenarios. In an initial study, a DragonBot played a digital tablet-based “food-sharing” game with preschool-age children and their parents [1]. This study revealed that through the interaction, children engaged in communicative and social behaviors, as well as language mimicry [1]. Parents guided children’s behavior and reinforced the robot as a social actor in the interaction, without prompting. This highlights how educational technologies, like these robots, are not designed to be replacements for parents or teachers – quite the opposite. The goal is to supplement what caregivers are already doing and scaffold or model beneficial behaviors that caregivers may not know to use.

4. CONCLUSION

Our goal is to demonstrate the efficacy of the DragonBot platform as an engaging and social learning companion,

peer, and conversation partner for young children. Future work includes refining the robot’s repertoire of behaviors, introducing more autonomy, developing more extensive curricula and games to support joint child-robot language activities, and formally evaluating the robot’s abilities to support language development at a local preschool.

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