

Abstract

This dissertation addresses an indispensable skill using a unique method to teach a critical component: helping children learn to read by using computer-assisted oral reading to help children learn vocabulary. We build on Project LISTEN's Reading Tutor, a computer program that adapts automatic speech recognition to listen to children read aloud, and helps them learn to read (<http://www.cs.cmu.edu/~listen>). To learn a word from reading with the Reading Tutor, students must encounter the word and learn the meaning of the word in context. We modified the Reading Tutor first to help students encounter new words and then to help them learn the meanings of new words. We then compared the Reading Tutor to classroom instruction and to human-assisted oral reading. The result: Second graders did about the same on word comprehension in all three conditions. However, third graders who read with the 1999 Reading Tutor, modified as described in this dissertation, performed better than other third graders in a classroom control on word comprehension gains – and even comparably with other third graders who read one-on-one with human tutors.

Story choice. In the spring of 1998, 24 students in grades 2, 4, and 5 at a low-income urban elementary school used the Reading Tutor with a student-only story choice policy. In the fall of 1999, 60 students in grades 2 and 3 at a (different) low- to middle-income urban elementary school used a revised version in which the Reading Tutor and the student took turns picking stories. The students who used the Take Turns Reading Tutor in fall 1999 averaged 64.1% new sentences out of ~35,000 sentences overall, calculated on a per-student basis. This was a significantly higher percentage of new material than the 60.1% for the ~10,000 sentences read by the students who used the student-only story choice policy Reading Tutor in spring 1998. Furthermore, the Reading Tutor's story choices helped the most for those who did not choose new stories themselves: about half of the students picked new stories less than half the time on their own turns, with some choosing as few as 15% new stories. With the Reading Tutor's choices included, all students read about 50% or more new stories.

Vocabulary help. By augmenting stories with vocabulary help such as short context-specific explanations or comparisons to other words, the Reading Tutor can help students learn words better than they would from simply reading the unaugmented stories.

We augmented text with "factoids": automatically constructed comparisons of a target word to a different word drawn from WordNet, an electronic lexical database. A four-month study conducted in Fall 1999 compared text with vs. text without factoids. A control trial consisted of a student seeing a target word in a sentence and – on a later day – answering an automatically constructed multiple choice vocabulary question on the target word. An experimental trial inserted a factoid prior to presenting the sentence containing the target word. In total, over 3000 trials were completed. There was no significant difference overall between experimental and control conditions; however, exploratory analysis identified conditions in which factoids might help. In particular, story plus factoid was more effective than story alone for the 189 trials on single-sense, rare words tested one or two days later ($44.1\% \pm \text{s.e. } 37.7\%$ vs. $25.8\% \pm \text{s.e. } 29.4\%$, $p < .05$ prior to correction for multiple comparisons). Story plus factoid was also more effective than story alone for third graders seeing rare words ($42.0\% \pm \text{s.e. } 28.4\%$ vs. $36.2\% \pm \text{s.e. } 22.9\%$, $p < .10$ prior to correction). The suspected benefit of seeing the factoid was perhaps due to a word recency effect – sometimes the comparison word was the correct answer in the multiple choice question.

Comparison to classroom instruction and human-assisted oral reading. Human tutors are often considered the gold standard for instruction, and while computer instruction can (sometimes) beat classroom instruction, it typically falls well short of one-on-one human tutoring. In a year-long study, 144 second and third graders at an urban elementary school received classroom instruction for most of the school day, along with one of three 20-minute-per-day treatments. Students were assigned to exactly one of: (a) reading (and writing) with the Reading Tutor, (b) reading (and writing) with a human tutor, or (c) continuing with regular classroom instruction. All three treatment conditions included a range of activities, including some directed at vocabulary development. Thus we were comparing three comprehensive treatments on a single aspect of learning to read, not three treatments aimed specifically at encouraging vocabulary development. Students were pre-tested and post-tested on the Woodcock Reading Mastery Test, a norm-referenced, professionally administered reading test with subtests measuring Word Attack, Word Identification, Word Comprehension, and Passage Comprehension. Students were also tested on oral reading fluency. This dissertation focuses on vocabulary learning, so we only report results on Word Comprehension. For second graders, all three conditions were comparable. For third graders, results were as follows. The 1999 Reading Tutor, with Take Turns and factoids, achieved an effect size of 0.56 over classroom instruction on Word Comprehension gains ($p = .042$). Human tutors achieved an effect size of 0.72 over classroom instruction ($p = .039$). There was no significant difference between human tutors and the Reading Tutor on Word Comprehension gains.

Follow-on experiments explored ways to make vocabulary assistance even more effective, such as adding short child-friendly explanations to text. An initial test confirmed that even low-reading students could understand short explanations well enough to do better on immediate multiple-choice questions than without such explanations. A within-subject experiment in summer 2000 measured word familiarity and word knowledge on eight (difficult) words with a paper test given one or two days after exposure to those words in one of four conditions: no exposure, definition alone, children's limerick alone, or definition plus children's limerick. Definitions increased all students' familiarity with the words, and limericks yielded a strong trend favoring increased familiarity. Also, while 2nd and 3rd graders performed essentially at chance on word knowledge, 4th and 5th graders learned enough from reading stories and definitions with the Reading Tutor to do better on word knowledge. This study furthermore ruled out the word recency effect as an explanation, since none of the words in the definitions or limerick showed up as answers on the multiple choice test. This experiment also shed light on the relationship between word familiarity and word knowledge: the correlation between word familiarity and knowledge was larger in higher grades. Limericks may have been more effective at strengthening the tie between word familiarity and word knowledge – a direction for future research.

Summary. First, taking turns picking stories helped children see more new sentences and more new stories than they would on their own. Second, augmenting stories with automatically constructed vocabulary assistance helped children learn more from their initial encounters with words than just the story alone – at least, for single-sense rare words tested one or two days later. Follow-on experiments point the way to even better vocabulary assistance. Finally, at least for third graders, the 1999-2000 Reading Tutor with Take Turns and factoids outperformed a classroom control on Word Comprehension gains – and was even competitive with one-on-one human-assisted oral reading.