Discourse Analysis: Written Text

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DISCOURSE ANALYSIS: WRITTEN TEXT

Written text can be approached from a variety of disciplinary perspectives and purposes. In the context of the present volume, we approach discourse analysis of written text by asking why written texts are of concern to literacy researchers, why they need to be analyzed, and how the texts and their analyses inform theoretical and empirical research in literacy. Written texts are of concern to literacy researchers because the ability to read and understand them is definitional to literacy, at least in Western culture. But *written text* is far from monolithic. There are any number of written text genre, differentiated by their purpose or function as well as their structure or form (e.g., narrative, poetic, persuasive, informative). And within a genre, texts vary in both their form and content. A primary goal of the analysis of written text is to describe structure and content. It is important to do so because well-established empirical findings indicate that structure and content impact how readers' read, understand, remember, and learn from written texts (Goldman, 1997; Goldman & Rakestraw, 2000; Hiebert, Englert, & Brennan, 1983; Lorch, 1989). The discourse analysis of written text provides a method for systematically describing texts that students read as well as those they write.

To get a sense of what we might want our analysis of written text to capture read over example texts 1 and 2. They each deal with the topic of river ecosystems and were written to introduce young adolescents (11 – 13 year olds) to the ideas of interdependence and environmental pollution. As you read them, think about how you might describe their characteristics, their similarities and their differences. (Do this now before reading on in the chapter.)

Text 1: The Tupelo River Mystery

> In the spring of 1999, a new nuclear power plant in the town of Bregsville went into operation. Local citizens and environmentalists were concerned because the power plant was located along a branch of the Tupelo River. They knew that a river is a very fragile **ecosystem**. The word ecosystem connects the idea of *eco*, which means a habitat or

environment, with that of *system*, which means a set of relationships. Environmentalists were worried that the nuclear power plant would upset the balance of relationships among everything in the Tupelo River ecosystem.

There are many parts of the Tupelo River's ecosystem. Some are organisms such as fish, insects, animals, and plants. They live in and around the river. River systems also contain non-living things such as water, the rocks on the bottom, and the mud on the banks of the river. The most important concept about any ecosystem, including the Tupelo River's, is that everything depends on everything else. A change in one part of the ecosystem could introduce changes in all parts of the ecosystem. There was concern that the operation of the nuclear power plant would introduce changes.

Text 2: Ecosystems

Any group of living and nonliving things interacting with each other can be considered as an ecosystem. Within each ecosystem, there are habitats that may vary in size. A habitat is the place where a population lives. A population is a group of living organisms of the same kind living in the same place at the same time. All of the populations interact and form a community. The community of living things interacts with the non-living world around it to form the ecosystem. The living members of a river's system are the plants and animals that live around and within the river -- and they are all connected to each other in what is called a food web.

Anything that is added to the water of our aquatic ecosystems that is not a normal part of the systems, and that should not be there, is a type of water pollution. There are many sources of water pollution. Some types of pollution can be traced directly to a particular spot, such as a factory, or industrial plant. These sources of water pollution are easier to control, because the actual point where the pollution is being added to the water can be identified.

Here are some of the things we think you might have come up with to describe the characteristics and the differences.

1. Text 1 is a story about a town; text 2 is more straight "content."
1. They both define ecosystem but they do it differently.
1. They are both about the same length and have the same number of paragraphs.
1. Text 2 talks about water pollution in general; text 1 talks about the impact of the nuclear power plant but doesn't say it is a potential source of pollution.
1. Text 2 talks about the food web but text 1 just says that things in an ecosystem depend on each other.

We suspect that as you engaged in the analysis and comparison process you were unsure of precisely how to describe what you were noticing. Discourse analysis provides a means to more systematically engage in the descriptive analysis and comparison of written texts. The particular perspective we take in this chapter assumes that discourse analysis is informed by knowledge of the content domain(s) that the text is about. In other words, the method is not "content free."

What is the Method?

Discourse analysis of written text is a method for describing the ideas and the relations among the ideas that are present in a text. The method draws on work in a variety of disciplines, including rhetoric, text linguistics, and psychology. These disciplines provide ways to describe and analyze how the structure and content of the text encodes ideas and the relations among the ideas. In describing these relations it is important to initially define the genre to which the text belongs because structures differ across genre. For example, narrative stories differ from persuasive essays; news articles have a different form than editorials; and fiction texts have different structures than nonfiction. Differences in structure imply different relations among the ideas in the texts, especially at the global level. With respect to the differences between the example texts 1 and 2, the first difference we listed reflects just such genre differences.

The global level of relations is often referred to as the rhetorical structure of the text. Different rhetorical structures are appropriate for different genres. For example, the rhetorical structure of many stories involves the occurrence of a problem that protagonist(s) attempt to resolve, and in "happy ending" stories are successful at resolving. The story typically consists of a series of episodes that are causally related. A common form of episode relations occurs when there are a number of preconditions that must be met in order to resolve the overall problem. In other narrative rhetorical structures, the interepisode relations may be temporal, with one episode

succeeding another but with goals that are not particularly related. (For further information about narrative structure, refer to Bamberg, 1997; Bloome, 2003; Mandler & Johnson, 1977; McCabe, 1997; Stein & Albro, 1997; Stein & Glenn, 1979; Trabasso & van den Broek, 1985).

The global structure of nonfiction texts contrasts with those of fictional ones, and there is less agreement about the rhetorical structures that apply. Meyer (1985) proposed a set of five "top-level" rhetorical structures in an attempt to systematize the structure of the major genre of expository texts. These were collection or list, description, causal, comparative, and problem/solution. (see also Weaver & Kintsch, 1991). These rhetorical structures may be signaled by particular words or phrases but do not have to be. Example text 2 is a description. Example text 1 is a bit more complicated but we think it may be best described as a nonfiction narrative perhaps similar to a feature article in a news magazine or newspaper.

The analysis of written text is also concerned with understanding the local relations among the ideas conveyed in a text, i.e., relations among information in sentences occurring relatively close together in the text. It is precisely the relations among ideas that define the coherence of the text and make it more than the sum of its parts. Indeed, Sanders, et al. (1992), defined coherence relations as the "aspect of meaning of two or more discourse segments that cannot be described in terms of the meaning of the segments in isolation. In other words, it is because of this coherence relation that the meaning of two discourse segments is more than the sum of its parts" (pg. 2). There are a number of ways coherence relations are established. Halliday and Hasan (1976) identified four primary logical connector relations: temporal as in an ordered sequence of events (e.g., the steps in a mathematical proof), additive as in elaborations of an idea (e.g., main idea followed by details), causal as in antecedent and consequent events, and adversative, as in the juxtaposition of contradictory information.

There are a number of discourse markers (also called linguistic cues) that are relevant to understanding local relations among ideas. A specific class of discourse markers, called connectives, express, signal, or cue the underlying conceptual coherence relations. Examples of connectives are because, furthermore, and however. Other kinds of signaling devices (Lorch, 1989) signal the relationships of sentences to paragraphs, paragraphs to one another, and to the overall theme of the text.

Lorch (1989) distinguished signaling devices from those aspects of a text that communicate the semantic content: Signals emphasize particular aspects of content or structure but they do not add content (Lorch, 1989). Signaling devices help readers pick out what to selectively attend to and how to differentiate the importance of different information in the text (Goldman & Duran, 1988; Goldman & Saul, 1990; Guthrie, 1988; Lorch & Chen, 1986; Lorch & Lorch, 1996). Lorch provided a list of signaling devices used in expository prose that included titles, headings and subheadings; repetition of content to emphasize, preview, or summarize; function indicators (pointer words like *thus*, pointer phrases like *in summary*, pointer sentences like *let me summarize what has been said*); relevance indicators (*let me stress that*); enumeration devices; and typographical cues (underlining, boldface, and spatial layout such as indenting, centering).

A large body of empirical research indicates that some genres and content structures are more difficult for readers to understand than others. For example, knowledge of narrative structure generally appears earlier than knowledge of expository structure (Crowhurst, 1990; Engelhard, Gordon, & Gabrielson, 1992; Grabe, 2002; Langer, 1986; Scott, & Windsor, 2000; Tolchinsky, Johansson , & Zamora, 2002;) Of course this may be a result of typical instructional practices of concentrating on narrative text in primary grades and not introducing expository forms until later (Duke, 2000; Pappas, 1993). When readers have knowledge of informational content structures and

use that information to guide their processing of text, their understanding and memory is better than in the absence of such knowledge (Carrell, 1992; Englert & Hiebert, 1984; Garner, Alexander, et al., 1986; McGee, 1982; Meyer, Brandt, & Bluth, 1980; Taylor & Beach, 1984; Taylor & Samuels, 1983). Although literacy researchers have always been aware of genre, content, and structure differences among texts, historically there was far less recognition of the role that such differences might play in outcomes for readers and the implications for literacy education. This is no longer the case. Thus, it is critical for literacy educators to describe and understand the content and structure of written texts, the demands they place on readers, and the relationship between written texts students read and those they write.

The Analysis of Written Text

The goal of analyzing written text is to arrive at systematic descriptions that provide a basis for comparing written texts with one another. But what kind of description? There are a number of issues to consider in answering this question, the most important of which is what questions the researcher wishes to address with the analysis. If, for example, interest is in how much of the text a student remembers exactly as it was presented, counting the number of words that can be reproduced in correct order and position might be all that is necessary. Of course, even word counting can become more complex (e.g., if location in the text (e.g., beginning, middle, end) was important). Indeed, early work on memory for written text used the word-counting method (Clark, 1940, cited in Carroll, 1972; Gromulicki, 1956; King, 1960, 1961 cited in Carroll, 1972). Word counting might also be useful if interest is in a simple measure of fluency of producing written text.

A fairly common reason for wanting a systematic description of written text is to determine the reading difficulty of a passage, referred to as passage *readability*. Traditional readability formulae such as the Flesch Reading Ease index make extensive use of word complexity (assessed

via number of syllables), number of sentences, and number of sentences per 100 words. (See Klare, 1974-5 for review). However, readability formulae do not correspond well with how easy the text makes it to understand the concepts and ideas. One reason for this is that making explicit the local relation between ideas sometimes results in longer sentences. Consider the contrast between examples 1 and 1A:

1. Torrential rains fell on Saturday. The road collapsed.

1a. The road collapsed because of the torrential rains that fell on Saturday.

Even though 1a is a longer sentence readers find it easier to understand the causal connection than in sentence 1 (Pearson, 1974-75).

Traditional readability formula also fail to consider the familiarity of the concepts in the passage. More recently, the lexile has been used to assess readability (Stenner & Wright, 2002). The lexile determines readability using sentence length and word frequency. Word frequency is a rough index of concept familiarity and is being widely used. (For additional information, see www. Lexile.com.) In addition to underestimating the impact of readers' knowledge of the passage topic, readability formulae do not take into account the text as a whole. That is, texts have global structure that transcends the individual words and sentences. It is perfectly obvious, for example, that the meaning of a text is entirely different when we reorder the sentences.

To illustrate the limitations of text descriptions that are based only on readability formulae, we need only refer back to the example texts 1 and 2. A number of the differences we noted would have been masked if all we had done was look at word counts and readability indices. The relevant data are 190 (text 1) versus 201 (text 2) words; 12 versus 11 sentences; 15.8 versus 18.2 words per sentence; 6 versus 5.5 sentences per paragraph; 47.3 versus 58 for the Flesch Reading Ease; 10.5 versus 9.6 for the Flesch Kincaid grade level; and 970 versus 1030 for the Lexile measure. On the

basis of these data the two texts are hard to distinguish. Thus, readability formulae provide only a rough descriptive and comparative index and miss many of the important characteristics of texts.

Typically, it is the ideas in text and their interrelations that are of interest to the literacy researcher. Some ideas can be conveyed in a word or two; others require several sentences and paragraphs. How then do we systematically describe the ideational content and structure of written text?

The most commonly accepted unit of analysis among literacy researchers is some form of the proposition, a construct that appeared in the work of a number of linguists, psychologists, and computer scientists during the 1970s (e.g., Anderson, 1976; Fillmore, 1968; Frederiksen, 1975; W. Kintsch, 1974; Kieras, 1981; W. Kintsch & van Dijk, 1978; Meyer, 1975; Schank, 1972; van Dijk, 1972). A widely used formulation, and the one we favor, is that of Kintsch and van Dijk (1978). Specifically, van Dijk and Kintsch (1983) defined the proposition as a theoretical unit that corresponds roughly to the meaning of a clause. A whole text is represented by organizing the set of propositions derived from the clauses and sentences in the text. Different forms of organizing the propositions include hierarchical lists, semantic networks, or procedural networks. The proposition itself consists of the simple concepts or *atomic propositions* and the *propositional scheme* (or complex proposition) into which the atomic propositions are arranged. The propositional scheme consists of a *predicate* and one or more *arguments*. Predicates are main verbs of clauses or connectives between clauses. Arguments have functional roles with respect to the predicate (e.g., agent, patient, object location) or can be embedded propositional schemes. A proposition refers to a state, an event or an action. The psychological plausibility of clause-level propositional schemes has been demonstrated in a variety of research studies although we will not review them here (Anderson & Bower, 1973; Graesser, 1981; Kintsch & Keenan, 1973; Ratcliff & McKoon, 1978).

In Figure 1, we present a schematic of the propositional scheme for the first sentence in example text 1, *In the spring of 1999, a new nuclear power plant in the town of Bregsville went into operation*. To generate the propositional representation shown in Fig. 1, we analyze its elements and decide whether it is an event or a state. As shown in Fig. 1, the decision we reach is that it is an EVENT. The decision is based on our understanding that the words *went into operation* mark a change in state of some entity, in this case *a new nuclear power plant*. Because it is an inanimate entity, we refer to the plant as an Object. We also know that events occur in time and space and indeed the first sentence provides us with this information. Time and place are indicators of the circumstances of the event. The structure of the propositional scheme conveys these relations. But the schematic in Fig. 1 does not accurately reflect the *atomic level* of analysis. The atomic level, resulting from further analysis of the phrases in the schematic, is shown in the lower portion of Fig. 1. The atomic level can be considered the basic, core level of meaning and although it may be useful from linguistic or philosophical perspectives to capture this level, it is often too detailed for purposes of looking at understanding and learning. For our purposes we typically represent propositions at the more molar level shown in Fig. 1.

Figure 2 shows the same sentence represented as a semantic network. We have left the links unlabeled but they could be labeled with object, time, and location.

While it is useful for didactic purposes to work out several sentences at the level of detail shown in Figure 1, it is often impractical to draw such structures for every sentence in a written text. The typical way in which we create the propositions of a text is in a list format as shown here.

i. Went into operation (OBJECT: new nuclear power plant, TIME: ii, PLACE: iii)

ii. in the spring of 1999

iii. in the town of Bregsville

We refer to the proposition labeled *i* as the predicate proposition; *ii* and *iii* specify the time and place of the main action. We use indentation to show that propositions *ii* and *iii* are subordinate to the predicate proposition. Depending on the discourse analyst, there might be additional propositions reflecting the adjectival modifiers of *plant*. For example, *iv*. TYPEOF plant: nuclear power; and *v*. MOD plant: new. These would also be indented to show that they are subordinate to the main action. The level of detail needed in the proposition specification depends on the questions the researcher is addressing. The next sentence in the paragraph would be similarly represented, as shown in Figure 3. In sentence 2 there are two clauses that are causally related, shown in the figure as a BECAUSE node (cross-hatched and rectangular). The argument *power plant* is common to sentences 1 and 2; this overlap is shown in Fig. 3 by having the node, shaded for emphasis) linked to the predicate of each sentence. Similarly, sentence 2 and 3 share an argument (*local citizens and environmentalists*). Understanding this connection requires the resolution of the referent for the pronoun *They* in sentence 3. Note that showing node overlap in the list format can get messy but arrows are often used to show which cross-sentence overlaps exist. Illustrations of this can be found in a number of published papers (e.g., Goldman & Varnhagen, 1986; Goldman, Varma, & Coté, 1996; Goldman, Varma, Sharp, & CTGV, 1999; Trabasso & van den Broek, 1985).

If we carried out the process demonstrated in Figs. 2 and 3 for the remainder of the sentences in the paragraph and passage, the result would be an organized network or list of propositions connected on the basis of the meaning relations among the ideas. Organizing the individual clauses into a network or list depends on the semantic relationships among the ideas, often producing a hierarchically organized structure of super- and sub-ordinated ideas. The title and first several sentences usually establish concepts that are subsequently repeated throughout the passage as more information about them is provided. Subsequent incoming information "attaches"

to these concepts creating the subordinate or supporting relation, as illustrated in Figs. 1, 2 and 3. Sentences that have many subsequent sentences connected to them take on more superordinate, thematic status in the passage (e.g., Goldman, Varma, & Coté, 1996; W. Kintsch & van Dijk, 1978; Meyer, 1975).

Texts in which the individual clauses are explicitly connected have high cohesiveness (Halliday & Hasan, 1972). Example 1A, previously discussed, is a highly *cohesive* sentence. *Coherence* is reflected in the connectedness among propositions in readers' representations. In Example 1, readers might infer the causal relation that is explicit in 1A, in which case the representation would be similarly coherent for 1 and 1A. Similarly, in Fig. 3, we noted that the reader needs to make an anaphoric reference to resolve the referent for *they* in sentence 3. If readers do not make that connection, they might make one between *Tupelo River* in sentence 2 and *river* in sentence 3, an inference based on the specific river being an instance or example of the general class of rivers. If readers failed to make either the anaphoric or the general-to-specific inference the two sentences would be unconnected and a gap in local coherence would exist. Lack of coherence in readers' representations of text make it difficult to understand the meaning of the text as a whole; information remains in bits and pieces, so to speak.

To foster the development of coherent representations, texts often supply cues (cohesive devices) in the text. This should make it easier to establish coherence but only for those readers who understand how to interpret the cues (Goldman & Rakestraw, 2000). Texts that have few cohesive devices require that readers work to fill in the gaps among ideas. Doing so frequently requires that readers have requisite prior knowledge of the content domain or knowledge of the genre of the text. If they do not and the text has few cohesive devices, understanding is often not very good. As might be expected, comprehension by readers who know little about the topic of a text is aided by

cohesive text. However, researchers have found that readers who have high content knowledge achieve deeper understanding of a text in which the cohesion is not obvious as compared to those in which cohesion is explicit (E. Kintsch, 1990; McNamara, Kintsch, Songer & Kintsch, 1996; Voss & Silfies, 1996). Discourse analysis permits researchers to compare texts in terms of propositional structure and the ease with which connections across propositions, hence coherence, can be achieved.

The Role of Prior Knowledge. Why should it be the case that readers with high knowledge of the topic achieve deeper understanding when they have to create coherence? Answering this question involves expanding our discussion of text representation to include an interpretive level. Researchers in the early 1980s recognized a distinction between creating a representation of the text itself and integrating the information in the text with prior knowledge, thereby constructing a representation of the situation described by the text. The representation of the text itself, labeled the *textbase*, is what we have been constructing thus far (see Fig. 3). The representation of the situation is referred to as *mental* (Johnson-Laird, 1983) or *situation model* (van Dijk & Kintsch, 1983) and reflects readers' interpretations of the meaning of the text (Perfetti, 1989), constructed by integrating prior knowledge with the ideas in the textbase. Interpretations come about through elaborative, explanatory, and evaluative processes. To conclude that learning has occurred, evidence of a situation model representation is needed (W. Kintsch, et al., 1993; McNamara, et al., 1996). Assessment of learning thus involves going beyond reproductive or recognition memory; readers need to demonstrate that they have formed a coherent model of the situation described in the text. This can be demonstrated in a variety of ways such as by applying the information to a new situation, providing verbal explanations or drawings that illustrate how something works (e.g., Chi, et al., 1994), or successfully carrying out a procedure (Mills, Diehl, Birkmire, & Mou, 1995).

Discourse Analysis of Texts Produced by Readers and Learners

Written discourse is not only a medium of information presentation. It is also a window into the mental model of the learner. Frequently, readers and learners are asked to produce text, sometimes to demonstrate what they have learned from reading a particular textbook selection, passage, or set of passages. These learner-produced texts can be analyzed and compared to what learners read or were presumed to have read. Other times learners produce written discourse "spontaneously" and in the absence of some just read "stimulus" material. In these situations, the written discourse communicates writers' content knowledge, beliefs, feelings, and command of the language. In the discussion that follows, we focus on learner-produced writing in the context of presented texts and only briefly discuss spontaneous writing.

Writing in response to presented text. When learners produce essay responses to open-ended questions, their writing samples can be analyzed with respect to "how close" they are to the presented text and how much they go beyond what was "in" the text through inferences and elaborations. We can look for evidence of coherence in the mental model and of appropriate integration of new and prior knowledge, both important benchmarks of understanding (Coté, et al., 1998; Coté & Goldman, 1999). As such, they act as a window into the internal representations that readers have constructed. By comparing texts learners write to those they have read it is possible to characterize comprehension and understanding. For example, we might want to know the degree to which they have accurately understood the meaning of the text or how they have interpreted the information, as reflected in elaborations and explanations. To facilitate such analyses, we want to conduct discourse analyses of the written texts produced by readers and learners and do so in a form that is compatible with the representation of the material that they read and from which they learn.

Responses to specific prompts and questions. Consider the three student-produced written texts provided in Table 3. These are the responses of three seventh grade students who had read *The Tupelo River* text in its entirety. They were asked to respond to the specific probe question "Explain the idea of an ecosystem." The researchers (Oney, et al., 2003; Goldman, et al., 2003) used this type of probe because they were interested in what students had understood about ecosystems. They were not interested in learners' memory for the story per se so rather than asking for recall of what they remembered from *The Tupelo River Mystery*, the researchers asked a targeted question.

To understand the students' writing samples, it is important to know the gist of *The Tupelo River Mystery* beyond the two paragraphs in the example at the beginning of the paper. (Full text is available at http://litd.psch.uic.edu/docs/river_7th.doc). Briefly, scientists decided to monitor the river to see if any changes in the ecosystem occurred. Over a ten month period they found that the Mayfly population had declined by over 70% and the Rainbow Darter by 50%, but the Elodea plant had increased by 20%. This was explained in terms of a food chain in which the Mayflies were central, serving as food for the Darter and eating the Elodea. The cause of the food chain disruption was a 5 degree increase in the river temperature, resulting in less dissolved oxygen and the negative impact on the Mayfly population. The scientists traced the rise in temperature to thermal pollution from the nuclear power plant.

We noticed several things about the seventh graders' responses. (Before reading on you might want to take the researcher's role and read over the responses, thinking about similarities and differences among them and between each and the passage.) First, the responses differ in length; however, longer is not necessarily better. Student 3 has the shortest response but perhaps the best explanation of an ecosystem. Student 2 likens an ecosystem to the food chain and includes a number of specifics about how the death of one animal or plant will affect what happens to others.

Student 2 seems to have accurate details but lacks the more interpretive understanding that Student 3 seems to have achieved. Finally, Student 1 seems to have bits and pieces of what the text contained but they are not connected in ways that show the interrelationships. If we were to paraphrase Student 1's response it might go something like the following: "An ecosystem is a cycle in which insects are important. They eat plants and are a food source for certain fish." Thus the more general notion of an ecosystem is missing. This contrasts dramatically with Student 3 who uses the specifics in the story to exemplify the general principles of an ecosystem.

If we want our analyses of these data to be capable of revealing the differences among these three kinds of responses, how are we to accomplish this? We need to specify the conceptual elements of an ecosystem as they are communicated in the text and look for correspondences in the students' responses. We start by dividing the responses into clauses, just as we did the text and ask whether these clauses are meaning preserving of propositions from the passage. We would also look at how the relations among the concepts are expressed and whether they are organized in a way that conveys a coherent situation or mental model of an ecosystem. This is the advantage of Student 3's response over that of the other two. Student 3 has inferred a set of core principles about ecosystems based on the information in the text ("An ecosystem is a relational environmental system. In an ecosystem, everything is related to one another. If one thing is removed, other things are effected.") These principles are then exemplified with the specific species and causal chain (water temperature increase □ decrease in Mayfly □ decrease in fish and increase in plant) that is described for the Tupelo River ecosystem. Student 3 seems to have used information from throughout the whole text in developing a mental model. In contrast, Student 1 appears to be largely focused on the information contained in the two paragraphs in the text about the food chain. Like Student 1, Student 2 seems to draw on these paragraphs but is less tied to the specifics of insects

and fish, suggesting more integration with prior knowledge of endangerment and interdependence in an ecosystem. These ideas are similar to the principles that Student 3 expresses, yet Student 2 does not abstract them beyond specific animals. We might conclude that Student 2 has a more concrete or specific situation model than Student 3.

Specific prompts such as the one illustrated for the Tupelo River Mystery and other kinds of open-ended questions are one way to elicit information from learners and are quite similar to the kinds of questions that teachers might pose to students on end-of-unit classroom tests for purposes of assessing learning. The recall task is another method that researchers commonly use to elicit text from students.

Writing in response to presented text: Recall. The recall (or retell) task asks students to write down (or say) what they remember from the text they have heard or read. This task is quite commonly used with many text genres. Here we focus on recall of an informational passage on metabolism typical of those used by many researchers. In research with passages of this genre, subjects typically recall about 25% to 40% of the predicate propositions from the textbase. In crediting students with recalling propositions, researchers need to decide whether to adopt a stringent or a looser criteria. A stringent criteria means that for credit to be given the student wording must be very close to the passage wording. More commonly looser criteria are used so that credit for inclusion of a proposition is based on comparability of meaning across the passage and students' productions. Comparability of meaning is usually based on the core idea of the predicate proposition.

The *Metabolism* passage shown in Table 2 has been used in research with children ranging in age from 8 to 12 years (Coté et al. 1998; Coté & Goldman, 1999). The *Metabolism* passage, and several others that were used in the same experiment, was written to begin in the style of a feature

article in a newsmagazine and to conform to a specific content structure (Coté, et al., 1998; Coté & Goldman, 1999). For example in the *Metabolism* passage (Table 2), the first paragraph reported a new scientific invention, which we hoped would provide students with a reason for wanting to learn more about metabolism. From there, the passage structure is typical of the informational text genre. The second paragraph provided definitional information on metabolism; the next four paragraphs provided information on "four factors that affect metabolic rate." The final paragraph related back to the first in stating how the new invention would measure metabolism. For the most part each sentence contained one predicate proposition and in cases where there were two clauses in a sentence we focused on the predicate that introduced new information. (For example, in sentence 4, *Different people have different metabolic rates that indicate how easily they can produce energy*, the new information and the main predicate we focused on was the underlined portion because the information in the second clause had already been given in the passage.)

Also in Table 2 are two examples that are representative of recall protocols obtained when students read the passage and were subsequently asked to recall "everything you remember." Several differences between the two recalls and between the recalls and the passage are evident. First, both recalls leave out much of the information in the passage. Student 1 wrote everything in a single paragraph and Student 2 created a list, using up and down arrows that we assumed meant increase and decrease, respectively. What about content? Both students have changed much of the wording from the exact wording of the passage. This is fairly typical and researchers often adopt the *meaning preserving* criterion: does the statement in the recall capture the meaning that was in the passage. If so, the student is credited with having remembered the information. By the *meaning preserving* criterion, each student would be credited with remembering the four factors. In addition, Student 1 included information from the passage to convey the impact the factor has on

metabolism. In contrast, Student 2 just indicated the relationship. Notice however that the way Student 1 expressed these relationships is not identical to the propositions in the text. To take just one example, the passage stated

> *For example, some foods are hard to digest, such as complex carbohydrates like rice. The body has to work harder to get energy from rice. If a person ate a steady diet of rice, the result would be a higher metabolic rate.*

Student 1 wrote:

> *Rice is hard to digest, so the metabolism would be high for someone on an all-rice diet.*

Student 1 received credit for remembering the underlined portions of the passage. Student 2 received credit for the same underlined information even though *rice* was not mentioned. Although other researchers might argue with this scoring decision, the important point is that such decisions need to be made on a principled and reliable basis. To achieve this, we have found it not only useful but necessary to keep a log of coding decisions so that inter- and intra-rater reliability can be achieved.

In general, the task of deciding on *meaning preserving* is nontrivial because of the variability in how people recall information they have read, even when they are accurate. As these two student examples illustrate, people combine multiple sentences and produce summary statements; they combine ideas from parts of different sentences; they make accurate as well as inaccurate inferences; and they express what they remember in different structural forms. To the degree that learners combine information and add information that goes beyond what is present in the text, we would credit their recall as reflecting situation model level understanding. (For more detailed discussion, see Coté, et al. (1998), Kintsch (1994, 1998), McNamara and Kintsch (1996), van Oostendorp and Goldman (1999), and van Dijk and Kintsch (1983).)

In the analysis of the responses to *The Tupelo River* and *Metabolism* texts, we have attempted to model the kind of thinking that researchers need to do when they are attempting to understand what students have learned from reading a passage or set of passages on specific topics. You might have noticed that this thinking depends on understanding the conceptual domain as well as how that information is encapsulated in the specific passage. If one goal of reading informational text is to enable learners to acquire conceptual knowledge, the content and structure of that conceptual domain must be part of the discourse analysis of written text. This is as true for the analysis of passages and what they afford in the way of opportunities to learn concepts and relations in a particular domain as it is for understanding the situation models that are suggested by what learners write about these topics after reading.

Spontaneous production of written discourse. The analysis of written text is often useful for assessing learners' prior knowledge, beliefs, feelings, and facility with the writing process. As indicated previously in our discussion, prior knowledge has a powerful impact on the way learners process, understand, and write about what they read. For informational text it is important to have a model of the conceptual domain in order to analyze both informational passages learners are provided with and what they learn as manifest in their written work. It is also possible to analyze essays that learners produce prior to any instruction in a topic area. These can be analyzed with respect to a conceptual model of the domain to estimate the contents and organization of learners' pre-instruction grasp of the domain. This information can be used in several ways, two of which are extremely important from the standpoint of literacy and instruction: as baseline assessments of domain understanding that can be compared to understanding at a later time; to select materials that are optimally suited to learners' incoming

knowledge level. (See Wolfe, et al. (1998) for an alternative method for matching texts to readers.)

Written productions can also be quite informative with respect to children's cognitive and social development. Both content knowledge and knowledge of linguistic conventions, especially genre, are evident in children's writing. For example, in a study by Chapman (1994, 1995), first graders' productions during "writers workshop" were analyzed in terms of what genres they represented. Chapman noted that over the course of the year children's writing became increasingly differentiated in terms of genre. Dyson (1997, 2003) examines the ways in which children construct their roles and relationships in text. In work with children in urban neighborhoods she documented both challenges to, and adoption of, gendered and cultural stereotypes (Dyson, 2003). From an instructional perspective, reader response logs are frequently advocated as a means by which children can develop engagement and enjoyment in text as well as comprehension and reflective processes (Barr, Blachowicz, Katz, Kaufman, & Wogman-Sadow, 2001).

Subjective but Scientifically Sound

Discourse analysis of written text is a necessarily subjective activity. Subjectivity does not, however, mean idiosyncratic or arbitrary. Scientifically sound discourse analysis follows principles and processes that assure the rigor and reliability of the endeavor. For example, discourse analysis needs to follow the standard procedures for developing coding schemes that can be used reliably by multiple coders (e.g., Strauss, 1987; Strauss & Corbin, 1990). These processes bring a greater degree of objectivity to the analysis. As mentioned previously, logs of decisions or difficult cases can help a rater maintain consistency across samples. Additionally, it is standard practice to include some measure of inter-rater reliability. Reliability measures may

be reported as simple correlations between raters, or when there is a finite set of possible observations, and one can compute both hits and misses in the coding of observations, then Cohen's Kappa may be used (Cohen, 1960). The purpose of having a second person code the data is to ensure that codes are applied in a principled manner. If two people can concur in their use of a coding scheme, then it seems more likely that the coding scheme represents an objective set of criteria for differentiating among examples, and that differences in coding are meaningful and not just *arbitrary or subjective* judgments. With such evidence of reliability, then discourse analysis can fulfill its promise as a tool for description and distillation of important similarities and differences in written texts.

An Exemplar of the Analysis of Written Discourse

Goldman and colleagues (Coté & Goldman, 1999; Coté, et al. 1998) conducted a series of studies on learning from informational texts that we will discuss as an example of how the theoretical and methodological issues introduced in the previous sections of this chapter can be applied to yield insights into student thinking and learning. The studies were designed to reveal how fourth and sixth graders think about informational texts similar to the *Metabolism* example (see Table 2) and what strategies they engage in as they attempt to learn from such texts. To gather information about their thinking, the students were asked to think aloud as the read the texts (for additional discussion of think aloud or verbal protocols, please see Pressley & Hilden, this volume). Specifically, they were asked to verbalize what they were thinking as they tried to understand the written passage, what they were doing to understand the passage, what they found easy or hard, and to describe any comprehension problems they had and what they were doing about them. Thus, oral discourse samples provided information about students' thinking about written discourse. Following the think aloud, students were asked to create a report on what they

had learned. They dictated the report to a researcher who typed it into a computer as the students watched. They were free to edit the text on the screen as they wished until they said they were satisfied with it.

Theoretical framework. The approach in these studies assumes that a) readers attempt to construct multiple levels of representation from written text, especially textbase and situation-model levels; b) different kinds of processing support the construction of different levels of representation; c) processing focused on the information in the written text supports textbase model construction; d) processing focused on connecting prior knowledge with information in the written text supports situation model construction; e) processing that focuses on creating connections among propositions in the text and between propositions in the text and prior knowledge propositions leads to more coherent representations; f) more coherent representations support better performance on retention and learning tasks. The main goal of these studies was to examine these assumptions through detailed analyses of students' thinking during comprehension and the relation of that thinking to the resulting representation. We were also interested in the impact of difficulty of the written text (easier and harder within each grade) on the kinds of processing in which readers engaged. These goals informed the selection and adaptation of passages for use in the study.

Passage content and structure. We chose topics and content that we thought would be unfamiliar to students and used a three-pronged validation process (readability, curriculum experts' ratings, and ease of comprehension ratings collected from other fourth and sixth grade students) to establish that the passages met our familiarity and difficulty level requirements (for details see Coté, et al., 1998). Passages conformed to a content structure like that of the *Metabolism* passage. We included explicit signals in the text to help readers understand the relations among the ideas. Those used in the *Metabolism* text are underlined in Table 2.

Analytic process. A coding system was developed to describe the types of processing that students engaged in as they constructed a representation of the text. Think aloud statements were assigned to one of five categories: Self explanations, Comprehension Monitoring for Problems, Predictions, Paraphrases and Irrelevant Associations. In a second analysis, the degree to which children made connections among the elements in the text or among text and statements in the think-alouds was examined. Such connections reflect reinstatements and rereadings of previously processed information.

We looked at the prevalence of each category as well as profiles of readers based on the combination of categories in their think-alouds. The reports that students generated were used as indicators of their representations. These were coded with respect to the inclusion of information from the presented passages as well as the coherence of the reports as texts themselves. Coté et al. (1998) provides information on the reliability process we used in each of these analyses.

Findings. Goldman and colleagues were able to show through parametric and nonparametric statistical tests in conjunction with case profiles of individual students that there were predictable relationships between the kinds of thinking students did during processing and the representations that resulted as reflected in the contents and coherence of their reports. We mention several noteworthy findings here. First, there was evidence that the majority of students on both easier and harder texts were integrating prior knowledge with the information in the text. However, these were local integrations in that they tended to focus on a single sentence and did not serve to connect across other parts of the text. Second, students used a range of strategies (e.g., use prior knowledge, ignore, reread, read ahead, reread prior sentence) in efforts to resolve comprehension problems and tended to be more successful at doing so on the easier passages. Third, when students read passages silently with no think-aloud (Experiment 2, Coté et al.,

1998), better recall performance was predicted by the number of times a sentence was accessed and by longer processing times. Coté et al. (1998) interpreted these measures obtained during silent reading as consistent with more elaborative processing and cross-sentence connections. Fourth, Coté & Goldman (1999) found that number of reinstatements and number of self-explanations were positively correlated. This pattern tended to be associated with more coherent reports of the information. Finally, the case analyses provided concrete manifestations of processing patterns associated with good and poor textbase construction and different levels of prior knowledge integration. Thus, the analyses of students' discourse as they processed written discourse yielded both quantitative and qualitative data that resulted in the identification of several patterns of processing and coherence in what was learned.

This line of research illustrates the rich information that can be gleaned by analyses of written text -- in this case the texts children read as well as the texts they produced themselves following the reading. It also meets standards of quality associated with discourse analysis of written text in three ways. First, the theory underlying the analyses has been carefully articulated and grounded in relevant models of text comprehension. Second, multiple methods and coding schemes were developed to characterize the texts that were read and to capture the phenomena that were observed. And third, the coding schemes were used systematically and resulted in high levels of interrater reliablity (between .80 and .92) on various measures. As a result, this research serves as an excellent example of scientifically sound discourse analysis and its utility for understanding text processing, learning, and their relationships.

Concluding Comments

The approach to analysis that we have illustrated here provides a more complex picture of written discourse and students' understanding of it than is provided by a typical "right answer"

approach to scoring students' responses. Although more complex, the approach conveys information about specific concepts and ideas that students understand and how deeply they understand them. It also conveys information about how students' thinking differs from the information conveyed in the text, their misconceptions, and gaps in their understanding. As such, discourse analytic approaches provide information that could guide instructional decision making in the classroom in ways that points on a multiple choice or short-answer test cannot. In the future, we hope that the discourse analytic approach will be more tractable for teachers to use in classroom instruction and assessment. There are some research efforts underway that are attempting to address this challenge through the use of various computational technologies (e.g., Foltz, Lahm, & Landauer, 1999; Golden, et al., 2003; Goldman, et al., 2003; E. Kintsch, et al. 2000; Wolfe, et al., 1998).

In closing, we wish to stress that researchers undertaking discourse analysis of written texts need to understand that it is an iterative process. It is driven by both theoretical and conceptual orientations and by the contents of the written discourse. In other words, even when researchers collect data with apriori ideas about the features or relationships that might be important, these ideas change as researchers engage in careful, scientific analysis of the written text that people produce. Discourse analysis is a process that successively approximates ways to adequately capture systematicity and variance across written texts and draw inferences about knowledge and learning.

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Table 1. Three Seventh Grade Students' Responses to the prompt "Explain the idea of an ecosystem" based on the Tupelo River Mystery passage

Student 1 An ecosystem is kind of like a cycle. A cycle that depends on its self. For example the insects that live in the water play in an important in the cycle. The insects eat a certain plant which helps the water in certain ways. Also the insect is a major food source for a certain species of fish. This insect does a very important part in keeping this ecosystem [flawless?]. If you remove this insect there will evetually be no fish and a huge surplus of plants. This is what I believe an ecosystem is.
Student 2 The ecosystem is like a chain that connects different species together and the different animals depend on each other and if one species becomes endangered then that mess the whole system up and the other animals won't be able to live right. When pollution is occured it can kill off lots of animals and destroy the whole ecosystem. An ecosystem is also similar to a food chain because if one species die or if a certain type of plant isn't growing any more then it will knock off the whole system. If an animal kills another species than that also will affect the ecosystem as well. Also if one animal dies then the other animal won't be able to eat and then the next animal will die off and then the whole system will be gone.
Student 3 An ecosystem is the relationship among the things in an environment. In an ecosystem, everything is related to one another. If one thing is removed, many other things are effected. In the story, the water temperature increased and it caused Mayflies to die. Fishes that feed on Mayflies began to die too. In contrast, the plants the Mayflies ate increased in number. That's an example of a food chain in the ecosystem.

Table 2. Metabolism passage and recalls by undergraduates

Metabolism

Customers in many pharmacies may soon be seeing the latest in new devices for the health conscious. A sports physiologist is developing the metabometer, a device that he hopes will measure the human body's ability to produce energy efficiently.

The rate at which the body produces energy is called metabolism. Different people have different metabolic rates that indicate how easily they can produce energy. The same person may have different metabolic rates, depending on the circumstances. Different species of animals also have different metabolic rates.

There are several factors that affect metabolic rate. One factor is the type of food a person or animal eats. For example, some foods are hard to digest, such as complex carbohydrates like rice. The body has to work harder to get energy from rice. If a person ate a steady diet of rice, the result would be a higher metabolic rate.

Another factor affecting metabolism is the climate of the environment. Temperature may cause the metabolism to change. People and animals that live in cold environments need to produce more energy in order to keep warm. Most animals that live in polar regions have high metabolisms. If people move from a warm to a cold climate, /their metabolic rates will increase.

Metabolic rate also differs depending on activity level. Changing the level of activity may cause the body to change its metabolism /because different activities require different amounts of energy. For example, basketball players use more energy than golfers so their metabolic rates are generally higher.

To some degree, metabolic rate is influenced by genetic inheritance. Children of parents who have high metabolic rates tend to have high metabolic rates also. This is because the body chemistry of the children is a combination of the body chemistry of the parents.

Metabolism is regulated by hormones produced by the thyroid gland, a tiny gland located at the base of the neck. These hormones regulate the behavior of all the cells in the body so that enough energy is produced. The metabometer will work by measuring hormone levels in the blood.

Student 1

A sports physiologist is trying to measure the metabolic rate by creating the metabolar. Metabolism is affected by many things. It depends on what someone eats. Rice is hard to digest, so the metabolism would be high for someone on an all-rice diet. Climate accounts for metabolism. People in colder climates have higher metabolic rates than people in warm climates. Genetics is responsible for metabolism too. If a child's parents both have high metabolic rates, the child will have a high metbolic rate too. Activity changes the metabolism. A golfer will have a lower metabolic rate than a basketball player because Golf does not require as much energy as Basketball.

Student 2

Metabolism -Deals w/ability of body to produce energy

-Influenced by 4 things:

1. Diet: harder food to digest= ↑ metabolism

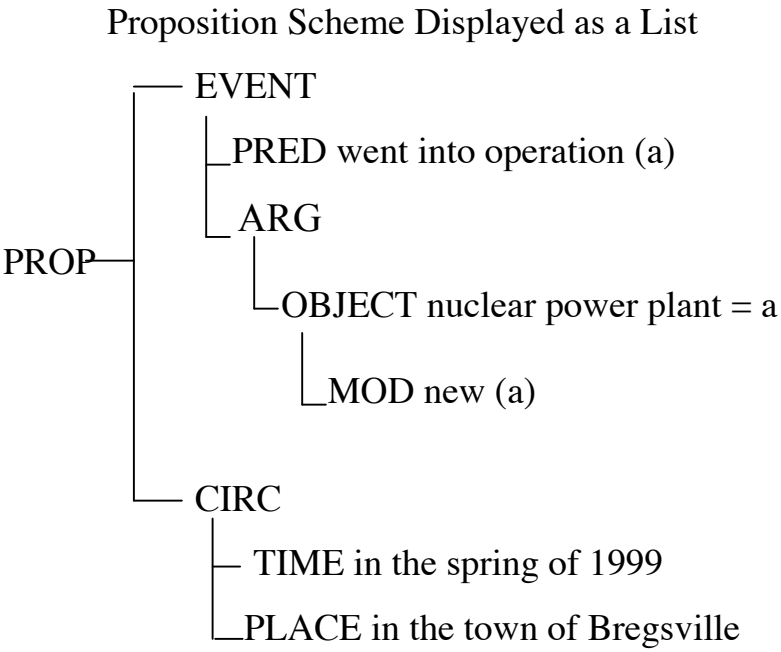
2. Climate: ↑ temperature= □ metabolism

3. Physical activity: ↑ activity= ↑ metabolism

4. Genetic: hormone released from thyroid, located at bottom of neck □

The new "metabometer" measures the hormones being release

Figure 1. Propositional Scheme Representation for the sentence *In the Spring of 1999, a new nuclear power plant in the town of Bregsville went into operation.*



PROP = propositional scheme; PRED = predicate; ARG = argument; MOD = modification; CIRC = circumstances.

Atomic Propositions

AP1: In (x1, AP6)

AP2: spring of 1999 = x1

AP3: New (x2)

AP4: Nuclear power (x2)

AP5: Plant = x2

AP6: Went into operation (x2)

AP7: In (x5, AP6)

AP8: town =x5

AP9: Of Bregsville (x5)

Figure 2. Semantic Network Representation of the Propositional Scheme for the sentence *In the Spring of 1999, a new nuclear power plant in the town of Bregsville went into operation.*

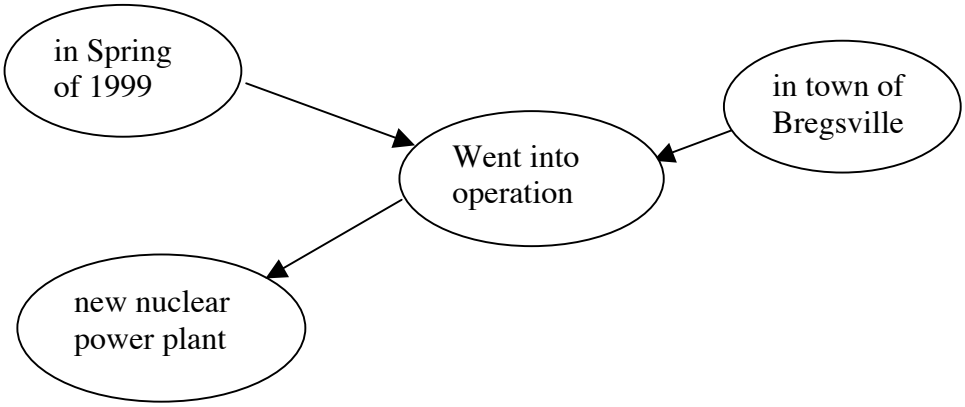


Figure 3. Construction of the representation of the initial part of text 1.

Identification of the clauses in the first two sentences
1. In the spring of 1999, a new nuclear power plant in the town of Bregsville went into operation.
2.1 Local citizens and environmentalists were concerned
2.2 because
2.3 the power plant was located along a branch of the Tupelo River.
3.1 They knew 3.2
3.2 that a river is a very fragile ecosystem.

Shorthand of the Propositional Schemes in the first three sentences.

1.1. Went into operation (OBJECT: new nuclear power plant, TIME: 1.2, PLACE: 1.3)
1.2. in the spring of 1999
1.3. in the town of Bregsville
2.1 Were concerned (AGENTS: local citizens and environmentalists)
2.2 Because (2.1,2.3)
2.3 Was located (OBJECT: power plant, LOC: 2.4)
2.4 LOC: 2.3, along a branch of the Tupelo River
3.1 They knew 3.1
3.2 Is (OBJECT: river, OBJECT: ecosystem)
3.3 Very fragile (ecosystem)