Tutor Me Elmo: Improving Engagement and Learning Gains in Intelligent Tutoring Systems with a Robotic Interface

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***Abstract* - We propose a study comparing the effects of a child-friendly, robotic interface on engagement and learning gains in 5 year old students compared to a read-aloud storybook covering the same information. The robotic interface, a modified Elmo Live toy, creates an ecologically valid learning environment by tapping into children's preconceptions of learning from Elmo as well as their desire to play with Elmo.**

Keywords-robots; tutoring; Elmo; children

Introduction

Intelligent Tutoring Systems, or ITSs, use artificial intelligence techniques to deliver individualized instruction. Compared with traditional forms of instruction, ITSs fare extremely well: a meta-analysis has found the typical improvement in learning of ITSs over classroom instruction is comparable to raising the performance of 50 percentile students to that of 85 percentile students [1]. Historically, ITSs have been built primarily for school age children, with a particular emphasis on middle school and high school. However, some ITSs have targeted even earlier grade levels. Project LISTEN, for instance, teaches children to read by listening as the child reads aloud and offers help when the child encounters trouble. Though this system is aimed mainly at 2nd to 5th graders, it has been used in 1st grade classrooms as well [2]. Another literacy ITS named "Marni" has targeted children ages 5 to 7 and was found to be a likeable program that promoted bonding between the student and the agent [3]. It is perhaps not surprising that both of these systems focus on literacy, since preliterate students might have difficulty learning content using a traditional computer interface consisting of a keyboard and a screen.

However, there is clearly significant content that is taught to children in school before they learn to read, yet it is taught not through books, but through activities and face to face interactions with an instructor and peers. The traditional PC-based ITS is ill suited to be used in such an environment by the nature of its interface. As a result, if ITSs are to be used by pre-literate students, a paradigm shift in the user interface is required.

One solution to address these concerns may be found in robotics. Conversational robots do not require a computer screen to read or a keyboard to type, and they can function as simple conversational partners through a speech interface. This makes them ideal for younger populations who can treat a robotic tutoring agent as an interactive toy.

Furthermore, younger users may find a robotic agent to be engaging [4], which encourages increased interaction times and should promote greater learning gains than less engaging methods of conveying information. It is our goal to investigate the possibility that robotic interfaces promote engagement among younger children and create learning gains that surpass those found with picture books, an ecologically valid control. To do this, we will use the popular character *Elmo* from the American television show *Sesame Street* to deliver lessons on environmentalism; the educational nature of the show and popularity of Elmo in the toy market lends credibility and mundane realism to both an educational book featuring Elmo and a robotic Elmo interface.

Methods

This experiment will be conducted using a class of students (roughly 5 years old in age) from a Southern Kindergarten, and students will complete the experiment one at a time. The information domain covered is environmentalism (Earth Science), a state mandated topic that is addressed every year after the student enters Kindergarten. The domain topics addressed are reuse, recycling, water conservation, saving electricity, growing plants, and discouraging littering.

Students will be pretested on this material by using a two-alternative, forced choice method of questioning. As students at this age typically are not fully literate, an experimenter will present the student with two pictures of Elmo performing a "good" and "bad" environmental act, and they will be asked to point to the picture that shows what Elmo is supposed to do. For instance, an experimenter may show a picture of Elmo throwing a stack of newspapers in a trashcan and a picture of Elmo throwing a stack of newspapers into a recycling bin. He or she would then ask the student which Elmo should do when he wants to get rid of some old newspapers. The questions are based either directly on material that will be covered in the experiment (recognition questions) or near transfers of the lessons in the experiment (transfer questions). A near transfer in this experiment occurs when a lesson covers some specific point (e.g., turn off the television to save electricity) and the child is asked a question with the same theme (e.g., should Elmo turn off a computer to save electricity?). The pre- and post-test formats are identical: 12 questions (6 memory, 6 transfer) are asked in the pictorial forced choice method so that different types of learning gains can later be assessed. Piloting will be conducted to test the viability of these materials.

After pretesting, each student will be exposed to two phases in the tutoring: the storybook phase and the robotic phase (counterbalanced). In the storybook phase, an experimenter will read two randomly selected sections of a book written and illustrated specifically for this experiment; the storybook has six sections that correspond to the six domain topics listed above. Each section has approximately four pages dedicated to that topic, with one or two sentences on each page and a colorful image of Elmo in some sort of relevant situation. In the robotic phase, two more sections (selected at random but not overlapping with the storybook sections) will be delivered by a robot Elmo toy. The remaining two sections not covered by the book or robot will be used to assess the baseline knowledge of the child.

The storybook and the narrative spoken by the robot are based on an identical script, with conversational components added to the robotic narrative to make the robotic session more interactive (Elmo asks one question of the child per section) and to give the robot a convincing personality (e.g., make the robotic Elmo laugh and cheer as the television character does). This experiment uses as its robotic interface an Elmo Live toy modified with a Phidgets InterfaceKit 0/16/16 that connects to a PC via USB.

After interacting with the storybook and the robot, the children will then be post-tested using new pictorial, forced choice questions. Finally, the children will be asked in a similar fashion how much they enjoyed the Elmo toy, with answers that depict activities they would like to do (read a book or play with an Elmo toy) and how they felt while the Elmo toy was talking. They will also be asked a few open-ended response questions to hear what the students had to say about the robot (to be used for improvements and future development). The entire session will be videotaped to record the affect and responses of the children during the experiment and their responses to the open-ended questions.

III. Future Direction and Contributions

In a few months time, we hope to carry out the proposed experiment in order to investigate the effects of a child-friendly robot on engagement and learning gains. Conversational robots may be the key to providing engaging, content-based tutoring for preliterate children, a population relatively ignored in the ITS community. It also represents a foray of intelligent tutoring systems into the field of robots, a union which may boost the popularity of ITSs.

IV. References

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