



Building Student Summarization, Writing and Reading Comprehension Skills With Guided Practice and Automated Feedback

Highlights From Research at the University of Colorado

A white paper from Pearson Knowledge Technologies

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Introduction

The Nation's Report Card for Reading¹ (National Center for Education Statistics, 2005) indicates about half of eighth- and twelfth-grade students score at or below a basic level of reading comprehension. In addition, according to the National Reading Panel, children can read, but they often don't understand the meaning of what they're reading or how to sort through what's relevant², which can lead to frustration and poor test scores.

This alarming statistic underscores the importance of taking steps to ensure that basic reading skills are mastered in the lower grades. One key skill that helps build the ability to comprehend material is to summarize text that has been read. Typically, summarizing is introduced to students in the third grade, but it continues to be a part of instruction in the higher grades as well.

To help students build summarization skills and, ultimately, strengthen overall comprehension abilities, University of Colorado at Boulder researchers developed Summary Street™, an automated tool to evaluate the content of students' summaries. Using Summary Street, students use their own words to write summaries of text they have read and receive immediate feedback. Summary Street measures student writing by comparing it with the actual text, evaluating it based on content knowledge as well as writing mechanics, redundancy and relevancy. With Summary Street, teachers can select texts from content areas such as science, social studies and history. They can retrieve automated reports showing individual student progress as well as class results and have access to all revisions of student writing.

To date, more than 2,000 students have used Summary Street, and in addition to significant improvement in student writing and comprehension performance across subject areas, students report that they find using Summary Street motivating, rewarding and fun. Summary Street includes more than 100 reading passages from across the curriculum, including selected readings from Pearson Prentice Hall's middle grades textbook programs, "Science Explorer" and "World Studies." This white paper summarizes recent research conducted at the University of Colorado at Boulder revealing that using Summary Street helps students build reading comprehension and writing skills.

¹ National Center for Education Statistics, 2005.

² Donovan, M., & Pellegrino, J. (EDS), "Learning and Instruction, A SERP Research Agenda." Published by The National Research Council of the National Academies, Wash. D.C., p. 52.

How Summary Street Works

Summary Street consists of a student interface, a teacher interface and the Knowledge Analysis Technologies™ (KAT) engine, which automatically evaluates the meaning of text by examining whole passages. The technology evaluates writing as accurately as skilled human graders, agreeing with them more often than they agree with each other.³

- **Student Interaction:** Students interact with the system by logging in through the Web. They select a text to summarize from a library of materials, enter their summary through a simple editing window, and receive immediate feedback on the quality of their summary. Figure 1 shows the graphic feedback that allows students to pinpoint and address their writing difficulties. With each subsequent change to their summary, students can track their progress toward the goals specified by their teacher via Summary Street.

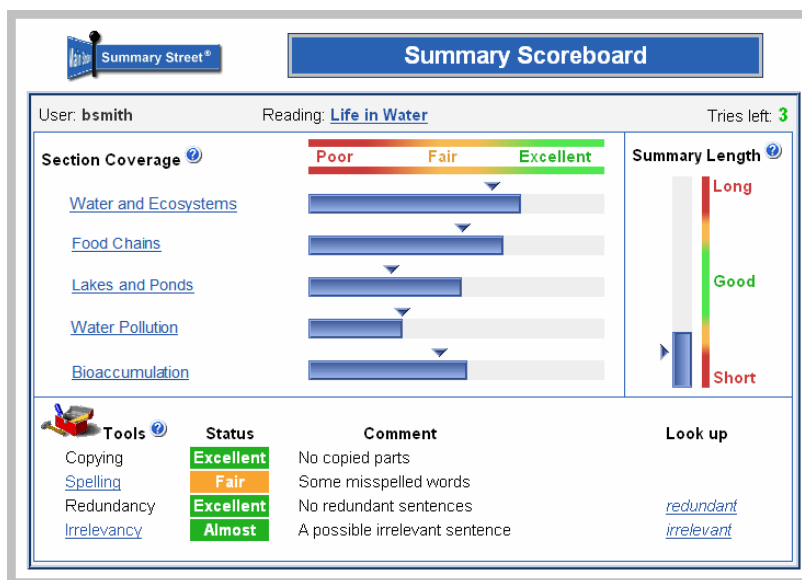


Figure 1: Summary Street Feedback Screen.

- Summary Street provides feedback on whether:
 - The summary covers the key points of each section of the reading passage
 - The summary has been condensed from the original text (the general guideline is about 15 percent of the original text length)
 - The student has used his or her own words, or simply copied from the original
 - There is too much repetition
 - There are any unrelated sentences that don't add anything to the overall value or meaning of the summary
 - There are any spelling errors and offers assistance in correcting them

³ Note: Summary Street's core features are included in WriteToLearn™, Pearson Knowledge Technologies' writing skills and reading comprehension development tool. In WriteToLearn, the summarization capabilities have been paired with an essay-writing component known as Intelligent Essay Assessor™ (IEA).

- **KAT Engine.** Summary Street technology is based on the KAT engine. The KAT engine is based on Pearson Knowledge Technologies' unique implementation of Latent Semantic Analysis (LSA), an approach that generates semantic similarity of words and passages by analyzing large bodies of relevant text. LSA then "understands" the meaning of text much the same as a human reader. The ability of LSA to comprehend natural language is similar to human comprehension, with results documented in a number of prestigious refereed professional journals (e.g., Landauer & Dumais, 1997). In Summary Street, the KAT engine uses LSA to derive the semantic similarity between the student-submitted summaries and the original text, and to find potentially repeated or unrelated content.
- **Teacher Interaction.** Teachers can log into Summary Street to set up class rosters and administer assignments. Student proficiency levels can be addressed by assigning materials at different difficulty levels, by modifying content scoring thresholds and expected summary length, and by allowing for different spell-checking options. Teachers can also monitor their class and student performance by choosing from a number of reports, starting at the class overview level or drilling down into the successive performance of one particular student.

University of Colorado Research Results

Researchers from the University of Colorado Institute of Cognitive Science evaluated Summary Street over the course of a five-year study funded by the Interagency Education Research Initiative, a collaborative effort sponsored by the National Science Foundation, The U.S. Department of Education and the National Institutes of Health.

Summary Street has been evaluated in a number of language arts and subject matter classrooms. Across several smaller studies and experiments, it has proven to measurably increase students' summarization, general writing, and reading comprehension skills. In one study, exposing students to only four weeks of practice, the students improved their content summary scores by an overall effect size of $d = 0.9$ (see figure 2). This means that for a class of mixed-ability students, students scoring at the fiftieth percentile can improve their writing performance with difficult materials to the eighty-second percentile. When the performance of low- and medium-ability students (the lower 75 percent of the distribution) is considered, the effect size rises to $d = 1.5$ for the most difficult materials. (An effect size of 1.0 corresponds to approximately a one-grade difference in elementary school. An effect size of 1.5 is extremely rare in educational research.)

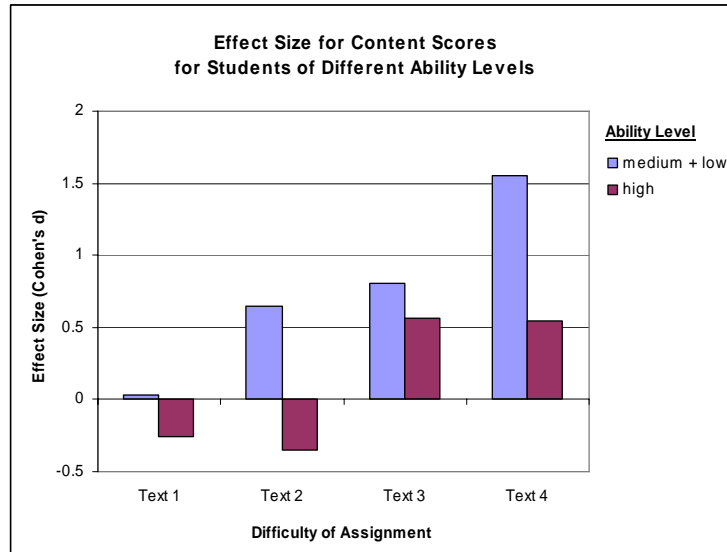


Figure 2: Effect sizes for summary content scores for low- and medium- (bottom 75 percent) vs. high-ability (top 25 percent) students. Based on 120 eighth-grade students randomly assigned to a control group with no feedback and an experimental group.

As corroborating evidence, independent scorers found increases not only in the student's ability to condense and abstract, but also in measures of organization and style. Repeated, guided practice led to improvement in writing ability across a broad range of measures. In the analysis of the long-term data, the before and after summary performance of matched classes showed that the increase in performance endured, even when students wrote without the support of Summary Street. Students included 50 percent more relevant content in their test summaries after having used Summary Street in their school work. Finally, students who used Summary Street increased their performance on gist-level comprehension items of a standardized comprehension test by an effect size of $d = 0.42$, compared with students who practiced summary writing without getting feedback.

The results of this work have been reported in refereed professional journals and conferences, and edited volumes (see Caccamise, Franzke, Eckhoff, Kintsch & Kintsch, in press; and Franzke, Kintsch, Caccamise, Johnson & Dooley, 2005).

Why Summary Street Works

In the current educational environment, struggling students rarely have enough opportunities to practice their writing skills in the classroom. As related research shows (e.g., Graham & Harris, 2005; or Patthey-Chavez, Matsumura & Valdes, 2004), students benefit most from specific, immediate and individualized feedback on their performance, especially when it addresses the content as well as the surface-level features. This feedback allows them to hone in on particular deficits and improve their performance until they can meet pre-defined criteria. Providing an environment with frequent, rich feedback opportunities is beyond the limits of typical classroom instruction and often beyond the limits of supportive parents or tutors. Summary Street provides this type of environment. It alerts the students to specific problems in their summaries without penalizing or overcorrecting them. It simply provides a way to improve performance until learning criteria are met. Research on the use of Summary Street proves that this type of guided practice with immediate feedback helps students improve reading comprehension and writing skills.

For more information, visit www.SummaryStreet.com.

About the Authors

Marita Franzke, Ph.D.

Marita Franzke works as a member of Pearson Knowledge Technologies' technical staff. She conducts research and leads design of emergent educational and communication technologies. Responsibilities include the planning, design and analysis of user trials and user interface design of end-user facing applications. In the last five years, Franzke was part of a group of researchers at University of Colorado at Boulder who conducted a large-scale trial of Summary Street in Colorado Public Schools. Previously, she has held research and manager positions at AT&T Broadband Labs, MediaOne Labs and US WEST Advanced Technologies. In these positions, Franzke conducted and published research in the areas of technology adoption and use in homes and communities, including TV and interactive TV, telephone, Internet and automatic speech recognition. She has a doctorate of philosophy in cognitive psychology from the University of Colorado at Boulder, and a vordiplom in psychology from the Ruhr-Universitaet Bochum in Germany.

Lynn A. Streeter, Ph.D.

As president of Pearson Knowledge Technologies, Lynn A. Streeter is responsible for widespread adoption of the company's products and technologies in the marketplace and maintaining its innovative focus and edge. Streeter has held vice president and general manager positions at US WEST Advanced Technologies, where she directed research and development; marketing for e-commerce; computer science; online multimedia training; information retrieval and interface design. Previously, Streeter held computer science technical management positions at Bellcore (now Telcordia) and Bell Laboratories. She also holds a patent with Thomas K. Landauer, Pearson Knowledge Technologies founder, and Karen E. Lochbaum, vice president of Software Engineering, for Latent Semantic Analysis, for the mathematical/scientific approach on which the KAT engine is based. At Bellcore, Streeter and Lochbaum used Latent Semantic Analysis to build a system called the Bellcore Advisor, which was used for several years to quickly identify people with specific expertise within the 5,000-person company. Streeter has a doctorate of philosophy from Columbia University and completed the Stanford Business School Executive Program. She has published numerous articles in speech technology and psycholinguistics, information retrieval, software engineering and artificial intelligence.

About Pearson Knowledge Technologies

Pearson Knowledge Technologies is the developer of products and services based on a unique automated text analysis technology that evaluates the meaning of whole passages. The company's KAT engine immediately measures writing and content in a way that simulates a skilled human grader and encourages better subject knowledge. Pearson Knowledge Technologies' writing and reading skills products, such as WriteToLearn™, Intelligent Essay Assessor and Summary Street, use the KAT engine to help improve writing, reading and comprehension skills, as well as build content knowledge for education and other markets.

Pearson Knowledge Technologies is a business of Pearson Education, the world's largest integrated education company, which in turn is part of Pearson, the international media company. Pearson's other primary operations include the Financial Times Group and the Penguin Group.

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