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Learning to learn vocabulary in content area textbooks

Robert M. Schwartz

Schwartz does research on reading and its instruction and teaches at Oakland University, Rochester, Michigan. Activities described here were developed in the classrooms of Barbara Harte and Greg Kopec in the Derby and Abbott Middle Schools.

■ After reading an introductory chapter in their earth science textbook, a group of middle school students generate these explanations of the term *scientific method:*

A method that a person has observed about and at the end of the experiment you make a conclusion if what you thought was right or wrong

Way something or someone does in science

Way for people to understand more about space-science-astronomy

Is like a hypothesis, a guess of what is going to happen and run test on it

Is the steps in which you answer a scientific question. Problem, Hypothesis, Record the data, Run experiment [note sequence].

Each student's explanation reflects some knowledge of the concept of "scientific method" but conveys a sense of a problem only partially solved. To solve the problem and further refine their concepts, students need strategies for combining new text information with their prior knowledge and procedures for monitoring the success of their attempts at independent vocabulary learning.

Concept of definition

Schwartz and Raphael (1985) have described an instructional procedure designed to help 4th and 5th graders achieve these goals. It is based on the

semantic networks described by Pearson and Johnson (1978), and although its content and structure are similar to other models of concept development (see McNeil, 1987, for a description of the Frayer Model and related mapping procedures), the instruction differs in its focus toward developing independent learning strategies.

Called CD or "concept of definition" instruction, it provides a framework for organizing conceptual information in terms of three types of relationships—categories, properties, and illustrations (see Example 1). Internalizing this "concept of definition" helps students to (1) select and evaluate sources of information for determining the meaning of a new term, (2) combine and organize new information with their prior knowledge about the concept, (3) test their understanding, and (4) recall vocabulary concepts.

The following discussion extends the application of CD instruction to content area reading, including improvements on the original instruction (Schwartz and Raphael, 1985), as well as procedures and activities that allow extensive use of the strategy in content areas. First, however, consider the role of CD instruction within content domains like science and social studies.

CD in content areas

Many children's first exposure to content specific vocabulary is in expository selections from their basal readers in elementary school. Ideally, reading strategies developed with these expository passages are later extended and applied in initial content instruction. Unfortunately, however, many of the vocabulary activities suggested in the teachers' manual and implemented in basal readers and workbooks do not promote independent learning. Most

instructional materials focus on practice activities that establish the meaning of particular sets of words rather than developing a process that students can apply independently.

This lack of attention to independent learning skills in advanced reading is surprising given its prevalence in beginning reading programs (Schwartz, 1986). Most beginning programs attempt to balance their emphasis on sight word versus decoding orientations in developing an initial reading vocabulary.

Decoding skills are strategies that students can use independently to identify unknown printed words that are familiar in their listening vocabulary. An efficient decoding process requires students to coordinate a number of different kinds of information. These include analysis of letter-sound relationships (phonics), structural components (e.g., inflected endings or word families), and semantic and syntactic clues from the surrounding sentence context.
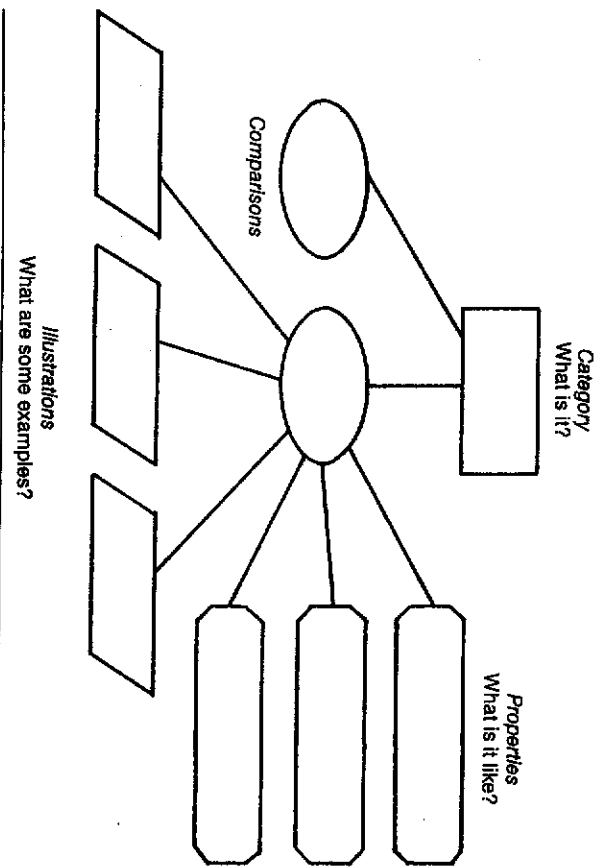
Similar attention needs to be given to helping advanced readers develop efficient word meaning strategies.

Unknown words

What can students do to determine the meaning of an unknown word? Several types of clues are potentially available. Foremost is the context in which the word occurs. Nagy, Herman, and Anderson (1985) suggest that a gradual, incidental accumulation of knowledge while reading is the primary force driving vocabulary development. The number of words acquired from context depends on estimates of the amount of reading that students do and the efficiency of their ability to learn from context.

Average middle school students

Example 1
Basic CD (concept of definition) Map

Category
What is it?

Properties
What is it like?

Comparisons

Illustrations
What are some examples?

(age 10-14) could acquire between 750 and 8,250 new words per year from incidental contextual learning (Herman, et al., 1987; Nagy, Herman, and Anderson, 1985; Wysocki and Jenkins, 1987). This is a large gain compared with the approximately 300 words per year directly taught in basal reader programs (Wysocki and Jenkins, 1987). Vocabulary knowledge can be improved by increasing the amount that students read or by increasing the efficiency of their learning from context. The concept of definition instruction addresses the latter of these two important goals.

Determining the meaning of an unknown word from context is not a trivial task (Konopak, 1988; McKeown, 1985). Schatz and Baldwin (1986) argue that in most literature and content textbooks, the context surrounding low fre-

quency, unfamiliar words is not particularly helpful. The clues provided are often too vague to specify a particular meaning and are likely to mislead readers who don't already know the target word.

In some cases a more precise meaning may be obtained by combining context clues with analysis of morphology, or word structure. Wysocki and Jenkins (1987, p. 69) describe this clue system as morphological generalization. The process "involves analyzing an unfamiliar word by separating it into its parts (e.g., prefix, stem, suffix), accessing the meaning of the parts, and then attempting to derive the meaning of the whole on the basis of these meanings." For example, a reader who was unfamiliar with *hydroplane* or *hydroponic* might be able to derive some properties or category information

from analysis of the word structure and add these to clues provided from the sentence or passage context.

When context and morphology fail to sufficiently specify a word's meaning, students are often referred to the dictionary. This just changes the context from which meaning must be derived, and Miller and Gildea's (1985, 1987) analysis of students' dictionary use suggests that this often complicates rather than solves the problem.

Given a number of dictionary definitions and explanations that contain words that are less familiar than those they are intended to define, children focus on those fragments of an entry that they are able to understand. Thus when asked to look up the meaning of *erode* and use it in a sentence, one 5th grade girl generated "Our family erodes a lot" (Miller and Gildea, 1987, p.98).

This seemingly illogical sentence is more reasonable when you consider that part of the dictionary entry for *erode* was "eat out, eat away." Miller and Gildea's analysis indicated that students often try to make up a sentence containing the part of the definition they understand, and then replace it with the unknown word. Thus, "Our family *eats out* a lot" is transformed into the baffling sentence for *erode*.

A schema for the task

It is hard to develop effective game strategies without a clear picture of the goal. Vocabulary learning from text is a game that requires students to coordinate information sources and orchestrate complex strategies. Typically they play this game awkwardly or not at all.

The concept of definition instruction doesn't change the game, but it makes it manageable. Students can use the CD to better understand the nature of

the learning task and the goal of developing word knowledge. As they internalize the organizational pattern shown in the Basic CD Map (Example 1), they develop an initial schema that they can bring to the task of vocabulary learning.

Internalizing this general structure enables students to engage in more metacognitive reasoning. That is, they can examine their existing word knowledge in terms of the types of meaning components they already know. Then they can select and monitor strategies to determine the information needed to complete the concept map, or differentiate the concept from other members of the same category.
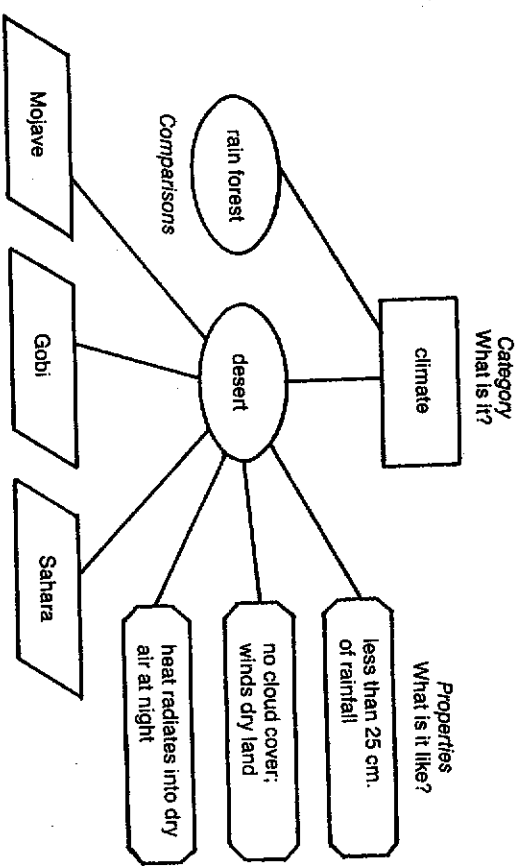
The schema can also aid them in evaluating the usefulness of a given context in determining the meaning of a word. They may realize that a particular context provides very general category information (e.g., an adjective or description of something), but it fails to provide sufficient information to determine particular properties or to generate examples.

Knowledge of the CD does not solve the problem of determining the meaning of any particular word, but it does provide knowledge of the goal, which in turn allows strategies like context or morphological analysis to operate more efficiently.

The Basic CD Map (Example 1) best fits the set of nouns that conform to this particular type of hierarchical structure. Like any schema or strategy, the structure needs to be used flexibly and modified to fit particular concepts.

For example, one of the exercises I've used to help students internalize the structure is to have them name themselves. They begin by writing their name in the center space and deciding on a category (e.g., boy, stu-

dent, 7th grader). They then list properties of themselves that are important or that make them different from other 7th graders.

When they come to "what are some examples," they are puzzled. There are no examples of them, in the sense that there are examples of elements or computers. After some discussion of the problem, I suggest they use the bottom blocks to give illustrations of the properties they listed. That is, if a student said he was extroverted, one example would be a sentence describing something he did that shows he is an extrovert.

Helping students to use the procedure flexibly is an important part of the instruction.

Updated version

Teachers who used the CD instruction as initially presented (Schwartz and Raphael, 1985) reported that students experienced a few common difficulties. Two modifications are incorporated in the Basic CD Map (Example 1) to help avoid these problems. First, the types of information included in the map are explicitly labeled as Category, Properties, and Illustrations. These labels provide additional support for the corresponding self questioning prompts "what is it," "what is it like," and "what are some examples."

Second, an explicit space for comparisons is included on the map. This space is helpful in several ways. Students initially have trouble responding to the "what is it" probe with a general category term. They often suggest a specific property or synonym. For example, they might decide that a desert is a "land that gets no rain." The comparison space allows the teacher to ask the student if s/he can think of one or more additional concepts that might fit under the same category:

"A category must have at least two members. If a desert is one type of land that has no rain, what is another type of land that gets little or no rain?"

This provides a way of evaluating and negotiating the appropriateness of the category selected. Under some circumstances you might decide that this was an appropriate category (with *scrub land* as a comparison term). But, since deserts were described in a textbook section on various *climates* this might be a better category, with information about the amount of rainfall shifted to the set of properties (see Example 2).

As indicated above, the comparison term also aids in selecting and evaluating the set of properties. A given set of properties may be sufficient to distinguish a *personal computer* from a *lawn mower* (two members of the category *machines*). On the other hand, if *calculator* is suggested as the comparison term, then a much more specific set of properties will be required to define *personal computer*.

Rather than suggesting that a student's set of properties is weak or incorrect, the teacher asks the student to evaluate whether that set of properties will distinguish the central concept from various comparison terms. The teacher might suggest a comparison that highlights critical or missing properties and then work with the student to revise the property list. This helps students to refine and further specify their knowledge.

Schwartz and Raphael (1985) described the set of four lessons that were used to introduce CD to 4th and 5th grade students. Activities and discussions designed to introduce the CD to middle school or secondary students are presented below (more detailed

Example 2
Completed concept map for desert

```
                    Category
                   What is it?

     Comparisons                              Properties
                                             What is it like?

   rain forest        climate
                                          less than 25 cm.
                                          of rainfall
   Mojave   Gobi   desert   Sahara
                                          no cloud cover;
                                          winds dry land

                                          heat radiates into dry
                                          air at night

              Illustrations
            What are some examples?
```

lesson plans are available from the author). The procedures are designed to gradually shift responsibility for mapping from the teacher to the students while providing modeling, feedback, and practice (Gordon, 1985; Pearson, 1985; Schwartz and Cramer, 1987).

The ultimate goal is for students to internalize the general CD map and use this mental structure to organize and refine conceptual information as they read.

CD Instruction
● *Demonstrating purpose*

The initial procedure is intended to demonstrate that organization and structure can aid memory. Telling students the purpose of instruction is often not as effective as demonstrating its value (Schwartz and Cramer, 1987).

One such demonstration employs playing cards from ace to 10 in alternating suits. Present the cards to the class in random order. Ask students to study the cards until they can write down the number and suit of each card without looking back at the display (they don't need to remember them in the sequence presented).

Reorganize the cards into four columns with a single suit in each column and the cards in ascending order. Have students view the display again and discuss how the pattern aids memory:

"Why was it easier to remember the cards the second time you saw them?

"If I had shown them to you this way originally, how would it have changed your studying?

"What patterns did you notice that helped you learn them?"

● *Activating prior knowledge*

The demonstration provides the rationale for learning to organize information about a word based on the structure of the concept map. Now show students that they are already familiar with the types of information needed for CD mapping by having the class brainstorm about some familiar concept like "tree" or "computer."

As you list their ideas on the board, point out that they know a lot about the concept, and that this knowledge can be organized into three groups: the category it belongs to (what is it), the properties that make it different from other members of the category (what is it like), and examples of the concept or illustrations of its use (what are some examples). As each set of information is discussed, relevant information from their list should be circled.

● *Content application*

Subsequent instruction appears both more meaningful and manageable once students see that organization can aid memory and that they are familiar with the type of information that needs to be organized. Next display the Basic CD Map (Example 1) and explain how it can help students in content courses when they need to learn the meaning of new concepts.

Learning technical vocabulary is often viewed as a difficult memorization task. Explain that by organizing information about new concepts using the map, students will be able to see relationships among the information in their books and information they already have. Learning is easier when students use this structure to identify new information, known information, and missing information.

Thinking about words in this way should help students decide if they know the meaning of a concept, and if not, what more they need to learn. It can help them comprehend their content texts and help them to discuss new concepts in class. Finally, organizing their conceptual knowledge can help students recall information (as shown in the previous demonstration) for use in problem solving or examinations.

The remaining introductory activities and discussions use the materials shown in Example 3. This categorization task helps to clarify the different types of information included on the CD map. Contrasting concepts can be suggested whenever students have difficulty deciding on the category or set of properties.

Link this discussion to the CD structure by mapping one or two of the concepts used in the categorization task. Demonstrate how a written definition can be generated from the map by combining information as you move clockwise around the map.

For Example 2, this might be: "A desert is a type of climate. Desert areas receive less than 25 cm. of rainfall a year. They usually have no cloud cover. Winds act to dry the land. Heat radiates into the dry desert air at night. Some examples of deserts are the Sahara, Gobi, and Mojave."

● *Context analysis*

When students develop some familiarity with the CD structure, they should begin to use the map to guide their attempts to determine the meaning of concepts from content texts. Complete context passages like the one shown in Example 3 support this process by including information on the category, set of properties, and examples.

Work with the students to identify information in the passages to answer the three mapping questions. Suggest contrasting concepts when necessary to help clarify the difference between responses to the "what is it" and "what is it like" questions.

For the fossil fuel passage in Example 3, you might ask "What is another source of energy other than fossil fuel?" The students reply "Solar energy." "Good! What are the properties that make fossil fuel different from solar energy?" After discussing the information from the passage, use this information to complete a concept map and construct a written definition for the term. The partial context passages in Example 3 are missing some of the information needed to complete a CD map.

Example 3
Categorization task in science

For each concept decide which phrases help answer the three general questions:
What is it?
What is it like?
What are some examples?

Desert
Less than 25 cm. of rainfall
Sahara
Climate
No cloud cover
Heat radiates into dry air at night
Winds dry the land
Gobi
Mojave

Lightning
Heat lightning
Caused by electrical charges in clouds
Discharges millions of volts
Type of severe weather
Produces pressure wave
Bolt lightning
Attached to tallest object

Words in complete contexts

These passages are considered complete because they contain one category term and at least 3 properties and 3 examples.

Desert

Fossil fuel
About 95% of the total United States energy needs are met by fossil fuels. Coal, crude oil, and natural gas are fossil fuels. These materials are called fossil fuels because they are the remains of plants and animals that lived a long time ago. Gasoline and fuel oil are both obtained from crude oil. Fuel oil, natural gas, and coal are the main fuels used to heat buildings, generate electricity, and transport people and objects.

Words in partial contexts

These are partial contexts because they do not include all the components needed to complete the concept map.

Seasons
The amount of radiant energy emitted by the sun generally stays at the same level. However, different latitudes do not receive the same amount of energy. The length of day varies with the time of year. The angle at which the sun's energy strikes the earth changes. These two variables cause the earth to have four seasons.

Dinosaurs
We study about many things in science, but one of the most interesting is studying about dinosaurs. These animals were one of the first reptiles and were amazing creatures. Can you imagine what a fight between a meat eating dinosaur like allosaurus and a plant eating dinosaur like stegosaurus would have been like?
Definition: Dinosaurs are reptiles. They were either meat eaters or plant eaters; none are alive today. Scientists study fossils to learn about them.

Evaluation and self checking

___ This is a complete definition.
___ This is not a complete definition. Things to add are: _____

Explain that when students come across an unknown word in their content text it may not provide enough information to complete a concept map. Although they do not need three properties and three examples to define a word, they do need enough of this type of information to know how the concept differs from other members of the same category.

Have students decide what information is provided in the passages and what additional information is needed. As students suggest other information for the map, point out that they have background knowledge that they can use to complete the maps. Also discuss where they might look to gain more information.

● *Internalizing the CD structure*

The evaluation and self checking activity in Example 3 is designed to promote internalization of the CD map in order to refine conceptual knowledge. Present several examples of partial content passages and related definitions (some well done, others still lacking information). Tell the class that these are samples written by other students. Their job is to evaluate the quality of the definition (is it complete—does it explain "what it is" and "what it is like") and to give examples.

Focus students' attention on whether it is possible to obtain more information from the context passage. Have them decide whether they can add to the definition from their background knowledge or where they might find the information needed to complete their mental map. When possible, they should generate a more complete definition.

After modelling the process involved in evaluating a definition, have students work in pairs to complete the other examples and discuss their decisions. Allowing students to discuss and explain their decision making process with their peers will help them clarify and internalize the procedures used to determine the meaning of concepts. Teachers can also diagnose and correct misconceptions about the process as they listen and participate in these discussions.

Strategy ownership

These activities and discussions provide a solid introduction to the CD and illustrate its use in coordination with contextual analysis of content area materials. My work with middle school science and social studies classes suggests that students need extended experience with this process to sufficiently internalize the CD structure and use it to guide independent learning of new concepts.

The nature of their additional practice is important. Concept maps can easily be converted into a worksheet format for defining the content vocabulary at the end of each chapter. This is both undesirable and inappropriate. The teachers I've worked with have found it increasingly easy to develop unique extension activities, such as the ones described below, as they experiment with the CD in their classes.

A primary goal for continuing instruction is that students develop a feeling of control and ownership of their word meaning strategies. This goal can be advanced in a number of ways. One important component is to use the CD to engage students in discussions of new vocabulary. When students express general confusion about a concept, the teacher should help them focus on whether they can generate possible categories, properties, or examples. A good sign of progress is that students begin to shift from saying

"I don't get it" to "I know it's a type of _____, but I don't know the properties that make it different from _____," or "The text doesn't give any examples of _____."

Ownership of the strategy can also be advanced by activities that encourage students to mentally play with CD. For example, at the beginning of the week the teacher might post 10 concept maps on a bulletin board with only the category information supplied. Gradually, over the week, the teacher adds properties, contrasting concepts, and finally examples. The students can work together or compete to identify all 10 terms.

A variation on this procedure is to have students select one or two words to map, leaving the central concept blank (but recording it on the backside of the map). Students can work in small groups to identify each other's concepts. The student who first identifies the concept gets 2 points.

The student who generated the map gradually reveals each category of information. S/he gets 1 point if the concept is identified based on the category alone, 3 points if identified from the category plus properties, and 2 points if it is identified based on the category, properties, and the examples (no points if the concept can't be identified from the map).

The scoring rewards students for providing a general but not misleading category, critical properties, and helpful examples. But more importantly, the activity allows students to generate, share, and discuss maps and concepts in a format that they might see as their own rather than something completed for the teacher.

Independent learners

This type of instruction is not meant to make students proficient at writing definitions. This would be an extremely limited goal with little impact on students' learning. Rather, the intention is to help them become more strategic at developing and refining their knowledge. The lessons and activities described above can facilitate this, but only to the extent that students take responsibility for their learning. If the purpose for content learning is merely to pass a test, strategies are helpful, but the knowledge gained has only short term value.

Strategies will be most efficiently learned within a context in which students feel some ownership for both the process and products of their learning (see Raphael, 1986). Learners can afford to leave the concept of "scientific method" unrefined if it is merely one of many problems on a test, but not if they confront the problem of function-ing as a scientist. Establishing this type of learning context is a continuing educational challenge.

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§

Elegant ways to make your writing gender neutral

Modern writers, especially those in education and other socially sensitive positions, are trying to avoid using masculine terms and pronouns in material actually referring to both men and women or to persons of unknown sex. The most common way is to use a term like *mail carrier,* which is gender neutral, rather than *postman,* or to substitute *her/his* for the common *his.*

You might want to try some more elegant and unobtrusive phrasings that will achieve gender neutrality and at the same time give your prose variety. Here are some suggestions adapted from the September/October 1987 issue of *Simply Stated,* a newsletter published by the American Institutes for Research (1055 Thomas Jefferson Street NW, Washington DC 20007).

● Use verbals: Change a nominal to a verbal expression to avoid the need for a pronoun. E.g.: "Anyone who uses or has in his possession..." can become "Anyone who uses or possesses...."

● Use an indefinite pronoun: Clauses using *if.. then* can often be changed to clauses with *who/what/that.* "If the student has failed the exam, he should..." might become "A student who has failed the exam should...."

● Use participles: Some *if..then* clauses can be changed to participial phrases without expressed subjects, shifting the expressed subject to the main clause. "If the researcher finds XXX, the researcher should..." might become "Upon finding XXX, the researcher should..." This requires care, however. You must be sure the implied actor in the participial phrase is the same as the expressed actor in the following phrase—otherwise you have the famous "dangling modifier."

● Use plurals: Statements that apply to classes of people can be made plural. "The teacher or college professor can prepare his work..." may become "Teachers or college professors can prepare their work...."

● Use an article: The pronoun *his* can often merely be omitted or be replaced with *a/an/the.* "If an employee cannot perform the duties of his position..." could become "If an employee cannot perform the duties of the position...."

● Delete reflexive pronouns: Reflexive pronouns can often be omitted. "The future teacher must qualify himself for..." becomes "The future teacher must qualify for...."

● Avoid reflexive verbs: Find an alternate for any reflexive verb that calls for an unacceptable pronoun—*to inform himself* could just as well be *to ascertain,* and *to remove himself* might become *to withdraw.*

● As a last resort, try the passive voice, so long as the new version or its context still makes clear who is doing what: "When the province has certified the teacher, he may..." could become "After having been certified, the teacher may..." (or: "After certification, the teacher may...").

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