What Does It Mean To Comprehend What One Reads?

Headsprout® Reading Comprehension:

Research Foundations

Marta Leon, PhD | T.V. Joe Layng, PhD | Melinda Sota

What does it mean to comprehend what one reads? Reading comprehension is not an ability that students either have or do not have. When students understand what they read, they are applying a constellation of skills and strategies to interpret the text based on both the features of the text and their own knowledge. When students are faced with a question about a text, what they do to answer that question may best be described as problem solving (Kintsch & Kintsch, 2005).

Yet what are the skills and strategies that lead to successful problem solving in reading when students must understand and answer questions about what they have read? Can those skills be effectively taught?

In reviewing the research on reading comprehension, the National Reading Panel (NICHHD, 2000) found that two major instructional factors influence reading comprehension: knowledge of vocabulary and active use of multiple comprehension strategies. The following sections describe the research and analysis that forms the foundation of Headsprout® *Reading Comprehension*, including how the program teaches vocabulary and comprehension strategies, and the scientific development process underlying the program.

now part of DYMO | Mimio®

Building Vocabulary

Research has consistently shown that vocabulary knowledge is a significant component of reading comprehension (see for example, Beck, Perfetti, & McKeown, 1982; NICHHD, 2000; Spearritt, 1972; Tannenbaum, Torgesen, & Wagner, 2006). Although students are continuously learning new words from multiple sources, researchers agree that explicit vocabulary instruction is a crucial component of a reading comprehension program (see for example, Jenkins, Matlock, & Slocum, 1989; Nagy, Herman, & Anderson, 1985; Stahl & Fairbanks, 1986). The challenge facing educators is how to provide explicit vocabulary instruction on the wide range of words that learners are expected to master within the limited amount of time typically available for this instruction (Nagy & Anderson, 1984).

Headsprout has developed a unique method of rapidly and explicitly teaching vocabulary by integrating findings from two fields of research on how children learn the meanings of words and form networks of related concepts: stimulus equivalence (Sidman, 1992) and rapid mapping (Bloom, 2000). The vocabulary words learned are then made firm and extended through multiple and varied use in later stories and questions. In addition, implicit vocabulary teaching occurs throughout the program through "Just-in-Time" Vocabulary (Stahl, 2005) and through learners' use of strategies to derive meaning from context. Each of these methods is described below.

Expanding Semantic Networks with Stimulus Equivalence

Research on stimulus equivalence is concerned with establishing and evaluating relations among different things, such as the relations among a word, a definition of that word, and a picture illustrating the word. Equivalence means that all things included in the relation acquire the same meaning or function (Sidman, 1992; Wilkinson & McIlvane, 2001). By setting up specific instructional sequences to systematically teach relations between words, definitions, and pictures, Headsprout *Reading Comprehension* is able to teach 24 such relations in less than five minutes. Because the new words are taught using definitions likely to already be a part of the student's repertoire, the new word automatically becomes a part of the student's larger set of semantic relations.

Structured Rapid Mapping

Rapid mapping (also called fast mapping) is the process operating when children seem to learn new words naturally and effortlessly. This process is based on the principle of learning by exclusion. For example, if there are two items in sight — a red one and a turquoise one — and the child is asked to point to the turquoise one, she will do so correctly as long as she has already learned what red is. The child will also likely retain the meaning of turquoise over time, even without extensive practice, and with no explicit teaching (Bloom, 2000). Headsprout *Reading Comprehension* incorporates procedures within its vocabulary instruction that lead to rapid mapping, allowing students to quickly and effortlessly "discover" the meanings of new words.

"Just-in-Time" Vocabulary

The number of words in a student's repertoire can vary widely among students. A word that is familiar to one student may be completely unfamiliar to another. This presents a challenge when reading in the classroom, as it is important for students to identify when they come across a word they don't understand and then to find the meaning of the word — a process that can be challenging for young students, as well as disruptive to ongoing reading comprehension. Stahl (2005) described this difficulty and its solution, called "Point of Contact" teaching. In Point of Contact teaching, students are taught to raise their hands when they encounter an unknown word so the teacher can provide a brief synonym or definition for it while the student is reading. Because this is brief and only occurs as needed, the disruption to ongoing reading is minimal. Headsprout *Reading Comprehension* has incorporated a very similar procedure, which we call "Just-in-Time" Vocabulary. When reading a story, students can click on selected words in the text to hear the word's pronunciation and a short definition as they are reading. This allows each individual student to receive help with unknown words, while avoiding extensive disruptions to ongoing reading. It can also be very helpful for English language learners, whose English vocabularies may be less extensive than those of their peers.

Strategy Learning

Explicitly teaching strategies for comprehending text is specifically recommended by the National Reading Panel (NICHHD, 2000), and questions asking what a word or phrase means are common in tests of reading comprehension. Headsprout *Reading Comprehension* teaches students when and how to apply specific strategies to derive the meaning of a word from context in order to answer these questions.

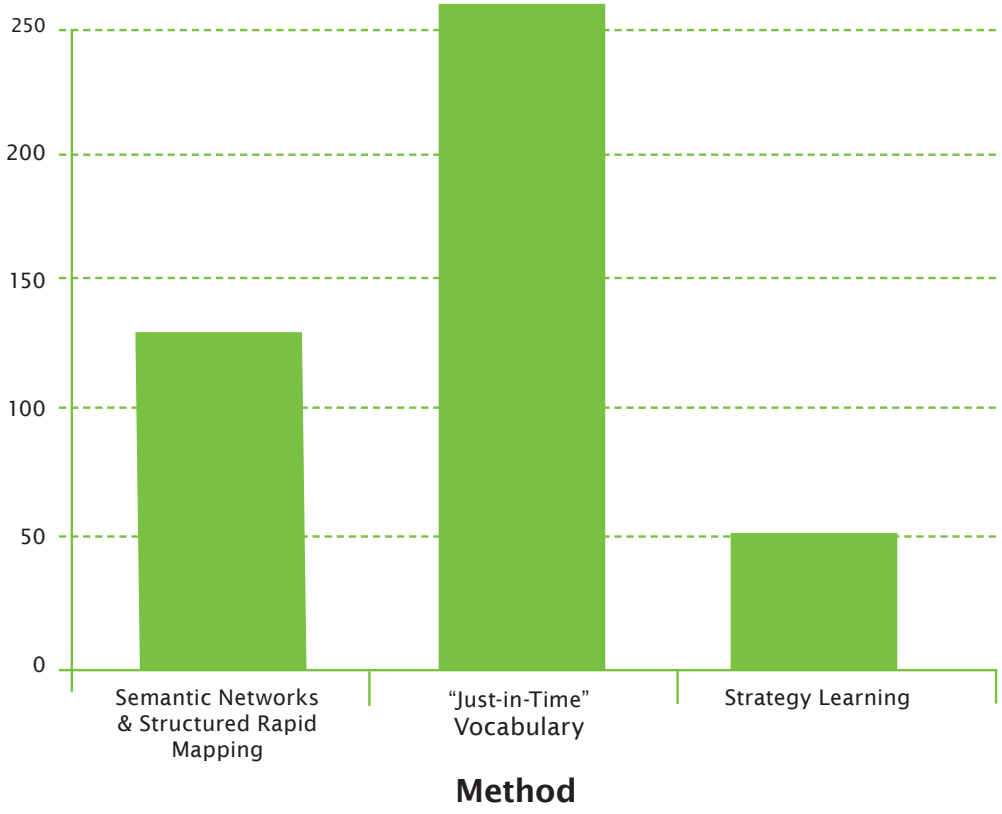
Application and Retention

In order for a word and its meaning to be retained for a long period of time, multiple and varied exposure to that word needs to occur (Stahl, 2005). Headsprout *Reading Comprehension* incorporates vocabulary words into passages that occur later in the program, as well as into reading comprehension questions and answers. This not only allows multiple exposures to the words, but requires students to actively process the word's meaning within new passage contexts.

Table 1. Five Major Methods of Building Vocabulary	
Semantic Networks	Designed to rapidly connect words, definitions, and visual representations, this activity is based on an area of research called stimulus equivalence. Students learn 24 relations between words, definitions, and pictures in less than 5 minutes.
Structured Rapid Mapping	An activity designed to allow students to learn new vocabulary quickly through discovery; developed based on research investigating how people rapidly learn new words in everyday environments.
"Just-in-Time" Vocabulary	Based on "Point of Contact" teaching (Stahl, 2005) — students can click on selected words in text to hear the word's pronunciation and a short definition as they are reading.
Strategy Learning	Students learn how to derive the meaning of a target word or phrase from context.
Application and Retention	In order to be used and retained, new words must be encountered in multiple contexts (Stahl, 2005). The words taught in the program occur in stories and passages throughout the program, and students later use these words to answer questions about text.

Figure 1 shows the number of words taught by each method of building vocabulary.

Figure 1. Number of Vocabulary Words Taught by Method



Alignment with Findings of the National Reading Panel

These five methods of building vocabulary are also consistent with the more general recommendations of the National Reading Panel (NICHHD, 2000). Upon reviewing the research on vocabulary instruction, the National Reading Panel determined that:

1) Vocabulary should be taught both directly and indirectly
2) Repetition and multiple exposure is important
3) Incidental learning can enhance acquisition
4) Use of computers can be an effective means of vocabulary instruction
5) Direct instruction should actively engage the student
6) Vocabulary should be taught with multiple methods

Table 2 describes how each of these points is addressed within Headsprout *Reading Comprehension*.

Table 2. Headsprout *Reading Comprehension* Alignment with Findings of the National Reading Panel

1) Vocabulary should be taught both directly and indirectly.	· Students are directly taught target vocabulary words before reading a passage and "discover" other word meanings through structured discovery learning exercises. · Students learn to derive word meaning from context. · Students are able to click on words in a text while reading, in order to hear the word's pronunciation and definition.
2) Repetition and multiple exposure is important.	·Students practice all semantic relations for each word taught, such as identifying the word that goes with a picture, identifying the picture that goes with a word, identifying the word that goes with a definition, and identifying the definition that goes with a word. ·Vocabulary words are used throughout the program in multiple contexts so students are exposed to the word multiple times and are required to use it in different situations. For example, a vocabulary word directly taught in one episode might be critical for answering a reading comprehension question in a later episode.
3) Incidental learning can enhance acquisition.	·Students are able to click on words while reading the texts in order to hear the word's pronunciation and definition. ·Students learn to derive word meaning from context.
4) Use of computers can be an effective means of vocabulary instruction.	·Headsprout *Reading Comprehension* takes full advantage of the interactive potential offered by a computer-based program, providing immediate feedback and instruction tailored to each student's responses. ·The individualized, interactive nature of the program requires each student to make active responses to every instructional piece.
5) Direct instruction should actively engage the student	·In a 5-minute vocabulary activity, a student makes over 25 unique responses, actively constructing 24 relations between words, definitions, and pictures illustrating the meaning of the words.
6) Vocabulary should be taught with multiple methods.	·Five major methods to teaching vocabulary are used within the program (summarized in Table 1).

Teaching Reading Comprehension Strategies

Reading comprehension is a complex and multi-faceted process, with the skills and strategies applied depending on factors related to the text, the question, the reader's background knowledge, and others (Kintsch & Kintsch, 2005; van den Broek et al., 2005). Despite the complexity inherent to this task, research has shown that instruction can have a positive and significant effect on reading comprehension (NICHHD, 2000).

Our analysis of standardized tests of reading comprehension revealed four major types of questions, each requiring a different strategy: literal comprehension, inferential comprehension, understanding of main idea, and deriving meaning from context. Analysis of these strategies into their components (Gardner, 1985) informed the instructional sequences used in Headsprout *Reading Comprehension* to teach students how and when to apply these strategies to answer questions about text, as well as how to use resources that may accompany text (see Table 3).

Table 3. Four Text Comprehension Strategies + Resource Use

Literal comprehension	Students learn how to answer questions by finding answers explicitly stated in a text.
Inferential comprehension	Students learn to activate and use their background knowledge to identify relevant portions of a text— which they then use to infer the answer to a question.
Main Idea comprehension	Students learn how to identify themes in a passage, and use these themes to determine the main idea of the passage or what the passage is 'mostly about.'
Derived Meaning (Vocabulary)	Students learn to use context to derive the meaning of a word or phrase.
Resource use	Students learn to answer questions about resources that accompany text or occur as part of a question, such as tables of contents, maps, diagrams and other illustrations.

Overarching Instructional Elements

In teaching students the skills and strategies involved in reading comprehension, Headsprout *Reading Comprehension* incorporates a wide range of instructional elements that have been found to positively impact learning across a wide range of skills. These include instruction in component skills, instruction in metacognitive components, modeling, and scaffolding.

Instruction in component skills

Component skills are those skills that are part of a more complex skill or task. Identifying and teaching component skills separately makes it more likely that students will learn more complex skills quickly and accurately (Johnson & Layng, 1992). In Headsprout *Reading Comprehension*, students first learn and practice the separate component skills required to apply each comprehension strategy. Once students have mastered the component skills, they begin to combine and integrate these component skills in order to apply the strategies to answer questions.

Instruction in metacognitive components

The ultimate goal of instruction in reading comprehension strategies is for students to independently use the learned skills and strategies when reading. In order for students to independently apply strategies, they need to not only know how to apply each strategy, but also when to apply each one, and to make this determination over a range of new materials. This can be considered a metacognitive skill, in that it requires students to monitor their own understanding of what the question is asking and determine which strategy to use to figure out the answer based on a combination of the text (or other material) and their own background knowledge (Johnston, 1985). In Headsprout *Reading Comprehension*, students learn to identify what a question is asking, and to use the strategy most appropriate based on the question requirements and the text characteristics.

Modeling

Headsprout *Reading Comprehension* includes "think aloud" models of each comprehension strategy via animated graphics and narrated dialogue. Once students have mastered the component skills relevant to each strategy, application of each strategy is modeled in the program. After watching the model, students have the opportunity to use the modeled strategy to answer comprehension questions and receive feedback. Later in the program, demonstrations occur to review and refine application of the comprehension strategies. These models help students combine the component skills of each strategy in order to successfully answer comprehension questions. In addition, the "think aloud" nature of the models demonstrates the processes involved in applying each strategy, which can help students to develop metacognitive skills associated with applying the strategies (Collins, Brown, & Newman, 1989).

Scaffolding

Scaffolding refers to transitioning students from highly guided instruction during the early stages of learning to independent application of the skills learned as the instruction progresses. Scaffolding is dynamic in that instruction and feedback are provided based on a student's specific responses during a problem-solving situation, and only provided as necessary (Lajoie, 2005; Wood, Bruner, & Ross, 1976). Headsprout *Reading Comprehension* employs instruction and feedback throughout the program that is based on the individual student's specific responses. As students master the skills involved in answering different types of questions, help is gradually withdrawn, and only reinstated if a student's responses indicate that the student is having a particular difficulty with a question. As students progress through the program, they answer increasingly complex reading comprehension questions, with instruction and feedback targeted toward the student's responses to the question. At the end of the program, students answer comprehension questions independently, in activities specifically designed to prepare them for the level of questions and support they will encounter on tests of reading comprehension and in other independent reading contexts.

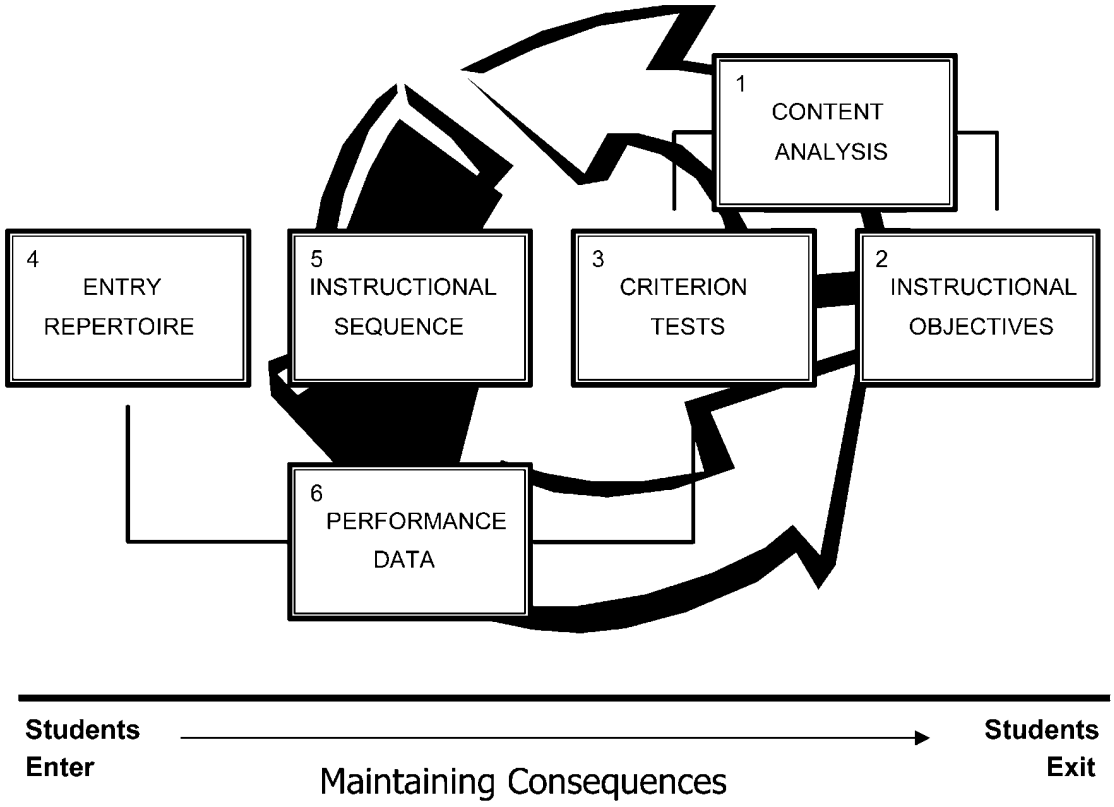
Table 4. Headsprout *Reading Comprehension's* instructional elements

Instruction in component skills	Students learn and practice the components of each reading comprehension strategy and then combine and integrate these components to answer questions.
Instruction in metacognitive components	Students learn not only *how* to apply the reading comprehension strategies, but *when* to apply them—a metacognitive skill necessary for independent use of the strategies.
Modeling	Students watch "think aloud" models to help them integrate the components of each reading comprehension strategy.
Scaffolding	Student work within the program is individualized and dynamic, so that the instruction and practice each student receives is based on the student's responses within the program.

Headsprout's Scientific Development Process

The content, instructional components, and instructional sequence of Headsprout *Reading Comprehension* were informed not only by an analysis of previous research, but also by Headsprout's scientific design and development process (Markle & Tiemann, 1967; Twyman, Layng, Stikeleather, & Hobbins, 2004). This process (see Figure 2) includes a continual cycle of testing and revision during development in which each instructional activity and sequence of activities is tested with individual learners, revised based on learners' interaction with the activity, and tested again. This process iterates until the activities meet a pre-specified criterion for effectiveness indicating that the learning objectives for the activity have been met (Layng, Stikeleather, & Twyman, 2006).

Figure 2. Headsprout's nonlinear programming process adapted from Markle and Tiemann (1967)



References

Beck, I. L, Perfetti, C. A., & McKeown, M. G. (1982). Effects of long-term vocabulary instruction on lexical access and reading comprehension. *Journal of Educational Psychology*, 74(4), 506-521.

Bloom, P. (2002). *How Children Learn the Meanings of Words*. Cambridge: MIT Press.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics. In R. Glaser & L. B. Resnick (Eds.) *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser* (pp. 453-494). Hillside, NJ: Lawrence Earlbaum Associates.

Gardner, M. K. (1985). Cognitive psychological approaches to instructional task analysis. *Review of Research in Education*, 12, 157-195.

Jenkins, J. R., Matlock, B., & Slocum, T. A. (1989). Two approaches to vocabulary instruction: The teaching of individual word meanings and practice deriving word meaning from context. *Reading Research Quarterly*, 24(2), 215-235.

Johnson, K. R. & Layng, T. V. J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist*, 47(11), 1475-1490.

Johnston, P. (1985). Teaching students to apply strategies that improve reading comprehension. *The Elementary School Journal*, 85(5), 635-645.

Kintsch, W. & Kintsch, E. (2005). Comprehension. In S. G. Paris & S. A. Stahl (Eds.) *Children's Reading Comprehension and Assessment* (pp. 71-92). New York: Routledge.

Lajoie, S. P. (2005). Extending the scaffolding metaphor. *Instructional Science*, 33, 541-557.

Layng, T. V. J., & Stikeleather, G., & Twyman, J. S. (2006). Scientific formative evaluation: The role of individual learners in generating and predicting successful educational out comes. In R. Subotnik & H. Walberg (Eds.), *The Scientific Basis of Educational Productivity* (pp. 29-44). Greenwich, CT: Information Age Publishing.

Markle, S. M., & Tiemann, P. W. (1967). Programming is a process [Slide/tape interactive program]. Chicago: University of Illinois.

Nagy, W. E. & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, 19(3), 304-330.

Nagy, W. E., Herman, P. A., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly*, 20(2), 233-253.

National Institute of Child Health and Human Development [NICHHD] (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Publication No. 00-4769). Washington, D.C.: U.S. Government Printing Office.

Sidman, M. (1992). Equivalence relations: Some basic considerations. In S. C. Hayes & L. J. Hayes (Eds.). *Understanding Verbal Relations* (pp. 15-27). Reno: Context Press.

Spearritt, D. (1972). Identification of sub-skills of reading comprehension by maximum likelihood factor analysis. *Reading Research Quarterly*, 8, 92-111.

Stahl, S. A. (2005). Four problems with teaching word meanings. In E. H. Hiebert & M. L. Kamil (Eds.) *Teaching and Learning Vocabulary: Bringing Research to Practice* (pp. 95-114). Mahway, NJ: Erlbaum.

Stahl, S. A. & Fairbanks, M. M. (1986). The effects of vocabulary instruction: A model-based meta-analysis. *Review of Educational Research*, 56(1), 72-110.

Tannenbaum, K., Torgesen, J. K., & Wagner, R. K. (2006). Relationships between word knowledge and reading comprehension in third-grade children. *Scientific Studies of Reading*, 10(4), 381-398.

Twyman, J. S., Layng, T. V. J., Stikeleather, G. and Hobbins, K. A. (2004). A non–linear approach to curriculum design: The role of behavior analysis in building an effective reading program. In W. L. Heward et al. (Eds.), *Focus on Behavior Analysis in Education*, Vol. 3, (pp. 55-68). Upper Saddle River, NJ: Merrill/Prentice.

van den Broek, P., Kendeou, P., Kremer, K., Lynch, J., Butler, J., White, M. J., & Lorch, E. P. (2005). Assessment of comprehension abilities in young children. In S. Stahl & S. Paris (Eds.), *Children's Reading Comprehension and Assessment* (pp. 107-130). Mahwah, NJ: Erlbaum.

Wilkinson, K. M & McIlvane, W. J. (2001). Methods for studying symbolic behavior and category formation: Contributions of stimulus equivalence research. *Developmental Review*, 21, 355-374.

Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 17(2), 89-102.

For more information, please contact:

schoolinfo@headsprout.com

www.Headsprout®.com