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Structure strategy interventions: Increasing reading comprehension of expository text

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Abstract

In this review of the literature we examine empirical studies designed to teach the structure strategy to increase reading comprehension of expository texts. First, we review the research that has served as a foundation for many of the studies examining the effects of text structure instruction. Text structures generally can be grouped into six categories: comparison, problem-and-solution, causation, sequence, collection, and description. Next, we provide a historical look at research of structure strategy interventions. Strategy interventions employ modeling, practice, and feedback to teach students how to use text structure strategically and eventually automatically. Finally, we review recent text structure interventions for elementary school students. We present similarities and differences among these studies and applications for instruction. Our review of intervention research suggests that direct instruction, modeling, scaffolding, elaborated feedback, and adaptation of instruction to student performance are keys in teaching students to strategically use knowledge about text structure.

Keywords: Text structure, structure strategy intervention

Introduction

Reading for understanding is vital for readers of all ages. The 2009 National Assessment of Educational Progress (U. S. Department of Education National Institute for Education Statistics, 2010) reported that 33% of 4th-grade students examined could not read at the basic level required to understand what they read. Comprehension of expository text is critical for academic success in school (National Educational Goals Panel, 1999). Despite its importance, in comparison to narrative texts, students receive less exposure to expository

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texts in early elementary school (e.g., Duke, 2000). This lack of exposure may place readers at a disadvantage because beginning in 4th-grade students increasingly are expected to learn from expository texts in language arts, science, and social studies (Guthrie & Davis, 2003).

Reading comprehension involves actively constructing new understandings by building relationships among the parts of text and between the text and one's pre-existing knowledge. Good readers build coherent mental representations of what they read by understanding different text structures, generating inferences, monitoring their understanding, and using multiple strategies to construct meaning. Use of text structure to understand how the important ideas of a text are inter-related increases readers' meaning making. Readers who use text structure can mentally examine how ideas in text are inter-related through the use of such relationships as sequence, comparison, causation, or problem and solution. These readers also may use external aids that show the top-level structure of a text to reduce memory demands. These aids include templates, text structure patterns, graphics, matrices, outlines, knowledge maps, or tree structures (e.g., Meyer, Young, & Bartlett, 1989).

Over the last 40 years, Meyer (e.g., 1971, 1975) and her colleagues (e.g., Meyer & Rice, 1982; Meyer et al., 1989; Meyer & Poon, 2001; Meyer et al., 2010) have studied text structures and readers' abilities to use them (see Table 1). Readers who use a "structure strategy" seek to identify and use the author's organization to organize their own understanding (Meyer, Brandt, and Bluth, 1980). The structure strategy facilitates comprehension by helping the reader to organize concepts based on the explicit or implied relationships that are communicated by the text. The strategy promotes comprehension compatible with van den Broek's coherence-based processes in his simulation model of comprehension (van den Broek, Rapp, & Kendeou, 2005). The causal connections of his model focus on the important cause-and-effect relationships that make up the logical structure of narrative text just like text structures build on each other to establish the logical structure for nonfiction text. Text structures not only describe the text itself, but also characterize readers' cognitive coherence representations (e.g., Meyer & Freedle, 1979, 1984; Sanders & Noordman, 2000). Good readers use their knowledge of text structures to build coherent memory representations (Meyer et al., 1980). Signaling words (see Table 1) can cue text structures and assist readers toward building coherent text representations. The key role of signaling words is in selection and encoding, particularly if readers have learned the structure strategy (e.g., Meyer & Poon, 2001).

The power of teaching students the structure strategy is that it enables them to a) follow the logical structure of text to understand how an author organized and emphasized ideas; b) use processes parallel to these structures to increase their own learning and thinking (e.g., comparing, finding causal relationships, looking for solutions to block causes of problems); and c) use these text structures to organize their own writing, such as written summaries, recalls, and essays.

In this paper we review empirical studies of interventions designed to teach the structure strategy in order to improve reading comprehension. First, we briefly discuss the basic research that served as a foundation for instruction about text structures. Next, we provide a historical look at structure strategy interventions. In this historical overview, we examine both the history and advancements in studies of structure strategy instruction. Finally, we review recent text structure interventions for elementary school students. For each intervention study included in this review, we examine the strategy instruction in terms of the number and types of text structures and/or signaling words taught, the methods of instruction, the rigor of the intervention design, and relevant findings.

Table 1. *Text Structures with Signaling*

COMPARISON (compare/contrast) – relates ideas by differences and/or similarities; complexity can be increased by the number and detail of issues compared. The main ideas are organized to provide a comparison, contrast, or alternative view (e.g., political speech).

instead, but, however, alternatively, whereas, on the other hand, while, compare, in comparison, in contrast, in opposition, not everyone, all but, have in common, similarities, share, resemble, the same as, just as, more than, longer than, less than, act like, look like, despite, although, difference, differentiate, different…

PROBLEM-and-SOLUTION – relates responding ideas; complexity can be increased by the identification of causes of the problems and ways to reduce them. The main ideas are organized in two parts: the problem (or question) part and the solution (or answer) part, which responds to the problem part (e.g., popular science articles, medical information).

Problem: problem, trouble, difficulty, hazard, need to prevent, threat, danger, puzzle, can hurt, not good, bad…

Solution: to satisfy the problem, ways to reduce the problem, so solve these problems, protection from the problem, solution, in response, recommend, suggest, reply…

CAUSE-and-EFFECT (causation) – relates ideas casually; complexity can be increased by embedded cause and effect paths and causal chains and reduced by similarity to familiar narratives. The main ideas are organized into cause and effect parts (e.g., directions, explanations, economic or science texts)

cause, led to, bring about, originate, produce, make possible, owing to, by means of, accomplish by, since, due to, because, in order to, reasons, why, if/then, on account of, in explanation, effect, affects, so, as a result, consequence, thus, therefore, accordingly, for the purpose of…

SEQUENCE (time ordered collection of events, ideas) – relates ideas via time. The main ideas are the steps or history presented (e.g., recipe steps, history books, biographies)

later, afterwards, after, then, subsequently, as time passed, following, continuing on, to end, finally, year(s) ago, at the start of, first, second, third, 1, 2, 3…, next, primarily, early, before, to begin with, more recently, again, finally, the former, the latter, not long after, soon, now, today, after a short while, meanwhile, steps, stages, time line, history, sequence, development, look for a series of dates in histories…

COLLECTION (listing, enumeration) – relates ideas simply by grouping them together; sometime the grouping is made explicit with enumeration. The main idea is the grouped list (e.g., "to do list," botany). Collection can be used with any of the other structures; sequence is a subtype of collection. For example, groups of solutions or causes are often presented.

and, in addition, also, include, moreover, besides, first, second, third, etc., subsequent, furthermore, at the same time, another , and so forth…

DESCRIPTION (generalization, settings) – relates ideas by elaboration of attributes, specifics, or setting information. The main ideas is that aspects of a topic are presented (e.g., newspaper article)

attributes of, characteristics are, for example, for instance, in describing, marks of, namely, properties of, qualities are, specifically, such as, that is…

Basic Text Structure Research

Historical antecedents of many structure strategy interventions were basic laboratory studies about text structure and its effects on learning and memory (Meyer & McConkie, 1973; Meyer, 1975; Meyer & Freedle, 1984; Meyer & Rice, 1982). Meyer (1971) identified the hierarchical, logical structure of two articles from *Scientific American* magazine and examined the relationship between the structure and what college students remembered from the text. Effects of this logical structure were seen in a) the kinds of idea units that were remembered (more high level information than low level information; this effect came to be known as the "levels effect"); b) the stability of the idea units in consecutive recalls (stability related to the logical structure [.55], rather than rated importance [-.25]); and c) the tendency for clustering on this basis (if a particular idea unit was recalled, then the idea directly above it the logical structure was recalled 70% of the time; overall recall was 23% of ideas from a passage) (Meyer, 1971). Logical structure accounted for much of the variance that might ordinarily be attributed to other variables, such as serial position effects and rate importance. These findings suggested that the logical structure of a passage is related to certain aspects of the cognitive structure that the participants constructed.

Next, Meyer (1974, 1975) combined the logical structure approach of the initial study with work by Joseph Grimes (1975) in linguistics. This provided methods for studying naturally occurring text and ways to control aspects of text structure and signaling for future experiments (see simplification of the approach in Meyer, 1985). Other text analysis methods at the time included work by Crothers (1972) and Frederiksen (1972, 1975). An important manipulation by Meyer (1975) was the embedding of a causation (cause-and-effect) paragraph in the same serial position in two texts. In one text the paragraph was located at the top third of the hierarchical, logical text structure. In the other text, the paragraph was located at the bottom third of the text structure (see Figure 1 for example of hierarchical, logical structure of a text). This manipulation was repeated with a text with the same structure but different content. Also, versions of the set of four texts were prepared with and without signaling words that explicitly signaled the text structures so that patterns in recall of ideas could be compared as they varied in content, structure, or level in the logical structure. Meyer found that the type and structure of relationships among concepts in text dramatically influenced comprehension when they occur at the top third of the structure. However, when the same pattern of relationships occurred low in the structure, they affected comprehension minimally (Meyer, 1975). This was an important finding because it encouraged future text structure research to focus on the main ideas organized within a text rather than the details.

Due to this focus on top-level of text structures, Meyer (1975) hypothesized that more organized text structures (causation, comparison, and problem-and-solution) would have greater mnemonic hooks for learning and memory than the structure of description (i.e., a collection of descriptions about a topic). Meyer and Freedle's (1979, 1984) data supported this hypothesis, showing that for college learners, comparison and causation structures had greater benefits for recall in comparison to description. Later work showed that the memory benefit for the more organized structure of comparison over a collection of descriptions held for adults who could use the structure strategy and who had high average and above vocabulary skills (Meyer et al., 1989). However, for young, middle-aged, and older adults with average vocabularies and no training in the structure strategy, the collection of descriptions yielded better recall than the comparison structure (Vincent, 1985). This effect of text structure has also been found with college level English as second language (ESL) readers (Carrell, 1984).

By 1976, Kintsch's hierarchical, text base analysis was becoming popular. The structure developed by Kintsch and colleagues (Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975) was based on argument repetition (i.e., repetition of words from the text), while Meyer's hierarchy was based on the semantic relations among ideas represented by text structures (see Figure 1 and Table 2). Dunn (1978) stated,

> "Unlike Kintsch's system, Meyer's system not only produces a hierarchical arrangement, but also states explicit inter-propositional relationships (including inter-paragraph relations among the items in text) to a much greater degree than do either Kintsch and his associates (e.g., Turner & Green, 1977) or Frederiksen…" (p. 10)

In 1976 Meyer directed her research efforts to the strengths of her approach; that is, representations of the top-level structures in text. Several research efforts were launched to investigate the differences in use of the structure strategy among students with varying reading and vocabulary proficiencies and ways to increase use of the structure strategy by changing the text (e.g., signaling), the task (e.g., repeated readings of text with different content but the same text structure), or the reader (e.g., various levels of instruction).

Meyer, Brandt, and Bluth (1978, 1980) studied whether good and poor 9th-grade readers organized their recall with the same text structure as that used by the author. Good and poor readers were identified by scores on a standardized reading comprehension test and corroborated by teacher appraisals. Two basic strategies were expected from the 9th graders: the structure strategy or the default/list strategy. While the structure strategy involves systematic processing based on text structure, the default strategy is not systematic. The reader using the default strategy lacks focus and simply tries to remember some ideas from the text. The recall produced by such a reader is a list-like collection of descriptions about the topic with little to no attempt to interrelate the ideas. Meyer et al. (1980) also examined the effects of signaling words for problem-and-solution and comparison text structures (see underlined words in Table 2 for the problem-and-solution text).

Table 2. *The Supertanker Text.*

(*Note: CAPITALIZED = author's message or main ideas; lowercase = major details; italics = minor details; underlined = signaling. In actual studies regular font was used for the text.)*

A PROBLEM OF VITAL CONCERN IS PREVENTION OF OIL SPILLS FROM SUPERTANKERS. A typical supertanker carries a half-million tons of oil and is the size of five football fields. A wrecked supertanker spills oil into the ocean; this oil kills animals, birds, and microscopic plant life. *For example, when a tanker* crashed *off the coast of England, more than 200,000 dead seabirds* washed *ashore*. Oil spills also kill microscopic plant life *which provide food for sea life and produces 70 percent of the world's oxygen supply*. Most wrecks RESULT FROM THE LACK of power and steering equipment to handle emergencies, *such as storms*. *Supertankers have only one boiler to provide power and one propeller to steer the ship.*

THE SOLUTION TO THE PROBLEM IS NOT TO IMMEDIATELY HALT THE USE OF TANKERS ON THE OCEAN since about 80 percent of the world's oil supply is carried by supertankers. INSTEAD, THE SOLUTION LIES IN THE TRAINING OF OFFICERS OF SUPERTANKERS, BETTER BUILDING OF TANKERS, AND INSTALLING GROUND CONTROL STATIONS TO GUIDE TANKERS NEAR SHORE. First, officers of the supertankers must get top training in how to run and maneuver their ships. Second, tankers should be BUILT with several propellers *for extra control* and backup boilers *for emergency power*. Third, GROUND CONTROL STATIONS SHOULD BE INSTALLED at places where supertankers come close to shore. These stations would act like airplane control towers, guiding *tankers along busy shipping lanes and through dangerous channels.*

Source: Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. (1980). Use of the top-level structure in text: Key for reading comprehension of ninth-grade students. Reading Research Quarterly, 16, 72–103. Copyright @ 1980 by the International Reading Association (www.reading.org).

For a subgroup of readers identified as comprehension "underachievers," signaling was expected to be particularly helpful. Students in this subgroup had better vocabulary (stanine score at least 4) than reading comprehension skills (one stanine below a student's vocabulary score). While "underachievers" had vocabulary test scores closer to the good readers, reading comprehension scores of the underachievers were closer to the poor readers. They were identified as readers who could use the structure strategy, but would not without the explicit prodding provided by the signaling words.

Meyer et al. (1980) found that reading ability was associated with the number of ideas recalled, as well as the organization of recalls. Readers classified as good readers recalled more ideas, and more frequently used the authors' structure to organize their recalls. The researchers also found that text signaling influenced underachievers text processing. When reading text with signaling, as shown in Table 2 and Figure 1, these readers switched to use of the structure strategy instead of the default/list strategy. Signaling did not affect the use of the structure strategy by good readers or poor readers. Regardless of random assignment to the signaling or no signaling conditions, good readers recalled the top-level structure of the passage and used it to organize their recall, while most poor readers did not (Meyer et al., 1980). This finding pointed to the importance of teaching signaling words as part of instruction in the structure strategy for students with poor reading comprehension skills. In this study, only 48% of the entire sample of 9th-grade students organized their recall with the same structure as the text on at least one of the problem-and-solution and comparison texts (Meyer et al., 1980).

From this text structure research, Meyer and collaborators (Meyer & Freedle, 1979, 1984; Meyer, 1984; Meyer & Rice, 1982) developed a processing model for getting text information into organized schemata for storage in memory based on text structures. First, readers determine whether they are interested in communicating with the writer of the text and following the writer's thesis and rationale. If not, readers should use a different reading strategy rather than the structure strategy. Next, readers select the structure strategy. If readers cannot use this strategy, the default/list strategy by default would be used. Figure 2 depicts the processing steps in using the structure strategy. The end point in the model is a reader using the identified working schema, corresponding to a text structure, as an organizing framework to differentially select, encode, and organize ideas from the text into a long-term memory representation.

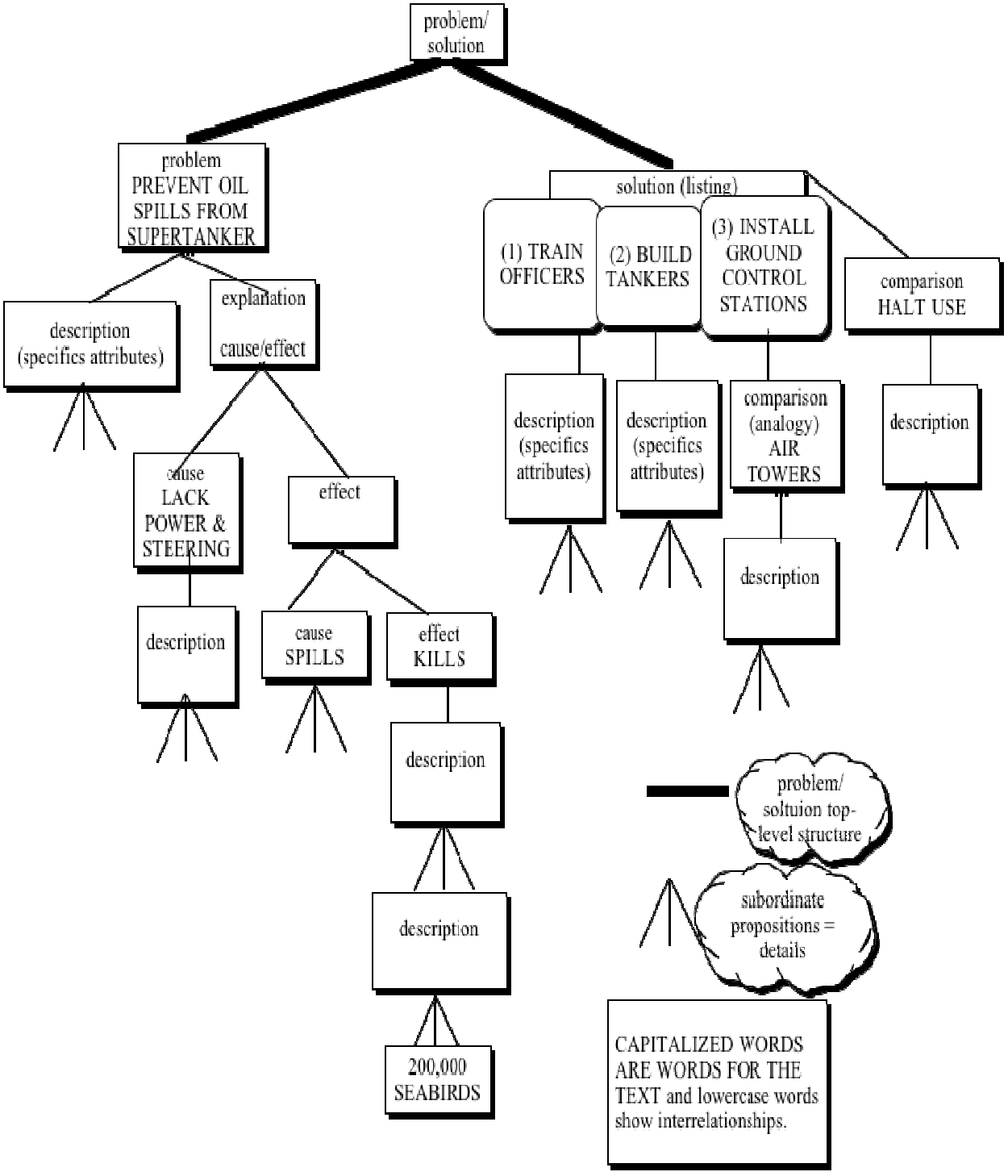

Figure 1. *Top-Level Structure of the Supertanker Text. From Meyer, B. J. F., Brandt, D. M., & Bluth, G. J. (1980). Use of the top-level structure in text: Key for reading comprehension of ninth-grade students. Reading Research Quarterly, 16, 72-103. Copyright @ 1980 by the International Reading Association (www.reading.org).*

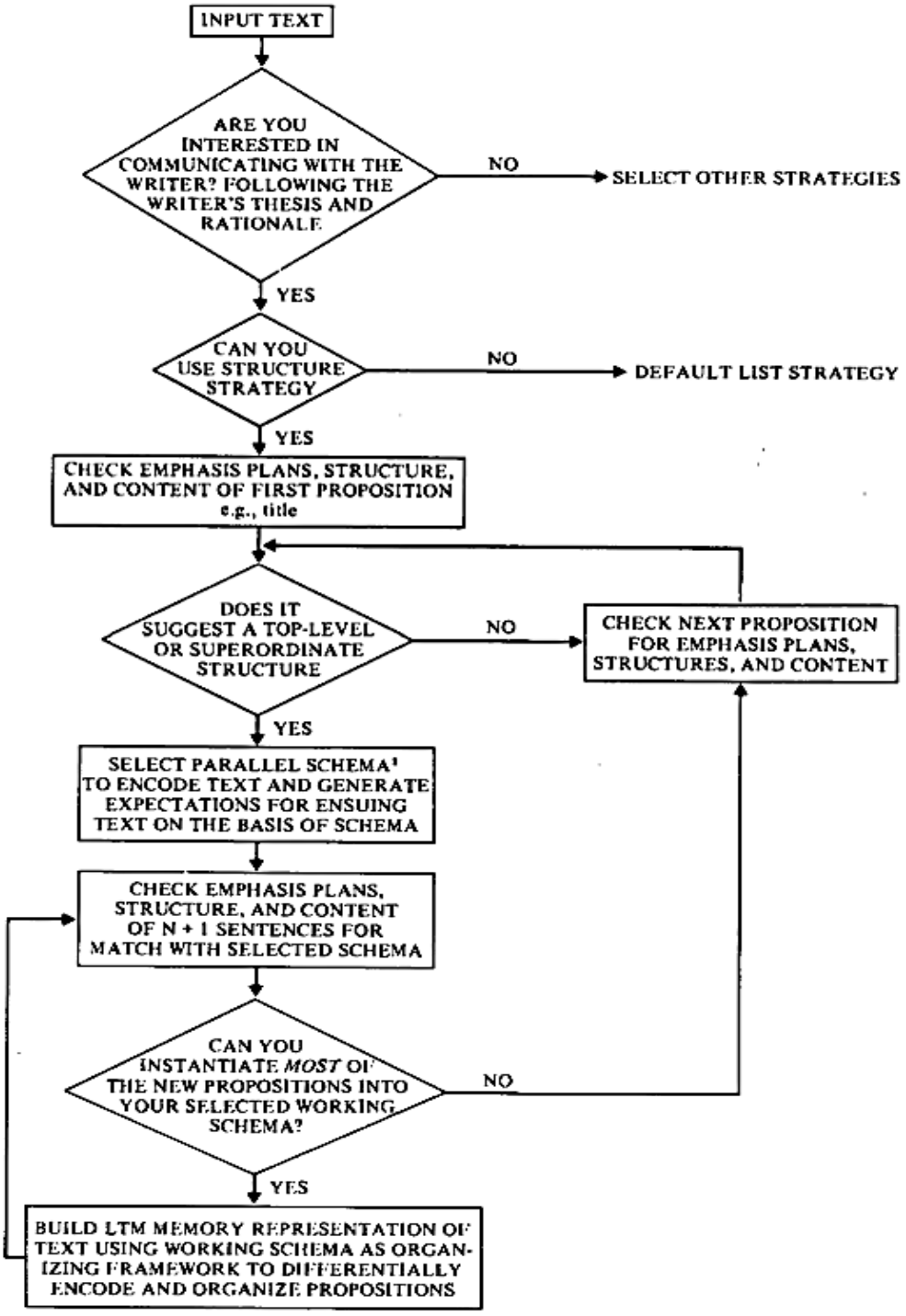

Figure 2. Model for getting text information into organized schemata for storage in memory. From Meyer, B. J. F. (1984). *Text dimensions and cognitive processing*. In H. Mandl, N. Stein & T. Trabasso (Eds.), *Learning and comprehension of text*. Hillsdale, NJ: Lawrence Erlbaum Associates. Permission: *Learning and comprehension of text* by Mandl, Heinz. Copyright 1984 Reproduced with permission of TAYLOR & FRANCIS GROUP LLC - BOOKS in the format Journal via Copyright Clearance Center.

Empirical studies of text structure and its effect on text processing and comprehension had several important implications for future intervention research. First, they provided evidence that text structure indeed exerted an influence on readers' mental representations of texts. Second, they suggested that readers vary in their ability to use the structure strategy, and this variability may be related to their overall reading ability and vocabulary. Finally, the findings from Meyer et al. (1978, 1980) suggested that many readers may be lacking in their knowledge of text structures. Overall, this basic research provided evidence that many readers would likely benefit from explicit instruction in the use of text structure and encouraged studies which investigated methods of teaching readers to use them.

Early text structure interventions (1978-1990)

In this section we discuss the early history of text structure interventions. These began in the 1970s with several doctoral dissertations or projects under Meyer's mentoring, which examined instruction designed to increase middle school to junior college students' use of the structure strategy (e.g. Brandt, 1978; Jessen, 1981; Meyer, Bartlett, Woods, 1978). Bartlett's dissertation (1978) was the first study to provide extended multiple sessions of explicit structure strategy instruction; he taught 9th-grade students Meyer's expository discourse types of problem/solution, comparison, causation, and collection of descriptions. All four structures were taught each day for five days of 1-hr instruction. Bartlett's approach asked students to find the main idea and then determine the text structure that organized the main idea. Emphasis was not placed on signaling words or patterns/templates to write main ideas or recalls. Explicit instruction of 6-steps to follow before, during, and after reading to use the top-level structure strategy were modeled and practiced. Texts used as examples for instruction and practice increased in complexity across the five sessions.

Structure strategy instruction increased students' ability to identify and use the text's top-level structure and nearly doubled the amount of information remembered over students in the control condition who received the same texts, but with instruction about punctuation (Bartlett, 1978). Instruction effects appeared durable over an extended period for readers scoring above the 19th percentile on a standardized vocabulary test (Bartlett, 1978). Teachers reported performance advantages across the curriculum for students who had received training with the structure strategy rather than the punctuation instruction.

Armbruster also worked with Meyer and her approach to text structure in the late 1970s and 80s. Subsequently, Armbruster, Anderson, and Ostertag (1987) taught the problem-and-solution structure to 5th-grade students in 11 days of direct instruction with social studies materials. One of two classrooms of students was randomly assigned to structure strategy training with the problem-and-solution structure and the other classroom to traditional instruction. Students in both groups read 13 100 to 500-word texts taken from 4th- and 5th-grade textbooks. The structure strategy group received problem-and-solution frames accompanied by blank lines for writing passage summaries. The frames were three boxes with an arrow from the problem box (something bad) pointing towards the action box (what people do attempting to solve the problem) and the results box (outcome of the action). A second arrow went from the action box to the results box. Instructors modeled how to identify the text structure and how to use the problem-and-solution structure to write a summary, following principles of direct instruction (e.g., Rosenshine & Stevens, 1986). Guidelines were provided for writing a summary of a problem-and-solution passage. These guidelines prompted students to write the problem, the solution, and the result of this solution, but did not emphasize problem and solution signaling words. Students in the structure strategy class wrote 50% more main ideas on an essay exam and included more main ideas in written summaries of a text than the traditional class, but the classes did not

differ on a short-answer fact test (Armbruster et al., 1987). Although the study's experimental design was limited in rigor, it provided instruction with a 5th-grade classroom setting with authentic texts.

In addition to these interventions, several early interventions investigated structure strategy interventions with adult learners. These studies covered a diverse group of learners including English language learners, college students, and adults learning within a community setting. Carrell (1985) generally followed Bartlett's (1978) training materials with the same four text structures outlined by Meyer (e.g., Meyer & Freedle, 1984). Unlike Bartlett, Carrell instructed high-intermediate ESL students from various language backgrounds enrolled in an intensive English program. One section of 14 students received structure strategy instruction, while the other section of 11 students read the same reading materials, but worked with linguistic operations, such as sentence combining, cohesion, and vocabulary. Similar to Bartlett, Carrell found that the structure strategy group showed substantially and significantly higher performance on measures of reading comprehension than the control group after training as well as three weeks later. Carrell's study was the first to show that direct instruction with the structure strategy instruction increased reading comprehension of ESL students.

In their intervention, Cook and Mayer (1988) built on the work of Meyer (Meyer, 1975; Meyer et al., 1980) by adding a number of important components to an instructional program which taught college students to use text structure to comprehend science texts. These components included a) a sorting task to measure text structure awareness, b) the application of text structure to passages taken from students' chemistry textbooks, and c) specification of descriptive text structures that occur in science textbooks. Cook and Mayer conducted two studies about text structure. They added a novel component of a sorting task in which students sorted 20 texts taken from high school science textbooks according to five expository text structures. In the first study, half of a group of 32 undergraduate university students received a 5-page instructional pamphlet about five text structures used in science textbooks: generalization, enumeration, sequence, classification, and compare/contrast. Cook and Mayer presented a couple of signaling words per structure for the classification (i.e., "there are two types"), comparison (i.e., "in contrast to"), and sequence ("and then") structures. The text structures classified by Cook and Mayer, particularly, generalization and classification, differ somewhat from Meyer's classification, but could be subsumed as subtypes of description. The students in the two groups worked at their own pace sorting texts into similar groups based on structure. The training group sorted the 4 texts per 5 text types correctly 79% of the time, while the no training group sorted them correctly 61% of the time.

The second study conducted by Cook and Mayer (1988) involved training junior college students and provided instruction about three of the five text structures. Students filled out three worksheets for the three trained text structures (generalization, enumeration, and sequence) using nine passages taken from their chemistry textbook. For example, the sequence worksheet had three steps: step 1 – identify the passage topic; step 2 – name each step in the sequence and outline the details of each; step 3 – say what varies from one step in the sequence to the next. Another section of the chemistry class received no training and served as the control group. Trained students increased their recall of the most important information and ability to answer application questions, but did not increase memory for facts. The results demonstrated the value of the structure strategy using an outlining format with description, listing, and sequence structures in the context of a science class.

The research about knowledge-map (k-maps) by Dansereau and colleagues (e.g., Dansereau et al., 1979; Holley, Dansereau, McDonald, Garland, & Collins, 1979) has similarities to the structure strategy. We will only briefly mention this large research literature (see O'Donnell, Dansereau, & Hall, 2002). To make a k-map from an existing text the creator of the k-map needs to identify and use text structures. Four of the links in k-maps are "part of," "type of/example of," "characteristic of," and "evidence for;" these are subtypes of the description text structure. The other two links are "leads to" and "analogous to;" they correspond to causation and comparison, respectively. Holley et al. (1979) provided college students with 5.5 hours of training over four sessions about these links applied to sentences, texts, and their own textbooks. Students with the k-map training performed better than a control group of students on multiple measures of reading comprehension associated with understanding main ideas. Geva's (1983) flowcharting of expository text is a combination of representations of text by Meyer et al. (1980) and Holley et al. (1979). Geva trained community college students to represent text in node-relation flowcharts. Relations were represented by different types of lines in a flowchart matching a key with relations of elaboration, cause-effect, process, example, and detail as well as topic and conclusion. Findings indicated that training with this approach led less skilled readers to more carefully read expository text and as result increase their reading comprehension. Mayer (1999) considered k-maps as an effective type of structure strategy along with Cook and Mayer's (1988) intervention and Meyer et al.'s (1980) hierarchical text structures displayed in Figure 1.

In addition to academic settings, early research examined the efficacy of structure strategies in non-academic settings. Meyer, Young, and Bartlett (1989) utilized some of the texts, feedback materials, and formats from Bartlett's training program in an instructional program designed for young (18 to 32 years old) and older (65 years and older) adults and primarily used everyday reading materials. Instruction consisted of 7.5 hours of instruction (5 sessions) spread over two weeks Instructors and peers (old and young adults) modeled the use of templates unique to each text structure in the composition of written main ideas and recall protocol. Participants were instructed to "choose it (overall/top-level text structure), use it, or lose it." The design of this study was the strongest of extant structure strategy intervention studies at the time. Participants were randomly assigned to three groups: structure strategy instruction, a contact control that practiced reading and recalling the same texts that were used in the structure strategy instruction, but with no instruction about text structure, and a no contact, wait-list control group. Alternate equivalent forms of measures were counterbalanced over a pretest, immediate post-test, and two-week delayed post-test. The instruction changed from Bartlett's earlier approach by incorporating use of signaling words to help identify text structures in simple advertisements to more complex materials (e.g., magazine articles).

Another major change from Bartlett's instruction (1978) was the addition of an initial step in which students were prompted to first search for the top-level structure of the text that could interrelate all the ideas in the text. This top-level structure would then lead to the main idea of the text. The main idea was identified as the ideas interrelated by the top-level structure. This step was added to assist the reader in constructing a coherent representation or situation model.

Some interesting findings regarding elements of effective instruction emerged from the Meyer et al. (1989) study. There were minimal effects of training when students were simply told the definition of different text structures along with some of their signaling words and an example of each text type. More intensive instruction, including modeling how to use text structure strategically for understanding and remembering, appeared to be required to see strong effects of structure strategy training. Often composition or reading textbooks simply

mention different text structures; this is not sufficient for increasing reading comprehension. This brief treatment of text structures in such textbooks may relate to barriers in getting teachers to use the structure strategy in elementary and middle school classrooms. Teachers may have encountered a cursory examination of text structure in college classes for composition or reading instruction, but did not see its value for increasing reading comprehension of their students. Thus, they may discount structure strategy interventions as recommended by research or colleagues who have used the strategy. This discounting may be attributed to a lack of depth in understanding the structure strategy as well as a lack of materials needed for modeling and direct instruction about strategically using text structure to increase reading comprehension. Some of the recent structure strategy interventions use intelligent tutors or scripted lessons for teachers, which may overcome some of these obstacles.

Overall, the early work on structure strategy instruction showed its potential for increasing reading comprehension. Positive effects for using the structure strategy were noted from work with elementary school children to retired adults. Most of the research involved 6th graders, 9th graders, high school students, college students (including junior college and ESL students) and adults, rather than early elementary school children. Most instruction programs involved modeling, practice, direct instruction, scaffolding, and multiple instructional sessions of increasing complexity of text materials.

Recent Developments in Structure Strategy Interventions

Text structure instruction across cultures and languages. More recent intervention research has explored the instruction of text structure with linguistically diverse populations. Several studies have explored instruction of expository structure in languages other than English including French (Raymond, 1993), Spanish (Leon & Carretero, 1995), and Dutch (Broer, Aarnouste, Kieviet, & Leeuwe, 2002). One of the first of these was Raymond (1993) who used the instruction and texts from Meyer et al. (1989) translated into French. As with the studies of Bartlett (1978) and Carrell (1985), Raymond randomly assigned two intact classrooms to either structure strategy instruction or a control group that read the same materials as the strategy group, but without instruction about text structures. In Raymond's study the control students worked on answering questions about the texts. The structure strategy training was in French and presented to native English speakers with high-intermediate level skills in French. Participants read articles for the pretest and post-test in French, but recalled them in English. The structure strategy group outperformed the control group on number of ideas recalled on the post-test.

Similarly, Leon and Carretero (1995) conducted an intervention to teach the structure strategy to high school students (ages 14 to 15 years) in Spain, adapting the instruction of Meyer et al. (1989) and a dependent measure from Meyer (1984). They examined the effect of reading comprehension skills (good and poor readers), the text structure intervention in Spanish, signaling, and time of post-testing. There were a number of interesting interactions among these variables. Overall, direct instruction about the structure strategy improved reading comprehension over the control groups who read the same social studies materials, but without instruction in the structure strategy. Additionally, the structure strategy instruction transferred to a text structure not studied in the intervention.

In their study of Dutch 6th graders, Broer, Aarnoutse, Kieviet, and Leeuwe (2002) provided structure strategy instruction for two text structures in a treatment they called the 'making schematics' strategy. The schematics were graphics for the causation structure and the classification structure (similar to Cook and Mayer's [1988] enumeration and a subset of Meyer and Freedle's [1984] collection of descriptions). For example, the schematic for

causation was a table headed with a subject row for the topic of a text to be placed. The next row in the table was for signaling words (i.e., "cause," "causes,", "result," and "led to"). The following row was divided into three parts: a column for cause(s), a box for a causal arrow, and a column for result(s). The next row was blank for students to write causes and effects found in a text. The final row was a place to write the main idea organized with causation. Many aspects of the schematic are similar to classroom applications of the structure strategy (e.g., Meyer, Ireland, & Ray, 2011).

Broer et al. (2002) used a non-equivalent control group design with multiple schools, 18 classes, and 354 6th-grade students from middle class homes in The Netherlands. Pairs of classes in a school were randomly assigned to the structure strategy or traditional Dutch reading and answering questions approach. There were 16 instructional lessons taught by the classroom teachers who were trained in the strategy. Students in the schematic/structure strategy condition increased their recognition of text structure, ability to make schematics, ability to formulate and deduce main ideas, and transfer of deducing main ideas from text with different top-level structures than those explicitly taught in the instruction. Effect sizes between the structure strategy and control condition ranged from 0.15 (on a general reading comprehension test) to 0.26 (main idea text) to 0.78 (making schematics four weeks after instruction). The Broer et al. (2002) study was an impressive applied study of structure strategy instruction delivered by classroom teachers at the upper level of elementary schools. All three of these studies showed the usefulness of the structure strategy across cultures.

Recently, Schwartz and colleagues (Mendoza & Schwartz, 2011; Yeh, Schwartz, & Baule, in press) conducted two interventions using the structure strategy via the training materials and testing materials of Meyer et al. (1989) with bilingual college students. One new aspect of this research is the examination of the effects of the structure strategy instruction on eye-movement patterns. Eye-tracing measures examined online processing during learning from texts. They indicate not only what a participant looks at but also how long the person's gaze remains at a particular point and how the eye moves over the text. Yeh, Schwartz, and Baule (in press) reported that after the text structure instruction recall of text information increased and eye-movement patterns changed. After instruction, English for speakers of other languages (ESOL) students made more fixations on the signaling words (e.g., "different" for the comparison text structure) and key areas of the text. The study demonstrated the effectiveness of the structure strategy for ESOL students.

Additionally, Mendoza and Schwartz (2011) taught bilingual college students from the UTEP and Universidad Autónoma de Ciudad Juárez the structure strategy. Results showed that these Spanish speakers also could learn the structure strategy in English. Interestingly, most students were able to transfer their new knowledge about text structures and their English signaling words to parallel structures and signaling in their native (Spanish) language. Texts used as the dependent measures were written in English and Spanish about topics relevant to prenatal screening.

Researchers who have examined the use of the structure strategy in diverse language contexts have included both elementary and college students. Their research adds to the earlier investigations by showing that instruction of the structure strategy aids reading comprehension for bilingual students and students in various cultures.

Structure strategy, signaling, and transfer to everyday learning. In an extension of the earlier work by Meyer et al. (1989), Meyer and Poon (2001, 2004) examined the interaction between structure strategy instruction and signaling in text. Their instructional program, which targeted younger and older adults, provided more instructional emphasis on writing with

the use of templates for writing main ideas or recalls with each text structure. These writing patterns have become important components of our recent work with children. For example, for the comparison structure the pattern for writing a main idea is located below. "The main idea was _____ and _____ (2 or more ideas) were compared on _____, _____, _____ (a number of issues)." The pattern for writing a recall from a text with a comparison top-level structure would include a) an introductory sentence with a comparison signaling word contrasting two ideas or political candidates; b) a paragraph or more about the first idea describing the issues for this idea or candidate; c) a transitioning signaling word, such as "In contrast," as a new paragraph is started to describe the second idea or candidate on the same issues. Meyer and Poon also added a sixth instructional session due to needs of older adults (Meyer, Talbot, Stubblefield, & Poon, 1998); this session applied the structure strategy to note-taking, long, unedited magazine articles, medical decision-making, articles from the Internet, and watching an informative video on nutrition. Younger and older adults participated in nine hours of either structure strategy or interest strategy training (reading the same texts as the structure strategy group, but with a motivation strategy), or no training (waiting-list control group). Participants also were randomly assigned to texts with or without signaling for pretests and post-test.

Both training groups reported positive changes in reading, but only the structure strategy group showed increased total recall from a variety of texts (d = 0.64), an informative video (d = 1.47), and information from the medical decision-making task (d = 0.93). The structure strategy intervention affected the organization of recall and was critical for producing readers who could use the structure strategy consistently across a variety of expository texts. The instruction also helped learners to use signals in text more effectively in order to employ the structure strategy across five passages consistently. When compared to the use of signaling without structure instruction, structure strategy training had a larger effect on reading comprehension. However, the relationship between strategy instruction and signaling was shown to be additive; structure strategy instruction plus signaling in texts produced more consistent use of the strategy across five texts. Results also indicated that signaling effects the encoding processes rather than retrieval processes. This was the first study with the structure strategy to show transfer from structure strategy training with texts to multimedia learning and remembering medical information during a simulated decision-making scenario. Moreover, this study, along with Meyer et al. (1989) and Meyer, Talbot, Poon, and Johnson (2001) demonstrated that successful structure strategy instruction could be conducted in a variety of both formal and informal educational contexts.

Structure Strategy Interventions in Elementary Schools

Web-based structure strategy instruction. In their studies of adult learning Meyer and colleagues frequently received feedback from adult participants who voiced their belief that the structure strategy instruction would be of particular use to their grandchildren coping with learning from texts in the school context. The first investigation to follow up on this suggestion (Meyer et al., 2002) involved 5th-grade students tutored by older adults in the structure strategy via the Internet. This invention became the first of many structure strategy interventions targeted for elementary school readers, as part of a renewed interest in investigating structure strategy instruction with younger readers.

Meyer et al. (2002) developed a Web-based delivery of the structure strategy intervention for 5th-grade readers based on the program developed by Meyer et al. (1989). In this intervention five text structures were introduced sequentially rather than all at once because previous work (Meyer, Poon, Theodorou, Talbot, & Brezinski, 2000) had found that adults with slightly reduced working memory resources learned the structure strategy better with

lessons introducing one or two text structures per training session versus all five at once. In Meyer et al. (2002) the comparison and problem and solution structures were taught first followed by causation, sequence, and description. These earlier structure were then reviewed in later lessons and integrated implicitly and explicitly with other text structures (cause and effect, sequence, and description) throughout a set of 25 lessons.

Meyer et al. (2002) tested whether 5th-grade students can learn the structure strategy via the Internet with feedback and support from their own personal human tutor. Two approaches to teaching the structure strategy via the Internet were examined. One approach involved an Internet instructor (depicted with a static picture) and retired adults trained in the structure strategy as tutors (displayed with a picture of a tutor or animal representation). Emails from Internet tutors provided delayed feedback on students' last lesson, encouragement, daily assignments, and additional instruction about the strategy with other examples, if necessary. The other approach only involved the Internet instructor, who provided delayed feedback on student work, but no tutors.

The students in the two structure strategy groups were compared to students in a control group who participated in extra sessions of the school's regular reading program. Students were randomly assigned to three groups: structure strategy with tutors, structure strategy without tutors, and a control group. Immediately after the intervention, the groups receiving structure strategy instruction tended to recall more information than the group with extra days of regular classroom reading. The average reader receiving structure strategy training had a total recall score equal to a reader in the control group who scored at the 77th percentile on the immediate posttest (effect size = 0.74). The superiority in total recall for the structure strategy group with tutoring over the control group in reading was clearly evident 2 1/2 months after the end of training. The average reader receiving structure strategy training with the aid of tutors had a total recall score equal to a reader in the control group who scored at the 81st percentile on the delayed posttest (effect size = 0.92). The structure strategy group with help from tutors tended to make more progress in mastering the strategy than the group without tutors. This was particularly the case for students whose messages from tutors focused on providing feedback about the structure strategy and the subject matter of the lessons rather than off-task socializing. Fifth graders in the structure strategy group with tutors made significantly greater gains in self-efficacy than students in the other two groups.

Most students in both structure strategy groups made progress in learning the structure strategy, although few consistently demonstrated mastery of the strategy after training. Those students who mastered the strategy were particularly diligent in their work in the lessons. One English as a second language learner (ELL) was conscientious in completing her lessons and following her particularly skilled tutor's instructions; she made outstanding gains in reading performance. Prior to the intervention she scored at the 28th percentile on a standardized reading comprehension test and did not use the structure strategy. After the intervention, however, she showed mastery of the strategy and scored at the 68th percentile on the standardized reading test. Equivalent texts about different content (supertankers or killer bees) with the same text structure (depicted in Figure 1) were counterbalanced over the pretest and post-test. Her pretest and immediate posttest recall of problem-and-solution texts are listed below (Meyer, 2003):

> *Pretest:* "This passage is about oil spills. The oil spills on the ocean and poisens them. When the oil spills it kills animals too and, poisens them. I can only remember something about 3 football fields."

> *Posttest: "*The problem is prevention of killer bees. Bees make honey 150 pound per year. They reproduce quickly in warmer climates. They don't live under 59 decreas. Some of them escaped from Africa and came to S.A. Brazil. If their nest is desterbed they will sting. One man was riding his horse in Brazil and the bees came up and started stinging him and his horse. He fell from his horse and survived, but his horse died because of all the stings from the bees. Bees can not see red, that's why bee keepers wear red when working with bees. A lot of bee strikes can kill a person. Mostly they live up to North Carolina. Dust can calm the bees. On way scientists teach the people of Brazil is don't desterb their nests and run from killer bees. Scientists can't stop all the killer bees" (Meyer, 2003).

This student recalled nine ideas on the pretest about supertanker text shown in Table 2. In contrast to the nine ideas recalled on the pretest, she recalled 88 ideas on the post-test about the problem of killer bees (Meyer, 2003). Most of the students (70%) in the control group did not organize their ideas with a problem part and a solution part. Most completely missed any of the suggested solutions, but this student has both a problem part, signaled with "problem," and a solution part, signaled with "one way." Her last three sentences are an attempt to recall the solution part of the passage. There was considerably more about the solution than produced by fifth-grade students in the control group. In this study we found that a problem with cause(s) and a solution designed to eliminate/reduce the cause(s) was particularly difficult for 5th-grade students.

One important finding from this investigation that was modified in subsequent Web-based structure strategy instructional programs was that 5th-grade students' had difficulty working with a table of signaling words in a pop-up help screen while the text was presented on another screen. A solution to this problem was an instructional aid in the form of laminated keys for each text structure. Each key contained a list of signaling words, an example on the topic of whales, the template/pattern for writing a main idea with the text structure, and a template for writing a recall with the structure. When a text structure was initially introduced to the student, it was added to a key ring available for consultation during the lessons (see Meyer, Wijekumar, & Lin [2011] for a picture of the problem-and-solution key).

One of the challenges that remained in extending this program of research from a paper-based to an electronic medium was the quality of the delivery of the system. Therefore, in more recent investigations, modifications in programming (e.g., use of a pedagogical animated agent to teach the structure strategy) have been explored. In order to increase the accessibility and quality of the delivery of the structure strategy instruction, we developed a Web-based system called Intelligent Tutoring of the Structure Strategy (ITSS) to teach the structure strategy to 5th- and 7th-grade students (Meyer & Wijekumar, 2007).

In several studies the researchers have examined the effectiveness of ITSS with 5th- and 7th-grade students. Unlike the previous Web-based program, ITSS used a web-based delivery system in which several instructional design features could be adapted including: feedback (immediate vs. delayed, minimal vs. elaborated), topic choice (whether or not students could choose text topics for practice lessons), and individualization (the extent of individualization of texts to match students' prior lesson performance).

Meyer et al. (2010) tested whether 5th- and 7th-grade students could learn the structure strategy via ITSS in six months of training for 90 minutes a week spread over two or three days. We examined different feedback and motivation conditions in delivering ITSS with a 2x2 pretest post-test design comparing: a) type of tutor immediate feedback (minimal feedback of "good," & "try again," versus substantial and specific feedback) from the I.T. (Intelligent Tutor, the animated agent); and b) motivational condition (programmed

sequence of practice examples vs. student choice of practice examples). In the elaborated feedback version, the animated agent provided elaborated feedback with scaffolding to improve performance on subsequent trials, while the other feedback version involved the animated agent providing only simple feedback about the correctness of a student's response. For example, in response to the same student's performance, the tutor in the elaborated feedback version said, "Your structure, main idea, and details are correct. Great Job! But your signaling words were incorrect. Using your signaling chart (key) as your guide, rewrite the signaling words." On a third deficient trial, students in the elaborated feedback group were given a model response to correct their writing of main ideas. This type of elaborated feedback was not provided for students in the simple feedback condition.

Students were stratified on reading comprehension and then randomly assigned to the conditions (including conditions for counterbalanced testing materials over time of testing). Choice of practice texts affected performance as students completed instruction on the first structure learned – comparison, but had no effect on post-test performances. Number of ideas recalled on this formative evaluation was greater for the choice group, but competency in using the structure strategy was not. Type of tutor feedback affected the ability to identify issues compared when students wrote main ideas in a formative evaluation of the comparison structure, but not the experimenter-designed post-test materials. Below is the pretest recall for a below-average reader in the 5th grade.

> *Pretest* (for an article comparing monkeys): "The monkeys are the smalls Monkeys weghy Less 4 onces a few in. tall."
>
> *Formative post-test* (after 10 ITSS lessons about the comparison structure): "There are 2 different kinds of bats. A Black flying fox bat and a leaf-nosed bat. The Black flying fox bat is one of the bigest, they grow up to 6 feet wide and weigh more than 3 pounds. They are jet black.
>
> Leaf-noised is smaller than the Black flying bat. The leaf-noise bat is only 1 foot wide. The leaf-noise bats come in different (colors) and mostely feeds on masquitoes and moths."

Data from a standardized reading comprehension test (*Gray Silent Reading Test* [GSRT]; Wiederholt & Blalock, 2000) clearly showed that below-grade-level readers made substantial gains from pretest to post-test with all versions of ITSS, and effect sizes ranged from 0.42 to 1.16. All ability levels of readers made greater gains on the GSRT if they received elaborated feedback. Students who received ITSS with elaborated feedback showed more improvement (*d = 0.55*) than students who received ITSS with simple feedback (*d = 0.15).* According to the GSRT manual, the average performance of the simple feedback group corresponds to a percentile rank of 79, while the average performance of the elaborated feedback group corresponds to a percentile rank of 91 (Wiederholt & Blalock, 2000). Substantial effect sizes also were found from pretest to post-test on various measures of reading comprehension, such as recall and strategy competence (*d* = .39 to .79, Meyer et al., 2010). Students also demonstrated maintenance of performance over summer break on most measures. For example, there was complete maintenance of the ability to use comparative signaling words 4 months after ITSS instruction.

In another design feature study with ITSS (Meyer, Wijekumar, & Lin, 2011), a more individually tailored version was developed to provide remediation or enrichment lessons to better match the needs of 5th-grade readers. Stratified random assignment was employed to compare the effects of two ITSS versions. Fifth-grade students in the more individualized condition made greater improvements from pretest to posttest on the standardized reading comprehension test (*d* = 0.55) than students in the standard condition (*d* = 0.30).

Additionally, students receiving more individualized instruction demonstrated higher mastery achievement goals when working in ITSS lessons than students receiving the standard instruction (d = 0.53). Also, 5th-grade students receiving more individualized instruction showed greater improvement using signaling, better work in lessons, and more positive posttest attitudes toward computers than students receiving standard instruction. Students in both conditions improved their recall of ideas from texts, use of the structure strategy, and understanding of comparison signaling words.

More recently, 4th- and 5th-grade classrooms have participated in efficacy trials with ITSS conducted in rural and suburban school districts. For this work Wijekumar, Meyer, and Lei (2011) are using a Multi-Site Cluster Randomized Trial (CRT) design to increase statistical power in testing treatment effects. Each school district serves as a site in the Multi-Site CRT design. Within each site or school district, classrooms were randomly assigned to ITSS or a control condition involving the usual language arts curriculum. The study is a replication of past work with 5th-grade students and an extension to 4th-grade students. A modification was made in the instruction to reduce the burden of typing for the younger students. Once students identified two or more topics compared and the issues on which they were compared, they completed a matrix task in which they clicked on text ideas relevant to cells in the matrix, rather than typing the information This procedure to reduce typing was used for both 4th- and 5th-grade students in the first five out of nine practice lessons for the comparison structure. In addition, during implementation some 4th-grade teachers voiced concern about typing demands. As a result, 4th graders, but not 5th graders, were switched to only constructing main idea statements and not recalling all they could remember from the texts in the ITSS lessons. Preliminary results show a significant interaction between grade level and treatment on the post-test with 5th-grade students making more progress. However, 4th graders show significant effects on most measures of reading comprehension but not for details on the comparison text. For the more difficult problem-and-solution text, 4th graders performed significantly better on all measures. This probably results from the fact that without training about the more complex problem with cause and solution, most upper elementary students completely miss the solution part. However, the comparison text contrasted two penguins on a number of the same attributes, many of which were memorable, such as orange ear patches. Fourth graders in control classrooms apparently remembered such isolated details as well 4th graders in the structure strategy classrooms.

In a pretest/post-test design, struggling readers in 4th and 5th grades received special group instruction with ITSS (Meyer & Wijekumar, 2011). The reading teacher who administered ITSS explained that his students, who had the greatest problems in reading, showed a 20 to 70 point gain on the state language arts assessment between 2010 and 2011, which he attributed to the immediate feedback in their structure strategy instruction from I.T. in ITSS. Interestingly, the teacher believed that his 5th-grade students gained more than his 4th-grade students, who seemed to struggle more with ITSS. The data showed statistically significant increases in reading comprehension on a standardized reading comprehension text from pretest to post-test, and no statistically significant time (pretest vs. post-test) by grade interaction (4th vs. 5th). One grade level did not make significantly greater progress than the other. In fact, effect sizes between pretest and post-test reading test scores were .78 and .79, respectively for 4th- and 5th-grade students. Additionally, performance on a signaling test, which tested the ability to use comparative signaling words, also showed statistically significant effects between pretest and post-test and no time by grade interaction. The effect sizes on the signaling test were 1.42 for 4th graders and 1.05 for 5th graders. The fact that 4th-grade students started at a lower level than the 5th-grade students may have led to more difficulty, frustration, or complaining, but they still benefited

as much as the 5th-grade students. Nearly all (80%) of the 4th graders in this study used the regular 5th-grade ITSS lessons (constructing recalls) rather the modified 4th-grade lessons (without constructing recalls) used in the ITSS efficacy trial.

ITSS lessons were originally designed for 5th-grade students via matching of standards and curriculum at the 5th-grade level. Perhaps ITSS is best suited to the 5th-grade level in terms of content and readiness for learning about text structure. However, ITSS covers a wide variety of content in science, social studies, history, and some sports topics in order to promote transfer to reading many types of nonfiction texts so interest in ITSS topics should not be confined to 5th grade. Additionally, ITSS may be appropriate for 4th graders because struggling 4th-grade readers had performance gains as large as struggling 5th-grade readers' after using ITSS in a pretest/post-test design (Meyer & Wijekumar, 2011). The greater effects for 5th-grade students in the efficacy trial may have resulted from the better match to the needs of 5th graders or to an ill-advised decision to delete the requirement of creating a recall protocol from the ITSS lessons for 4th grade. The efficacy data cannot differentiate between these two explanations due to different versions of ITSS for the two grade levels.

Currently, another efficacy trial is underway with 7th- and 8th-grade students as part of a grant awarded by the U.S. Department of Education Institute of Education Sciences. The study with 7th-grade students is a replication study of earlier work (Meyer et al., 2010), but also examines effects in both rural and suburban schools. Work with 8th-grade students extends our lessons to older middle school students. In preparation for this extension we wrote lessons to meet Pennsylvania standards in social studies, science, and writing for 8th-grade students. Series of two or three related lessons on a topic using multiple texts with complex structures were added to the compilation of over 100 ITSS lessons as we extended Web-based structure strategy to 8th grade.

Classroom-based interventions in the primary grades. In addition to Web-based instructional programs there has also been renewed interest in teaching text structure in the early grades during the elementary school and preschool years (e.g., Culatta, Hall-Kenyon, Black, 2010; Hall, Sabey, & McClellan, 2005; Hall-Kenyon, & Black, 2010; Williams et al., 2005; Williams et al. 2007; Williams, Stafford, Lauer, Hall, & Pollini, 2009). For example, Culatta, Hall-Keyon, and Black (2010) reported a pretest post-test pilot study project with 71 children ages 4 to 5 years old in four preschool classrooms. The study was a collaborative project of speech-language pathologist and early childhood educators using playful, but systematic instruction in theme-based units over 16 weeks with instruction four days each week. Teachers adapted the unit that was initially co-planned by university researchers (Culatta and Hall-Kenyon). Exit data from participating teachers indicated that the teachers had learned to value expository texts and explicit instruction about them. The intervention focused on two expository text structures: comparison and problem-and-solution.

Meyer (e.g., Meyer & Freedle, 1984) had originally thought that the problem-and-solution structure would be particularly easy for readers due to its similarity to narratives, but learned that was not the case (e.g., Meyer et al., 1989; 2010; Meyer, 2003) when problem-and-solution texts involved identifying and reducing the cause of problems. For example, when adults were asked to identify the most difficult of five text structures to learn and use with the structure strategy, problem-and-solution was most frequently listed. With readers across the life span, use of the structure strategy with scientific text organized with a problem (& cause) and solution (blocking/reducing of the cause) is usually more difficult than text organized with a comparison structure (Meyer et al., 1989). Also, Meyer (2003) reported that over 70% of 5th graders showed no understanding about using the problem-and-solution structure after reading a newspaper article of this type. Overall, research with 4th graders to

retired adults suggests that the problem-and-solution texts appear particularly challenging when used in scientific exposition with a problem and its cause(s) and a solution that was aimed at eliminating or reducing the cause(s). Without the underlying causal relationships, this responding structure (question–answer; problem–solution) can be easy to learn, and this appears to be the tact taken by Culatta et al. (2010). A teacher presented a problem in a narrative about a son's escaping hamster to preschool children. Then, the children constructed hamster cages. Next, the problem of hamsters escaping from cages and cages to solve the problem were discussed in an expository framework.

Except for Bartlett's (Bartlett, 1985; 1989; 2010; Bartlett & Meyer, 1981) continued interest in the structure strategy with preschool and elementary school children, until recently there was a dearth of studies with children younger than 5th grade. Williams, Hall, and Lauer (2004) reviewed the literature on awareness of text structure and interventions with text structure, particularly in elementary school grade levels. They noted the lack of intervention studies to teach the structure strategy with students in early grades until recently. They mentioned that a few studies were conducted in the 1980s, but interest in the topic waned without leading to any movements of magnitude in applying research findings to the classroom. However, Williams and her students' research represents major strides in bringing the structure strategy to 2nd grade (e.g., Williams et al., 2005; Williams et al., 2007; Williams, et al., 2009) as well as preschool children (e.g., Culatta et al., 2010).

Williams et al. (2005, 2007) examined direct instruction with the comparison structure (compare-contrast) with second grade students. Her work combines the influences of Meyer (e.g., Meyer et al., 1980; Meyer & Freedle, 1984; Meyer et al., 2002), Armbruster et al. (1987), and her own prior work with narratives, strategies, concept learning, and reading with learning disabled students (e.g., Gersten, Fuchs, Williams, & Baker, 2001). In Williams et al. (2005, 2007) classrooms (128 students in all) were randomly assigned to structure strategy instruction with the comparison text structure, traditional instruction which contained the same content but no structure strategy instruction, or a no instruction control. Signaling words were taught (called clue words); eight clue words from Williams et al. (2005) were "both," "however," "and," "alike," "compare," "but," "than," and "contrast." Note that "and" appears to be a confusing comparison signaling word in that it usually indicates the collection of two things together. Content aligned with the New York State curriculum standards in both language arts and the content areas. Williams' teacher-led instruction with at-risk primary school children used clue words (signaling words), general text structure focused questions (What is this paragraph about? How are they the same? How are they different?), and graphic organizers (e.g., matrix). In addition, the intervention included text analysis (the close analysis of short pieces of well-structured text) and paragraphs that embody the characteristics of a particular text structure. The goal of using well-structured text was to increase familiarity with structure in order to help children strengthen their mental representation of a specific structure. These target paragraphs became more complex across the lessons in the intervention. At first, all the sentences reflect the structure, and later, other sentences (called distractors) are added that include details about the topic but do not reflect the structure. In the second lesson, lions and eagles were contrasted on one issue, skin covering, in a one-paragraph text that also included a similarity (Williams et al., 2005). This contrasts to ITSS where the introductory comparison lessons involved two-paragraph texts that compare two ideas on three contrasted issues. Sequentially moving from one contrasted issue per lesson in early lessons to more contrasted issues in later lessons may be particularly important for at-risk learners and younger readers.

In Williams et al.'s first intervention study (2005) students learned how to classify animals on the basis of issues, such as how they bear their young or get oxygen. Students in the

structure strategy group as well as students in the control group learned this content about classifying animals. Adding structure strategy instruction did not reduce learning of vocabulary or other content area concepts. Both groups that received content instruction performed better on the content than the no content control group. Children in the structure strategy group also demonstrated use of the comparison structure with both similar content (animals) as well as new content, indicating that readers were able to transfer strategy knowledge to new contexts (Williams et al., 2005).

Williams, Stafford, Lauer, Hall, and Pollini (2009) replicated these findings in an extended and improved version focused on science topics (e.g., animals) and the comparison text structure. The clue words were reduced from eight to six, and "and" and "than" were deleted from the original list. Additionally, later lessons added a pro-con version of the comparison structure and added some pro-con clue words. As students progress through instructional modules, they become more challenging. Students answer comprehension questions with oral and written responses in early lessons. Later they write summaries with assistance of a form, and by the end of the module they write free summaries without assistance. Again, primary-grade children demonstrated greater learning of the comparison (compare/contrast) structure and improved their ability to understand novel text (Williams et al. 2009). Additionally, they learned domain knowledge similar to students who received content instruction without time devoted to text structure (Williams et al. 2009).

In addition to work with the comparison text structure, researchers have investigated structure strategy instruction with causative text in the primary grades. In a series of lessons developed and evaluated by Williams et al. (2007), the cause and effect structure was taught in the domain of social studies. The lessons focused on the colonists and early American pioneers. The cause-effect general questions were "What happened?" and "Why did that happen?" The clue words were "because," "so," "therefore", and "since." Similar effects were reported as those reported about the comparison lessons and science topics in terms of boosts to reading comprehension and domain learning similar to students who did not learn about text structure. Transfer was observed, but it appeared to be not as strong as that for the comparison lessons (Williams et al. 2007).

In summary, recent interventions with elementary and pre-school students have indicated that the structure strategy can be successfully taught to younger learners, and is associated with improvements in comprehension similar to previous interventions targeted to adults. Although questions remain as to the best method of Web-based instruction with readers in earlier grades, from these interventions several important implications for instruction can be gleaned. First, it is important to provide appropriate scaffolding and instructive feedback to students, increasing the complexity of text and instruction as students improve in their use of the structure strategy. In addition, it is important to select texts which match the reading level of the learner, particularly in initial instruction of a particular text structure. Intervention research also suggests that not only can the structure strategy be taught within a classroom setting; doing so will provide comprehension benefits while not detracting away from content learning. Finally, in adapting structure strategy instruction to younger learners, careful thought of readers' needs and capabilities is needed in order to avoid creating instructional tasks that are too difficult or confusing for young readers to complete.

Conclusions

Much progress has been made in the rigor and extent of research examining the effects of the structure strategy with different types of readers in different contexts. There is substantial and consistent evidence over 30 years that instruction with the structure strategy

increases recall from expository text and the organization and quality of readers' recalls. Additionally, there is evidence that structure strategy instruction can increase understanding and use of signaling words, production of good main ideas and summaries, standardized reading comprehension tests scores, and answers to questions. Additionally, structure strategy instruction changes the type of ideas readers underline as important, readers' think-aloud protocols, and their eye movement patterns while reading.

The momentum to bring the structure strategy to elementary school children is currently in full force in part due to funding from the U. S. Department of Education Institute of Education Sciences for the work of Meyer and Williams and their colleagues in recent years. It is hoped that this momentum continues with positive effects on readers from preschool to retirement age. In order for this to happen in K-12 schools, teachers and administrators need to understand the strategy and its importance for reading and learning from text. Although the structure strategy can be provided through a Web-based platform, many students will not acquire the benefits of structure strategy instruction without a school environment valuing and supporting the intervention.

There are still many questions yet to answer about the structure strategy. These include how much instruction to provide with each text structure at different age levels and with what types of texts. Additional research in adapting instruction to meet the needs of children throughout the elementary school years is needed in order to help readers meet the demands of progressively difficult texts in a variety of different domains. Care should be taken so that children learning about text structures in preschool or primary grades realize that they have started on a path of increasing their knowledge and use of the structure strategy with increasingly more varied and complex reading materials and tasks. This tact may avoid giving younger readers the notion that they already know about the structure strategy and need not engage in further instruction. As can be noted in the intervention by Samuels et al. (1988), college students benefited from instruction about the text structure of a scientific journal article. This benefit for reading comprehension held when a journal was presented in the ideal organized manner and when it was not. As readers age, their instructional needs change, and it is important to create structure strategy instruction which is sensitive to the needs of readers in particular phases of their education. Potential areas for study include the timing and amount of structure strategy review throughout years of schooling and extensions to meet the developing needs of the maturing reader. This further research will allow educators to meet the needs of the maturing reader who will interact with more varied and complex informational materials in nonfiction texts and on the Web.

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