PIERO COSI [1], RON COLE [2]

MINDSTAR BOOKS - AN IMAGINATIVE NEW GENERATION OF INTELLIGENT TUTORING SYSTEMS IN SCIENCE AND IN READING

Abstract: MindStar Books represents an imaginative new generation of intelligent tutoring systems in science and in reading. Great strides are seeking in the quest to immerse students more effectively in multimedia learning activities in which they are challenged, motivated and empowered to acquire the knowledge and skills to learn reading and science.

1 Introduction

MindStar Books are designed to scaffold effective science learning with the following aims:

- They will enable students, especially including English, Italian, and Spanish language learners, to acquire the prerequisite vocabulary and concepts to listen to and understand science texts that are read aloud to them, eventually by a virtual tutor, while they view illustrations that help them visualize the science being explained.
- They will assess students' understanding of the science through spoken presentation of deep reasoning questions, challenging answer choices representing common misconceptions, and immediate formative feedback on their answer choices.
- They will engage students in activities that lead to accurate, fluent and expressive reading of grade-level texts; skills that correlate highly with reading com-prehension and future reading success (Baker et al., 2008),

[1] ISTC-CNR, UOS Padova
Istituto di Scienze e Tecnologie della Cognizione, Consiglio Nazionale delle Ricerche - Unità Organizzativa di Supporto di Padova - Italy
[piero.cosi, giulio.paci, giacomo.sommavilla, fabio.tesser]@pd.istc.cnr.it.
[2] BLT
Boulder Language Technology
Boulder, Colorado, USA
rcole@bltek.com

(Fuchs, L.S. et al., 2001), (LaBerge, D., Samuels, S. 1974), (Perfetti, C., 1985), (Reynolds, R.E., 2000), (Samuels, S., 1997), (Stanovich, K.E., 2000).

These are important and exciting aims based on prior research and development, and they are within grasp. As for "Scientific Foundations", MindStars Books are based on theory and evidence indicating that a student's ability to read and understand a text - their reading comprehension ability - consists of two component skills: listening comprehension and word reading automaticity. Listening comprehension is an individual's ability to listen to a text and an-swer spoken questions about it. Reading fluency is the ability to recognize words accurately and effortlessly. Research shows that students' reading comprehension abilities can be accurately predicted by independent measures of their listening comprehension skills and their ability to recognize words accurately and rapidly (Gough, et al, 1996), (Gough & Tunmer. 1986), (Hoover, & Gough., 1990).

MindStar Books are designed to help students develop these two essential skills and each MSB consisted of three independent activities:

- narrated multimedia science explanations;
- multiple choice questions for assessing students' knowledge and providing them with immediate feedback on their answer choices;
- reading practice, which used automatic recognition of children's speech while reading aloud to provide them with feedback on their reading.

2 Design and Organization of MindStars Books

The MindStars Books Toolkit was developed to provide an easy to use authoring environment for developing the listening comprehension activities in MS Books, and publishing the book in a library.

The MSB Editor, is an authoring tool that was used to create, test and refine the books developed over the course of the project by various teachers. The Editor is an intuitive, flexible and powerful tool that could be used by individuals with no programming experience for creating, testing and publishing MSBs. Creation of a book within the MSB Editor produces a published book with all of the interactive science learning and reading activities, which included automatic feedback to students on their oral reading fluency. Working from a completed script, a complete MSB can be developed and published in a single day.

In particular the MSB Editor is a tool that enables an author to:

a) type in each sentence MSB will say, eventually by a virtual tutor;

b) record the sentences in English and record the Italian and Spanish translation of each sentence;
c) select a picture that will be presented with each narrated sentence (portions of pictures are highlighted using Photoshop);
d) include optional sound files into the narration;
e) design one or more multiple choice questions, with optional illustrations, that are presented after the page has been narrated;
f) record the questions and answer choices in English and both Italian and Spanish. Once the listening comprehension activities have been developed, the oral reading fluency training activities, which follow listening comprehension, are generated automatically, using the text that is narrated, eventually by a virtual tutor, during listening comprehension training.

3 Listening Comprehension

In MSBs, each page of a science text is narrated, eventually by a virtual tutor, while the student views illustrations that help them visualize the science. The narration is self-paced in alignment with research that indicates that self-paced presentations improve learning (Baker, 2003), (Cole, et al., 2003), (Cole, et al., 2007a).

Students can stop and resume the narration after each sentence is spoken, and have the sentence repeated in English or say an Italian or Spanish translation of the sentence. After listening to one or more pages of text, students are presented with multiple choice questions (MCQs) to assess their understanding of the vocabulary and concepts. These are deep reasoning questions with challenging answer choices that represent common miscon-ceptions. Students can listen to the question and answer choices either in English or in Ital-ian or Spanish as often as they like.

After selecting an answer, the student receives immediate feedback about the answer they selected. A positive feedback is obviously provided to a correct answer. If the student selects an incorrect answer choice, learning is supported by providing a hint; e.g., that spider has 8 legs, so it can't be an insect. After two tries, the correct answer is presented to the stu-dent, along with an explanation as to why the answer is correct. During listening compre-hension activities, words are not presented on the page, as the goal is to have students listen carefully while viewing illustrations; research indicates that printed words can distract the student's attention from the illustrations and reduce learning (Cole et al., 2007b).

4 Oral Reading Fluency (ORF)

ORF practice and training occurs immediately after the listening comprehension activities are completed; that is, after all pages of the science text have been narrated to the student and MC questions have completed.

The goal of the ORF training is to help students learn to read grade level science texts accurately and fluently; oral reading fluency has been demonstrated to be a strong predictor of reading comprehension and later reading proficiency (LaBerge, D., Samuels, S. 1974), (Perfetti, C., 1985), (Ward, 2011).

Fluency training occurs through repeated reading of each page of the science text. The student is presented with the first page of the text, with each sentence displayed on the page. The student can choose to practice reading the text, with eventually support from a virtual tutor, before reading it independently. During practice, the student can listen an entire sentence to be read, or individual words in a sentence to be pronounced. The students can record themselves reading these sentences or words and play back their recordings to compare their reading with the correct one, eventually spoken by a virtual tutors. During playback of their recordings, each word is highlighted on the page as it spoken by the student. English learners can listen to MSB read a translation of the sentence in Italian or Spanish. When the student has finished practicing, they click an icon to read the page independently. Immediately after reading the page, the student receives feedback on the number of words they read correctly (out of the total number of words on the page), and their reading rate (relative to MSB's natural reading rate). The MSBs highlight words that the speech recognizer scored as misread or skipped, so the student can practice reading these words and sentences. Repeating readings of the page, with practice before each reading and feedback on the student's reading performance immediately after independent reading, continues until the student achieves a criterion level of oral reading performance (90% word reading accuracy, reading speed within 10% of MSB's) or after three independent readings. Repeated reading of texts with feedback and practice following each reading has been shown to be a powerful tool to improve reading fluency, which correlates highly with reading comprehension (Baker et al., 2008), (Fuchs, L.S. et al., 2001), (LaBerge, D., Samuels, S. 1974), (Perfetti, C., 1985), (Reynolds, R.E., 2000), (Sam-uels, S., 1997), (Stanovich, K.E., 2000).

5 Final Considerations

English, Italian and Spanish speech recognizers needed for ORF practice are already well developed and at an advanced level. Development and evaluation of MindStars Books is already on a good stage for English and Spanish and will be hopefully extended to Italian in the next year, depending on the effective funding of various submitted research projects and grants.

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Author name, affiliation and email

Piero Cosi, Giulio Paci, Giacomo Sommavilla, Fabio Tesser

ISTC-CNR, UOS Padova
Istituto di Scienze e Tecnologie della Cognizione
Consiglio Nazionale delle Ricerche
Unità Organizzativa di Supporto di Padova
Via Martiri della libertà, 2
35137 Padova

[piero.cosi, giulio.paci, giacomo.sommavilla, fabio.tesser]@pd.istc.cnr.it