I've Seen This Before?

The Effects of Self-Monitoring and Multiple Context Instruction on Knowledge Representation and Transfer Among Middle School Students

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THE EFFECTS OF SELF-MONITORING AND MULTIPLE CONTEXT INSTRUCTION ON KNOWLEDGE REPRESENTATION AND TRANSFER AMONG MIDDLE SCHOOL STUDENTS

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Abstract

Both multiple context learning and self-reflection training are posited to affect students' knowledge representations by fostering decontextualization, abstraction, and schema formation. Schemata, in turn, theoretically facilitate transfer. One hundred eighty-six low-SES middle school students of mixed ethnicities were taught to use concept mapping as a means of understanding material in either one subject area or two subject areas. In addition, half of the students in each group were trained in metacognitive self-monitoring techniques. The transfer task was a problem in a third subject area. Students were asked to complete the transfer task and then to complete three questionnaires, one eliciting alternative solutions to the transfer task, one assessing their schemata, and one addressing their metacognitive activity. In addition, a small, randomly selected subsample of students from each treatment group did not take the transfer task, instead completing only the questionnaires. It was hypothesized that students who both engaged in self-monitoring and were exposed to two subject areas would form better schemata, engage in greater metacognitive activity, and perform better on the transfer measure than other students. Although the main predictions were not confirmed, some support was found for the beneficial effects of monitoring on schema formation. In addition, it was found that, given a relatively brief treatment period, at-risk students *were* able to learn the cognitive strategy of concept mapping, to engage in metacognitive activities such as self-monitoring, to construct good concept mapping schemata, and to transfer to a large degree. Results are discussed and suggestions are made for future work in this area.

Introduction

In our educational system, students move from classroom to classroom learning science, or math, or social studies, often without making connections across their various classes. The subjects are generally taught as self-contained pieces; students then follow this example by *not* connecting these pieces together.

However, sometimes students may learn similar material in different subject areas—just as in the real world, concepts taught in one area do relate to concepts in another. Rather than keeping these pieces separate, students need to be taught to combine related items, to transfer knowledge from one domain to another. How can we help students see these links? How can we facilitate this transfer?

This study examines how learning a strategy in one versus two distinct subject areas, with or without self-monitoring training, affects students' ability to transfer to a new subject area. Both multiple context learning and self-reflection training are posited to affect students' knowledge representations by fostering decontextualization, abstraction, and schema formation. It was hypothesized that self-monitoring students exposed to multiple contexts would form better schemata than other students, thus facilitating transfer.

What Is Transfer and Why Is It so Important?

The term *transfer* as used in the literature generally involves the flexible use of information across task boundaries (Brown & Campione, 1984) or the use of knowledge gained in one known domain to solve a problem posed in a new, different domain (Gick & Holyoak, 1980; Perkins & Salomon, 1989). It has also been defined as the effect of previous problem-solving experience on learning or performance in a new problem-solving situation (Mayer & Wittrock, 1996).

The literature has much to say on the difficulty in obtaining transfer and the challenge involved in training for it (Brown & Campione, 1984; Campione, Brown, Ferrara, Jones, & Steinberg, 1985; Crisafi & Brown, 1986; Detterman, 1993; Ennis, 1989; Gick & Holyoak, 1980, 1983; Holyoak, Junn, & Billman, 1984; Holyoak & Koh, 1987; Holyoak & Thagard, 1995; King-Johnson, 1992; Nickerson, 1994; Perkins & Salomon, 1989; Reed, Dempster, & Ettinger, 1985; Reed, Ernst, & Banerji, 1974; Resnick, 1987; Salomon & Perkins, 1987, 1989; Sternberg & Frensch, 1993; Sternberg & Ketron, 1982). Nonetheless, transfer is an important goal. Industry complains that high school graduates are unable to function well in the workplace because they lack the problem-solving skills necessary for success, and conditions of employment are now likely to change several times during one's life (Resnick, 1987; Resnick & Resnick, 1992). In this environment, it is clear that the ability to transfer skills and concepts from one domain to another can significantly affect an individual's likelihood of success. Because schools are not able to teach students *all* they will need to know for the future, students must be taught how to use what they *have* learned to successfully solve new problems or learn new skills. Schools must address the issue of transfer, and transfer needs to be placed high on the list of classroom goals.

Conceptions of Transfer

The literature describes many theories of transfer. Researchers differentiate between near transfer and far transfer (Brown & Campione, 1984). Near transfer is the use of knowledge acquired from one domain in a second, similar domain. Far transfer involves relating knowledge to a very different domain. The transfer of a concept from one particular math problem to another similar type of math problem would be considered near transfer; using that concept in a physics context could be categorized as far transfer.

Brown and Campione (1984) identify "three faces of transfer." They suggest that the research literature has examined transfer from three different perspectives, asking three different questions: (a) How and when does transfer occur? (b) Is transfer an index of individual differences related to intelligence? and (c) How can we train for transfer in academic settings? Regarding young children's transfer abilities, they present research showing that children as young as two or three years old *can* transfer, given appropriate experimental materials. Although they posit clear age-related trends in the development of transfer in individuals, they also note that—within narrow age ranges—individual differences in transfer related to intelligence exist as well. More specifically, higher ability students learn related material more easily and transfer the results of their learning more flexibly (or farther) than do lower ability students. Finally, Brown and Campione argue that programs intended to train for transfer must include three main factors: (a) *skills training* in the use of task-specific strategies, (b) *self-regulation training* in the monitoring of these skills, and (c) *awareness training* in the significance of these activities.

Gagné (1970) discusses vertical and lateral transfer. He characterizes vertical transfer as the spontaneous assembly of learned subskills into an integrated whole. Vertical transfer thus entails the creation of a generalized approach from specific examples. Lateral transfer is defined as the application of skills broadly across subject areas. Using the same knowledge or skills in math, and science, and language arts could therefore fall into the category of lateral transfer.

Salomon and Perkins (1989) posit that there are two distinct "roads" to transfer: *low-road transfer* and *high-road transfer*. Low-road transfer is defined as transfer that occurs "when a performance practiced to near automaticity in one context becomes activated spontaneously by stimulus conditions in another context" (p. 151). It is characterized by (a) extensive, varied practice (i.e., practice that occurs in a variety of somewhat related and expanding contexts), and (b) practice to automaticity (i.e., processing that becomes fast, effortless, reflexive in a transfer situation, and not limited by processing capacity). For instance, an individual who knows how to drive a car can transfer that knowledge to the operation of a truck, without much serious cognitive effort. Low-road transfer has the benefit of efficiency but tends to inhibit high-road transfer (because of the latter's dependence on conscious control and analytic awareness). High-road transfer involves intentional generalization—or mindful abstraction—from a context; this type of transfer occurs deliberately and with effort. *Mindful* refers to its being consciously guided by metacognitive processes. *Abstraction* is defined as "the extraction from or identification in a learned unit of material, in a situation or in a behavior, some generic or basic qualities, attributes, or patterns of elements . . . [abstraction] involves both decontextualization and re-representation of the decontextualized information in a new, more general form" (p. 125).

Self-monitoring and metacognition are key components of high-road transfer. High-road transfer occurs when an individual is consciously attempting to integrate past experiences to solve current problems. Thus, whereas low-road transfer is directed by automated performance, and varied practice is needed for far transfer of this type, high-road transfer is directed by conscious decontextualization; personal motivation and self-monitoring are necessary to achieve this road to far transfer. For instance, the decoding skills necessary for reading a passage become automatic; reading this new sentence is thus a case of low-road transfer. In contrast, the case of a student who learns something in history class and then abstracts that knowledge and applies it to a current event story when reading a newspaper could be considered high-road transfer.

According to Salomon and Perkins (1989), high-road transfer can be of the *forward-reaching* kind, as when a student mindfully abstracts a rule or schema to be used later, or of the *backward-reaching* kind, as when a student faced with a novel problem-solving situation thinks back and deliberately searches for previous knowledge to apply to the new situation. They also distinguish between "what" is transferred and "how" it is transferred. What is transferred can be an overarching principle abstracted from one context and usable in another: a piece of factual knowledge, a learning strategy, a cognitive style, and so on. These researchers argue that the mechanisms by which transfer occurs—that is, the how of transfer—are clearly linked to the what of transfer. For example, some mechanisms of transfer (some *hows*) may be more appropriate for the transfer of explicit knowledge or strategies (some *whats*), whereas other mechanisms of transfer (other hows) may be more appropriate for the transfer of general abilities or groups of strategies (other *whats*).

Salomon and Perkins also discuss the amount and distance of transfer: *Amount* is defined as the extent to which learning of A improves performance on B; *distance* is determined by looking at how remote or novel B is from A. It is hypothesized using this theory that high-road transfer will result in greater distance of transfer (due to generalization and abstraction) but not necessarily a greater amount of transfer in an original (or closely related) learning situation (due to "too much" possible abstraction). In contrast, the researchers theorize that low-road transfer will result in greater amounts of transfer (because low-road transfer leads to automatic activation of "bundles" of responses) but not in great distance of transfer (because far transfer requires intentional examination to detect similarities).

In their review of the transfer literature, Mayer and Wittrock (1996) discuss four historical views of transfer: (a) general transfer of general skill, (b) specific transfer of specific behaviors, (c) specific transfer of general skills, and (d) metacognitive control of general and specific strategies. The general transfer of general skill view of transfer advocated fostering transfer through general schooling; the doctrine of formal discipline posited that teaching subjects such as Latin and geometry would help "train the mind." Educational research failed to uphold this first theory, giving rise to the second view of transfer: namely, that only specific transfer of specific behaviors existed. Drill and practice on specific skills were the educational result of this new view of transfer. However, because this theory did not account for *any* general transfer at all, a third view of transfer arose. The specific transfer of general skills view suggests that high-road transfer occurs when the same general strategy is needed in two different learning or problem-solving situations. Thus, this view blends the specific transfer view that two tasks must have the same component process for transfer to occur with the general transfer view that certain skills have general applicability across domains. Furthering these ideas, the fourth view of transfer, metacognitive control of general and specific skills, adds metacognition to the transfer equation. This final—and most recent—view of transfer focuses on the metacognitive processes involved in attaining transfer, proposing that transfer is "mediated by the problem-solver's cognitive and metacognitive strategies" (1996, p. 48). Successful transfer in this view occurs when a student is able to (a) recognize the requirements of the new problem, (b) select the appropriate specific and general skills that apply to the new problem, and (c) monitor the application of these skills in solving the new problem. This view integrates the *general* (metacognitive skills, domain-independent principles and skills) with the *specific* (domain-specific skills, use of metacognition within a specific context), suggesting that transfer is fostered when the processes outlined above lead people to manage the way they use their prior knowledge to create new solutions to a novel problem.

The analogical transfer literature examines transfer from yet another perspective. This framework suggests that knowledge is transferred from one domain to another by a mapping process, in which the individual attempts to find a set of one-to-one correspondences between portions of each domain (Brown, Kane, & Echols, 1986; Gick & Holyoak, 1983). Analogical transfer studies generally involve two components. First, students are given at least one problem and its solution as an example. Then, students are presented with a novel problem to solve, whose solution they can arrive at by using the problem-solving strategy from the previous problem. A two-pass paradigm allows students to attempt a solution with no further information, and then—following a hint to use the previously presented problem—to make another attempt at solving the target problem. Most of these types of studies have been conducted either with preschool children (Brown & Campione, 1984; Brown et al., 1986; Crisafi & Brown, 1986; Holyoak et al., 1984, for example) or with adults (such as college students; see, for example, Gick & Holyoak, 1980, 1983; King-Johnson, 1992; Phye, 1989; Reed et al., 1985; see Bassok & Holyoak, 1989, for a notable exception to this trend). By varying the tasks, conditions, and number of trials, experimenters have attempted to manipulate transfer outcomes.

Research in this area suggests that one of the major blocks to successful transfer is the failure to spontaneously notice transfer potential (Bassok & Holyoak, 1989; Brown & Campione, 1984; Detterman, 1993; Gick & Holyoak, 1980, 1983; Nickerson, 1994). Even in studies in which participants are given a problem and solution to review and are then immediately presented with a new problem whose statement and solution are analogous to the first problem, a large number of participants (generally 80%, as cited by Brown and her colleagues) fail to transfer (Brown et al., 1986; Gick & Holyoak, 1980, 1983; Reed et al., 1985). In order to transfer a solution from one situation to another, individuals must notice the relationships between previous examples, general schemata, and the current problem. Facilitating this recognition has been the subject of numerous studies (Brown & Campione, 1984; Brown & Kane, 1988; Crisafi & Brown, 1986; Gholson, Dattel, Morgan, & Eymard, 1989; Gick & Holyoak, 1980, 1983; Phye, 1989; Reed et al., 1974; Reed et al., 1985, for example).

In the analogical transfer framework, researchers posit four requirements for transfer (Holyoak et al., 1984; Holyoak & Koh, 1987; Holyoak & Thagard, 1995; Novick, 1988). Individuals need to (a) construct mental representations of the known and novel problems, (b) notice the potential for transfer and select a source for the novel problem (that is, the "known" problem), (c) create an initial partial mapping between the elements of each problem, and (d) evaluate and extend the mapping to find a solution for the new problem. When teachers make connections for their students, recognition is bypassed and mapping the correspondences from source to target becomes the primary concern. In contrast, when students need to make their *own* connections, recognition is crucial.

Taking into consideration the numerous conceptions of transfer described in this section, my study sought to borrow from the analogical transfer paradigm while focusing on far rather than near transfer, training for transfer rather than the two other proposed "faces" of transfer, lateral rather than vertical transfer, and high-road rather than low-road transfer. In addition, following the suggestions of Brown and Campione (1984), Salomon and Perkins (1989), and Mayer and Wittrock (1996), the relationship between metacognition and transfer was explored.

Metacognition

Metacognition is defined as "knowledge or cognition that takes as its object or regulates any aspect of any cognitive endeavor" (Flavell, 1981, p. 37) or as knowledge about, awareness of, and control over one's thoughts, motivations, and feelings (Wittrock, in press). Thus, students who think about their thought processes, or monitor their progress, or are aware of the cognitive strategies they use to solve a problem are engaging in metacognitive activity.

As noted previously, many researchers highlight the important connection between transfer and metacognition. Self-monitoring is a key component of high-road transfer's "mindful abstraction" requirement; in addition, backward-reaching transfer involves an individual deliberately searching for previous knowledge to apply to the new situation (Salomon & Perkins, 1989). Mayer and Wittrock (1996) stress the importance of students monitoring the application of specific and general skills in a problem-solving situation. Brown and her colleagues argue that children should be fully informed participants in any training enterprise—that is, children should be helped to understand why to use strategies and when it is necessary to do so—and that children should be trained in self-management of the strategies they should use (Brown, Campione, & Day, 1981). Further, research on metacognitive processes suggests that students who monitor their learning and are aware of when to use which strategies often become more active in their own information processing; create more complex, efficient representations; and abstract information better than do students who do not engage in self-monitoring activities. These types of results in turn lead to greater transfer of training (Belmont, Butterfield, & Ferretti, 1982; Berardi-Coletta, Buyer, Dominowski, & Rellinger, 1995; Wittrock, in press).

In order to better understand metacognitive processes, we can examine differences in students' metacognitive activities. What kinds of activities do successful learners engage in when trying to understand new material and how do the activities they choose influence their learning? What do successful learners do that less successful learners fail to do? Research has shown that older students engage in more metacognitive processing than do younger students (Moynahan, 1978; Zimmerman & Martinez-Pons, 1990) and that "gifted" or more academically successful students surpass other students on numerous metacognitive measures (Bransford et al., 1982; Slife, Weiss, & Bell, 1985; Swanson, 1992; Zimmerman, 1986; Zimmerman & Martinez-Pons, 1990).

Successful students surpass other students in two ways: (a) They possess more information about their cognition (metacognitive *knowledge*), and (b) they engage in more techniques to help foster learning (metacognitive *activities*). Research shows that successful students *are aware of* the knowledge they possess, individual differences in problem-solving, strategies that are appropriate in given situations, and the difficulties associated with different learning situations (Bransford et al., 1982; Slife et al., 1985; Swanson, 1992). Students use this awareness of their cognition (i.e., metacognitive knowledge) in order to engage in activities that foster learning (i.e., metacognitive activities). In particular, successful students *engage in the following activities*: They play a more active role in their learning; they process new information more effectively; they relate new information to previous information; they use elaboration techniques to better understand new material; they organize and transform presented material; they set goals for themselves; they plan their strategies; and they seek assistance when needed (Bransford et al., 1982; Zimmerman & Martinez-Pons, 1990). In addition, successful students are likely to be engaged in—and excel at—monitoring, or self-regulating, their performance (Puntambekar, 1995; Slife et al., 1985; Zimmerman & Martinez-Pons, 1990).

Metacognition is clearly made up of various components; however, researchers sometimes fail to highlight these differences. I draw two different distinctions in this paper: (a) metacognitive *knowledge* versus *activity* (see above), and (b) *cognitive* versus *metacognitive* processes. This second distinction—between cognitive and metacognitive processes—is an important one, and one which is often blurred in the literature. Although some of the activities listed above can be considered metacognitive in their own right (for instance, relating new information to previous information), other activities are labeled metacognitive when used in a metacognitive way or when found in conjunction with their linked metacognitive knowledge (for instance, assistance-seeking). That is, certain cognitive strategies can be considered metacognitive in nature not simply when students use them, but rather when students understand their underlying importance, know when to use them, or check that they are using them. To further elucidate this point, throughout this paper I attempt to use the term *strategy* when referring to the cognitive side, and *activity* (or *metacognitive knowledge*) when referring to the metacognitive side. Although my terminology could be criticized as rather arbitrary (and certainly it is not ideal), I find it preferable to the literature's use of such terms as "strategy use training" (see, for instance, Snyder & Pressley, 1990; they use the phrase "specific strategy knowledge" to refer to that which I term here "metacognitive knowledge") often without distinguishing between the cognitive (e.g., training students to use a strategy) and the metacognitive (e.g., training students to engage in activities such as monitoring the use of the strategy, understanding when to use a strategy, and so on). More discussion on this distinction will be included in the following section, as it relates to similar distinctions made by other researchers.

Training Students to Learn

Returning to our discussion of more and less successful students, given that some students are engaging in adaptive activities and others are not, can we teach all students to employ useful techniques and to become more aware of their learning? Can we, in effect, teach students to be better learners? Research has shown that students *can* be taught to engage in metacognitive activities, which, in turn, can enhance their performance and foster transfer (Berardi-Coletta et al., 1995; Brown et al., 1981; Lodico, Ghatala, Levin, Pressley, & Bell, 1983; Salomon, Globerson, & Guterman, 1989). However, as indicated in the preceding section, this instruction needs to emphasize more than just cognitive strategies alone: Students must be taught the circumstances under which such strategies should be used and the monitoring processes to ensure that such strategies are appropriate. Bruner (1985) argues that all learners have a host of learning strategies at their command, the key being in learning how to learn. "We would do well," states Bruner, "to equip learners with a menu of their possibilities and . . . to arm them with procedures and sensibilities that would make it possible for them to use the menu wisely" (p. 8). Snyder and Pressley (1990) discuss a "good strategy user model" in which a good strategy user is a student who possesses a number of different strategies (and metacognitive activities, as distinguished above) from which to choose when confronted with a cognitive challenge. These students are aware of various strategies, understand when particular strategies and activities are appropriate, and know how to implement such strategies and activities.

Brown et al. (1981) outline three types of "strategy training" found in the literature: (a) blind training, (b) informed training, and (c) self-control training.

Blind training does not include the students as active participants in the training process; rather, students are told to use a strategy without being given sufficient explanation so as to be able to understand the significance of using the strategy (see, for example, research on training for deliberate memory strategies, such as Turnure, Buium, & Thurlow, 1976). Thus, students in these studies learned to use a strategy to enhance recall, yet failed to transfer this strategy to similar learning situations (because they were not told *why* using the strategy was important). The strategies taught in this type of training vary; however, using my definition above, all would be considered cognitive strategies. *Informed training* includes both instruction in how to use a strategy and some information regarding the significance of the strategy (see, for example, Paris, Newman, & McVey, 1982). Although transfer is subsequently found, it is generally seen only in tasks that closely resemble the original training tasks. This type of training includes both cognitive strategy training and some metacognitive knowledge. It does not, however, include metacognitive activity such as a monitoring or evaluation component. Finally, *self-control training* involves instruction in the use of a strategy in conjunction with explicit instruction in how to employ, monitor, check, and evaluate that strategy (see, for example, Delclos & Harrington, 1991; Lodico et al., 1983; Palincsar & Brown, 1989; Puntambekar, 1995; Sawyer, Graham, & Harris, 1992; Salomon et al., 1989). This training can include instruction in cognitive strategies, but it also encompasses a metacognitive monitoring component. Brown and her colleagues suggest that this type of activity training is the most successful in inducing transfer of training to many settings.

Much research bolsters Brown's assertion that when training includes a self-reflection component, transfer is fostered. For example, Lodico and her colleagues (Lodico et al., 1983) trained second-grade children to monitor the relationship between their strategy use and their performance; this monitoring, in turn, led to significantly greater transfer in a new situation compared with a control group. Sawyer et al. (1992) found that fifth- and sixth-grade students with learning disabilities receiving strategy training outperformed control group students on subsequent composition measures; further, generalization of the composition strategy was best for students receiving self-monitoring training as well. Salomon and his colleagues (Salomon et al., 1989) used a computerized "Reading Partner" program to train seventh-grade students in reading principles and metacognitive activities. These researchers found that trained students reported greater mental effort, showed better metacognitive reconstruction (when asked to explain good reading tips to a friend), and performed significantly better both on a near transfer reading task and a far transfer writing task than students in the control groups. Furthermore, performance differences were statistically accounted for by trained students' ability to describe good metacognitive activities. Delclos and Harrington (1991) studied the impact of strategy monitoring training on the problem-solving transfer of fifth- and sixth-grade students, finding that students who received problem-solving training and engaged in self-monitored practice performed better on a complex transfer problem than did control students. Berardi-Coletta and her colleagues (Berardi-Coletta et al., 1995) asked college students to solve various problems; while the students worked on the problems, some were asked questions designed to focus attention on (a) what they were doing (i.e., monitoring) and (b) how they were checking their progress (i.e., evaluating). The researchers found that those students in the metacognitive treatment group (i.e., those students who monitored and evaluated) developed more sophisticated representations and performed better and faster on a subsequent transfer problem than did other students. Finally, in earlier pilot work, I found a direct relationship between transfer performance and metacognition, with higher performing sixth- and seventh-grade students reporting more metacognitive activity (Klein, 1994).

In summary, training in the classroom should include not just strategy training, but also more explicit instruction regarding those strategies. Students should be taught when and where to use the strategies and how to engage in activities to monitor and evaluate their usage. Students should learn to be aware of their learning. Students should also be taught how these activities positively affect their performance. This will motivate them to engage in these activities, as well as help them to understand that involvement in these activities (and not just innate ability or increased effort) is how good students perform well. Note that, using the terminology presented in the preceding section, this approach includes training for strategy use, metacognitive knowledge, *and* metacognitive activity. These training aspects will lead to more active processing of information, decontextualization, abstraction, and knowledge restructuring, which will all work to foster transfer.

Representation and Abstraction of Knowledge

Underlying the issue of transfer is the representation of knowledge. In order for a person to transfer a concept from one problem to another, he or she must first have processed the relevant information such that it is accessible when needed (Nickerson, 1994; Sternberg & Frensch, 1993). If relevant knowledge is not represented appropriately, transfer goals are sure to fail. Researchers discuss this representation of knowledge in various ways.

Sternberg and Frensch (1993) characterize transfer as a function of four mechanisms: (a) encoding specificity, (b) organization, (c) discrimination, and (d) set. These mechanisms set transfer in a memory framework, focusing on the encoding and recall processes that affect transfer. The *encoding specificity* mechanism specifies that transfer of an item depends upon how the item was encoded; encoding is integrally linked to retrieval. If information is taught as isolated and encapsulated, it will be less accessible later on. The *organization* mechanism states that the organization of old information either facilitates or impedes transfer to a new situation. For instance, individuals may organize their knowledge at a relatively surface-structural level or at a more deep-structural level. The *discrimination* mechanism suggests that an item is labeled as either relevant or irrelevant to a new situation, affecting transfer accordingly. Both an irrelevant label in a relevant situation (i.e., lack of recognition of transfer potential) and a relevant label in an irrelevant situation (i.e., negative transfer) will adversely affect transfer. Finally, the *set* mechanism provides that an individual's mental set to achieve (or not achieve) transfer affects transfer performance. An individual's unique way of seeing a task or situation may carry over to other tasks or situations. For instance, "hints" to use previously presented information help prime individuals and thus facilitate transfer.

Mayer (1984) discusses three cognitive processes in which individuals must engage in order to achieve meaningful learning: selection, organization, and integration. First, individuals must select relevant information. Next, they must organize this information into a knowledge structure, connecting these pieces of information together into a coherent whole. Finally, individuals must integrate the new information into their existing knowledge structures. This final cognitive process of integration involves building connections between new, incoming information and relevant, existing knowledge.

Other researchers discuss representation of knowledge in terms of mental models. Mental models are defined as models or structures constructed by an individual based on his or her available knowledge. The underlying need for, or goal of, mental models is one of explanation or understanding (Norman, 1988; Seel, 1993). Individuals attempt to create mental models for objects or events that they wish to better understand. Further, mental models have predictive value in helping to explain novel situations or objects.

The construction of mental models depends upon the existence of one's individual experiences, the competence to retrieve the necessary knowledge, and the ability to apply this knowledge to a novel situation (Seel, 1993). The use of mental models can simplify the learning process by allowing an individual to assimilate new information with previously acquired knowledge. In addition, transfer can be facilitated by identifying analogies between different situations (Seel, 1993).

Schema theory also describes how individuals organize and represent the knowledge they acquire and how cognitive structures facilitate the use of knowledge (Glaser, 1984; Rumelhart, 1980). A "schema" is a structure that represents knowledge stored in memory. People use their schemata of previously experienced situations to interpret new, related experiences. By integrating and assimilating new information with prior knowledge and by abstracting information to obtain more generalized structures, people make sense of new objects, situations, and relationships.

The creation of a schema can be viewed as an abstraction or generalization. If an individual processes only one example of a problem-solving strategy or approach, its representation in memory may be isolated and disconnected (see both encoding specificity and organization, above). The example will probably stay context-dependent, not allowing for a general schema to evolve, and making transfer more difficult. However, as an individual encounters more examples of the same or similar strategies or concepts, he or she can construct a more general schema.

Researchers discuss this generalized representation in several ways. Brown et al. (1986) refer to this construction as "a generalized mental model" (p. 105). Holyoak et al. (1984) discuss the representation of problems in terms of a "more abstract knowledge structure that describes the commonalities between the two domains" (p. 2053). Salomon and Perkins (1989) term the mindful abstraction of a rule "forward-reaching transfer." They stress the importance of both decontextualization of the new information and representation of that information in a more general form. Mayer and Wittrock (1996) discuss the importance of "abstract[ion of] the general principle or strategy" (p. 26). Schraw, Dunkle, Bendixen, and Roedel (1995) suggest a sequence of events that may lead to generalization: First, specific strategy knowledge is acquired within a particular domain; next, metaknowledge about the strategy is constructed; and, finally, "general strategy metaknowledge" is formed, which can then be applied across multiple domains. Whether termed schema, generalized mental model, abstract knowledge structure, or general strategy metaknowledge, this representation is helpful to an individual because it contains general, decontextualized information about the strategy or concept, such as a *context-independent* (or perhaps less dependent) version of the strategy or concept, *when* it is useful, *how* to use it, or *in what contexts* it has been applied.

Schemata are less context-dependent than singular examples in memory and more stable and available for future retrieval (Druckman & Bjork, 1994; Gick & Holyoak, 1983). Thus, an individual may be better equipped to transfer a concept from one domain to another if an associated schema exists. For example, helping students construct a schema or actually giving students a schema or problem-solving strategy to use fosters transfer (Brown & Kane, 1988; Crisafi & Brown, 1986; Gick & Holyoak, 1983; King-Johnson, 1992). In these studies, the relevant schema was presented as part of the problem, implicit within its representation. Participants were then asked to summarize the basic strategy or rule or, with younger children, to explain to someone else how to solve the problem. Gick and Holyoak (1983) found that embedding a summary of the underlying strategy in two example story problems resulted in higher rates of transfer for college students on a subsequent analogous task. Similarly, Catrambone and Holyoak (1993; as cited in Holyoak & Thagard, 1995) asked students to write general statements comparing two source analogs and then gave students the appropriate responses. They found that students performed very well on the transfer task, even though a week passed between the study and test sessions. Crisafi and Brown (1986) found that stating the general rule underlying all tasks and then having the children in the study explain that rule to Kermit the Frog enhanced children's transfer. Because the children explicitly stated the rule, their attention was focused on the similarities of the problems without being directly told of the similarities. Thus, the rule statement and explanation to Kermit probably allowed the children to represent, abstract, and recognize the novel problem by using the underlying schema.

In addition to being relevant in retrieval issues, schema formation also facilitates transfer by simplifying the mapping and evaluation processes. Individuals use mapping to understand new material (or solve a new problem) by adapting the solution of a source problem. Mapping entails the construction of a network of correspondences between the elements of the known material and the elements of the novel material. Mayer and Wittrock (1996) characterize this mapping process as the creation of "appropriate connections between the solutions for the base and the target problems" (p. 55). Brown and Campione (1984) argue that a successful intervention to facilitate mapping and evaluation—and thus enhance transfer—should emphasize underlying similarities and minimize surface structure differences. Mappings can be defined at multiple levels of abstraction; finding the optimal level of abstraction—the level that maximizes the correspondences between two analogous problems—is a crucial part of the mapping process (Gick & Holyoak, 1983). In addition, there are two ways in which mappings can be created. One way, termed "reasoning from an analog," involves mapping a new problem directly with a known problem, bypassing an explicit, separate schema. In contrast, "reasoning from a schema" describes the process of mapping a new problem with an existing schema stored in memory (Gick & Holyoak, 1983; Holyoak & Thagard, 1995). A schema is easier to apply than an example, because of its closer similarity to the novel problem: A schema shares underlying features with the novel problem without having a divergent surface structure such as another example might have (Holyoak & Thagard, 1995; Sternberg & Frensch, 1993). Thus, mapping from a schema and applying the schema's solution to the novel problem better facilitate transfer than mapping from an example (Gick & Holyoak, 1983). For instance, Brown and her colleagues (Brown et al., 1986) found that young children who understood the underlying goal structure of the presented stories and could ignore trivial details transferred the solution across stories better than children without a clear goal structure in mind. Grasping the underlying structure of the stories and committing surface differences to a secondary position are thought to have facilitated children's mapping and evaluation.

The representation of knowledge is thus a crucial part of the transfer process, and schemata appear to foster transfer on various levels. As discussed above, one way to aid students in schema creation is to present them with a schema directly. Less intrusive, and perhaps more like real life, we can instead train for transfer by exposing students to similar concepts in multiple subject areas. Under the proper circumstances, students can (and do) induce schemata from these examples.

Exposing Students to Multiple Contexts

In order to train for transfer in our classrooms, teachers need to utilize varied contexts and to conduct training within those specific contexts rather than on its own. Strategy training in multiple contexts encourages a broader application of the taught strategy and facilitates subsequent transfer (Druckman & Bjork, 1994; Snyder & Pressley, 1990). Druckman and Bjork (1994) posit that learners engaged in varied practice construct a more elaborated and variable encoding of the task information; this encoding is thought to result in both better retrievability and more decontextualization of the information. Bassok and Holyoak (1989) suggest that transfer might be enhanced if analogous examples are presented within different contents. Similarly, Sternberg and Frensch (1993) argue that explicitly showing students how to apply learned information in a variety of contexts and then requiring students to find new applications themselves allow students the opportunity to encode the information in multiple contexts and thus retrieve it more easily later. Adams (1989) also highlights the importance of diverse problem domains, positing that transfer is maximized through multiple context training. She distinguishes between *abstract* knowledge (i.e., information taught in a content-free manner, removed from the context and conditions of its application) and *abstracted* knowledge (i.e., principles abstracted by the learner via repeated exposure in a variety of contexts and problem situations). Whereas abstract knowledge is not expected to be retrieved in appropriate contexts (due to its isolated structure in memory), abstracted knowledge is more likely to be transferred.

Delclos and Harrington (1991) stress the importance of practice in using a new strategy to solve actual problems, as well as of multiple examples of the use of the new strategy. Indeed, giving individuals multiple examples before presenting them with a transfer task has been employed in many studies to enhance transfer (Brown & Campione, 1984; Brown & Kane, 1988; Crisafi & Brown, 1986; Gick & Holyoak, 1983). Druckman and Bjork (1994) also emphasize the benefits of concrete examples paired with abstract instruction. Students should understand how the strategies or information can be used in many situations; this will induce abstraction and thus foster transfer to new situations in which the strategy has not been previously taught.

Two examples, whether in one or varied contexts, can help foster transfer because of schema induction. Holyoak and Thagard (1995) suggest that presenting the learner with multiple examples and encouraging processing of their common structure foster schema formation. As discussed previously, an individual can construct a schema by abstracting the common elements of two examples. Obviously, this construction relies on the provision of at least *two* prior examples, which are subsequently mapped to induce a schema. As Gick and Holyoak (1983) argue, "Indeed, the schema is defined by the correspondences between two analogs" (p. 12).

Gick and Holyoak (1983) also argue that training in multiple contexts leads to conflicting results. On one hand, dissimilar examples make it more difficult for students to learn a concept: The mapping process to create a schema is more complex due to the many surface differences and few surface similarities between analogs. On the other hand, dissimilar examples allow a concept to be used more flexibly once acquired because the abstract schema created from diverse contexts will capture essential similarities while excluding any irrelevant context-specific details. Thus, students trained in multiple contexts will have a *harder* time inducing schemata, yet—if successful—they will also induce *better* schemata. These better schemata lead to easier retrieval and less context-dependence, which in turn lead to greater transfer (Gick & Holyoak, 1983).

Crisafi and Brown (1986) found greater recognition and subsequent transfer when children were presented with examples in two contexts prior to the transfer task as compared with just one previous example. In fact, these children did not transfer the strategy until the third task (i.e., until they had been given the two prior examples) suggesting that the children needed *two* contexts before they could transfer. In earlier pilot work, I found similar results with sixth and seventh graders: Students exposed to a problem-solving strategy in two contexts performed significantly better on a transfer task than did their one-context counterparts (Klein, 1994). Likewise, Gick and Holyoak (1983) found that exposure to multiple examples with differing contents helped college students focus on shared structural features, facilitating transfer. In addition, they found that students who were able to describe well the ways in which two stories were similar (i.e., had “good” schemata) were significantly more likely to demonstrate transfer ability. These studies bolster Gick and Holyoak’s (1983) argument that the creation of a general schema with two examples enhances transfer over the one-example case. Although schema formation *may* be possible with only one example, it would be less likely (because there would be less impetus for the individual to abstract) and probably less accurate (because it would be more difficult to decide on the appropriate abstraction with only one example).

In summary, students should engage in varied practice, in multiple contexts, and in concrete applications of the information or strategies they are learning. This will facilitate variable encoding, which will lead to easier retrievability and greater transfer.

Rationale for This Study

I chose to investigate the effects of exposure to a concept in multiple subject areas and metacognitive self-monitoring training on the transfer of middle school students. In this section, I explain the choices made, the reasons for those choices, and hypotheses regarding the outcomes of this study.

Operationalizing metacognition. As the preceding sections demonstrate, the term metacognition, as it is used in the literature, is rather broad and encompasses any number of processes, activities, or knowledge. It is therefore particularly useful to select for study a comparatively general form of metacognition such as *monitoring*. The metacognitive process of monitoring blends both metacognitive knowledge and metacognitive activity: Although monitoring is a learning *activity*, it involves *knowledge* about cognition in order to function properly. For instance, clearly one cannot monitor (a metacognitive activity) strategy use (a cognitive activity) without some information regarding how those strategies function in a particular learning situation (the metacognitive knowledge). Thus, monitoring captures many aspects of metacognition under one specific activity.

Selecting participants. Although much of the work on transfer has been done either with young children or with college students, I chose to investigate transfer using middle school students. Young children have trouble with metacognitive processing. They have what Brown and her colleagues (Brown et al., 1981) term a "production deficiency" (p. 14)—children use a strategy when told to do so, but they are deficient in their ability to use it on their own spontaneously. In addition, young children require relatively simple problem-solving tasks suitable to their level, whereas middle school students can be given more interesting and complex tasks. In contrast, college students (and adults) are too old; it would be preferable to help inform classroom instruction in the fostering of transfer earlier than those late years. Further, research on both young children and adults has come to very similar conclusions regarding transfer; thus, rather than looking for differences, I was able, by studying middle school students, to look for those familiar patterns in an intermediate age group. It is these school-age children who often learn similar concepts in different subjects in school without making the connections. Middle school students were therefore selected as suitable targets for this study.

Describing the underlying processes and hypothesizing. In this study, the effects of self-monitoring and multiple context training on students' schemata and subsequent transfer were examined. How did I expect these manipulations to affect knowledge representation and transfer? Given the evidence in the previous literature review, transfer and metacognition are clearly linked. As hypothesized by Brown and her colleagues, research has shown that training for transfer works better when training for monitoring is included. However, less has been written about the processes underlying these phenomena and the reasons *why* metacognition and transfer are so interconnected. In order to better understand how metacognition affects transfer and how multiple contexts and self-control training interact, we can consider how varied contexts and self-reflection affect the processes that lead, in turn, to better transfer.

Training in metacognitive monitoring is expected to foster transfer in two ways: directly, by aiding in the retrieval of relevant information, and indirectly, via its effect on knowledge representation. When self-reflecting, students engage in activities such as redefining, reorganizing, and breaking down the task or problem; summarizing the main ideas or issues behind a task or problem; and searching for relevant prior knowledge or similar problems. These activities foster retrieval of relevant material, which directly affects transfer. In addition, self-monitoring is expected to foster transfer via its effect on knowledge representation. Monitoring is a "mindful" activity; it leads to the active processing of information and the construction of meaning. This processing, in turn, leads to decontextualization, abstraction, and a restructuring of knowledge. For instance, Berardi-Coletta and her colleagues (Berardi-Coletta et al., 1995) found that students who were instructed to monitor their problem solving used more efficient problem representations than their control group counterparts. These researchers suggested that ongoing self-reflection leads to more complex, efficient representations, which in turn promote more effective monitoring. As posited by Delclos and Harrington (1991), monitoring may lead to "a fundamental restructuring of the domain-specific knowledge" (p. 41). Efficient representations or encoding of material can make subsequent retrieval easier. Self-monitoring thus fosters transfer because the processes of recognition (i.e., retrieval, as improved by initial encoding), mapping, and evaluation are simplified both directly and via knowledge representation.

Exposure to similar material or strategies in multiple subject areas is also expected to foster transfer by affecting knowledge representation. Multiple contexts lead to variable encoding; this encoding promotes a more generalized representation in memory, less context-dependence, more abstraction, and schema induction. This abstraction, just as stated above, then leads to greater transfer by simplifying the steps involved in the transfer process.

Thus, when multiple context instruction and self-monitoring are combined, transfer will be fostered. Multiple contexts affect knowledge representation; this should then enhance the *effectiveness of future monitoring* by allowing students to use metaknowledge already available in memory in order to help monitor their progress. Self-reflection, in turn, will continue to foster more abstract representations of information.

For this study, my hypotheses were that (a) students who possessed good schemata would perform better on the transfer task than would students with poor schemata; (b) students who were exposed to two subject areas and were trained in self-monitoring would have better schemata than would both one-subject self-monitoring-trained students and two-subject not self-monitoring-trained students; (c) students who reported engaging during the learning and transfer tasks in high levels of metacognitive activity would perform better on the transfer task than would other students; (d) two-subject self-monitoring students would self-monitor better (i.e., report higher levels of metacognitive activity) than would one-subject self-monitoring students (as well as all other students); and (e) two-subject self-monitoring students would outperform all other students on the transfer task.

Method

Participants

Participants were sixth- and seventh-grade students, taken from one local middle school. Classrooms were selected to ensure that students had not had prior concept mapping experience; in addition, honors classrooms were excluded. Six classrooms were included in the study, comprising two language arts, two social studies, and two science classrooms. Parental informed consent and student assent were obtained for each participant. Of the 186 participating students, 37 were omitted from the analyses because they were absent on one or more days of the study. In addition, data from nine students were omitted because they were found not to be able to function within the normal range for their grade level (two were categorized as low English language proficiency students and seven as learning disabled students). Finally, an additional seven students were dropped due to missing data. All these students were dropped completely and were not included in any further analyses, thus making a total of 133 students included in the initial analyses. As will be explained later, additional students were dropped for subsequent analyses.

All students attended a lower socioeconomic status (SES) middle school in the Los Angeles area. Standardized test scores at the school were reported to be at the bottom of the district; further, 84% of the students were involved in the free or reduced price lunch program. Students were of mixed gender and ethnicity, with the breakdown as follows: 49% male and 51% female; and 22% Asian American, 29% African American, 47% Latino, and 2% White. Thus, although the focus of the study was not at-risk students, participants were indeed disadvantaged.

Materials

Materials were created or revised for use in this study. All materials were pilot-tested in advance, and changes were made (as indicated by piloting) before their actual use in this study. In addition, to control for reading level, all materials were reviewed by teachers for grade-level appropriateness (and subject area appropriateness) prior to their use.

Learning tasks. The lessons that students were taught prior to the transfer task incorporated *concept mapping* as an underlying learning strategy (refer to Jonassen, Beissner, & Yacci, 1993 for more in-depth discussion of concept mapping). A concept map is a graphical representation of information and consists of nodes and labeled lines. Nodes correspond to concepts within a particular subject area or domain, lines (or links) indicate relationships between pairs of concepts (or nodes), and a label on each line explains how two concepts are related. The basic theory underlying concept mapping is that the mapping process helps students organize and connect their existing knowledge into a more coherent whole by requiring them to identify important concepts and to create and appropriately label links between these concepts. These maps explicitly show interrelationships within a given domain. Meaningful learning is fostered by giving students the opportunity to connect prior knowledge with newly introduced concepts and by encouraging students to identify novel relationships among concepts (Heinze-Fry & Novak, 1990; Novak, Gowin, & Johansen, 1983).

Concept maps have been used successfully as instructional tools and are expected to facilitate understanding of subject matter, summarization of important information, and recall in review situations (Heinze-Fry & Novak, 1990; Horton et al., 1993; Jonassen et al., 1993; Novak & Gowin, 1984). Research indicates that students who use concept maps are better at integrating, organizing, comprehending, retaining, and recalling new material (Armbruster & Anderson, 1984; Holley & Dansereau, 1984; Jonassen et al., 1993; Okebukola & Jegede, 1988). In addition, concept maps have recently gained popularity as assessment tools (Baker, Niemi, Novak, & Herl, 1992; Herl, 1995; Herl, Baker, & Niemi, 1996; Jonassen et al., 1993; Ruiz-Primo & Shavelson, 1995).

Although most of the work in concept mapping has been conducted with high school or college students, Novak and Gowin (1984) suggest that the technique of concept mapping is appropriate for all levels of students. Stice and Alvarez (1987) used concept maps with students from kindergarten through fifth grade with positive results, noting a greater awareness of meaningful learning of concepts and increased organization in concept mapping students. Novak and his colleagues (Novak et al., 1983) found that seventh- and eighth-grade students were certainly capable of using concept mapping strategies and that concept mapping students actually demonstrated better transfer to novel problem-solving tasks than did control students. Research has thus demonstrated concept mapping to be a real, authentic, and practical task useful in actual classroom settings.

On both Day 1 and Day 2 of the study, concept mapping was presented to the students as a useful learning strategy. Lessons on both days followed the same format: (a) teacher presentation of a concept mapping activity using a familiar topic within a particular content area (*preliminary lesson*); (b) teacher-led lesson on a new topic within the same content area (*main lesson*); and (c) student construction of individual concept maps of the new topic, with completion of monitoring worksheets by monitoring group students (*practice phase*). All teacher lessons were scripted in advance by the researcher.

Two social studies lessons, one science lesson, and one language arts lesson were created for this study, each incorporating the subject area material to be learned by the students in the context of a concept mapping task. Preliminary lessons included "Middle School" (social studies), "What Is America?" (also social studies), "Little Red Riding Hood" (language arts), and "Recycling" (science). Main lessons included "The Settlement of Jamestown" (social studies), "The Pilgrim Experience" (also social studies), "The Kid in the Red Jacket" (language arts; Park, 1987), and "Adaptation" (science). Topic areas for the preliminary lessons were selected so as to be known already and familiar to the students. Main lesson topics were selected because students should have been exposed to the material earlier in the curriculum (5th grade). Thus, none of the material should have been *completely* new; it was expected that this would allow students to concentrate more on the concept mapping task and be able to focus less on the specific content details. All teacher scripts and student materials are included in Appendix A.

Monitoring worksheet. Following the procedures used by Delclos and Harrington (1991) in their study, a self-monitoring worksheet was used. Using their booklet as a model, I adjusted the questions to fit within the framework of this study (see Appendix B). The monitoring worksheet's directions explained the importance of monitoring and instructed students to "do the following things and answer the following questions" while completing the concept mapping task. The worksheet included five short items of the format "*Look at the assignment on the next page carefully*. Have you thought about how to complete it?" These items were divided into three sections, indicating at what point in the concept mapping process students should attempt to answer them (e.g., "After you read the assignment but before you actually start working on it"). Monitoring items were aimed at explicitly directing students to monitor their work. Pilot work indicated that certain questions (modeled after Delclos and Harrington's work) were too vague for this student population; thus, questions were modified to clarify their intended purpose before actual use.

Prior knowledge measures. Measures were created to assess (and control for) students' prior knowledge of the language arts or science material to be presented in the transfer lesson (see, for example, Baker et al., 1992; Heinze-Fry & Novak, 1990). These two measures were created to directly address the content in the transfer task and were composed of six items each (see Appendix C). For each of the measures, students were asked to answer two types of questions: (a) three content knowledge questions (e.g., "Give an example of an animal adaptation" or "What is a 'personal narrative'?"), and (b) three experience-related questions (e.g., "How often do you read books outside of class?").

Transfer tasks. Two transfer tasks were created by the researcher (see Appendix D). Both utilized the same task, within two different contexts; students performed only *one* of the two tasks. Each transfer task consisted of a passage (including both text and pictures) for the students to read, followed by an organizational task in which students were asked to "prepare to write a report."

A prewriting scenario was chosen as a transfer task because it was expected that students' concept mapping strategy understanding from the previous lessons related to the organization needed for a prewriting activity. Jonassen and his colleagues (1993) suggest that concept mapping can be "used as a substitute for outlining as a prewriting strategy, allowing learners to freely associate ideas prior to committing to a rigid, linear structure" (p. 157). Novak and Gowin (1984) similarly discuss the merits of concept mapping as a prewriting activity. Thus, it was expected that students who transferred their mapping schemata to this new task would be more likely to use concept mapping as a prewriting or planning-to-write strategy.

Pilot work was conducted in order to ensure that transfer was not *too* difficult, given the study conditions. It was found that students were able to transfer (i.e., knew to use concept mapping) to the new content area. Pilot work also demonstrated that the materials were clear and understandable to the students.

Alternatives questionnaire. The alternatives questionnaire's sole purpose was to give students who had not used concept mapping on the transfer task a chance to demonstrate that they knew concept mapping *could* have been used (see Appendix E). The questionnaire included only one question, which asked students to "think of other ways (or other approaches) you could have used to prepare to write your report."

Schema questionnaire. The schema questionnaire was used to elicit information regarding students' existing schemata about concept mapping (see Appendix F). The questionnaire included three questions to assess schemata directly ("What is a concept map?" "How do you make a concept map?" "What can you use a concept map for?") and 18 questions that sought to get at the level of abstractness of students' schemata indirectly (9 ratings of the usefulness of concept mapping in various situations, and 9 ratings of the "goodness" of different concept maps). Pilot work was conducted to ensure that items yielded variability of responses, as well as to decide how to phrase certain items. Results indicated that some items were clearer to students than others, and that, overall, the questionnaire would provide useful information. As with all the measures, this questionnaire was reviewed by teachers prior to its use.

Metacognitive questionnaire. The metacognitive questionnaire was modified from the Self-Assessment Questionnaire (O'Neil & Abedi, 1996; O'Neil & Brown, in press; O'Neil, Sugrue, Abedi, Baker, & Golan, 1992) to obtain self-report data on students' general metacognitive activities during the learning and transfer tasks. During the process of its creation, the Self-Assessment Questionnaire has undergone numerous statistical analyses and a series of modifications. Its various versions have been tested on college, 12th-grade, and 8th-grade students. The 12th-grade version (O'Neil & Abedi, 1996) includes four metacognition subscales (5 items per subscale): awareness, cognitive strategy, planning, and self-checking. The 8th-grade version (O'Neil & Brown, in press) includes only the cognitive strategy and self-checking subscales (6 items per subscale). (Both versions also include two additional subscales—worry and effort—unrelated to the current study.) The two subscales (awareness and planning) missing in the current 8th-grade version are a result of the amount of time it takes 8th graders to complete the questionnaire.

Statistical data are available for both 8th- and 12th-grade versions of the Self-Assessment Questionnaire. Because the metacognitive questionnaire used for this study included some aspects of each previous version described above, both sets of analyses will be reported here. Cronbach's alpha coefficients for 8th-grade students for past work were .64 and .74 for cognitive strategy and .72 and .77 for self-checking (two alpha values are reported for each subscale, due to the questionnaire's use under two different conditions). For 12th graders, the alpha coefficient was .77 for cognitive strategy, .78 for planning, and .73 for self-checking. Further, factor analyses in prior work showed that—for all subscales listed for both sets of students—all items within each subscale loaded significantly on only one factor.

As stated above, previous work had found the length of the questionnaire to be an issue with younger students. However, because the worry and effort subscales (used in the eighth-grade version) were not used in this study, I decided to include the planning subscale in conjunction with the cognitive strategy and self-checking subscales, to assess a total of three aspects of metacognition. Pilot work suggested this was not too long an instrument for the student population. The awareness subscale was not included due to both time constraints and concern that the items in this subscale might be beyond the level of sixth- and seventh-grade students.

In summary, the metacognitive questionnaire modified for use in this study (see Appendix G) included 17 items in three subscales: cognitive strategy (7 items), planning (5 items), and self-checking (5 items). Sample items include "I selected and organized relevant information to complete the assignment," "I tried to understand the goals of the assignment before I tried to complete it," and "I checked my work while I was doing it" for cognitive strategy, planning, and self-checking, respectively. Individual items were taken from both the 8th-grade and 12th-grade versions of the Self-Assessment Questionnaire and were modified to work with this study's subject matter (e.g., "on the assessment" was changed to "on the assignment") and participants (e.g., "I attempted" was changed to "I tried"). This new version was reviewed for acceptability by a principal investigator on previous work in this area, and two more items were added to the cognitive strategy subscale at his suggestion (H. F. O'Neil, Jr., personal communication, May 7, 1996). Finally, although care was taken to keep the instrument items in the order and context found on the previous versions, wording was modified, and in some cases (e.g., worry subscale), items were missing entirely; thus the current instrument's statistical characteristics may possibly differ from those described above.

Design

Previous research has found asymmetry in transfer performance, with greater levels of transfer being found from a mathematics context to a science context than vice versa (Bassok & Holyoak, 1989). This finding may not be so surprising, as mathematics is often taught as a content-free tool, independent of any particular domain of application (Bassok & Holyoak, 1989). Mathematics was not used as a subject area in this study. However, to control the subject area of the transfer task to some degree, lesson and transfer task subject areas were varied. One-subject students were taught two lessons in the same subject area (social studies) and then completed a transfer task in one of two subject areas (either science or language arts). Two-subject students were taught a lesson in social studies and a lesson in a different subject area (either science or language arts), and then completed a transfer task in the previously unexposed area (either language arts or science).

A 3 x 2 design was utilized. Independent variables included the number/type of content areas (one subject, two subject-language arts, two subject-science) and the availability of self-monitoring training (monitoring, no monitoring). Within each class, students were randomly assigned by gender and ethnicity to one of following six treatment groups: (a) one subject area, no training; (b) one subject area, self-monitoring training; (c) two subject areas (social studies and language arts), no training; (d) two subject areas (social studies and language arts), self-monitoring training; (e) two subject areas (social studies and science), no training; and (f) two subject areas (social studies and science), self-monitoring training.

Procedure

Prior to beginning the study, I met with the six teachers participating in the study and briefed them on all procedures. Teachers were given the materials and teacher scripts in advance and were asked to review them so that they would be familiar with the lessons and procedures prior to conducting the study. All teachers were randomly assigned to Day 2 lessons (Day 1 lessons were all the same). In addition, information on students' gender, ethnicity, English language proficiency, disability status, and ability level (standardized test scores) was collected from the principal. This facilitated random assignment by gender and ethnicity, as well as the organizational process of moving students between classrooms.

Day 1. Students were assembled according to their treatment groups, and moved to the appropriate classrooms. Thus, students were mixed with other students from different classrooms, and did not necessarily have their own teacher. Teachers stayed in their own rooms, but the group of students they instructed varied from day to day to control for teacher effects. Students were told they were participating in a study and that they should try their best to do well on all tasks.

Every student received the same social studies lesson on Day 1. The preliminary introduction to concept mapping used the topic "Middle School" followed by a main lesson entitled "The Settlement of Jamestown." During the preliminary lesson (which took approximately 10 minutes), teachers discussed the relevance of concept mapping (by explaining how concept mapping could help students to better understand and organize the relationships between specific historical figures and events), illustrated what a concept map is and how one constructs a concept map, and facilitated the creation of a group concept map on the topic area by the students in the class. During the main lesson (which lasted about 15 minutes), teachers read the textual material aloud section by section (with students following along on their own copies of the material), pausing to pose relevant questions for the students to answer at the end of each section. During the practice phase, students were given 30 minutes to create their own social studies concept maps about Jamestown. Self-monitoring students were told to read the instructions on the monitoring worksheet and to answer the monitoring questions at specific times while they worked on the practice concept mapping task. In addition, following Brown's self-control training suggestions, instructions on the monitoring worksheet explicitly emphasized for the students the usefulness and significance of these self-reflection techniques.

Day 2. Day 2 activities were similar to Day 1 activities. One-subject students were exposed to concept mapping in the familiar area of "What Is America?" followed by another social studies lesson entitled "The Pilgrim Experience." Two-subject–language arts students were taught that concept mapping could help them to better understand and organize relationships between characters and events in a book. They were presented with concept mapping using the familiar story of "Little Red Riding Hood," followed by a lesson on the short story "The Kid in the Red Jacket." Two-subject–science students were instructed on the usefulness of concept mapping in understanding and organizing relationships between scientific phenomena. They received a preliminary lesson on "Recycling" followed by the lesson "Adaptation."

Following the lesson, students in each group practiced creating their own (social studies, language arts, or science) concept maps. Self-monitoring students were again instructed to complete their monitoring worksheets during the practice phase. At the end of the session, teachers administered the prior knowledge measure in the content area in which students would be given the Day 3 transfer task.

Day 3. Approximately one quarter of the students (evenly divided by sex) from each of the six conditions were randomly selected. These students were asked to complete the schema and metacognitive questionnaires without ever having seen the transfer task, in order to better assess students' schemata immediately prior to the transfer task. (These nontransfer students completed a filler task during the time most students were completing the transfer task.) It was expected that these randomly selected students would be representative of the larger treatment groups from which they were taken. Since the transfer task in itself could be an opportunity for schema induction and knowledge abstraction, it was suspected that these first, "unadulterated" schema data might be more precise indicators of the schemata held by students than the posttransfer task data that were collected. However, as the schema questionnaire itself could serve to adjust students' mental set for transfer (i.e., could be considered a "hint"), these students did not complete the transfer task after the administration of the questionnaires either.

While these nontransfer students completed the filler task, the remaining students were given the transfer task. Half the students were given the science task "Adaptation," while the other half were given the language arts task entitled "The Kid in the Red Jacket." The tasks began with a passage that students were given 10 minutes to study. Next, students were given written directions (which were also read aloud) that instructed them to prepare to write a report on the topic about which they had just read. Students were allowed to refer back to the passage when completing this prewriting activity. Students were given 25 minutes to complete this prepare-to-write task.

Once students finished working on the transfer (or filler) tasks, all materials were collected. All students then completed the alternatives questionnaire (5 minutes), the schema questionnaire (10 minutes), and the metacognitive questionnaire (5 minutes). Students were then thanked for their participation in the study and debriefed.

Results

Initial Coding and Variable Selection

Metacognitive questionnaire. Metacognitive data were examined first for intercorrelations among the 17 items. The items were found to be well correlated with each other (correlations ranging from .0 to .6, with a mean of .26), and a preliminary factor Scree plot clearly showed the existence of only one factor: general metacognition. Further analyses revealed a Cronbach's alpha coefficient of .86, indicating that the items formed a reliable scale. After creating a total metacognitive scale that included all 17 items (M = 50.72, SD = 8.20), the new metacognition variable was found to be normally distributed, with only minor skewness and kurtosis.

Schema questionnaire. Turning next to the schema questionnaire, it was found that two items were not well understood by the students: the cousins item and the tournament item. Scores on these items were uncorrelated with other items and were dropped from the analysis. The first three open-ended questions on the schema questionnaire were coded together into one variable (a verbal description of concept mapping), with the total number of points possible ranging from 0 to 11. Coding awarded one point for each aspect of concept mapping understood by the student. For instance, students received one point for stating that concept mapping involved relationships or connections. A complete listing of the coding scheme can be found in Appendix H. The other items on the questionnaire were coded using the numbers circled or entered by the students.

A factor Scree plot clearly showed the number of factors to be three. Therefore, a factor analysis expecting three factors was performed using 17 schema variables from the questionnaire. These three factors were found to account for 39.5% of the variance in the variables. The rotated factor matrix is shown in Table 1.

Factor 1 includes items that answer the question "What is concept mapping *used for*?" These seven items were combined into one scale (*M* = 19.66; *SD* = 4.48). Cronbach's alpha for this scale was calculated to be .76. This new schema used-for variable was found to be normally distributed with minor skewness and kurtosis.

Factor 2 includes seven items that are good or prototypical examples of concept mapping. This factor answers the question "What do concept maps *look like*?" For these items combined into a scale (*M* = 22.40; *SD* = 3.40), the Cronbach's alpha was found to be .60. The new schema looks-like variable was also found to be normally distributed with minor skewness and kurtosis.

Table 1

Factor Loadings for Rotated Factor Matrix Using Schema Questionnaire Variables (*N* = 133)

Questionnaire item	Factor 1	Factor 2	Factor 3
Classifying rocks and minerals	.70		
Studying for social studies test	.69		
Learning math formulas	.67		
Understanding the Sumerians	.64		
Understanding effects of toxic spill	.62		
Following characters and plot	.54		
Memorizing historical dates	.48		
Living things		.67	
Types of balls		.65	
Computers		.60	
U.S. government		.52	
Preparing to write essay	.41	.46	
Ways to solve problem		.46	
Extinction		.22	
Visual map of the U.S.			.77
Venn diagram of names			.70
Verbal descriptions			-.52

Note: Blanks indicate factor loadings less than |.30|.

Finally, Factor 3 includes two items that are "bad" examples of concept maps (i.e., what a concept map *is not*) and a third item that defines verbally *what a concept map is*. These variables were combined into a scale with a Cronbach's alpha of .52. (Note that the signs for the Venn diagram and U.S. map items were first reversed, so that they could be added to the negatively correlated verbal description variable.) This schema definition scale (M = 7.85; SD = 2.74) was found to be normally distributed with no skewness and only minor kurtosis.

Transfer tasks and alternatives questionnaire. Because the concept mapping lessons were short, and large amounts of practice were not possible, the transfer task scoring criteria did not deal with format or accuracy issues; rather, the system gave students the "benefit of the doubt" by allowing credit for concept maps that were well formed and extensive, even if they included some incorrect content or imperfect formatting. A simple coding scheme was utilized. Transfer was coded on a 0-to-4 scale, with a score of 0 indicating absolutely no use of concept mapping on the transfer task and no mention of concept mapping on the alternatives questionnaire; a score of 1 indicating that students did not use concept mapping on the transfer task, but did mention concept mapping on the alternatives questionnaire; a score of 2 indicating a low-level concept map was created (three or fewer nodes, two or fewer links); a score of 3 indicating the use of something similar to concept mapping, but without link labels (e.g., spider map, cluster map); and a score of 4 indicating extensive use of concept mapping on the transfer task. Examining this variable further, it was found to be poorly distributed in a U-shaped curve, rather than bell curve. The scores were thus recoded on a 0-to-2 scale (combining scores of 1, 2, and 3 together) to form a new scale with 0 indicating no transfer, 1 indicating some type of mid-level transfer, and 2 indicating full-blown transfer. Although this recoded variable had only three possible values, statistical consultants agreed it would be acceptable for use in MANOVA analyses. This new transfer variable (M = 1.06; SD = .80) was normally distributed, with minor skewness and kurtosis, and was thus chosen for use in further analyses.

Prior knowledge measures. The first three items on the prior knowledge measures were coded together, with 2 points possible per item, making a total score of 0 to 6 possible. These items addressed students' existing content knowledge. However, due to the low overall scores and small variability between students (*M* = 1.35; *SD* = 1.07), this first part of the measure was not used in further analyses.

In contrast, the last three items on the measures were combined to form new scores, which yielded a Cronbach's alpha of .52. This new prior knowledge variable (*M* = 7.26; *SD* = 2.06) was normally distributed, with minor skewness and kurtosis. The items included in this variable addressed students' past experiences with materials that might help them on the transfer task reading passages (i.e., read relevant books or stories, read outside of class, read relevant short stories/magazines). It was this prior knowledge variable that was then used in subsequent analyses.

Covariate selection. Standardized test scores in reading, language arts, and mathematics were obtained for each student. Reading (*M* = 35.97; *SD* = 25.55) and language arts (*M* = 36.46; *SD* = 25.32) variables were found to be normally distributed, with minor negative skewness and no kurtosis. The mathematics variable (*M* = 38.85; *SD* = 28.42) was found to be negatively skewed, and varied somewhat from a normal distribution.

In order to decide which variables might be useful as covariates for the analyses, I investigated the intercorrelations among the possible covariate candidates: reading score, language arts score, math score, and prior knowledge score. In addition, I looked at the correlations between the possible covariates and the dependent variables: metacognition, schema used-for, schema looks-like, schema definition, and transfer. These correlations are presented in Table 2 and Table 3. In addition, although random assignment was utilized, content treatment groups were found to differ by reading, language arts, and mathematics test scores (but not by prior knowledge score).

Table 2

Correlations Among Possible Covariate Variables

Variables	READING	LANGARTS[a]	MATH[a]	PRIORKNO[b]
READING	1.00	.69*	.64*	.03
LANGARTS	—	1.00	.66*	-.03
MATH	—	—	1.00	-.10
PRIORKNO	—	—	—	1.00

[a] $n = 121$. [b] $n = 117$.

*$p < .001$.

Table 3

Correlations Between Possible Covariate Variables and Dependent Variables

	Covariate variables			
Dependent variables	READING	LANGARTS	MATH	PRIORKNO
METACOGNITION	.05[a]	.07[a]	.05[a]	.30[b]*
SCHEMA USED-FOR	.16[a]	.16[a]	-.06[a]	.24[b]*
SCHEMA LOOKS-LIKE	.07[a]	.12[a]	.05[a]	.13[b]
SCHEMA DEFINITION	.32[a]*	.36[a]*	.43[a]*	.04[b]
TRANSFER	.14[c]	.09[c]	.05[c]	.07[d]

[a] $n = 121$. [b] $n = 127$. [c] $n = 93$. [d] $n = 99$.

*$p < .001$.

Since the metacognition and schema used-for variables were both significantly positively correlated with the prior knowledge composite, prior knowledge was chosen as a covariate in subsequent analysis. This was done even though this prior knowledge measure was not a "true" measure of prior knowledge. That is, it did not measure students' prior *content* knowledge, but rather gave some indication of students' prior *experience* with materials that might help them to perform better on the transfer task. In addition, since the schema definition variable was found to have a significant positive correlation with all the test scores, and since, further, reading, language arts, and math test scores were all found to be highly intercorrelated, reading was chosen for use as a second covariate. Since research has shown that "smarter" students transfer better and engage in more metacognitive activity than other students, this standardized test score can stand in as a proxy for intelligence or ability. In addition, this was an important covariate since random assignment did not do enough to even out differences by treatment group along this dimension. The decision to use the reading score (rather than the math or language arts score) was made due to its logical connection: It makes sense to control for students' reading abilities in a situation in which they are expected to read the transfer passages and questionnaire items. A reading score is also seen as a more general measure than either language arts or mathematics scores.

Process data. Process data were coded in order to ensure that students in the various conditions did indeed "comply" with the treatments. Clearly, if students did not comply with the treatment instructions, including those students in the analyses would not make sense. For instance, labeling students as "monitoring" when one knows they *did not* monitor would achieve no useful purpose. Compliance was judged very leniently; students were labeled as "complying" if (a) they completed some part of the concept map on both Day 1 and Day 2 (practice phase compliance—applicable to all students), and (b) they filled in some part of the monitoring worksheet on both Day 1 and Day 2 (monitoring compliance—applicable to monitoring students only). Only one student was dropped from further analyses due to lack of compliance on the practice phase concept mapping task. In contrast, 27 noncomplying students were excluded due to lack of monitoring compliance.

Further analyses showed a gender effect, with noncomplying students more likely to be boys than girls. Although the participants were about evenly distributed by gender (49% boys and 51% girls), 62% of the noncomplying students were boys while only 38% were girls. I further examined noncomplying students to determine whether they differed in other ways from complying students. Although noncomplying students were more likely to be two-subject–language arts students than anything else, this fact was discounted because noncompliance occurred mainly on Day 1 when all students were given the *same* content area (90% of noncomplying students did not complete the monitoring worksheet on the first day). Students' ethnicity and standardized test scores were also investigated; however, no additional differences emerged.

Subsequent Analyses

Preliminary work. Although preliminary statistical analyses should have been conducted for the effects of gender and ethnicity, this was difficult to accomplish due to the student exclusion rate. For gender analyses, cell sizes ranged from 2 to 10, with two of the cells including only 2 students (see Table 4). For ethnicity analyses, similar problems emerged (see Table 5). Thus, although these preliminary analyses were run, results from the analyses are interpreted here with skepticism.

Table 4

Number of Students per Cell for Gender Analyses

Condition	Male	Female
One subject, no monitoring	6	9
One subject, monitoring	4	2
Two subject (langarts), no monitoring	7	4
Two subject (langarts), monitoring	2	6
Two subject (science), no monitoring	10	7
Two subject (science), monitoring	5	5

Table 5

Number of Students per Cell for Ethnicity Analyses

Condition	Latino	Other
One subject, no monitoring	6	9
One subject, monitoring	4	2
Two subject (langarts), no monitoring	5	6
Two subject (langarts), monitoring	5	3
Two subject (science), no monitoring	6	11
Two subject (science), monitoring	6	4

Note: Due to small *n*s, ethnicity was collapsed into Latino vs. Other.

A multiple analysis of covariance (MANCOVA) test was performed by ethnicity, content treatment, and monitoring treatment using the dependent variables listed in the previous section (metacognition, schema used-for, schema looks-like, schema definition, and transfer) and including two variables as covariates (prior knowledge and reading). No significant differences were found. A similar MANCOVA was run substituting gender for ethnicity to test for significant effects involving gender. This multivariate test of significance was found to be significant (Wilks's lambda = .60, p = .004, N = 67; covariate prior knowledge significant for metacognition [t = 3.08, p = .003] and schema used-for [t = 2.17, p = .035] variables; covariate reading significant for schema definition [t = 3.07, p = .003] variable). A three-way interaction effect was found to be significant (Wilks's lambda = .66, p = .02, N = 67), with the univariate F-test significant for the schema definition variable only, $F(2, 53) = 5.96$, p = .005 (see Table 6). Follow-up tests revealed that for non-monitoring students, a straight gender effect was found, $F(1, 35) = 10.66$, $p = .002$, with females better able to define a concept mapping schema than males (adjusted means of 8.90 and 6.65 for females and males, respectively). For monitoring students, a Content x Gender interaction was found to be significant, $F(2, 16) = 10.26$, $p = .001$. Further analyses showed that whereas there were no differences for one-subject or two-subject–language arts students, two-subject–science students did differ: Male monitoring two-subject–science students had better concept map definitions than did female monitoring two-subject–science students, $F(1, 6) = 11.29$, $p = .015$ (adjusted means of 11.07 vs. 6.82).

Although significant results were found by gender, there are various peculiarities that make these results suspect. First, as discussed previously, the small cell sizes are a problem. Next, significant differences were detected for only one of the three content treatments. Finally, only one dependent variable was significant in the multivariate analysis, and that variable had the lowest reliability of all the dependent measures ($\alpha = .52$). For all these reasons, I decided not to include gender in the main analyses.

Main analyses. In order to test the main study hypotheses—that content and monitoring treatments would differentially affect students' metacognition, schemata, and transfer—a MANCOVA analysis was conducted using content and monitoring treatments as independent variables; metacognition, three schema indicators, and the transfer variable as dependent variables; and prior knowledge and reading test score as covariates. Adjusted group means for transfer, metacognition, and schema variables are presented in Tables 7, 8, and 9,

Table 6

Adjusted Means (and Standard Deviations) for Schema Definition Variable for Content by Monitoring by Gender Analysis

	Non-monitoring		Monitoring	
Condition	Male	Female	Male	Female
One subject	6.74 (1.63)	8.81 (2.24)	7.20 (2.06)	12.26 (0.71)
Two subject (langarts)	7.47 (2.88)	9.53 (2.58)	7.41 (2.83)	7.36 (2.25)
Two subject (science)	5.90 (2.42)	8.04 (2.16)	11.07 (1.34)	6.82 (2.33)

Table 7

Adjusted Means (and Standard Deviations) for Transfer Variable for Content by Monitoring Analysis

Condition	One-subject	Two-subject (langarts)	Two-subject (science)
Non-monitoring	1.08 (0.92)[a]	1.18 (0.75)[b]	0.99 (0.87)[c]
Monitoring	1.02 (0.89)[d]	.75 (0.89)[e]	1.45 (0.84)[f]

Note. Possible transfer scores ranged from 0 to 2.

[a] $n = 15$. [b] $n = 11$. [c] $n = 17$. [d] $n = 6$. [e] $n = 8$. [f] $n = 10$.

Table 8

Adjusted Means (and Standard Deviations) for Metacognition Variable for Content by Monitoring Analysis

Condition	One-subject	Two-subject (langarts)	Two-subject (science)
Non-monitoring	49.42 (7.32)[a]	47.70 (8.26)[b]	51.14 (7.79)[c]
Monitoring	48.19 (12.98)[d]	52.77 (6.49)[e]	50.97 (5.74)[f]

Note. Possible metacognition scores ranged from 17 to 68.

[a] $n = 15$. [b] $n = 11$. [c] $n = 17$. [d] $n = 6$. [e] $n = 8$. [f] $n = 10$.

respectively. The multivariate test of significance was found to be significant (Wilks's lambda = .68, $p = .014$, $N = 67$; covariate prior knowledge significant for metacognition [$t = 2.67$, $p = .009$] and schema used-for [$t = 2.02$, $p = .048$] variables; covariate reading significant for schema used-for [$t = 2.10$, $p = .04$] and schema definition [$t = 2.09$, $p = .041$] variables). An effect for the monitoring treatment was found to be significant for the schema used-for variable, $F(1, 59) = 4.37$, $p = .041$ (multivariate test not significant). Monitoring students were found to have better schemata regarding the use of concept mapping than non-monitoring students (adjusted means of 24.46 and 22.12, respectively). No other significant effects were found.

The 24 remaining nontransfer students (those students who were given a filler task in place of the transfer task) were expected to have more "pristine" schemata, not having had the additional opportunity of the transfer task to

Table 9

Adjusted Means (and Standard Deviations) for Schema Variables for Content by Monitoring Analysis

Condition	One-subject	Two-subject (langarts)	Two-subject (science)
SCHEMA USED-FOR			
Non-monitoring	23.82 (2.89)[a]	20.06 (5.24)[b]	22.49 (4.97)[c]
Monitoring	26.01 (4.62)[d]	24.62 (4.34)[e]	22.73 (4.95)[f]
SCHEMA LOOKS-LIKE			
Non-monitoring	18.56 (2.92)[a]	19.09 (3.00)[b]	18.67 (3.10)[c]
Monitoring	20.21 (3.82)[d]	18.43 (2.13)[e]	19.60 (3.06)[f]
SCHEMA DEFINITION			
Non-monitoring	7.92 (2.13)[a]	7.82 (2.76)[b]	9.20 (2.49)[c]
Monitoring	6.93 (2.94)[d]	8.56 (2.20)[e]	7.11 (2.82)[f]

Note. Possible schema used-for and schema looks-like scores ranged from 7 to 28. Possible schema definition scores ranged from 2 to 19.

[a] $n = 15$. [b] $n = 11$. [c] $n = 17$. [d] $n = 6$. [e] $n = 8$. [f] $n = 10$.

improve their schemata. Thus, an analogous MANCOVA to the one just described was run with these nontransfer students (obviously excluding the transfer variable). No significant results were found.

In addition, a new variable was introduced into the analysis in order to run a MANCOVA that included as an independent variable whether students were in the transfer or nontransfer condition. This MANCOVA could then test for differences in metacognition and schema formation based on transfer task exposure. Although clearly unbalanced in terms of cell size (with 67 transfer students and only 23 nontransfer students), it was nonetheless thought to be an acceptable statistical test as no other assumptions were violated. However, this test also yielded no significant results.

Hypotheses regarding relationships between metacognition and schema formation were also tested; it was expected that metacognitive activity and schema formation would be positively correlated. However, for both non-monitoring and monitoring transfer students, no significant correlations between metacognitive score and the three schema scores were found (see Table 10). Similarly, for non-monitoring nontransfer students, no significant

Table 10

Correlations Between Metacognition and Schema Variables for Transfer Students

	SCHEMA USED-FOR	SCHEMA LOOKS-LIKE	SCHEMA DEFINITION
Non-monitoring students[a]			
METACOGNITION	.20	.10	.01
Monitoring students[b]			
METACOGNITION	-.02	.15	.02

[a] $n = 47$. [b] $n = 33$.

correlations existed (see Table 11). However, for nontransfer students in the monitoring condition, significant correlations were found between overall metacognition and both students' used-for and looks-like schema components (see Table 11).

Prior to running the study, I hypothesized that students with better concept mapping schemata would be more likely to transfer than low-schema students. Likewise, I expected that students reporting high levels of metacognitive activity would be more likely to transfer than other students. Students were thus divided into high- and low-schema groups using the schema used-for variable. This variable was selected from the three possible schema variables because significant differences were found in previous analyses (see above). Students with schema used-for scores less than or equal to the schema used-for mean (M = 22.9) were

Table 11

Correlations Between Metacognition and Schema Variables for Nontransfer Students

	SCHEMA USED-FOR	SCHEMA LOOKS-LIKE	SCHEMA DEFINITION
Non-monitoring students[a]			
METACOGNITION	.11	.25	-.21
Monitoring students[b]			
METACOGNITION	.88*	.89*	.18

[a] $n = 17$. [b] $n = 7$.

*$p < .01$.

identified as low-schema students; students with scores larger than the mean were identified as high-schema students. Students were also divided into high- and low-metacognitive groups using the metacognition variable. Students with total metacognitive scores less than or equal to the metacognition mean ($M = 52$) were identified as low-metacognitive students; students with scores higher than the mean were identified as high-metacognitive students. Transfer was then investigated using these metacognition- and schema-level classifications.

An ANOVA was run for the transfer outcome measure, using level of metacognition and level of schemata as independent variables. No significant differences were found.

Because it could be argued that a self-reported measure of metacognitive activity might be able to identify self-monitoring students (rather than simply using monitoring condition to identify them), the metacognition level variable was then used to search further for differences in student schemata. A MANCOVA using content area and level of metacognitive activity as independent variables and prior knowledge and reading scores as covariates was used to test for differences in the three schema formation variables. The overall multivariate test was not significant (covariate reading significant for schema definition [$t = 2.00$, $p = .049$] variable; covariate prior knowledge approached significance for schema used-for [$t = 1.73$, $p = .087$] variable); however, an interaction effect for level of metacognition by content area was found to be significant for the schema used-for variable, $F(2, 81) = 3.71$, $p = .029$ (multivariate test approached significance: Wilks's lambda = .87, $p = .079$). For one-subject students, no significant differences were found by level of metacognitive activity. However, for both two-subject groups, significant differences emerged. For two-subject–language arts students, adjusted means showed that high-metacognitive students had better schemata for how concept maps can be used than low-metacognitive students, $F(1, 29) = 18.91$, $p < .001$ (adjusted means of 25.47 and 19.63, respectively). Likewise, for two-subject–science students, a significant effect was found for level of metacognitive activity, $F(1, 35) = 4.30$, $p = .046$, with high-metacognitive students demonstrating better used-for schemata than low-metacognitive students (adjusted means of 24.58 and 21.17, respectively).

Next, I investigated whether students who possessed good schemata reported higher metacognitive activity than students with poor schemata. An ANCOVA using content area, monitoring treatment, and schema level as independent variables and prior knowledge and reading scores as covariates was used to test for differences in metacognitive activity. A Monitoring x Schema level interaction effect was found to be significant, $F(1, 75) = 4.42$, $p = .039$. Further investigation showed that for high-schema students, total metacognitive scores varied significantly by monitoring: High-schema monitoring students obtaining higher total metacognitive scores than high-schema non-monitoring students, $F(1, 52) = 3.96$, $p = .05$ (adjusted means of 54.15 and 50.40, respectively). No such differences were found for low-schema students, and no other significant differences were found.

Finally, a variable was created to distinguish between those students who transferred completely (i.e., transfer = 2) and those who did not transfer at all (i.e., transfer = 0). I then tried to look at the problem backwards, asking the question "How did students who transferred successfully differ from those students who did not transfer at all?" A number variables were investigated to determine whether there were differences between these two categories of students. Based on their distributions, neither gender, ethnicity, content treatment, nor monitoring treatment seemed to play a significant role in determining transfer. However, high-transfer students did on average score higher on all the metacognition and schema variables than did low-transfer students. In addition, high-transfer students scored higher on the reading and prior knowledge measures. A MANCOVA using the metacognitive activity and three schema indicators as dependent variables, reading and prior knowledge measures as covariates, and transfer level and monitoring as independent variables (content could not be included due to small sample size) was found to be significant (Wilks's lambda = .64, $p = .021$, $N = 48$; covariate prior knowledge significant for metacognition [$t = 3.18$, $p = .003$] variable; covariate reading significant for schema used-for [$t = 2.42$, $p = .02$] variable). An effect for monitoring was significant for the schema definition measure, $F(1, 42) = 4.77$, $p = .035$ (multivariate test not significant), with monitoring students more likely to have good verbal concept mapping schemata than non-monitoring students (adjusted means of 9.05 and 7.38, respectively). In addition, a significant effect was found for transfer level for the schema looks-like variable, $F(1, 42) = 4.68$, $p = .036$ (multivariate test not significant). Students who showed a high level of transfer were more likely to have better schemata regarding what a concept map looks like than students who did not transfer at all (adjusted means of 19.9 and 18.2, respectively).

Discussion

The main hypotheses of this study focused on the expected effects of both self-monitoring and exposure to concept mapping in multiple contexts on students' metacognitive activity, concept mapping schemata, and transfer. I suggested that both self-monitoring and multiple context instruction should strengthen students' metacognitive activity and schemata, which would in turn boost transfer.

These treatment hypotheses were by and large not supported by the data. However, it was found that students—regardless of treatment condition—*were* able to transfer concept mapping to a new context to a large degree. In addition, results showed that many students engaged in high levels of metacognitive activity and formed good concept mapping schemata.

During the planning of this study, I attempted to devise treatments and measures that would fairly and adequately test my hypotheses. I selected concept mapping as an underlying strategy because—although it had not been utilized in the transfer literature—it appeared to embody the characteristics of a "transferable" thing: Concept mapping is a teachable strategy, is usable in a variety of contexts, and is able to be abstracted from any particular application. In addition, it has the advantage of being a strategy that is clearly applicable to classroom instruction, something that many previous studies' transfer tasks lacked (e.g., the Tower of Hanoi problem, missionaries-and-cannibals problem, and Duncker's radiation problem). I then wrote preliminary and main lessons that presented concept mapping to students within particular content areas and that explained both the rationale and the logistics for constructing concept maps. I created transfer tasks intended to elicit *far transfer* (by presenting a task that involved relating concept mapping knowledge gained in one content area to a different area and situation), *lateral transfer* (by requiring students to apply their concept mapping skills broadly across content areas), and *high-road transfer* (by demanding of students their conscious attempts at integrating past concept mapping experiences to solve the transfer task using concept mapping). In the monitoring treatment, I incorporated the three types of training Brown and Campione (1984) suggest: skills training (preliminary lessons and practice phases), self-regulation training (the monitoring worksheet itself), and awareness training (the worksheet directions which emphasized the significance of self-monitoring). In addition, I focused on a general form of metacognition, namely monitoring, expecting to capture many aspects of metacognition under one treatment. Finally, I designed the content treatment such that students would receive similar concept mapping instruction, albeit in one versus two content domains.

Measures were based on previous literature whenever possible. In addition, all measures and materials were pilot-tested prior to their use. The metacognitive questionnaire was modified from a much-used instrument. Although previously used with slightly older students, it proved to be adequate for use with sixth- and seventh-grade students. The existence of only one factor (general metacognition) rather than three factors (as reported in some of the prior work) probably reflects the age of the students. Prior research in the area of metacognition clearly shows a developmental trend in metacognitive processing, with younger students unable to use metacognitive strategies on their own. Thus, it is not surprising to find that slightly older students are able to engage in the required processes, yet do not necessarily distinguish between the different components of metacognition.

The monitoring worksheet was also adapted from a previously-tested instrument. It was modified to include explicit instructions on what to do (e.g., "Check to be sure you have shown the main ideas") together with the follow-up questions to answer (e.g., "Have you shown how these ideas relate to one another?"). In addition, directions were added to emphasize the importance and relevance of monitoring one's work.

Only the schema questionnaire was entirely new, due to a lack of such an instrument in previous work. Although past research has discussed schemata, the exact definition of a schema is somewhat ill defined. A schema is a memory structure, an abstracted or generalized piece of knowledge that contains such information as when the knowledge is useful, how to use it, and in what contexts it has been applied. I thus attempted to incorporate into the schema questionnaire items that would elicit this kind of information. Whereas past researchers have elicited schemata by asking students to write about or verbally describe similarities between two analogs, I chose to use a broad-based approach in order to obtain more information (and use a less pointed method than actually asking students to compare the two concept mapping tasks). Students were asked to describe concept mapping in an open-ended format, to rate the usefulness of concept mapping in various situations, and to rate the "goodness" of various concept maps. I expected this instrument to characterize the level of abstractness of students' ideas about concept mapping. Given the results from the factor analysis, it appears that the questionnaire probably did this well. I was able to interpret all three factors as components of a concept mapping schema. However, which of these three factors is most important? Can we devise an instrument that yields just one, general measure of a student's schema? Clearly, further research is necessary to answer these questions.

Treatment Effect Results

I began by looking at the effect of self-monitoring on various student outcomes. I theorized earlier that metacognitive activity affects transfer both directly and also indirectly, via knowledge representation. Thus, self-monitoring students were expected to perform better on the transfer task, to engage in greater amounts of metacognitive activity, and to have better concept mapping schemata than non-monitoring students.

To some degree, this was the case. Self-monitoring students were found to have more developed schemata regarding the use of concept mapping than did non-monitoring students. "Use of concept mapping" was measured by examining the situations in which students reported finding concept mapping more or less helpful. Thus, students who monitored their work were more likely than others to understand under what circumstances concept mapping could be used. Based on analysis of data only from students who transferred either well or not at all, the monitoring treatment was found to affect the schema definition component as well. Monitoring students were more likely to understand what a concept map is than non-monitoring students.

Some support was also found for the effect of self-monitoring on students' concept mapping schemata for those students who were not given the transfer task at all. These "unadulterated" data were expected to show more clear differences between conditions than transfer students' data would. That is, because the transfer task could be considered an additional context in which to form schemata, non-monitoring students who *were* presented with the transfer task could be expected to further develop their schemata. This could cause the difference between monitoring and non-monitoring students' schemata to shrink. In contrast, those students *not* presented with the transfer task did not have this additional schema-building opportunity. Therefore, the finding (although based upon small sample size) that nontransfer students in the monitoring condition showed a high correlation between metacognitive activity and both the used-for and the looks-like schema components bolsters the argument that monitoring positively affects schema formation.

Thus, in general, it was found that monitoring students developed better concept mapping schemata than non-monitoring students. When examining the results as a whole, the monitoring treatment was found to positively affect all three schema measures (used-for, looks-like, and definition), albeit in varying circumstances. However, no support was found for the hypothesis that the monitoring treatment fostered metacognitive activity.

Nevertheless, there is certainly some interplay between the definition of a "monitoring student" and that of a "high-metacognitive" student. I theorized that students who engage in metacognitive activity (including self-monitoring) should achieve both better schemata and better transfer; however, membership in the monitoring group is not the only measure of this activity. In fact, the metacognitive questionnaire yields another reasonable measure of the metacognitive activity that might foster schema formation and transfer.

Looking at the data in this light, results showed that, for high-schema students, metacognitive scores varied significantly by monitoring. That is, monitoring students who had good concept mapping schemata reported greater levels of metacognitive activity than non-monitoring students with good schemata.

Using the level of metacognitive activity in place of monitoring treatment, it was found that high-metacognitive students had better schemata regarding the use of concept mapping than low-metacognitive students *for two-content students only*. This was not the case for one-content students: Students exposed to concept mapping in only one content area had similar concept mapping schemata regardless of metacognitive activity. Thus, exposure to two content areas seems to have helped students who were engaging in high metacognitive activity to create better concept mapping schemata.

Turning to the other hypothesized difference by monitoring condition, no evidence was found to support the contention that self-monitoring (or metacognitive activity in general) affects transfer ability. In fact, not much was found that might reasonably predict whether or not a student used concept mapping as a strategy on the transfer task. As an exception to this statement, it was found that students who transferred well had a better conception of what good concept maps look like than those students who did not transfer at all.

Finally, in the content treatment, I used two different two-content treatments (language arts or science as second content area) in order to control for the possibility that transfer to certain content areas (or from certain pairs of content areas) might be easier than others. No differences were found between the two-content treatments. Comparing the one-content versus the two-content condition, I hypothesized that exposure to multiple contexts would affect metacognitive activity, schema formation, and transfer. For the most part, this hypothesis was not supported. To begin with, no effect was found of the content treatment on transfer. As described earlier, Gick and Holyoak (1983) argue that examples presented in two different content areas make it more difficult for students to learn a concept because construction of a schema from dissimilar examples is more complex. However, if constructed, the schema induced will be *better* or deeper than a schema induced from similar examples. Results did indicate that content exposure differentially affected students' schemata depending upon their level of metacognitive activity. As stated above, exposure to multiple content areas positively affected the concept mapping schemata of those students who engaged in high levels of self-regulation. Although ideally one would like to then focus on two-content area students who had induced better schemata, this study's design precludes this kind of analysis. However, future research could further elucidate this interesting point.

Performance Results

Fortunately, it is not the case that students simply did not transfer at all: 69% of the students used concept mapping to some degree on the transfer task, and 38% transferred to a large degree. However, neither is it the case that *too* many students transferred, since 31% of the students did not transfer at all.

In fact, these numbers demonstrate that regardless of condition, these at-risk students who were given only brief training in concept mapping *did* transfer their concept mapping skills to a new domain. In addition, examining once again the metacognition and schema scores, it appears that students were engaging in metacognitive activity and schemata construction *regardless of condition*. On a metacognitive scale including 17 items, students scored an average of 51; that is, their average score per item (on a scale of 1 to 4) was three or "pretty much so." Previous work in this area with 8th-grade students found metacognitive scores in the 2.7 range (O'Neil & Brown, in press). Therefore, in my study, students reported engaging in a fair amount of metacognitive activity. Likewise, students' schemata were well formed. For the schema used-for and looks-like components (possible scores ranging from 7 to 28), students averaged approximately 20 and 22 points, respectively. Thus, findings indicate that generally low-performing, at-risk students can be taught the cognitive learning strategy of concept mapping with relatively little instructional time and can indeed understand, use, and monitor their use of this strategy quite well. High scores on the metacognitive measure also suggest that whether or not students received the monitoring treatment, they did appear to be monitoring their work—a positive result indeed.

Alternative Explanations

Returning to the issue of treatment effects, many possible reasons why transfer was not tied to condition exist. It may be that the strategy of concept mapping is not the best task to use in order to test for transfer. Concept mapping had not been utilized in the transfer literature. I selected concept mapping because I wanted to use a task that was relevant and interesting to students while investigating transfer; in addition, concept mapping is a strategy that is usable across content areas and that is in actual use in classrooms. However, perhaps the decision to define transfer as the use/non-use of concept mapping was inappropriate for the transfer task. Although many other studies have used the "had it/didn't have it" approach to transfer, in those studies it was often less clear what a "good" answer was, objectively speaking. For instance, in studies by Holyoak et al. (1984), transfer (i.e., a good answer) consisted of solving the problem in a manner analogous to the presented problem, *regardless of whether or not another approach might achieve the stated goal equally well.* Clearly, in this study, it was possible to create a fine report plan without ever utilizing concept mapping, yet these plans did not receive high transfer scores. The reason for this is simple: Just as in previous work, it is the use of the learned strategy (i.e., concept mapping) that signals transfer. However—unlike previous laboratory-based studies—in a real-life classroom situation it seems quite possible (even likely) that good students who bring good study strategies to the task may approach the report-planning task in a different (i.e., not concept mapping)—yet completely acceptable—way. Thus, these students were for the purposes of this study not transferring. In addition, it is possible that students who understood concept mapping did not use the strategy for motivational reasons. Students were asked to create report plans for themselves, not for a teacher or another student. Thus, they may have used less explicit techniques for organizing the information, knowing that *for themselves* whatever they did was enough.

However, both these types of students still may have understood the concept mapping strategy better and formed better schemata having been influenced by the treatment conditions. In fact, this is indeed the case: Although transfer did not seem to be affected by the treatments, schema formation was certainly affected—at least by the monitoring condition, and possibly to some extent by content exposure.

Although all materials were reviewed both by outside teachers and by the actual classroom teachers who subsequently taught the lessons, later probing revealed that reading level may have been an issue. Teachers expressed concern with the material's difficulty level after the conclusion of the study, and it was subsequently discovered that the school's test scores were quite low. In particular, teachers voiced concern over the monitoring worksheet, suggesting that their students might have found the worksheet difficult. Further, some students appeared to have had trouble moving between the concept mapping task and the monitoring worksheet, preferring to focus on one or the other. Due to classroom constraints, both monitoring and non-monitoring students within a particular content condition were in the same room. This necessitated the use of written (rather than verbal) instructions regarding self-monitoring. Thus, although monitoring students were prompted to read and complete the monitoring worksheet while they worked on their concept maps, few verbal directions were given. These circumstances may account for the large noncompliance problem found in the study (22% of students did not comply with monitoring treatment). However, because some of the monitoring treatment hypotheses were actually supported, this explanation cannot be the sole factor responsible for lack of results.

In addition, four short lessons on concept mapping (two preliminary and two main lessons) may not have been enough to allow deep schema formation to occur. A review of the student maps does seem to indicate a fair understanding of the procedures involved in creating a concept map (even if the deeper issues of usability and relevance are impossible to gauge from these maps). Data from the schema questionnaire seem to suggest that schema formation did occur and did vary by monitoring condition. Thus, the length of the lessons could also not fully explain the lack of differences found.

It is also possible that the lessons themselves were too similar (whether within or across content area) to elicit content treatment effects. Lessons were presented within a similar format (preliminary lesson, main lesson, practice phase). In addition, it was clear to the students that both days of lessons were part of a study—not an everyday occurrence. Lastly, the materials themselves were similar from day to day: Monitoring worksheets were identical and practice phase handouts differed little. Although these similarities were included on purpose (to control for the effects of other, less important differences), they may have diminished the effect of the content treatment by making the content exposure differences too minor.

On the other hand, given that most students did seem to understand and use concept mapping after only a brief instructional period, perhaps it is not the small number of lessons or their similarities, but rather the wide variety within those four lessons *even in the one-content condition* that might account for small treatment effects. Even in the one-content condition—where little variability in the presentation of concept mapping should be expected—students received lessons in topics as diverse as middle school life, Jamestown, the Pilgrim experience, and the nature of America. In fact, the main thread that ties these diverse topics together is the phrase "social studies." Thus, it is possible that this wide variability made the domain differences in the two-content conditions less salient, creating a rather weak treatment condition.

Taking this explanation further, the lessons themselves were clearly beneficial to the students. Low-achieving students given the opportunity to learn this material in this manner performed quite well, both in terms of their understanding of the concept mapping task (i.e., their schemata) and their transfer rates. They understood that concept mapping could be used in a new and very different context and proceeded to apply what they knew about concept mapping to this new domain. Further research could examine the quality of report plans for those students who did not use concept mapping on the transfer task. It is possible that nontransfer students actually created very good report plans, yet chose not to use a concept mapping approach. Similarly, further research could develop alternative scoring schemes for high-transfer students' concept maps, in order to score them for content and structure. These scores could then expand the current 3-point transfer scoring rubric into a 4- or 5-point scale with which to further investigate possible transfer differences.

Implications for Future Research and Practice

So, can we teach students to be better learners? I believe that more work needs to be done in this area to clarify whether or not my hypotheses are correct. In addition, further work with at-risk students will help to find additional ways of boosting transfer. Also, because it appears that self-monitoring training may help students form better schemata, more research on this type of training is needed. Prior research has found very young children incapable of metacognitive activity; however, these data support the claim that sixth- and seventh-grade students can be taught to monitor their work. In particular, the data show that low-achieving, at-risk students can learn, understand, monitor, and transfer to new situations the cognitive strategies with which they are presented. How do we best instruct these students in self-monitoring their work? What can we do to blend instruction on metacognitive techniques with mainstream classroom instruction? Once we have sufficient data to answer these questions, we can begin implementing these types of programs in middle school classrooms in order to improve student learning.

Conclusion

Research has shown that transfer is neither easily elicited nor simply explained. Study after study has found individuals not able to recognize what investigators see as obvious parallels. Yet research has also shown children as young as two and three years old able to transfer if the circumstances are geared towards that goal.

Students in our schools, as well as adults in the work force, may often find themselves in a situation in which using their previous knowledge from a very different area could help them solve a new problem in the current area. By further investigating facilitators of transfer, we can help inform instruction and actual classroom practices in the creation of learning environments that support the sometimes elusive goal of transfer.

APPENDIX A

Teacher Scripts and Student Materials

Teacher Script
Preliminary Concept Mapping Lesson
in Social Studies—Middle School

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

This lesson teaches students about the basics of concept mapping. The lesson uses the content area of middle school in social studies as a base example, and the teacher will instruct students in an interactive fashion.

The first portion of the lesson is totally scripted. The second half is less so, because one cannot anticipate exactly which nodes and links students will suggest. Thus, a sample concept map for the topic area is included. Note, however, that this is not the one, correct answer—concept maps by their very nature are personalized and the teacher will need to improvise during his or her lesson. The entire lesson should take no more than 10 minutes.

Teacher: Today, we're going to learn how to create something called a concept map. A concept map is a way to organize information and ideas in social studies. A concept map can also help you to understand historical concepts while you're learning them. These maps do this by letting you show the connections between important ideas and events in history.

There are many different kinds of concept maps. Today, I'm going to show you how to make one kind of concept map. We're going to learn how to represent or show ideas in a visual manner (that is, not just with words). I'm going to use the topic of Middle School to illustrate how we can create a concept map.

(Write word Middle School as title on the board. Then, on the left side of the board, write Concepts. Under this heading, you will begin your list below. On the right side, write Links—see below)

Teacher: So, let's suppose we're studying middle school and that we're trying to organize or better understand the school as an institution. The first thing we need to do in order to create a concept map is to come up with the important concepts or ideas in a particular topic area. Then, we need to come up with the linking words that help connect these ideas together. So, let's think about the important ideas related to middle school. We can first write middle school, and then maybe learning. *(under concepts, write middle school and learning).* Those are important concepts. What else can you think of that is important when we talk about middle school? What else? What else? ... *(prompt students...possible answers include: teachers, students, principal, homework, chalkboard, studying, knowledge, different from elementary school, cliques, boy/girlfriends, social life, parties, etc. ... If students mention help, or other linking verbs, place under the Links heading)*

Good. Now, let's try to come up with a few linking words. These are ways of connecting the concepts together. We'll also come up with more as we make our concept map. We can write down things like: helps, teaches, do/does, is an example of, leads to, has, is, is a part of, influences, is related to, comes before ... *(write these under Links heading)*

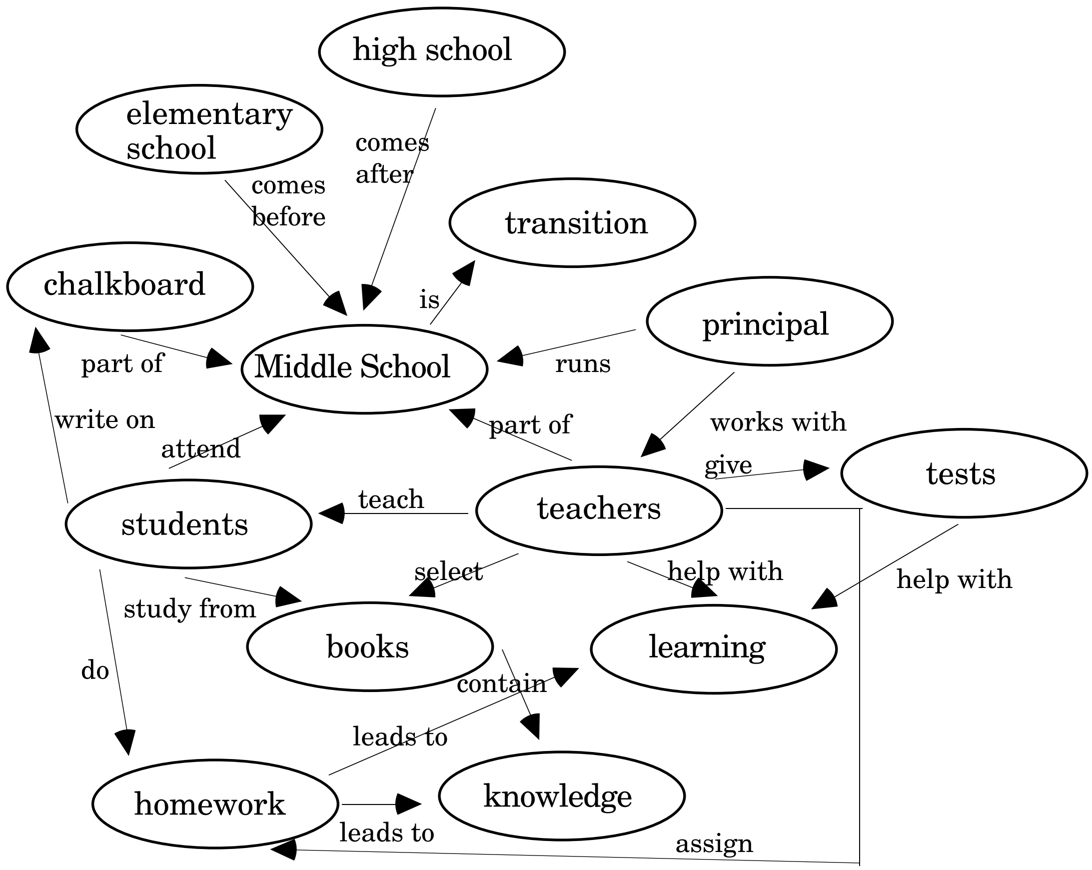
Okay, so you can see from our lists that under Concepts we have ideas and things. "Learning" is an idea or concept. "Chalkboard" is just a thing. The links are words that connect these words together.

Now, we're going to actually make a concept map. We start by selecting the most important concepts and place them in the middle of our map. We write the concept down and circle it, like this *(write middle school and circle it)*. Another important concept is learning so let's add that too *(write learning and circle it—refer to attached concept map for details)*. Now we need to decide how these two concepts connect to one another. Let's see—middle school leads to learning, right? So, we'll add a link here by drawing a line with an arrow and labeling it "leads to." *(draw line with arrow from middle school circle to learning circle and label it leads to)* Links always connect one concept to another, with an arrow, and you always have to label your links. When you try to draw a link, think of a sentence that uses both concepts, like "middle school leads to learning." The middle part (leads to) is your link. What other connections can we make from our list of concepts? What important concept should we add next? *(continue, either taking suggestions or prompting/giving answers as necessary—see attached concept map for some possible links)*

Above should take no more than 10 minutes ... at that point, summarize with the following:

In a concept map, you can always reuse the links (so two links may be labeled with the same connection) but you can only use a concept once. Also, these maps can get pretty full—you just have to make sure you keep your writing neat so that we can read your concepts and links. As you can tell, each concept map is individual—there is no one right answer. You're just trying to show how certain social studies concepts are connected or related.

Okay, now we're going to have a lesson in social studies about the settlement of Jamestown and you're going to make your own concept maps.


high school
elementary school
comes before
comes after
transition
chalkboard
is
principal
part of
Middle School
runs
write on
works with
attend
part of
give
tests
teach
teachers
students
select
help with
help with
study from
books
learning
do
contain
leads to
homework
knowledge
leads to
assign

Teacher Script
The Settlement of Jamestown

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

All teacher-led lessons will be taught in an interactive fashion, with teacher reading aloud from the text and pausing between sections for summarization, clarification, and analysis. These pauses will be teacher-led, and suggested questions for class discussion will be included. Since this is presumably review for the students, all discussion should be kept short. Entire lesson should take no more than 15 minutes.

Begin by passing out The Settlement of Jamestown handouts.

Teacher: Okay, we're going to talk a little about early settlement of Jamestown. You should think back to when you learned this material in your social studies class. If it is not familiar to you or you've forgotten some of it, don't worry—that's why we're reviewing it. Okay, who can tell me something about Jamestown? What was Jamestown?

Brief discussion of Jamestown ... select two or three students only (if no students volunteer information, simply continue to next section).

Teacher: I am going to read this handout aloud. Please follow along as I read, starting at the first paragraph.

Teacher should read the first paragraph aloud as follows:

Arrival in the New World

On April 26, 1607, settlers from England arrived in the New World to found (set up) the *colony* of Jamestown. They explored the area of Chesapeake Bay in Virginia, chose the site that would become Jamestown, and began *building* their settlement.

Teacher: What's a colony? *(a settlement, a collection of houses, churches, etc. set up in the New World ...)* The text mentions the "New World." What does that refer to? *(North America)* I'll continue reading the next section.

Teacher should read the section as follows:

The Early Settlers

All of the early settlers who came to Virginia to set up the colony of Jamestown were white men. Their professions included: farmers (called *yeomen*), soldiers, carpenters, bricklayers, general workers, and gentlemen. *Gentlemen* were wealthy people with no occupation or manual skills. They were not expected to do ordinary work. They were only supposed to manage estates and provide advice. Among the early settlers from England to arrive in Jamestown, one out of every three was a gentleman. These gentlemen did not do any real work. The other settlers resented working and didn't want to work hard.

Teacher: Okay, so people came from England and started the colony of Jamestown. Who were these people? *(keep discussion brief)* What do you think about these gentlemen? How do you think the carpenters felt about them? *(resentment, reluctance on the part of anyone to do work, gentlemen were looking for opportunity, gold, etc.)* I'll read the next section now.

Teacher should read the section as follows:

<u>Money for the Colony</u>

A private company called the *Virginia Company of London* paid for the English colonization of Jamestown. This company's aim in starting the colony was *profit*. This means that the company wanted to make money from the colony. The Virginia Company hoped to find gold or other valuable minerals, trade with the native people (the Algonquin Indians), and possibly use the natives as workers for the colony.

Teacher: Why did the Virginia Company of London pay for the colony? *(profit, money)* How did the Company expect to make money? *(gold, trade, exploitation of native Indians)*

Teacher should read the section as follows:

<u>Problems in Jamestown</u>

Virginia did not have precious minerals. The Indians were spread out over a large area and not interested in living with the settlers. The settlers suffered from many *diseases*, like malaria and dysentery. Most importantly, Jamestown's settlers were *not willing* to farm for themselves. This led to *food shortages*. They relied on England to send food to them or on the Algonquin Indians to give them food. England was far away and food often arrived spoiled. Also, the settlers often *attacked* the Indians. This caused the Indian chief to forbid his people from trading anything with the settlers. Because of these problems, only 59 of the over 900 settlers were alive in the spring of 1610.

Teacher: So, there were lots of problems in Jamestown, huh? What do you think the biggest problem was in Jamestown? *(lack of food due to settlers not wanting to work and internal tensions)* Who were the Algonquin? *(native people)* I'll keep reading now.

Teacher should read the section as follows:

<u>Jamestown Turns Around</u>

Soon after the setting up of Jamestown, *Captain John Smith* took charge of the settlers. He asked for help from the Indians to help end the food shortage. He also *established a rule* that settlers had to *work* for food. Then, the settlers managed to plant and harvest a crop of *tobacco*. In 1614, Jamestown began exporting (selling) tobacco to England.

Teacher: What did John Smith do? *(made rules, made all people work for food)* It says the settlers began growing and selling tobacco. Given what you read about the settlers, do you think they knew tobacco would be profitable (money-making)?

Teacher should read the section as follows:

Tobacco Production

Four years later, the Virginia Company of London was still not sure that tobacco would be a profitable (money-making) product for *trade*. To make tobacco profitable, planters needed *cheap labor* to plant and harvest the crop and *a great deal of land* on which to *grow* the tobacco. The tobacco planters began asking poor white people in England and Ireland to come to Jamestown. Thousands of desperate people sold themselves into *indentured servitude*. This meant that they worked without pay for three to seven years in order to get to the New World. As tobacco *profits* grew, the need for more land grew. Angered because the settlers were trying to take over their land, the Algonquin Indians finally attacked Jamestown. The settlers fought back, and made war on the Indians. By 1638, having found both land and workers, the settlers *exported* three million pounds of tobacco to England!

Teacher: What did the tobacco growers need in order to grow their crop? *(cheap labor and plenty of land)* Who can tell me why tobacco was so important for the settlers? *(began making profit, able to trade for food, enticed more workers to Jamestown from England)*

Teacher: Now turn to the last page of your handout. We're now going to make concept maps of the Settlement of Jamestown just like the sample one I showed you how to do on the board. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of the settlement of Jamestown. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. And don't forget to label all of your links—each link should have an arrow and a label. For those students who have a colored Monitoring Worksheet on the page before the last page, read the directions at the top of the page and follow them. You should work on your Monitoring Worksheet and Concept Map together.

Teacher Script
Preliminary Concept Mapping Lesson in Social Studies #2
What is America?

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

This lesson teaches students about the basics of concept mapping. The lesson uses the content area of "What is America?" in social studies as a base example, and the teacher will instruct students in an interactive fashion.

The first portion of the lesson is totally scripted. The second half is less so, because one cannot anticipate exactly which nodes and links students will suggest. Thus, a sample concept map for the topic area is included. Note, however, that this is not the one, correct answer—concept maps by their very nature are personalized and the teacher will need to improvise during his or her lesson. The entire lesson should take no more than 10 minutes.

Teacher: Today, we're going to review how to create a concept map. Remember: A concept map is a way to organize information and ideas in social studies. A concept map can also help you to understand historical concepts while you're learning them. These maps do this by letting you show the connections between important ideas and events in social studies.

There are many different kinds of concept maps. Today, we're going to review the same kind of concept map as yesterday. We're going to learn how to represent or show ideas in a visual manner (that is, not just with words). I'm going to use the topic of What Is America? to illustrate how we can create a concept map.

(Write word What Is America? as title on the board. Then, on the left side of the board, write Concepts. Under this heading, you will begin your list below. On the right side, write Links—see below)

Teacher: So, let's suppose we're studying America and that we're trying to organize or better understand what America is. The first thing we need to do in order to create a concept map is to come up with the important concepts or ideas in a particular topic area. Then, we need to come up with the linking words that help connect these ideas together. So, let's think about the important ideas related to America. We can first write America, and then maybe Freedom. *(under concepts, write America and Freedom)* Those are important concepts. What else can you think of that is important when we talk about America? What else? What else? ... *(prompt* students ... possible answers include: freedom, equality, the Constitution, the Founding Fathers, President, Congress, Judges, democracy, diversity, "melting pot", flag, states, country, people, North America, old, powerful ... If students mention linking verbs, place under the Links heading)

Good. Now, let's try to come up with a few linking words. These are ways of connecting the concepts together. We'll also come up with more as we make our concept map. We can write down things like: is an example of, leads to, has, is, is a part of, influences, is related to, is made up of, stands for, comes before ... *(write these under Links heading)*

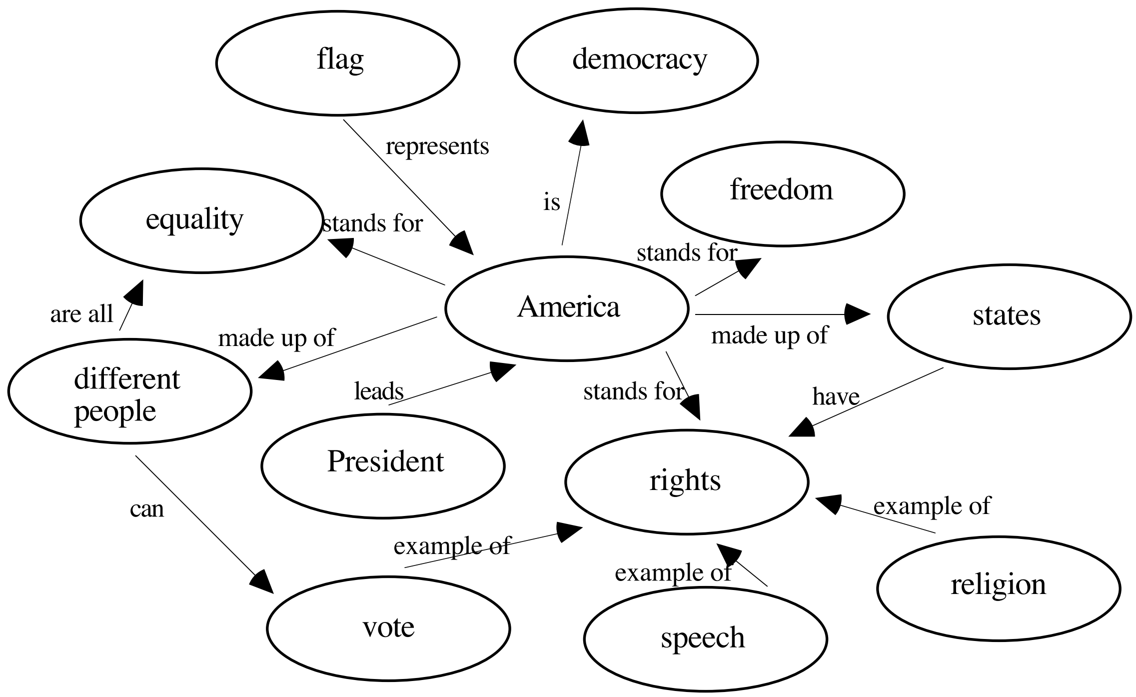
Okay, so you can see from our lists that under Concepts we have ideas and things. "Freedom" is an idea or concept. "Flag" is just a thing. The links are words that connect these words together.

Now, we're going to actually make a concept map. We start by selecting the most important concepts and placing them in the middle of our map. We write the concept down and circle it, like this *(write America and circle it)*. Another important concept is freedom so let's add that too *(write freedom and circle it—refer to attached concept map for details)*. Now we need to decide how these two concepts connect to one another. Let's see—America stands for freedom, right? So, we'll add a link here by drawing a line with an arrow and labeling it "stands for." *(draw line with arrow from America circle to freedom circle and label it stands for)* Links always connect one concept to another, with an arrow, and you always have to label your links. When you try to draw a link, think of a sentence that uses both concepts, like "America stands for freedom." The middle part (stands for) is your link. What other connections can we make from our list of concepts? What important concept should we add next? *(continue, either taking suggestions or prompting/giving answers as necessary—see attached concept map for some possible links)*

Above should take no more than 10 minutes ... at that point, summarize with the following:

In a concept map, you can always reuse the links (so two links may be labeled with the same connection) but you can only use a concept once. Also, these maps can get pretty full—you just have to make sure you keep your writing neat so that we can read your concepts and links. As you can tell, each concept map is individual—there is no one right answer. You're just trying to show how certain social studies concepts are connected or related.

Okay, now we're going to have a lesson in social studies about the Pilgrims and you're going to make your own concept maps.


flag
democracy
represents
is
freedom
equality
stands for
stands for
America
states
are all
made up of
made up of
different people
leads
stands for
have
President
rights
can
example of
example of
example of
religion
vote
speech

Teacher Script
The Pilgrim Experience

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

All teacher-led lessons will be taught in an interactive fashion, with teacher reading aloud from the text and pausing between sections for summarization, clarification, and analysis. These pauses will be teacher-led, and suggested questions for class discussion will be included. Since this is presumably review for the students, all discussion should be kept short. Entire lesson should take no more than 15 minutes.

Begin by passing out The Pilgrim Experience handouts.

Teacher: Okay, we're going to talk a little about the Pilgrims. You should think back to when you learned this material in your social studies class. If it is not familiar to you or you've forgotten some of it, don't worry—that's why we're reviewing it. Okay, who can tell me something about the Pilgrims? Who were the Pilgrims?

Brief discussion of the Pilgrims ... select two or three students only (if no students volunteer information, simply continue to next section).

Teacher: I am going to read this handout aloud. Please follow along as I read, starting at the first paragraph.

Teacher should read the first and second sections aloud as follows:

Introduction

Most people can tell you that Thanksgiving celebrates a big feast between the *Pilgrims* and the *Indians*. But can you tell me who the Pilgrims really were? In this lesson, you're going to learn all about the Pilgrims and how they founded *Plymouth*.

The Church of England

In 1534, King Henry VIII of England broke away from the *Roman Catholic Church* and started his own *Church of England*. Some English people thought the Church of England was too much like the Roman Catholic Church and wanted to *purify* (clean out) the church. They wanted to get rid of all reminders of Catholic services, like the fancy clothes worn by priests. Because they wanted to purify the church, these people were known as *Puritans*. Some Puritans then wanted to break away from the church all together. They wanted to form their own separate churches, so they were known as *Separatists*.

Teacher: The text discusses King Henry VIII. What country was he King of? *(England)* What did he do? *(Started his own church)* What does "purify" mean? *(clean out, cleanse)* Who were the Separatists? *(people who wanted to form their own church)* What do you think the King thought of Separatists? *(let students speculate)* Let's continue reading and find out.

Teacher should read the section as follows:

Persecution

English law at the time said that everyone in the country had to belong to the Church of England. Separatists were *persecuted* (discriminated against) and were not allowed to freely practice their *religion*. Because Separatists were afraid of being put in prison, some left England to go to the *Netherlands*. One such Separatist group was known as the *Pilgrims* because their leader said they were on a holy journey—a "pilgrimage."

Teacher: So, King Henry VIII didn't think highly of Separatists, right? What does persecuted mean? *(discriminated against, not allowed to be free ...)* Where are the Netherlands? *(country in Europe near England)* I'll read the next section now.

Teacher should read the section as follows:

The Move to North America

Since the Pilgrims did not speak Dutch, they never felt at home in the Netherlands. They didn't want to go back to England, though, because they were persecuted there. In 1619, the Virginia Company gave the Pilgrims permission to settle in Virginia. A group of investors hoping to earn money from the new colony agreed to pay for the Pilgrims' trip to *North America*. In 1620, 35 Pilgrims (together with a number of hired workers) boarded the *Mayflower*, a ship heading for Virginia.

Teacher: Why did people pay for the Pilgrims to go to North America? *(profit, money-making from the colony)* What was the *Mayflower*? *(ship going to New World)*

Teacher should read the section as follows:

Arrival in Massachusetts

The Pilgrims never made it to Virginia. Strong ocean storms drove the *Mayflower* off course. On November 11, after 11 weeks at sea, the ship dropped anchor off the tip of Cape Cod, in what is now *Massachusetts*. Although the Pilgrims knew they were hundreds of miles north of Virginia, they were too tired and sick to travel any farther. They decided to look for land close by to start their settlement. They chose a small bay by which to start their *colony* and began building *Plymouth Plantation*.

Teacher: What happened to the Pilgrims on the Mayflower? *(driven off course, landed in Massachusetts instead of Virginia, settled there)* What did they call their new colony? *(Plymouth)*

Teacher should read the section as follows:

The Mayflower Compact

The *Mayflower* passengers were Pilgrims and hired workers. The workers argued that they had only agreed to *settle* in Virginia, not some place hundreds of miles away from there. The passengers had a problem. So, they wrote and *signed* an agreement called the *Mayflower Compact* that said that everyone would agree to go along with the majority's decisions for the good of the colony. This agreement was the very beginning of a future democratic government.

Teacher: There were some disagreements between the Pilgrims and the workers on the Mayflower, right? Why did they disagree? *(workers didn't want to stay in Massachusetts, argued)* What was the Mayflower Compact? *(agreement to go with majority decision, example of democracy)* Was England a democracy at the time? Did people vote? *(no! king ...)* Why was the Mayflower Compact so great? *(let people decide for themselves, vote, majority rules)* I'll read the last section now.

Teacher should read the last section as follows:

Help From the Indians

Just like the settlers in Jamestown, the Pilgrims in Plymouth had a rough time at first. Many *died* because of the *cold winter*, lack of *food*, and *disease*. The following spring, though, an Indian named *Squanto* visited the Pilgrims. Squanto spoke English and *taught* the Pilgrims how to hunt, fish, and plant corn. Squanto also helped *make peace* between the Pilgrims and Chief Massasoit of the Wampanoag Indians. Unlike the settlers in Jamestown, the Pilgrims were hard workers and good planters. In the fall of 1621, the Pilgrims invited the Indians to a feast *celebrating* the Pilgrims' first *harvest*. This friendship between the Pilgrims and the Indians also led to greater *trade* between the two people. Because of all this, the second permanent English settlement in North America *survived*.

Teacher: What problems did the Pilgrims face at Plymouth? *(famine, disease, cold)* Who was Squanto? *(Indian who taught Pilgrims to plant, fish, hunt; also made peace between Pilgrims and Indians)* Do you think there were "gentlemen" among the Mayflower passengers? *(no--all worked)* What's a "harvest?" *(picking food once planted and ready to eat)* How did the Indians influence the Pilgrims? *(taught them to plant, traded with them)*

Teacher: Now turn to the last page of your handout. We're now going to make concept maps of the Pilgrim Experience just like the sample one I showed you how to do on the board. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of the Pilgrim experience. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. And don’t forget to label all of your links—each link should have an arrow and a label. For those students who have a colored Monitoring Worksheet on the page before the last page, read the directions at the top of the page and follow them. You should work on your Monitoring Worksheet and Concept Map together.

Teacher Script
Preliminary Concept Mapping Lesson in Language Arts
Little Red Riding Hood

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

This lesson teaches students about the basics of concept mapping. The lesson uses the story of Little Red Riding Hood in language arts as a base example, and the teacher will instruct students in an interactive fashion.

The first portion of the lesson is totally scripted. The second half is less so, because one cannot anticipate exactly which nodes and links students will suggest. Thus, a sample concept map for the topic area is included. Note, however, that this is not the one, correct answer—concept maps by their very nature are personalized and the teacher will need to improvise during his or her lesson. The entire lesson should take no more than 10 minutes.

Teacher: Today, we're going to learn how to create something called a concept map. A concept map is a way to organize main ideas in language arts. A concept map can also help you to understand a story better after you've read it. These maps do this by letting you show the connections between important main ideas and characters in the story.

There are many different kinds of concept maps. Today, I'm going to show you how to make one kind of concept map. We're going to learn how to represent or show ideas in a visual manner (that is, not just with words). I'm going to use the story of *Little Red Riding Hood* to illustrate how we can create a concept map.

(Write words Little Red Riding Hood as title on the board. Then, on the left side of the board, write Concepts. Under this heading, you will begin your list below. On the right side, write Links—see below)

Teacher: Most of you probably remember the story of Little Red Riding Hood. She takes her basket and goes to visit her grandmother who lives in a cottage in the forest. At the beginning of her journey, she meets a Stranger who asks where she's going. She tells him and it turns out to be the Big Bad Wolf. So, the Wolf goes to Grandma's house and dresses in her clothes and gets into bed. When Little Red Riding Hood arrives, she's surprised to see her Grandmother looking a little different. "Oh! What big eyes you have!" ("The better to see you with," replies the Wolf.) "Oh! What big ears you have!" ("The better to hear you with," replies the Wolf.) "Oh! What big teeth you have!" ("The better to eat you with," replies the Wolf.) At that point, Little Red Riding Hood either gets eaten by the Wolf or clobbers the Wolf and rescues Grandma from the closet, depending on which version you read.

Teacher: Now that I've reminded you about the story, let's suppose we're studying the story of Little Red Riding Hood and that we're trying to better understand the story. The first thing we need to do in order to create a concept map is to come up with the main ideas and characters in the story. Then, we need to come up with the linking words that help connect these ideas together. So, let's think about the important ideas related to Little Red Riding Hood. There's the idea of a Stranger, right? So, we can first write stranger, and then maybe Wolf. *(under concepts, write stranger and wolf).* Those are important concepts in the story. What else can you think of that is important to the story? What other characters? What else? What else? ... *(prompt students ... possible answers include: Little Red Riding Hood, Grandma, journey, forest, eyes, ears, teeth, cleverness/trickery ... If students mention eat, or other linking verbs, place under the Links heading)*

Good. Now, let's try to come up with a few linking words. These are ways of connecting the concepts together. We'll also come up with more as we make our concept map. We can write down things like: wants to eat, is going to, is related to, ... *(write these under Links heading)*

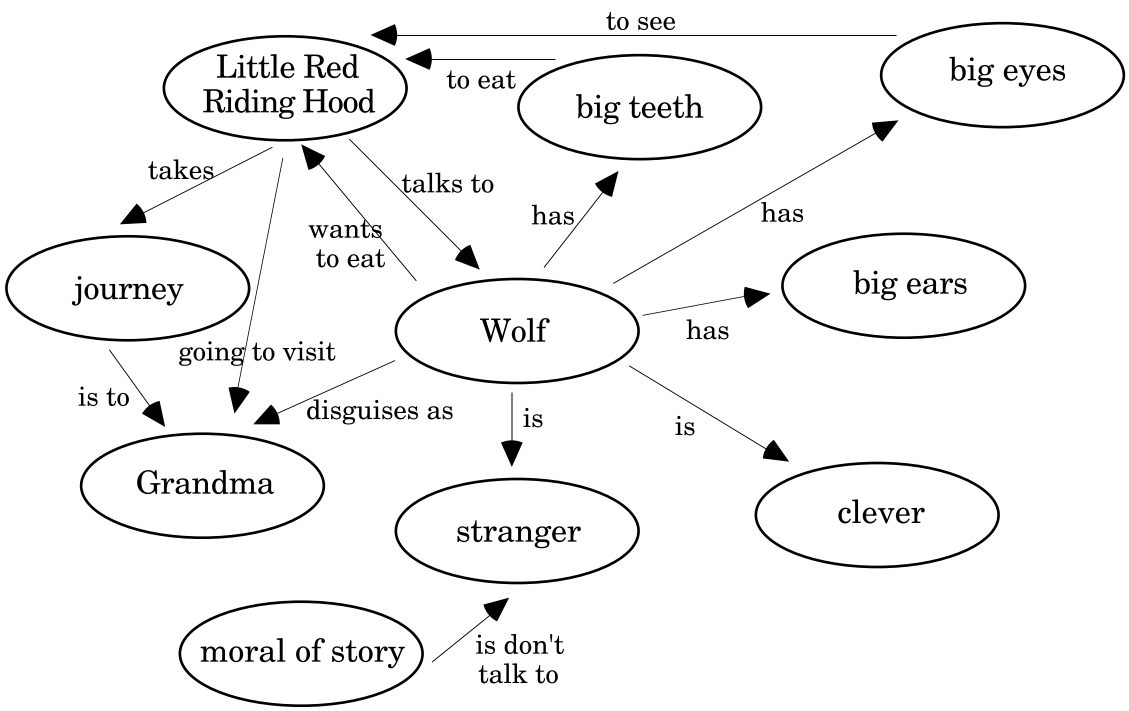
Okay, so you can see from our lists that under Concepts we have ideas and things. "Stranger" is an idea or concept. "Teeth" are just things. The links are words that connect these words together.

Now, we're going to actually make a concept map. We start by selecting the most important concepts and place them in the middle of our map. We write the concept down and circle it, like this *(write Little Red Riding Hood and circle it).* Another important concept is Wolf so let's add that too *(write wolf and circle it—refer to attached concept map for details)*. Now we need to decide how these two concepts connect to one another. Let's see—the wolf wants to eat Little Red Riding Hood, right? So, we'll add a link here by drawing a line with an arrow and labeling it "wants to eat." *(draw line with arrow from Wolf circle to Little Red circle and label it wants to eat)* Links always connect one concept to another, with an arrow, and you always have to label your links. When you try to draw a link, think of a sentence that uses both concepts, like "Wolf wants to eat Little Red Riding Hood." The middle part (wants to eat) is your link. What other connections can we make from our list of concepts? What important concept should we add next? *(continue, either taking suggestions or prompting/giving answers as necessary—see attached concept map for some possible links)*

Above should take no more than 10 minutes ... at that point, summarize with the following:

In a concept map, you can always reuse the links (so two links may be labeled with the same connection) but you can only use a concept once. Also, these maps can get pretty full—you just have to make sure you keep your writing neat so that we can read your concepts and links. As you can tell, each concept map is individual—there is no one right answer. You're just trying to show how the main ideas and characters in the story are connected or related.

Okay, now we're going to have a lesson in language arts and you're going to read a story. Then, you'll make your own concept maps.



Teacher Script

The Kid in the Red Jacket

by Barbara Park (New York: Knopf, 1987)

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

All teacher-led lessons will be taught in an interactive fashion, with teacher reading aloud from the text and pausing between sections for summarization, clarification, and analysis. These pauses will be teacher-led, and suggested questions for class discussion will be included. Since this is presumably review for the students, all discussion should be kept short. Entire lesson should take no more than 15 minutes.

Begin by passing out The Kid in the Red Jacket handouts.

Teacher: Okay, we're going to read a story. It's a personal narrative. Who can tell me what that means?

Brief discussion of personal narrative (writing style, first person, tone) ... select two or three students only (if no students volunteer information, simply give brief definition and continue to next section).

Teacher: All right. I am going to read this story aloud. Please follow along as I read the introductory paragraph and first paragraph.

Teacher should read the introductory paragraph and first section as follows:

When Howard's parents decide to move to Rosemont, Massachusetts, Howard doesn't want to go. He doesn't want to be a new kid, on a new block, in a new school. As the school year begins, Howard is eager to make friends. We pick up the story on his second day of school ...

Alone at a *New School*

At lunch, I sat by myself again. Only this time I picked a seat next to the wall so I could sort of blend in with the bricks.

As I started to eat I realized that a lot of the *guys in my class* were sitting at the next table. And since I was blending in with the wall pretty good, I could *watch* them without being too obvious. The guy I watched the most was this kid named *Pete*. I guess I was sort of scouting him out to see what kind of *friend* he'd make. Scouting is what they do in professional sports. It's a sporty word for spying.

Teacher: Howard's new in school, right? He's alone. Who can tell me what he's doing and what he's thinking? *(looking for friends, watching people, lonely)* I'll keep reading now.

Teacher should read the next sections as follows:

Playing Soccer

It might sound dumb, but after lunch I felt like I knew the guys in my class a little better. I guess that's why at recess I hung around the group that was getting ready to play *soccer*. I was sure somebody would pick me. Maybe they'd pick me last, but I'd get picked. It's sort of this unwritten rule every kid knows. If you're standing there to play, somebody's got to pick you, even if you stink.

Getting to Know You

Pete *picked* me. I didn't get chosen first or anything, but I wasn't last, either. A kid with his ankle in a cast was last. Still, it felt good when Pete chose me. All of a sudden he just looked over at me and said, "I'll take the kid in the red jacket."

It's funny. I used to think that being called something like that would really bother me. But the weird thing was, being called the kid in the red jacket hardly bothered me at all. Let's face it, after a couple of days of not being called anything, almost any name sounds good.

Teacher: Howard is telling us all about his thoughts and feelings, right? What happened after lunch? *(played soccer, Pete picked Howard)* What do you think Howard felt like when Pete picked him? *(happy to be chosen)*

Teacher should read the section as follows:

Advice

My *father* gave me some *advice*.

"*Horn in*," he said one night at dinner. I was explaining how much I hated to *eat lunch alone*, and he looked right up from his pork chop and said, "Horn in."

"Er, horn in?" I repeated, confused. I guess it must be one of those old-time expressions they don't use much anymore.

"Sure. Be a little pushy. Stand up for yourself," he went on. "Sometimes you've just got to take the bull by the horns."

"Oh geez. Not more horns," I groaned.

"Bull by the horns," repeated Dad. "Haven't you ever heard that before? It means you've got to get right in there and *take charge*. If you don't want to eat alone, then *sit right down* at the lunch table with the rest of them. Just walk up there tomorrow, put your lunch on the table, and sit down. That's all there is to it."

Teacher: Who does Howard talk to at dinner? *(his father)* What advice does his father give him? *(horn in, sit down, take a chance ...)* What does "horn in" mean? I'll keep reading now.

Teacher should read the section as follows:

Learning How to "Take Charge"

I knew what Dad was getting at. I think it's something all *new kids learn* sooner or later. Even if you're the shy type, you have to *get a little bold* if you want to make any friends. You have to *say hi* and *talk to people*, even if it makes you nervous. Sometimes you even have to sit down at a lunch table without being invited.

I have to admit that "horning in" part worked out pretty well. The next day at lunch I took a deep breath, sat down at the table with the other guys, and started eating. That was that. No one seemed to mind, really. They hardly even stared.

Teacher: So Howard got a little bold, didn't he? What did he do? *(sat down and ate lunch with the guys)* Why does he say all new kids learn that sooner or later? I'll read the last section now.

Teacher should read the last section as follows:

It Gets Easier

After that it got *easier*. Once kids have seen you at their table, it's not as hard to accept you the next time. Then pretty soon they figure that you must *belong*, or you wouldn't be sitting there every day.

I'm not saying that after horning in I automatically started to love Rosemont, Massachusetts. All I mean is, the more days that passed, the less I felt like an *outsider*. I guess you'd say stuff started feeling more *familiar*.

Teacher: Why does Howard say it gets easier? *(get used to it, sense of belonging, less of an outsider ...)* What does "familiar" mean? *(something you know ...)*

Teacher: Now turn to the last page of your handout. We're now going to make concept maps of *The Kid in the Red Jacket* just like the sample one I showed you how to do on the board. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of the story. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. And don't forget to label all of your links—each link should have an arrow and a label. For those students who have a colored Monitoring Worksheet on the page before the last page, read the directions at the top of the page and follow them. You should work on your Monitoring Worksheet and Concept Map together.

Teacher Script
Preliminary Concept Mapping Lesson in Science—Recycling

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

This lesson teaches students about the basics of concept mapping. The lesson uses the content area of recycling in science as a base example, and the teacher will instruct students in an interactive fashion.

The first portion of the lesson is totally scripted. The second half is less so, because one cannot anticipate exactly which nodes and links students will suggest. Thus, a sample concept map for the topic area is included. Note, however, that this is not the one, correct answer—concept maps by their very nature are personalized and the teacher will need to improvise during his or her lesson. The entire lesson should take no more than 10 minutes.

Teacher: Today, we're going to learn how to create something called a concept map. A concept map is a way to organize scientific information and ideas. A concept map can also help you to understand scientific concepts while you're learning them. These maps do this by letting you show the connections between important ideas and scientific phenomena in science.

There are many different kinds of concept maps. Today, I'm going to show you how to make one kind of concept map. We're going to learn how to represent or show ideas in a visual manner (that is, not just with words). I'm going to use the topic of recycling to illustrate how we can create a concept map.

(Write word Recycling as title on the board. Then, on the left side of the board, write Concepts. Under this heading, you will begin your list below. On the right side, write Links—see below)

Teacher: So, let's suppose we're studying recycling and that we're trying to organize or better understand recycling. The first thing we need to do in order to create a concept map is to come up with the important concepts or ideas in a particular topic area. Then, we need to come up with the linking words that help connect these ideas together. So, let's think about the important ideas related to recycling. We can first write recycling, and then maybe garbage or trash. *(under concepts, write recycling and garbage/trash)* Those are important concepts in recycling. What else can you think of that is important when we talk about recycling? What else? What else? ... *(prompt students ... possible answers include: environment/the earth, new materials, oceans, rain forests, animals/living things, people, air, water, pollution, bottles, cans, newspaper, recycle centers ... If students mention reduce, reuse, or other linking verbs, place under the Links heading)*

Good. Now, let's try to come up with a few linking words. These are ways of connecting the concepts together. We'll also come up with more as we make our concept map. We can write down things like: reduces, reuses, helps, leads to, is an example of, causes, has, is, is a part of, influences, is related to, ... *(write these under Links heading)*

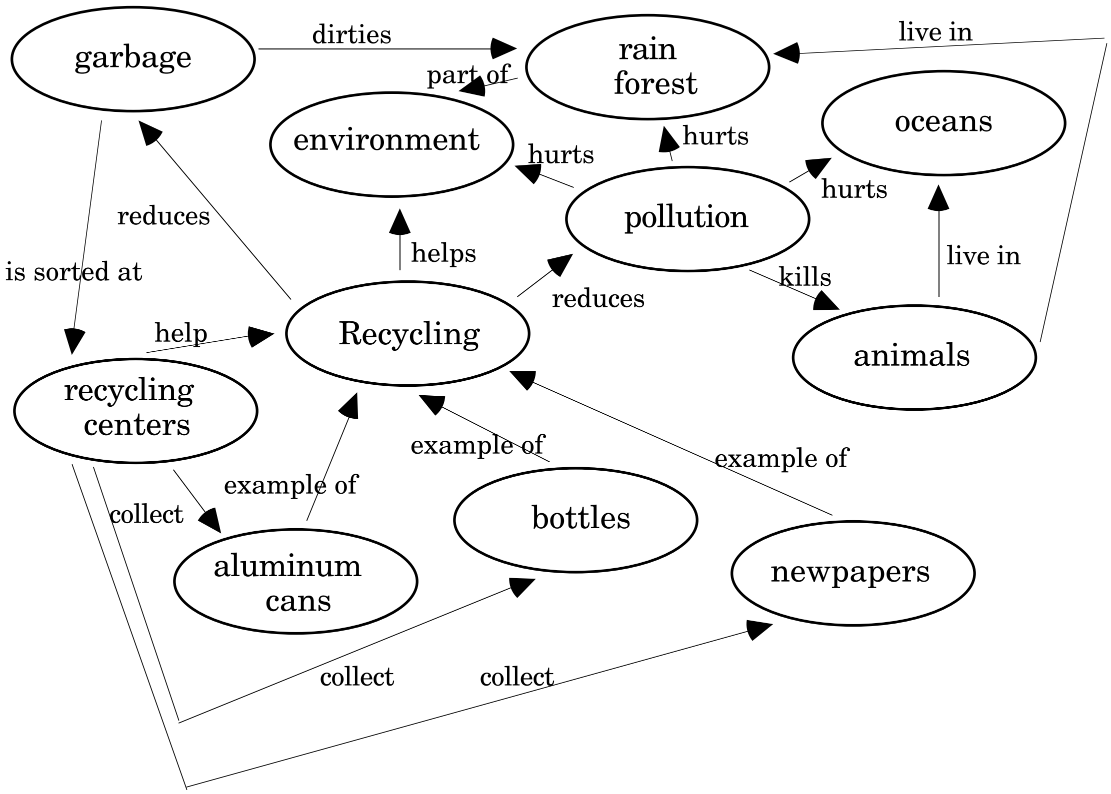
Okay, so you can see from our lists that under Concepts we have ideas and things. "Recycling" is an idea or concept. "Aluminum cans" are just things. The links are words that connect these words together.

Now, we're going to actually make a concept map. We start by selecting the most important concepts and place them in the middle of our map. We write the concept down and circle it, like this *(write recycling and circle it)*. Another important concept is garbage so let's add that too *(write garbage and circle it—refer to attached concept map for details)*. Now we need to decide how these two concepts connect to one another. Let's see—recycling reduces garbage, right? So, we'll add a link here by drawing a line with an arrow and labeling it "reduces." *(draw line with arrow from recycling circle to garbage circle and label it reduces)* Links always connect one concept to another, with an arrow, and you always have to label your links. When you try to draw a link, think of a sentence that uses both concepts, like "recycling reduces garbage." The middle part (reduces) is your link. What other connections can we make from our list of concepts? What important concept should we add next? *(continue, either taking suggestions or prompting/giving answers as necessary—see attached concept map for some possible links)*

Above should take no more than 10 minutes ... at that point, summarize with the following:

In a concept map, you can always reuse the links (so two links may be labeled with the same connection) but you can only use a concept once. Also, these maps can get pretty full—you just have to make sure you keep your writing neat so that we can read your concepts and links. As you can tell, each concept map is individual—there is no one right answer. You're just trying to show how certain science concepts are connected or related.

Okay, now we're going to have a lesson in science about adaptation and you're going to make your own concept maps.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Teacher Script
Adaptation

NOTE: Italics signifies directions to teacher; regular text denotes actual instruction.

All teacher-led lessons will be taught in an interactive fashion, with teacher reading aloud from the text and pausing between sections for summarization, clarification, and analysis. These pauses will be teacher-led, and suggested questions for class discussion will be included. Since this is presumably review for the students, all discussion should be kept short. Entire lesson should take no more than 15 minutes.

Begin by passing out Adaptation handouts.

Teacher: We're going to talk a little about adaptations in living things. You should think back to when you learned this material in your science class. If it is not familiar to you or you've forgotten some of it, don't worry—that's why we're reviewing it. Can anyone tell me something about adaptations? What is an adaptation?

Brief discussion of adaptation ... select two or three students only (if no students volunteer information, simply continue to next section).

Teacher: I am going to read this handout aloud. Please follow along as I read, starting at the first paragraph.

Teacher should read the first paragraph aloud as follows:

Introduction

Have you ever watched a hummingbird? A hummingbird's wings allow it to fly near a flower and suck nectar with its long beak. This is a good example of *adaptation*. The hummingbird's wings and long beak help it to get food. A hummingbird needs food to live or *survive*. So, its fast wings and long beak are adaptations that help the hummingbird survive. In this lesson you will learn all about adaptation.

Teacher: How does the hummingbird use its body to get food?*(wings to fly near flower, beak is long and skinny and can get into flower to get nectar)*

Teacher should read the section as follows:

What Makes Living Things Different From One Another?

One thing that is special about adaptation is that different animals have different adaptations. Think for a minute about how living things are different from each other. Each kind of animal or plant has certain *features* that make it different from other kinds of living things. A tiger has sharp teeth. A frog has a long, sticky tongue. Pine trees have cones and apple trees have flowers. Living things also have their own way of *doing certain things*. Robins build their nests out of twigs. Plants turn their leaves to face the sun. Every kind of living thing is unique because of its special features or characteristics and how it uses them to survive.

Teacher: Living things have characteristics or features that make them different from each other. What does a frog have? *(long, sticky tongue)* What do you think the frog uses its tongue for? *(let students try to answer)* Can you think of another behavior that animals do to survive? *(let students guess)* Let's read the next section and see.

Teacher should read the section as follows:

<u>Staying Alive</u>

Each living thing's special features and special behaviors help it to stay alive or survive. A characteristic or behavior that helps a living thing to survive is called an *adaptation*. A tiger's sharp teeth and claws are an adaptation for catching and eating other animals. A frog's long, sticky tongue is an adaptation for catching insects. Activities such as building nests and facing sunlight are also adaptations that help with survival. Adaptations help living things in many ways. Adaptations *help* living things get food, protect themselves, move, and carry on life processes.

Teacher: So, a frog's tongue is an adaptation for catching bugs. What is an adaptation? *(characteristic or behavior that helps living thing survive)* How do adaptations help with survival? *(helps with getting food, protection, movement)* Can you name other examples of adaptations? What are they used for? *(some examples include different bird beaks for getting different kinds of food, cactus plant storing water and protecting itself with spines, jackrabbit's long ears for desert living, panda's sixth finger for stripping leaves off bamboo stems, human opposable thumb).* Let's read the next section.

Teacher should read the section as follows:

<u>Adaptations Within a Habitat</u>

Adaptations help living things survive within a particular habitat. A *habitat* is the area or place where an animal or plant lives. Many different habitats exist on the earth. A shark lives in an ocean habitat. A cactus lives in a desert habitat. Sharks and cacti have adaptations just for their habitat. For instance, a shark can swim to get around its ocean habitat. A cactus can store water to live in its dry desert habitat. Sometimes, plants and animals that live in the same habitat *share* adaptations. A camel lives in the desert like a cactus. Like a cactus, a camel can also store water to help it survive the dry desert weather. So, a camel and a cactus share an adaptation for a desert habitat.

Another example of a habitat is the arctic. Animals that live in the arctic need special adaptations to survive the cold. The snowshoe hare (rabbit) lives in the arctic habitat. The hare's thick, white fur keeps the animal warm and lets it hide from *predators* (hunters) in the snow. The arctic fox also has thick, white fur. Like the hare, the arctic fox's fur keeps it warm and helps it hide from predators. The fox and the hare are not closely related, but they do share an adaptation. Both animals have thick, white fur that *protects* them in their habitat. This adaptation keeps them warm and hides them from predators in their arctic habitat.

Teacher: Who can tell me what a habitat is? *(the area or place where a living thing naturally lives)* Can you name some habitats? *(desert, rain forest, ocean, arctic ...)* Good—this section talked about the desert habitat and the arctic habitat. What adaptation do animals have for the desert habitat? *(storing water ...)* What adaptations do animals have for the arctic habitat?*(thick, white fur)* How do these adaptations help them to survive? *(protection from cold and ability to hide from predators, protection from heat, availability of water to live)* What about their habitat makes this adaptation so useful? *(arctic is cold and white and snowy; desert is dry and often hot)* Okay, let's continue.

Teacher should read the section as follows:

Animals living in the same habitat often *share* adaptations for survival, like the fox and the hare. But, each habitat has many living things that live there in *different* ways too. For instance, zebras and giraffes are often found in the same habitat, the grasslands. In what ways are zebras and giraffes alike? Both have interesting markings. Also, both zebras and giraffes eat the same type of food, plants.

How are these animals different? A giraffe has a long neck, while a zebra's neck is shorter. A giraffe reaches leaves high in the trees with its long neck. A zebra reaches grass on the ground with its shorter neck. So, giraffes and zebras have different adaptations that both help them *reach food* in their habitat. Also, giraffes have a splotchy pattern and zebras have stripes. The splotchy pattern helps the giraffe survive in its habitat by helping it hide from predators. The zebra's striped pattern is a different adaptation that also helps protect it from its predators. So, giraffes and zebras have different adaptations that help protect them in their habitat.

Teacher: So, giraffes and zebras have different adaptations for the same purposes, right? Their necks are different, but both help them reach food. Their patterns are different, but both help protect these animals from predators.

Teacher: Now turn to the last page of your handout. We're going to make concept maps on adaptation just like the sample one I showed you how to do on the board. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of adaptation. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. And don't forget to label all of your links—each link should have an arrow and a label. For those students who have a colored Monitoring Worksheet on the page before the last page, read the directions at the top of the page and follow them. You should work on your Monitoring Worksheet and Concept Map together.

The Settlement of Jamestown

Arrival in the New World

On April 26, 1607, settlers from England arrived in the New World to found (set up) the *colony* of Jamestown. They explored the area of Chesapeake Bay in Virginia, chose the site that would become Jamestown, and began *building* their settlement.

The Early Settlers

All of the early settlers who came to Virginia to set up the colony of Jamestown were white men. Their professions included: farmers (called *yeomen*), soldiers, carpenters, bricklayers, general workers, and gentlemen. *Gentlemen* were wealthy people with no occupation or manual skills. They were not expected to do ordinary work. They were only supposed to manage estates and provide advice. Among the early settlers from England to arrive in Jamestown, one out of every three was a gentleman. These gentlemen did not do any real work. The other settlers resented working and didn't want to work hard.

Money for the Colony

A private company called the *Virginia Company of London* paid for the English colonization of Jamestown. This company's aim in starting the colony was *profit*. This means that the company wanted to make money from the colony. The Virginia Company hoped to find gold or other valuable minerals, trade with the native people (the Algonquin Indians), and possibly use the natives as workers for the colony.

Problems in Jamestown

Virginia did not have precious minerals. The Indians were spread out over a large area and not interested in living with the settlers. The settlers suffered from many *diseases*, like malaria and dysentery. Most importantly, Jamestown's settlers were *not willing* to farm for themselves. This led to *food shortages*. They relied on England to send food to them or on the Algonquin Indians to give them food. England was far away and food often arrived spoiled. Also, the settlers often *attacked* the Indians. This caused the Indian chief to forbid his people from trading anything with the settlers. Because of these problems, only 59 of the over 900 settlers were alive in the spring of 1610.

Jamestown Turns Around

Soon after the setting up of Jamestown, *Captain John Smith* took charge of the settlers. He asked for help from the Indians to help end the food shortage. He also *established a rule* that settlers had to *work* for food. Then, the settlers managed to plant and harvest a crop of *tobacco*. In 1614, Jamestown began exporting (selling) tobacco to England.

Tobacco Production

Four years later, the Virginia Company of London was still not sure that tobacco would be a profitable (money-making) product for *trade*. To make tobacco profitable, planters needed *cheap labor* to plant and harvest the crop and *a great deal of land* on which to *grow* the tobacco. The tobacco planters began asking poor white people in England and Ireland to come to Jamestown. Thousands of desperate people sold themselves into *indentured servitude*. This meant that they worked without pay for three to seven years in order to get to the New World. As tobacco *profits* grew, the need for more land grew. Angered because the settlers were trying to take over their land, the Algonquin Indians finally attacked Jamestown. The settlers fought back, and made war on the Indians. By 1638, having found both land and workers, the settlers *exported* three million pounds of tobacco to England!

tobacco plant

Name: ____________________

Teacher: ________________________

Concept Mapping Task

The Settlement of Jamestown

Create a concept map on the settlement of Jamestown. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of Jamestown. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. Don't forget to label all of your links—each link should have an arrow and a label.

Concepts		Links	
profit	____________	led to	____________
settlers	____________	is/was a part of	____________
____________	____________	____________	____________
____________	____________	____________	____________
____________	____________	____________	____________

The Pilgrim Experience

Introduction

Most people can tell you that Thanksgiving celebrates a big feast between the *Pilgrims* and the *Indians*. But can you tell me who the Pilgrims really were? In this lesson, you're going to learn all about the Pilgrims and how they founded *Plymouth*.

The Church of England

In 1534, King Henry VIII of England broke away from the *Roman Catholic Church* and started his own *Church of England*. Some English people thought the Church of England was too much like the Roman Catholic Church and wanted to *purify* (clean out) the church. They wanted to get rid of all reminders of Catholic services, like the fancy clothes worn by priests. Because they wanted to purify the church, these people were known as *Puritans*. Some Puritans then wanted to break away from the church all together. They wanted to form their own separate churches, so they were known as *Separatists*.

Persecution

English law at the time said that everyone in the country had to belong to the Church of England. Separatists were *persecuted* (discriminated against) and were not allowed to freely practice their *religion*. Because Separatists were afraid of being put in prison, some left England to go to the *Netherlands*. One such Separatist group was known as the *Pilgrims* because their leader said they were on a holy journey—a "pilgrimage."

The Move to North America

Since the Pilgrims did not speak Dutch, they never felt at home in the Netherlands. They didn't want to go back to England, though, because they were persecuted there. In 1619, the Virginia Company gave the Pilgrims permission to settle in Virginia. A group of investors hoping to earn money from the new colony agreed to pay for the Pilgrims' trip to *North America*. In 1620, 35 Pilgrims (together with a number of hired workers) boarded the *Mayflower*, a ship heading for Virginia.

Arrival in Massachusetts

The Pilgrims never made it to Virginia. Strong ocean storms drove the *Mayflower* off course. On November 11, after 11 weeks at sea, the ship dropped anchor off the tip of Cape Cod, in what is now *Massachusetts*. Although the Pilgrims knew they were hundreds of miles north of Virginia, they were too tired and sick to travel any farther. They decided to look for land close by to start their settlement. They chose a small bay by which to start their *colony* and began building *Plymouth Plantation*.

<u>The Mayflower Compact</u>

The *Mayflower* passengers were Pilgrims and hired workers. The workers argued that they had only agreed to *settle* in Virginia, not some place hundreds of miles away from there. The passengers had a problem. So, they wrote and *signed* an agreement called the *Mayflower Compact* that said that everyone would agree to go along with the majority's decisions for the good of the colony. This agreement was the very beginning of a future democratic government.

<u>Help From the Indians</u>

Just like the settlers in Jamestown, the Pilgrims in Plymouth had a rough time at first. Many *died* because of the *cold winter*, lack of *food*, and *disease*. The following spring, though, an Indian named *Squanto* visited the Pilgrims. Squanto spoke English and *taught* the Pilgrims how to hunt, fish, and plant corn. Squanto also helped *make peace* between the Pilgrims and Chief Massasoit of the Wampanoag Indians. Unlike the settlers in Jamestown, the Pilgrims were hard workers and good planters. In the fall of 1621, the Pilgrims invited the Indians to a feast *celebrating* the Pilgrims' first *harvest*. This friendship between the Pilgrims and the Indians also led to greater *trade* between the two people. Because of all this, the second permanent English settlement in North America *survived*.

Name: ____________________

Teacher: _________________________

Concept Mapping Task

The Pilgrim Experience

Create a concept map on the Pilgrims. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of the Pilgrim experience. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. Don't forget to label all of your links—each link should have an arrow and a label.

Concepts		**Links**	
Pilgrims	____________	led to	____________
persecution	____________	is/was a part of	____________
____________	____________	____________	____________
____________	____________	____________	____________
____________	____________	____________	____________

The Kid in the Red Jacket

by Barbara Park (New York: Knopf, 1987)

When Howard's parents decide to move to Rosemont, Massachusetts, Howard doesn't want to go. He doesn't want to be a new kid, on a new block, in a new school. As the school year begins, Howard is eager to make friends. We pick up the story on his second day of school ...

Alone at a *New School*

At lunch, I sat by myself again. Only this time I picked a seat next to the wall so I could sort of blend in with the bricks.

As I started to eat I realized that a lot of the *guys in my class* were sitting at the next table. And since I was blending in with the wall pretty good, I could *watch* them without being too obvious. The guy I watched the most was this kid named *Pete*. I guess I was sort of scouting him out to see what kind of *friend* he'd make. Scouting is what they do in professional sports. It's a sporty word for spying.

Playing Soccer

It might sound dumb, but after lunch I felt like I knew the guys in my class a little better. I guess that's why at recess I hung around the group that was getting ready to play *soccer*. I was sure somebody would pick me. Maybe they'd pick me last, but I'd get picked. It's sort of this unwritten rule every kid knows. If you're standing there to play, somebody's got to pick you, even if you stink.

Getting to Know You

Pete *picked* me. I didn't get chosen first or anything, but I wasn't last, either. A kid with his ankle in a cast was last. Still, it felt good when Pete chose me. All of a sudden he just looked over at me and said, "I'll take the kid in the red jacket."

It's funny. I used to think that being called something like that would really bother me. But the weird thing was, being called the kid in the red jacket hardly bothered me at all. Let's face it, after a couple of days of not being called anything, almost any name sounds good.

Advice

My *father* gave me some *advice*.

"*Horn in*," he said one night at dinner. I was explaining how much I hated to *eat lunch alone*, and he looked right up from his pork chop and said, "Horn in."

"Er, horn in?" I repeated, confused. I guess it must be one of those old-time expressions they don't use much anymore.

"Sure. Be a little pushy. Stand up for yourself," he went on. "Sometimes you've just got to take the bull by the horns."

"Oh geez. Not more horns," I groaned.

"Bull by the horns," repeated Dad. "Haven't you ever heard that before? It means you've got to get right in there and *take charge*. If you don't want to eat alone, then *sit right down* at the lunch table with the rest of them. Just walk up there tomorrow, put your lunch on the table, and sit down. That's all there is to it."

Learning How to "Take Charge"

I knew what Dad was getting at. I think it's something all *new kids learn* sooner or later. Even if you're the shy type, you have to *get a little bold* if you want to make any friends. You have to *say hi* and *talk to people*, even if it makes you nervous. Sometimes you even have to sit down at a lunch table without being invited.

I have to admit that "horning in" part worked out pretty well. The next day at lunch I took a deep breath, sat down at the table with the other guys, and started eating. That was that. No one seemed to mind, really. They hardly even stared.

It Gets Easier

After that it got *easier*. Once kids have seen you at their table, it's not as hard to accept you the next time. Then pretty soon they figure that you must *belong*, or you wouldn't be sitting there every day.

I'm not saying that after horning in I automatically started to love Rosemont, Massachusetts. All I mean is, the more days that passed, the less I felt like an *outsider*. I guess you'd say stuff started feeling more *familiar*.

Name: ____________________

Teacher: ________________________

Concept Mapping Task

The Kid in the Red Jacket

Create a concept map on the main ideas in *The Kid in the Red Jacket*. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of the story. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. Don't forget to label all of your links—each link should have an arrow and a label.

Concepts		Links	
Howard	____________	felt	____________
being alone	____________	picked	____________
____________	____________	____________	____________
____________	____________	____________	____________
____________	____________	____________	____________

Adaptation

Introduction

Have you ever watched a hummingbird? A hummingbird's wings allow it to fly near a flower and suck nectar with its long beak. This is a good example of *adaptation*. The hummingbird's wings and long beak help it to get food. A hummingbird needs food to live or *survive*. So, its fast wings and long beak are adaptations that help the hummingbird survive. In this lesson you will learn all about adaptation.

What Makes Living Things Different From One Another?

One thing that is special about adaptation is that different animals have different adaptations. Think for a minute about how living things are different from each other. Each kind of animal or plant has certain *features* that make it different from other kinds of living things. A tiger has sharp teeth. A frog has a long, sticky tongue. Pine trees have cones and apple trees have flowers. Living things also have their own way of *doing certain things*. Robins build their nests out of twigs. Plants turn their leaves to face the sun. Every kind of living thing is unique because of its special features or characteristics and how it uses them to survive.

Staying Alive

Each living thing's special features and special behaviors help it to stay alive or survive. A characteristic or behavior that helps a living thing to survive is called an *adaptation*. A tiger's sharp teeth and claws are an adaptation for catching and eating other animals. A frog's long, sticky tongue is an adaptation for catching insects. Activities such as building nests and facing sunlight are also adaptations that help with survival. Adaptations help living things in many ways. Adaptations *help* living things get food, protect themselves, move, and carry on life processes.

Adaptations Within a Habitat

Adaptations help living things survive within a particular habitat. A *habitat* is the area or place where an animal or plant lives. Many different habitats exist on the earth. A shark lives in an ocean habitat. A cactus lives in a desert habitat. Sharks and cacti have adaptations just for their habitat. For instance, a shark can swim to get around its ocean habitat. A cactus can store water to live in its dry desert habitat. Sometimes, plants and animals that live in the same habitat *share* adaptations. A camel lives in the desert like a cactus. Like a cactus, a camel can also store water to help it survive the dry desert weather. So, a camel and a cactus share an adaptation for a desert habitat.

Another example of a habitat is the arctic. Animals that live in the arctic need special adaptations to survive the cold. The snowshoe hare (rabbit) lives in the arctic habitat. The hare's thick, white fur keeps the animal warm and lets it hide from *predators* (hunters) in the snow. The arctic fox also has thick, white fur. Like the hare, the arctic fox's fur keeps it warm and helps it hide from predators. The fox and the hare are not closely related, but they do share an adaptation. Both animals have thick, white fur that *protects* them in their habitat. This adaptation keeps them warm and hides them from predators in their arctic habitat.

Different Adaptations Within a Habitat

Animals living in the same habitat often *share* adaptations for survival, like the fox and the hare. But, each habitat has many living things that live there in *different* ways too. For instance, zebras and giraffes are often found in the same habitat, the grasslands. In what ways are zebras and giraffes alike? Both have interesting markings. Also, both zebras and giraffes eat the same type of food, plants.

How are these animals different? A giraffe has a long neck, while a zebra's neck is shorter. A giraffe reaches leaves high in the trees with its long neck. A zebra reaches grass on the ground with its shorter neck. So, giraffes and zebras have different adaptations that both help them *reach food* in their habitat. Also, giraffes have a splotchy pattern and zebras have stripes. The splotchy pattern helps the giraffe survive in its habitat by helping it hide from predators. The zebra's striped pattern is a different adaptation that also helps protect it from its predators. So, giraffes and zebras have different adaptations that help protect them in their habitat.

Name: ____________________

Teacher: __________________________

Concept Mapping Task

Adaptation

Create a concept map on adaptation. You can refer back to your handout in order to help you come up with concepts and help you understand how to link them together. Remember: Concepts are ideas or things. Think about important ideas or aspects of adaptation. Two concepts have already been placed on the list, but you don't need to use those if you don't want to. Links are words that connect concepts together. Think about how your concepts are related. Don't forget to label all of your links—each link should have an arrow and a label.

Concepts		**Links**	
adaptation	____________	is an example of	____________
food	____________	helps	____________
____________	____________	____________	____________
____________	____________	____________	____________
____________	____________	____________	____________

APPENDIX B

Monitoring Worksheet

Name: ____________________

Teacher: ________________________

Monitoring Worksheet

Directions: People can improve their learning and understanding by thinking about their work while they are working. Answering the following questions while you complete your assignment will help you to do a good job on the assignment. If you do a good job, you'll also learn more. By monitoring your work, you can become a better student!

So, while you are completing the assignment on the next page, please do the following things and answer the following questions.

After you read the assignment but before you actually start working on it:

1. Look at the assignment on the next page carefully. Have you thought about how to complete it?

2. Check to see if you have enough information to complete the assignment. Do you? If not, where can you get it?

Halfway through your assignment (for instance, after adding 4 concepts):

3. Think about similar assignments you've done that might help you to complete this assignment. Can you think of any? If so, which one(s)?

After you finish your assignment:

4. Check to be sure you have shown the main ideas. Have you shown how these ideas relate to one another?

5. Check your work to be sure it is accurate and that you haven't forgotten anything. Is your assignment complete?

APPENDIX C

Prior Knowledge Measures

Name: ____________________

Teacher: ______________________

Prior Knowledge—Language Arts

Directions: I want to know what you know about certain topics in language arts. You may know a great deal or you may know hardly anything about these topics. Either way is okay—I'd just like to find out. Answer the following questions as best you can. Even if you are not sure about your answer, but think you know something, feel free to guess. Do not spend too much time on any one item. Also, rather than leaving a blank, please write "don't know" if you don't know the answer.

1. What is a "personal narrative?"

2. What is the usual structure of a fictional story? How does the story usually unfold?

3a. Briefly describe what it's like to move to a new school.

3b. Have you ever moved to a new school or had to make new friends?
❏ Yes ❏ No

On a scale of 1 to 4, how often do you do each of the following? Circle your answer below.

	Hardly ever	Sometimes	Pretty often	Very often
4. Read fictional stories.	1	2	3	4
5. Read books outside of class.	1	2	3	4
6. Read stories told by a narrator.	1	2	3	4

Name: ____________________

Teacher: __________________________

Prior Knowledge—Science

Directions: I want to know what you know about certain topics in science. You may know a great deal or you may know hardly anything about these topics. Either way is okay—I'd just like to find out. Answer the following questions as best you can. Even if you are not sure about your answer, but think you know something, feel free to guess. Do not spend too much time on any one item. Also, rather than leaving a blank, please write "don't know" if you don't know the answer.

1. What is adaptation?

2. Give an example of an animal adaptation.

3. What is a habitat?

On a scale of 1 to 4, how often do you do each of the following? Circle your answer below.

	Hardly ever	Sometimes	Pretty often	Very often
4. Read books about science.	1	2	3	4
5. Read books outside of class.	1	2	3	4
6. Read magazines about science.	1	2	3	4

APPENDIX D

Transfer Tasks

Name: ____________________

Teacher: ________________________

Planning a Report on Adaptation

Prepare to write a report on *adaptation*. <u>Don't write the actual report</u>—this is a *pre-writing* activity. Instead, think about all the ways you might be able to better understand and organize the important ideas about adaptation that you've just read. Think also about how you can show how these ideas relate to one another. Use everything you know about good organization to plan this report. You should organize what you want to say now, so that you can use the work you do today to write the adaptation report tomorrow. <u>Remember</u>: Don't write the report now! Simply organize the information you will put into your report so that it will be easier to write the report tomorrow.

Name: ____________________

Teacher: ________________________

Planning a Report on *The Kid in the Red Jacket*

Prepare to write a book report on *The Kid in the Red Jacket*. <u>Don't write the actual report</u>—this is a *pre-writing* activity. Instead, think about all the ways you might be able to better understand and organize the important ideas from the story that you've just read. Think also about how you can show how ideas in the story relate to one another. Use everything you know about good organization to plan this report. You should organize what you want to say now, so that you can use the work you do today to write the book report tomorrow. <u>Remember</u>: Don't write the report now! Simply organize the information you will put into your report so that it will be easier to write the report tomorrow.

APPENDIX E

Alternatives Questionnaire

Name: ____________________

Teacher: _________________________

<u>Alternatives Questionnaire</u>

You have just finished your work to prepare to write your report. Can you think of other ways (or other approaches) you could have used to prepare to write your report? Make a list of as many other ways as you can think of:

1.
2.
3.
4.
5.

APPENDIX F

Schema Questionnaire

Name: ____________________

Teacher: ________________________

Mapping Questionnaire

1. What is a concept map?

2. How do you make a concept map?

3. What can you use a concept map for?

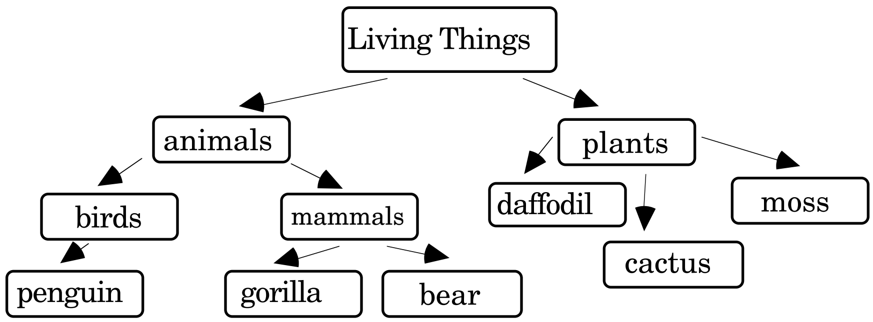
4. For each of the following situations, rate (on a scale of 1 to 4) how useful concept mapping would be:

	Not useful	Somewhat useful	Pretty useful	Very useful
Following the characters and plot of a complicated story	1	2	3	4
Understanding the Sumerians in social studies class	1	2	3	4
Learning math formulas	1	2	3	4
Classifying rocks and minerals	1	2	3	4
Figuring out how you and your cousins are related	1	2	3	4
Studying for a social studies test	1	2	3	4
Memorizing important historical dates	1	2	3	4
Preparing to write an essay	1	2	3	4
Understanding the effects of a toxic spill in a creek on the plants and animals in that area	1	2	3	4

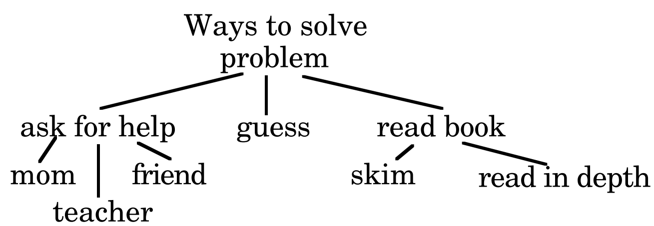
5. For each of the following examples, rate (on a scale of 1 to 4) how good a concept map it is.

Rating Scale

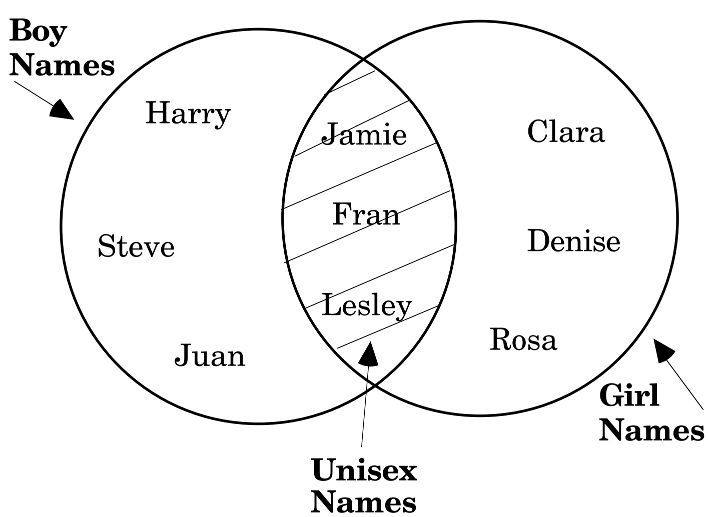
1=Not good 2=Somewhat good 3=Pretty good 4= Very good



EXAMPLE #1 SCORE:



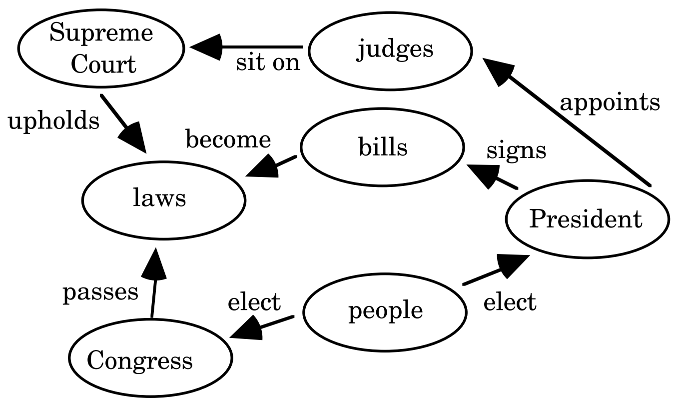
EXAMPLE #2 SCORE:



EXAMPLE #3 SCORE:

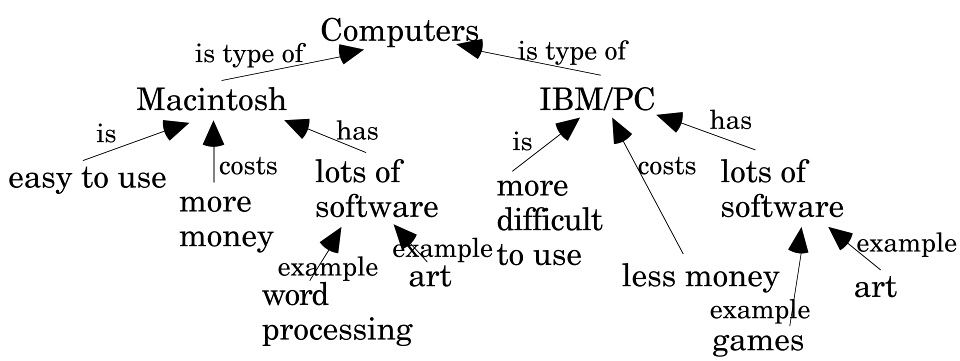
Rating Scale

1=Not good 2=Somewhat good 3=Pretty good 4= Very good



EXAMPLE #4 SCORE:

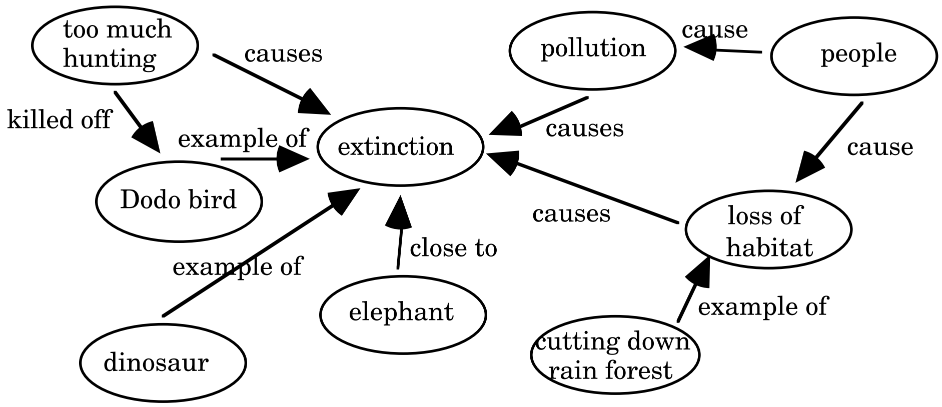
EXAMPLE #5 SCORE:



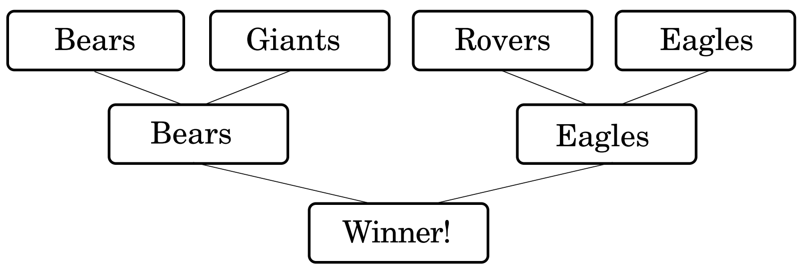
EXAMPLE #6 SCORE:

Rating Scale

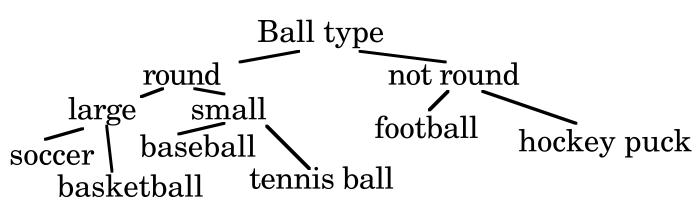
1=Not good 2=Somewhat good 3=Pretty good 4= Very good



EXAMPLE #7 SCORE:



EXAMPLE #8 SCORE:



EXAMPLE #9 SCORE:

APPENDIX G

Metacognitive Questionnaire

Name: ____________________

Teacher: ____________________

Attitudinal Questionnaire

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and decide how you thought or felt while you were creating your concept maps. Circle the number which best describes you.

	Not at all	Somewhat	Pretty much so	Very much so
1. I checked my work while I was doing it.	1	2	3	4
2. When completing the task, I tried more than one way to do it.	1	2	3	4
3. I tried to understand the goals of the assignment before I tried to complete it.	1	2	3	4
4. I went over my answers.	1	2	3	4
5. I selected and organized relevant information to complete the assignment.	1	2	3	4
6. I tried to figure out what the task required.	1	2	3	4
7. As I worked through the assignment, I asked myself how well I was doing.	1	2	3	4
8. I thought through the meaning of the assignment before I began to complete it.	1	2	3	4
9. I made sure I understood just what had to be done and how to do it.	1	2	3	4
10. I corrected my errors.	1	2	3	4

	Not at all	Somewhat	Pretty much so	Very much so
11. When completing the task, I translated the task into a different form.	1	2	3	4
12. I determined how to complete the task.	1	2	3	4
13. As I did the assignment, I asked myself questions to stay on track.	1	2	3	4
14. I tried to discover the main ideas.	1	2	3	4
15. I tried to understand the assignment before I tried to complete it.	1	2	3	4
16. I asked myself how the task related to what I already knew.	1	2	3	4
17. When completing the assignment, I tried to make everything fit together.	1	2	3	4

APPENDIX H

Coding Scheme for Schema Questionnaire Items 1-3

One point awarded for mentioning each of the following:

- Like a cluster, brainstorm, spider map, etc.
- Pieces: nodes, words, circles
- Pieces: links, lines, arrows
- Important or main ideas/concepts
- Relationships, connections, togetherness, linking, sentence-making
- Important ideas in middle, related ideas nearby
- Graphical, visible, diagrammatic, picture, chart
- Used to: show important concepts, relevant relationships, organize information, better understand, learn material
- Looks like this (with picture) OR description of creation process (e.g., make circles, draw lines to connect)
- One application of concept mapping (e.g., prewriting, studying for test)
- More than one application given OR varied applicability, can apply concept mapping in many content areas (this additional point awarded after award for single application given—see previous bullet)

REFERENCES

Adams, M. J. (1989). Thinking skills curricula: Their promise and progress. *Educational Psychologist, 24*, 25-77.

Armbruster, B. B., & Anderson, T. H. (1984). Mapping: Representing informative text diagrammatically. In C. D. Holley & D. F. Dansereau (Eds.), *Spatial learning strategies: Techniques, applications, and related issues* (pp. 189-209). Orlando, FL: Academic Press.

Baker, E. L., Niemi, D., Novak, J., & Herl, H. (1992). Hypertext as a strategy for teaching and assessing knowledge representation. In S. Dijkstra, H. P. M. Krammer, & J. J. G. van Merrienboer (Eds.), *Instructional models in computer-based learning environments* (pp. 365-384). Berlin: Springer-Verlag.

Bassok, M., & Holyoak, K. J. (1989). Interdomain transfer between isomorphic topics in algebra and physics. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 153-166.

Belmont, J. M., Butterfield, E. C., & Ferretti, R. P. (1982). To secure transfer of training instruct self-management skills. In D. K. Detterman & R. J. Sternberg (Eds.), *How and how much can intelligence be increased* (pp. 147-154). Norwood, NJ: Ablex.

Berardi-Coletta, B., Buyer, L. S., Dominowski, R. L., & Rellinger, E. R. (1995). Metacognition and problem solving: A process-oriented approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 205-223.

Bransford, J. D., Stein, B. S., Vye, N. J., Franks, J. J., Auble, P. M., Mezynski, K. J., & Perfetto, G. A. (1982). Differences in approaches to learning: An overview. *Journal of Experimental Psychology: General, 111*, 390-398.

Brown, A. L., & Campione, J. C. (1984). Three faces of transfer: Implications for early competence, individual differences, and instruction. In M. E. Lamb, A. L. Brown, & B. Rogoff (Eds.), *Advances in developmental psychology* (Vol. 2, pp. 143-192). Hillsdale, NJ: Lawrence Erlbaum Associates.

Brown, A. L., Campione, J. C., & Day, J. D. (1981). Learning to learn: On training students to learn from texts. *Educational Researcher, 10*(2), 14-21.

Brown, A. L., & Kane, M. J. (1988). Preschool children can learn to transfer: Learning to learn and learning from example. *Cognitive Psychology, 20*, 493-523.

Brown, A. L., Kane, M. J., & Echols, C. H. (1986). Young children's mental models determine analogical transfer across problems with a common goal structure. *Cognitive Development, 1*, 103-121.

Bruner, J. (1985). Models of the learner. *Educational Researcher, 14*(6), 5-8.

Campione, J. C., Brown, A. L., Ferrara, R. A., Jones, R. S., & Steinberg, E. (1985). Breakdowns in flexible use of information: Intelligence-related differences in transfer following equivalent learning performance. *Intelligence, 9*, 297-315.

Crisafi, M. A., & Brown, A. L. (1986). Analogical transfer in very young children: Combining two separately learned solutions to reach a goal. *Child Development, 57*, 953-968.

Delclos, V. R., & Harrington, C. (1991). Effects of strategy monitoring and proactive instruction on children's problem-solving performance. *Journal of Educational Psychology, 83*, 35-42.

Detterman, D. K. (1993). The case for the prosecution: Transfer as an epiphenomenon. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 1-24). Norwood, NJ: Ablex.

Druckman, D., & Bjork, R. A. (1994). *Learning, remembering, believing: Enhancing human performance.* Washington, DC: National Academy Press.

Ennis, R. H. (1989). Critical thinking and subject specificity: Clarification and needed research. *Educational Researcher, 18*(3), 4-10.

Flavell, J. H. (1981). Cognitive monitoring. In W. P. Dickson (Ed.), *Children's oral communication skills* (pp. 35-60). New York: Academic Press.

Gagné, R. M. (1970). *The conditions of learning* (2nd ed.). New York: Holt, Rinehart & Winston.

Gholson, B., Dattel, A. R., Morgan, D., & Eymard, L. A. (1989). Problem solving, recall, and mapping relations in isomorphic transfer and nonisomorphic transfer among preschoolers and elementary school children. *Child Development, 60*, 1172-1187.

Gick, M. L., & Holyoak, K. J. (1980). Analogical problem solving. *Cognitive Psychology, 12*, 306-355.

Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive Psychology, 15*, 1-38.

Glaser, R. (1984). Education and thinking: The role of knowledge. *American Psychologist, 39*, 93-104.

Heinze-Fry, J. A., & Novak, J. D. (1990). Concept mapping brings long-term movement toward meaningful learning. *Science Education, 74*, 461-472.

Herl, H. E. (1995). *Construct validation of an approach to modeling cognitive structure of experts' and novices' U.S. history knowledge.* Unpublished doctoral dissertation, University of California, Los Angeles.

Herl, H. E., Baker, E. L., & Niemi, D. (1996). Construct validation of an approach to modeling cognitive structure of U.S. history knowledge. *Journal of Educational Research, 89*, 206-219.

Holley, C. D., & Dansereau, D. F. (1984). Networking: The technique and the empirical evidence. In C. D. Holley & D. F. Dansereau (Eds.), *Spatial learning strategies: Techniques, applications, and related issues* (pp. 81-108). Orlando, FL: Academic Press.

Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984). Development of analogical problem-solving skill. *Child Development, 55,* 2042-2055.

Holyoak, K. J., & Koh, K. (1987). Surface and structural similarity in analogical transfer. *Memory and Cognition, 15*, 332-340.

Holyoak, K. J., & Thagard, P. (1995). *Mental leaps: Analogy in creative thought.* Boston: MIT Press.

Horton, P. B., McConney, A. A., Gallo, M., Woods, A. L., Senn, G. J., & Hamelin, D. (1993). An investigation of the effectiveness of concept mapping as an instructional tool. *Science Education, 77*, 95-111.

Jonassen, D. H., Beissner, K., & Yacci, M. (1993). *Structural knowledge: Techniques for representing, conveying, and acquiring structural knowledge.* Hillsdale, NJ: Lawrence Erlbaum Associates.

King-Johnson, D. A. (1992). Using analogies to form conceptual models to facilitate transfer. *Contemporary Educational Psychology, 17*, 1-7.

Klein, D. C. D. (1994, April). *Transferring critical thinking skills across content areas: What helps?* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Lodico, M. G., Ghatala, E. S., Levin, J. R., Pressley, M., & Bell, J. A. (1983). The effects of strategy-monitoring training on children's selection of effective memory strategies. *Journal of Experimental Child Psychology*, *35*, 263-277.

Mayer, R. E. (1984). Aids to prose comprehension. *Educational Psychologist, 19*, 30-42.

Mayer, R. E., & Wittrock, M. C. (1996). Problem-solving transfer. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 47-62). New York: Simon & Schuster Macmillan.

Moynahan, E. D. (1978). Assessment and selection of paired associate strategies: A developmental study. *Journal of Experimental Child Psychology, 26*, 257-266.

Nickerson, R. S. (1994). The teaching of thinking and problem solving. In R. J. Sternberg (Ed.), *Thinking and problem solving* (pp. 409-449). San Diego, CA: Academic Press.

Norman, D. A. (1988). *The design of everyday things.* New York: Doubleday.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* New York: Cambridge University Press.

Novak, J. D., Gowin, D. B., & Johansen, G. T. (1983). The use of concept mapping and knowledge vee mapping with junior high school science students. *Science Education, 67*, 625-645.

Novick, L. R. (1988). Analogical transfer, problem similarity, and expertise. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*, 510-520.

O'Neil, H. F., Jr., & Abedi, J. (1996). Reliability and validity of a state metacognitive inventory: Potential for alternative assessment. *Journal of Educational Research, 89*, 234-245.

O'Neil, H. F., Jr., & Brown, R. S. (in press). Differential effects of question formats in math assessment on metacognition and affect. *Applied Measurement in Education*.

O'Neil, H. F., Jr., Sugrue, B., Abedi, J., Baker, E. L., & Golan, S. (1992). *Final report of experimental studies on motivation and NAEP test performance* (CSE Tech. Rep. No. 427). Los Angeles: University of California, National Center for Research on Evaluation, Standards, and Student Testing.

Okebukola, P. A., & Jegede, O. (1988). Cognitive preference and learning mode as determinants of meaningful learning through concept mapping. *Science Education, 72*, 489-500.

Palincsar, A. S., & Brown, A. L. (1989). Instruction for self-regulated reading. In L. B. Resnick & L. E. Klopfer (Eds.), *Toward the thinking curriculum: Current cognitive research* (pp. 19-39). Alexandria, VA: Association for Supervision and Curriculum Development.

Paris, S. G., Newman, R. S., & McVey, K. A. (1982). Learning the functional significance of mnemonic actions: A microgenetic study of strategy acquisition. *Journal of Experimental Child Psychology, 34*, 490-509.

Park, B. (1987). *The kid in the red jacket.* New York: Knopf.

Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context-bound? *Educational Researcher, 18*(1), 16-25.

Phye, G. D. (1989). Schemata training and transfer of an intellectual skill. *Journal of Educational Psychology, 81*, 347-352.

Puntambekar, S. (1995). Helping students learn 'how to learn' from texts: Towards an ITS for developing metacognition. *Instructional Science, 23*(2), 163-182.

Reed, S. K., Dempster, A., & Ettinger, M. (1985). Usefulness of analogous solutions for solving algebra word problems. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*, 106-125.

Reed, S. K., Ernst, G. W., & Banerji, R. (1974). The role of analogy in transfer between similar problem states. *Cognitive Psychology, 6*, 436-450.

Resnick, L. B. (1987). *Education and learning to think.* Washington, DC: National Academy Press.

Resnick, L. B., & Resnick, D. P. (1992). Assessing the thinking curriculum: New tools for educational reform. In B. R. Gifford & M. C. O'Connor (Eds.), *Changing assessments: Alternate views of aptitude, achievement and instruction* (pp. 37-76). Boston: Kluwer.

Ruiz-Primo, M. A., & Shavelson, R. J. (1995, April). *Concept maps as potential alternative assessments in science.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. Spiro, B. Bruce, & W. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 33-58). Hillsdale, NJ: Lawrence Erlbaum Associates.

Salomon, G., Globerson, T., & Guterman, E. (1989). The computer as a zone of proximal development: Internalizing reading-related metacognitions from a reading partner. *Journal of Educational Psychology, 81*, 620-627.

Salomon, G., & Perkins, D. N. (1987). Transfer of cognitive skills from programming: When and how? *Journal of Educational Computing Research, 3*, 149-169.

Salomon, G., & Perkins, D. N. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. *Educational Psychologist, 24*, 113-142.

Sawyer, R. J., Graham, S., & Harris, K. R. (1992). Direct teaching, strategy instruction, and strategy instruction with explicit self-regulation: Effects on the composition skills and self-efficacy of students with learning disabilities. *Journal of Educational Psychology, 84*, 340-352.

Schraw, G., Dunkle, M. E., Bendixen, L. D., & Roedel, T. D. (1995). Does a general monitoring skill exist? *Journal of Educational Psychology, 87*, 433-444.

Seel, N. M. (1993, April). *Mental models and strategies of teaching in complex learning environments.* Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA.

Slife, B. D., Weiss, J. & Bell, T. (1985). Separability of metacognition and cognition: Problem solving in learning disabled and regular students. *Journal of Educational Psychology, 77*, 437-445.

Snyder, B., & Pressley, M. (1990). Introduction to cognitive strategy instruction. In M. Pressley (Ed.), *Cognitive strategy instruction that really improves children's academic performances* (pp. 7-26). Cambridge, MA: Brookline Books.

Sternberg, R. J., & Frensch, P. A. (1993). Mechanisms of transfer. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 25-38). Norwood, NJ: Ablex.

Sternberg, R. J., & Ketron, J. L. (1982). Selection and implementation of strategies in reasoning by analogy. *Journal of Educational Psychology, 74*, 399-413.

Stice, C. F., & Alvarez, M. C. (1987). Hierarchical concept mapping in the early grades. *Childhood Education, 64*, 86-96.

Swanson, H. L. (1992). The relationship between metacognition and problem solving in gifted children. *Roeper Review, 15*(1), 43-48.

Turnure, J. D., Buium, M., & Thurlow, M. (1976). The effectiveness of interrogatives for promoting verbal elaboration productivity in young children. *Child Development, 47*, 851-855.

Wittrock, M. C. (in press). Metacognition. In C. Weinstein & B. McCombs (Eds.), *Strategic learning: Skill, will, and self-regulation.* Mahwah, NJ: Lawrence Erlbaum Associates.

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology, 11*, 306-313.

Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*, 51-59.