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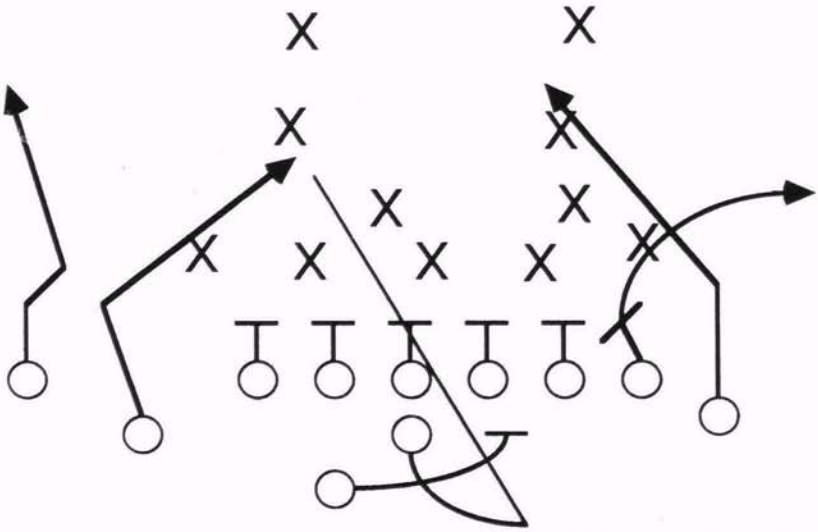
Teaching Students to Construct Graphic Representations

When they construct graphic representations of text they read, students better understand which ideas in the text are important, how they relate, and what points are unclear.



Spot art by Glenn Scimonelli and Al Way

When we first met Tony, he learned from his textbook by reading the questions, finding the answers in the chapter, and then memorizing them—a strategy typical of average and low-achieving students.

After a few training sessions, Tony learned a graphic outlining procedure that helps him analyze text. Now Tony skims the titles, subtitles, and illustrations of his textbook to determine the organizational pattern of the passage, key concepts and their relationships, and points that may need clarification. For many passages, Tony can easily identify what parts are important, how they are related, and where to find specific information—all in about five minutes before engaging in sustained reading! Then he reads to adjust and refine his understanding. After reading, he constructs a graphic representation that reflects his analysis.

This article provides generic models and guidelines for constructing graphic representations and offers suggestions for teaching students to represent prose text in mental models and graphic outlines.

What Are Graphic Representations?

Graphic representations are visual illustrations of verbal statements. Many graphic representations are familiar to most adults: flow charts, pie charts, and family trees, for example. More sophisticated graphics include spider maps, fishbone maps, network trees, and compare/contrast matrices. These and other types of graphic representations are pictured in Figure 1.

Many graphic representations are associated with frames. Frames are sets of questions or categories that are

fundamental to understanding a given topic. They are often the underlying organizational schema for prose text. Figure 1 shows a frame for each of the "generic" graphic structures.

Graphic representations are important because they help the learner to comprehend, summarize, and synthesize complex ideas in ways that, in many instances, surpass verbal statements (Van Patten et al. 1986). Consider, for example, how much prose text it would take to describe a complex social or political organization, "high-tech" machinery for industry or science, living organisms, or systems such as solar heating. A good graphic representation can show at a glance the key parts of a whole and their relations, thereby allowing a holistic understanding that words alone cannot convey.

Reading with an appropriate graphic structure in mind can help students select important ideas and details as well as detect missing information and unexplained relations. Moreover, constructing and analyzing a graphic helps students become actively involved in processing a text. Graphics foster nonlinear thinking, unlike prose summaries and linear outlines. For example, spider maps and matrices can be read left to right as well as top to bottom, thereby providing in-depth processing and rich contextual associations. Further, graphic representations provide input in two modes (visual and verbal), rather than just one (Paivio 1971). And, once a graphic has been constructed, summarizing—a task students typically find difficult—is relatively easy.[1]

Constructing Graphic Outlines

A fundamental rule in constructing graphic representations is that the structure of the graphic should reflect the structure of the text it represents. The generic graphic outlining procedure described below is appropriate for studying prose text across the content areas. (See the References for problem solving and decision making cited in endnote 1 for procedures for outlining in other learning situations.) Here we discuss an ordinary chapter assignment.

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Survey. First, the students survey the title, subheadings, illustrations and their captions, the initial summary or abstract (when available), and the objectives of the text to determine what the passage discusses and how the discussion is structured. Students should ask themselves questions like these: Are concepts presented in a hierarchy? Does the text suggest a timeline of information? Does the author compare and contrast two or more concepts? Is the text an explanation of something? What signal words are apparent? These questions should recall particular graphic structures associated with the topic and organizational structure of the text, such as a compare-and-contrast matrix or spider map. In this questioning process, the student interacts intensively with the text: his or her thoughts go back and forth from the text to memory and current perceptions.

Represent. The student begins to form a hypothesis about the structure of the text and mentally searches his or her repertoire of graphic structures for the best "fit." All representations have a corresponding mental model. The mental model constructed by the learner *is* his or her fundamental understanding of a given text or problem: it identifies the essence of what is important and how the parts or ideas are related. At this point, the mental model is essentially a tentative prediction of what graphic representation would best express the information in the text.

Whether or not the student attempts to construct a graphic at this point—or at all—depends on the student's prior knowledge, the clarity of the text, the weight of the evidence in support of the student's hypothesis, and the purpose for learning. If the text is poorly written or if the student is confused or lacks prior knowledge of an appropriate structure, he or she may be unable to construct a graphic representation without sustained reading and repeated corrections.

For example, students in a language arts class had read a text about two types of families: nuclear and extended. Since the text described the characteristics of each type, the students recognized that this structure lent itself to a graphic representation comparing and contrasting two or more things. Accordingly, they decided to sketch the outlines of a compare/contrast matrix with the two types of families as "Name" headings (see fig. 1). Had the text been less clear, the students should have withheld judgment as to the predicted structure.

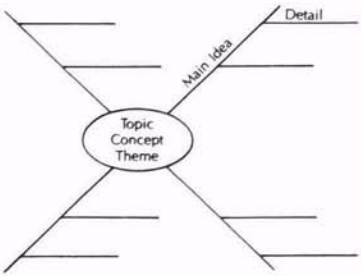
Once a graphic form has been predicted, students need to examine their background knowledge of the topic and the structure and to survey the text features again to determine how the specific graphic should be organized.

In the example above, when the students glanced through the first part of the text, they saw that the picture of the nuclear family had a father, a mother, and a few children, whereas the picture of the extended family had adults with gray hair, middle-aged adults, young adults, and small children. With that in mind, they were able to hypothesize that family size and composition would be likely "Attributes" for their matrix. The students recognized, however, that there might be other categories of information that could not be predicted from the headings and illustrations in the text, so their rudimentary representation was incomplete. They also recalled that in many families, the mother or father is absent and won-

Fig. 1. Graphic Forms with Corresponding Text Frames

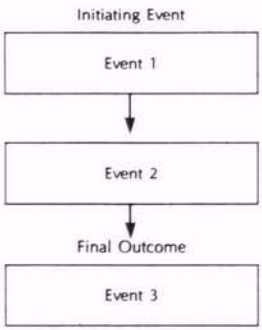
Graphic representations are visual illustrations of verbal statements. Frames are sets of questions or categories that are fundamental to understanding a given topic. Here are shown nine "generic" graphic forms with their corresponding frames. Also given are examples of topics that could be represented by each graphic form. These graphics show at a glance the key parts of the whole and their relations, helping the learner to comprehend text and solve problems.

Spider Map



Used to describe a central idea: a thing (a geographic region), process (meiosis), concept (altruism), or proposition with support (experimental drugs should be available to AIDS victims). Key frame questions: What is the central idea? What are its attributes? What are its functions?

Series of Events Chain



Used to describe the stages of something (the life cycle of a primate); the steps in a linear procedure (how to neutralize an acid); a sequence of events (how feudalism led to the formation of nation states); or the goals, actions, and outcomes of a historical figure or character in a novel (the rise and fall of Napoleon). Key frame questions: What is the object, procedure, or initiating event? What are the stages or steps? How do they lead to one another? What is the final outcome?

Continuum/Scale

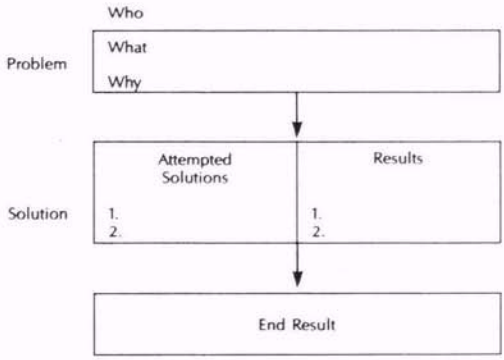
Used for time lines showing historical events or ages (grade levels in school), degrees of something (weight), shades of meaning (Likert scales), or ratings scales (achievement in school). Key frame questions: What is being scaled? What are the end points?

Compare/Contrast Matrix

	Name 1	Name 2
Attribute 1		
Attribute 2		
Attribute 3		

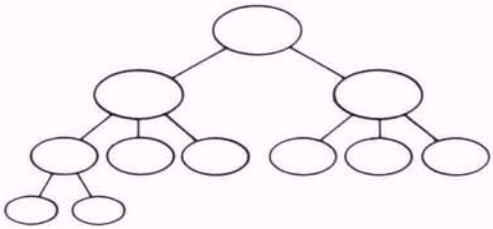
Used to show similarities and differences between two things (people, places, events, ideas, etc.). Key frame questions: What things are being compared? How are they similar? How are they different?

Problem/Solution Outline



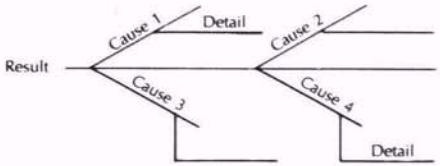
Used to represent a problem, attempted solutions, and results (the national debt). Key frame questions: What was the problem? Who had the problem? Why was it a problem? What attempts were made to solve the problem? Did those attempts succeed?

Network Tree



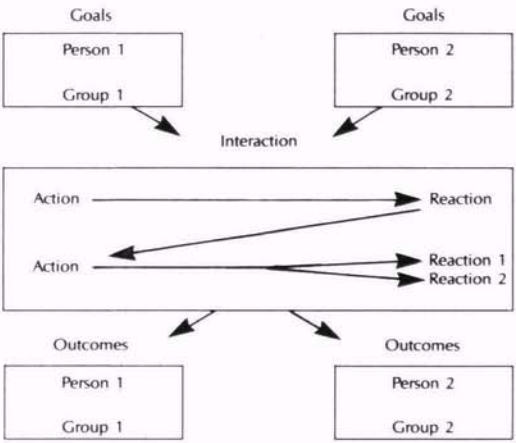
Used to show causal information (causes of poverty), a hierarchy (types of insects), or branching procedures (the circulatory system). Key frame questions: What is the superordinate category? What are the subordinate categories? How are they related? How many levels are there?

Fishbone Map



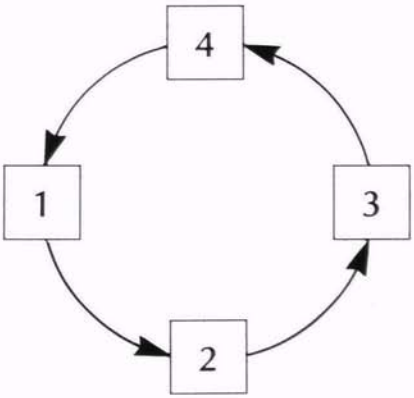
Used to show the causal interaction of a complex event (an election, a nuclear explosion) or complex phenomenon (juvenile delinquency, learning disabilities). Key frame questions: What are the factors that cause X? How do they interrelate? Are the factors that cause X the same as those that cause X to persist?

Human Interaction Outline



Used to show the nature of an interaction between persons or groups (European settlers and American Indians). Key frame questions: Who are the persons or groups? What were their goals? Did they conflict or cooperate? What was the outcome for each person or group?

Cycle



Used to show how a series of events interact to produce a set of results again and again (weather phenomena, cycles of achievement and failure, the life cycle). Key frame questions: What are the critical events in the cycle? How are they related? In what ways are they self-reinforcing?

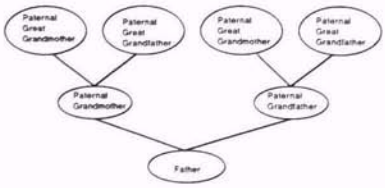
dered how the text would classify this type of family.

Read with comprehension monitoring. Having hypothesized a graphic outline, the students are ready to read the material with the following purposes: to fill in gaps in understanding, to look for ideas not yet accounted for in the representation, and to clarify any questions raised during the survey or while reading. This is a stop/start process requiring numerous pauses to compare new information to the hypothesized representation and to prior knowledge of the topic. In making these comparisons, the student can test anticipated ideas and relations as well as clarify or revise previous ideas. To continue checking for comprehension, each student may make a brief summary of his or her understanding *at various points* or generate questions and additional predictions.

In the example above, the students discovered that, for the two types of families, ethnicity and patterns of living also varied and therefore could be additional "Attribute" categories for their matrix. They had also determined that families with only one parent were counted as nuclear families.

After students have thoroughly read the passage, they should reflect on their *overall* understanding, asking questions such as these: What were the most important ideas in the text, and how do they relate? Were the representations I predicted the most accurate and complete? How should I revise my mental model? Are there any points that I find puzzling or unclear? Are they important? Do I need further clarification or research?

At this point, the students in the example above asked themselves whether the matrix they had constructed actually contained all of the appropriate categories. They also noted that the matrix did not contain some important definitions (for example, culture), so they decided to construct a list of terms and definitions. They remained puzzled over one issue: they had noted that the race of the extended family in the picture was white, whereas the text stated that extended families were more often Hispanic and Oriental; and they knew from experience that many black families were composed of several generations. Even after looking back at the text, they could not resolve these contradictions, so they decided to conduct additional research on families.



Outline. Having chosen one of the graphic forms, the student should complete the graphic outline, using the questions or categories in the appropriate frame as a guide. Students may add some details from their own background knowledge, or even change the representation at this point.

Summarize. Finally, the student should construct a summary based on the information in the graphic outline. Paragraphs or oral reports should be built around the major parts of the graphic outline.

For instance, a summary of the passage in the example above would indicate that it described two types of families and would point out similarities or differences in size, composition, ethnic association, and patterns of living, using the matrix to organize the sentences in the summary. A second paragraph in the summary would refer to the key terms and their definitions, seeking to relate the terms in some cohesive way.

While written summaries and individual reports have great value, students do not always have to write a summary. They can construct their graphic outlines in a "low-risk" discussion with other class members, as described by Davidson (1982). Alternatively, Dansereau, O'Donnell, and Lambiotte (1988) have recommended a cooperative learning format, with one student summarizing a graphic outline to another, and the second reacting to the summary.

Training Students to Use These Procedures

It is crucial to introduce graphic outlining to students in a positive way. We recommend presenting just one graphic form at a time, following the procedure below.

1. *Present at least one good example of a completed graphic outline* that matches the type of outline you will teach. Using cooperative learning is a good way to ensure that students examine the sample graphic outline(s) closely.

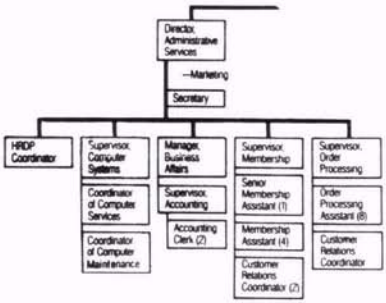
2. *Model how to construct either the same graphic outline or the one to be introduced*. Describe the decision-making process, and show students how to use frame questions to choose and plan an outline. It is also helpful to model the process of summarizing.

3. *Provide procedural knowledge*. Discuss when students should use the graphic and why, and what their responsibility is in the learning process. They need to appreciate that, with practice, they can master the technique, which will serve them well in other courses. This appreciation should help motivate students to invest the time needed to develop their repertoires of graphic outlining strategies.

4. *Coach the students*. Have students work as a whole class and then in small groups to plan their first graphics. Ask them to share and compare their outlines with the other groups. Also, ask them to explain how and why they made the decisions that they did. Provide them with ample feedback. Help them understand that planning and revision are crucial parts of the procedure. Some children think that only weak students should need to rework their plans.

5. *Give the students opportunities to practice* outlining individually and independently, and then give them feedback.

In addition to following these steps, educators must address other issues when teaching students these strategies. First, responsibility should shift gradually from the teacher to the student as students become more capable of organizing information for themselves. Even very knowledgeable educators may find it difficult to let students assume more responsibility.



Second, teachers must be willing to permit individual differences in thinking. Once students begin graphic outlining, it becomes readily apparent how unique each person's outline is. Teachers need to be tolerant of differences but not quite so accepting of errors.

Third, teachers need to be willing to reveal their own thinking processes, including confusion and making mistakes, while they demonstrate how to revise a hypothesis, graphic outline, or summary. Having students observe how the teacher makes such decisions may be more valuable than merely showing them a polished finished project. Many students, teachers, and administrators concentrate so often on "getting the right answer" that they are afraid to admit they are confused or need to change their minds (cf. Schon 1988).

Fourth, the training process requires a sizable amount of time. It takes a real commitment on the part of teachers and administrators, who need to be convinced that learning how to organize information spatially will help students and teachers perform better. They need to know that the time spent initially will pay off later, whenever the student needs to understand, summarize, and remember printed information.

Fifth, teachers need to set clear objectives, tests must be based on the objectives, and passages should be chosen for having structures that support those objectives, where possible. If the teacher's objective is for students to know about comparisons and contrasts, the passage should not present each topic as if it were a collection of discrete details.

In conclusion, graphic organizers and outlines are fundamental to skilled thinking because they provide information and opportunities for analysis that reading alone and linear outlining cannot provide. These opportunities can be especially beneficial to low-achieving students. Clearly, teaching all students to develop and use graphic representations effectively is well worth the effort and investment of time.□

1. Many researchers discuss the uses and effects of graphic representations in problem solving (e.g., Bransford et al. 1986, Greene 1987, Silver 1987), expert teaching (Clark and Peterson 1986), creative thinking and decision making (McTighe and Lyman 1988, Perkins 1986, Wales et al. 1986), computer databases (Pierce and Kise in preparation), and graphic outlining systems (Holley and Dansereau 1984a and b, Jones 1986, Jones et al. 1985).

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