PART I

UNDERSTANDING THE ROLE OF PREDICTING IN LEARNING

Do you know good readers use predictions all the time, often unconsciously because it just comes as a natural part of what they have learned to do? Poor readers, however, do not use predictions when they read or do not use them effectively. You can learn to teach all children and adolescents how to predict and how to use prediction as an essential learning strategy. Let's begin by examining how three teachers currently use prediction in their classrooms. As you read each classroom vignette, think about how teachers engage students in predicting and how, if at all, these predictions facilitate students' learning.

Scenario 1: Superficial Predictions and Missed Opportunities

Thirty-six ninth graders enter their English classroom. They notice the change in the physical environment – there are pictures of the ocean, a large "fish" made of paper, and fishing tackle scattered around the room. One of the windows is covered with paper on which the sea has been drawn. On the board in the front of the classroom is a writing prompt: "Write about a struggle you have had with nature." Given their usual routine of

bellwork, students open their writer's notebooks and begin writing.

After fifteen minutes of writing, their teacher holds up a book and reads the title, *The Old Man and the Sea* by Ernest Hemingway (1952). After a pause, she asks the class, "What do you think this book will be about?" The students look around; Micha raises her hand, "an old guy that goes out to sea?" Javier adds, "maybe it's about a guy who gets old working out at sea." The class seems to agree and Ms. James continues. She reads the back cover copy about a man who struggles with nature, who finds himself, and gains a greater understanding of his life. "What do you think now?" she asks the class.

Anthony says, "I guess it's about an old guy who goes out to sea to find himself." Shawntel agrees with Anthony, but says, "This better not be some fishing story like we had last year. I hated that boring story." Ms. James starts to read the first few pages. Several paragraphs into the book, she asks, "Now what do you think?" Shawntel, without raising her hand, says, "See I told y'all – boring."

When she finished reading aloud, Ms. James asked the class to discuss their predictions for the next section of the story with their peers. Luis quietly said, "I'm not

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into this book. I think we're gonna have to hear about this old guy's trip."

Scenario 2: Using Clues from the Text to Predict

The 20 kindergarteners sit on the rug in the front of the room, excitedly waiting for their teacher to start her interactive read aloud. The students in Ms. Martinez's class know this routine well and appreciate the conversations they have with one another and their teacher during the read aloud time. Ms. Martinez uncovers the book, which was sitting on the easel under a sheet of paper. "*Ten Dogs in the Window*" (Masurel, 1997) she says. "Let's see, do we all remember our numbers? Let's count the number of dogs in the window to see if we agree with the author. Are there really ten dogs in the window?" Together the students count as Ms. Martinez points to each dog. "Yes, ten dogs. I wonder why they are in that window. It's a very nice window. Let's see. I think they all belong to one family and they are waiting for their family to come home. What do you think? Why are they in the window? Angel?"

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Angel responds, "My dog likes to wait in the window. I only got one dog."

Ms. Martinez listens to Angel and says, "Maybe that's what the author is going to tell us about – dogs waiting in

the window for their people to come home. But room nine, we know that we're not always right with our predictions the first time. Why else would those ten dogs be in the window? Creshena?"

Creshena looks up at her teacher and says, "They at the pound. That place, you know, where you could get a new dog." Quefon raises his hand, "Maybe they be lookin' for a new house; new people?" Ms. Martinez pauses and says, "Interesting. I just don't know. We have some good predictions. Partner A, please tell your partner why you think those ten dogs are in the window." At this point, the classroom fills with talk. Students are sharing predictions with one another.

Ms. Martinez says, "Okay room nine. Remember those predictions. Let's see what the author has to tell us." She then begins reading the book. Several pages into the book Ms. Martinez says, "So, the dogs are looking for new places to live. Did you notice how each person who picks out a dog looks like the dog he or she picks? Let's look at this person – he's wearing a red jacket and hat. He has a big moustache. Which dog do you predict he'll want to take home?" The class agrees that the Scottish terrier will be picked next, and sure enough the students get it right. Ms. Martinez says, "Let's look back at that page.

How did you know? What clues did the author or illustrator give you that this man might pick this dog? Talk with your partners." Around the room, children talk about the look of the dog, the look of the man, the fact that both have "whiskers" on their face, and that in the illustration, the dog is one of two dogs looking toward the man. Ms. Martinez continues reading the book allowing students to predict which person will adopt which dog. Each time they do so, she flips back a page and asks students how they made their predictions.

Scenario 3: Incorporating Prior Knowledge into Predictions

"Okay, what do we know so far?" asks Mr. Jackson of his sixth-grade social science class. "Yes, Jessica tell us something."

"Well, Greece is a great place. They created a country that other people envied." Jessica reported to the class.

"The art, the politics, the architecture, they had everything. Other groups had tried to conquer them, but they always won. They were the best of the best!" added Brian.

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"So, will Macedonia attack Greece?" asked Mr. Jackson. "Using what you know so far, do you think this small country will attack the 'best of the best' as Brian put it?

Write your predictions in your history journals – let's take three minutes. Ready?"

As the timer rung following three minutes of independent writing, Mr. Jackson started reading from the text:

> Macedonia lay north of Greece. The Macedonians raised sheep and horses and grew crops in their river valleys. They were a warrior people who fought on horseback. The Greeks looked down on them, but by 400 B.C., Macedonia had become a powerful kingdom. (Spielvogel, 2006, p. 399)

"Let's talk about this. The author seems to provide support for both sides of the issue. Have any of you changed your minds or are your predictions still holding?" asked Mr. Jackson.

"I've changed a bit," said Dominique. "I originally wrote that Macedonia wouldn't be so stupid as to attack powerful Greece. After hearing that, I think they will attack, but that they'll lose. They fight on horses, but Greece is so powerful and has so many people."

"I didn't change my prediction," noted Kaila. "Greece isn't a big deal now, so they had to lose at some time."

"Let's see if you're right," Mr. Jackson said and continued reading:

> In 359 B.C., Philip II rose to the throne in Macedonia. Philip had lived in Greece as a young man. He admired everything about the Greeks – their art, their ideas, and their armies. Although Macedonia was influenced by Greek ideas, Philip wanted to make his kingdom strong enough to defeat the mighty Persian Empire. In order to achieve this goal, Philip needed to unite the Greek city-states with his own kingdom. (Spielvogel, 2006, p. 399)

"Okay, so this guy Philip wants to make this happen. It seems pretty clear that he's going to make a try for Greece. Now the author has given you his strategy. He needs to unite the city-states. What do you need to know to make a good prediction about the outcome of this strategy?" asked Mr. Jackson.

Jeff said, "Well, you gotta know what a city-state is and you have to know about Greece and Macedonia."

Gabby added, "You gotta use everything you know AND what the author is telling you. He said that the new king was named Philip. So, I remember Philip the Great. His name tells me something. I also know that Greece loses power. Their government was organized into city-states, which has both good points and bad points. The author also said that Philip lived in Greece, so I think he knows how

to get at the city-states. I think his strategy will work and he'll be the ruler of all of the land."

Having glimpsed the instruction in three different classrooms, what are your thoughts about the usefulness of making predictions as a learning strategy? Did you notice that the use of predictions were not of equal use in each of the three classrooms we visited?

In the first classroom, Ms. James missed a number of opportunities to model and teach predictions. The students probably wondered why their classroom environment had changed and why all of the sea life cluttered the room. Simply using the book title and back cover copy did not result in sophisticated predictions or increased interest or engagement in the text. In this classroom, a good idea – helping students make predictions – was not implemented in a way that helped students learn.

In the second classroom, Ms. Martinez taught her kindergarteners to pay close attention to the text to make, confirm, and revise their predictions. The students in this classroom benefited from classroom talk, teacher modeling, and purposeful instruction that served to focus their attention. With practice, the students in this classroom are likely to learn how to use features in the

text – both the author's words and the illustrator's ideas – to understand what they read.

In the third classroom, Mr. Jackson activated his students' background and prior knowledge and helped his students make connections between what they know and what they are reading. These students are engaged in authentic interactions and transactions with the text as they learn to negotiate meaning (e.g., Rosenblatt, 1995). Mr. Jackson clearly communicates that idea that answers are not simply found in the text or that the text has one right interpretation. Instead, he is teaching his students that reading is a complex interaction between cognitive engagement, textual understanding, and stored knowledge.

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From these scenarios, at least three reasons for creating and maintaining a focus on teaching students to make predictions are evident; engagement, activating background knowledge, and exercising the use of reading strategies.

THE BENEFITS OF MAKING PREDICTIONS

Engagement

Engagement is a major goal all teachers have for their students. To be engaged in reading, to want to read to understand, is directly linked with learning (Frey, 2004;

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Guthrie & Wigfield, 1997). In other words, it's hard to learn in the absence of engagement.

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When students make predictions in an authentic way, they are more engaged in reading, talking, writing, listening, and learning. Making predictions requires that the learner is paying attention to the task at hand. Making predictions also encourages students to talk with one another and with their teacher – another way to increase engagement.

As you no doubt noticed from Ms. Martinez's and Mr. Jackson's classrooms, students were engaged in the lesson. They were paying attention; their brains were focused on the text and what they wanted to know about the text. In both cases, student learning increased because of this engagement.

Activating Existing Knowledge

In making a prediction, students use what they already knew to inform their supposition of what might happen next. Making a prediction requires that students think about what they already know, what their life experiences have taught them, and about how the world works. Beyond engagement, activating and building background knowledge is directly linked with student achievement (Marzano, 2004).

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The best example of activating background knowledge we have presented thus far occurred in Mr. Jackson's classroom. He regularly asked students to incorporate what they already knew – from personal experience or formal schooling – into their responses. In doing so, Mr. Jackson facilitated his students' use transaction with the text and the development of their schema for understanding the world.

Exercising the Use of Reading Strategies

When students make predictions at the onset of their reading or as they engage in reading, they will benefit from using a wide variety of reading skills and strategies beyond "predictions." Of course, predicting requires the integration of a number of strategies, such as visualizing, inferring, summarizing, and connecting. With practice, students will begin making predictions and using strategies with increased automaticity and ease.

Of course, using reading strategies in authentic ways improves students' achievement (Fisher & Frey, 2004). Not all students are aware of all the strategies available to them to improve their ability to make reading predictions. However, teachers can provide students a wide repertoire of strategies that can help them self-regulate their own

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reading and becoming better predictors and thus skilled readers.

In the class scenarios in this section, students engaged in text clues, inferring, summarizing, and making connections. Ms. Martinez, for example, helped students use visual clues and specific words in making predictions. Mr. Jackson focused on connections and summarizing as his students made predictions.

While these teachers helped their students make predictions based on reading, making predictions is not new. Humans have used their skills in predicting for centuries. Predicting, at least at the human level, can even be considered a survival skill.

HUMANS: A HISTORY OF PREDICTING

The ability to bring cognitive talent to bear on predicting what might happen next is one way humans have learned to survive as a species. Nomadic tribes, for example, use prediction as a way of life. As they travel from place to place, members of the tribe predict where they might find herds of game, where they might find sources of water, where potential enemies might be hiding out, or where friends and trading partners might be located.

For about 11,000 years, many cultures have produced food and relied on prediction to ensure a stable food supply. To be a farmer is to be a prognosticator. Will there be a drought this year or next? How much land can I cultivate if I hire ten people to work for me this year? What will be the long-term effect if I continue to use certain herbicides or pesticides on my farm?

Jared Diamond (1999) proposed that successful domestication of plants and animals led to food storage and surpluses which, when coupled with many other factors, led to some cultures becoming technologically more advanced. Without predictive abilities, Diamond contends, food production on such a scale would not have been possible and the technology we now find commonplace might not yet exist. In other words, our ability to predict resulted in the advancement of society.

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Predictions Reduce Uncertainty

Predictions are the means we use to reduce those elements of our world about which we are uncertain. The way we do that is to continually aggregate or collect information and compare that against other knowledge we have stored away. Without stored information and the ability to gather new information, predictions are little more than wild guesses. Such guesses are useless in making

sense of an environment upon which we depend for survival and for meaning. Predictions allow people to examine their past and present situations to make meaningful new estimations about what the future might hold.

Given the importance of human predictive ability, we can ask ourselves how the brain makes sense of the world in order to make predictions. Bound up in the capacity to make predictions are theories of memory, learning, and recall—elements that allow for receiving, storing and retrieving information, critical components in making predictions.

PROCESSING INFORMATION: A CRITICAL ASPECT OF PREDICTION

A model for processing information or learning, cognition and memory looks like the one found in Figure 1.1. In this model, based on the work of Frank Smith (2004), working memory and short-term memory appear as two different, but overlapping, memory systems. The distinction is important in describing how the brain processes information that could result in a prediction.

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Short-Term Memory

Short-term memory is very limited in its capacity for storage. New information can push other information aside. For example, have you ever tried to remember a phone number being told to you only to realize that you forgot why you

were calling? In short-term memory, information must be used, and needs to be used quickly, or it will be forgotten.

[Insert Figure 1.1 about here]

Short-term memory is too limited in the amount of information it can store and in the length of time before memory decays without rehearsal to complete complex cognitive functions. In other words, short-term memory has limited use in making predictions. We cannot make predictions about the meaning of a complex sentence unless we are able to store sufficient information about individual words while also reading ahead to determine which other words might make change the meaning of the sentence as a whole.

Try an example. Read the sentence fragment below and focus on the word "running."

I am running…

At this point in the sentence, you have some idea that you (as the first-person "I") have become the subject of the verb, and you know that the verb is running. You do not know yet what other contexts to bring to bear to determine exactly what "running" means, though. You will have to read the rest of the sentence to get that information all the time retaining the possible meanings for the word until

you can reduce the uncertainty you have about the eventual meaning of the sentence. If the meaning is that you have an errand to attend to quickly, then the sentence could be:

I am running to the store to buy milk and eggs.

But if the meaning is that you will have to propel yourself very quickly on foot, then the sentence could be:

I am running a marathon tomorrow at noon.

The final determination of the meaning of the word and thus of the sentence has to be stored and integrated as the rest of the sentence is read, possibly with preceding sentences or those that might follow.

"Do you have the results of the test?" asked Maria?

"I am running the analysis software, right now," replied Bill.

Ah, now you know that running, in this case, refers to executing or processing information on a computer. To make sense of the final sentence, you needed to pull your knowledge about computers forward from long-term memory into working memory.

Working Memory: Pulling Stored Knowledge Forward

Working memory allows the thinker to bring long-term memory to bear along with information stored in short term memory until such time as

- the problem is solved,

- the information integrated or
- the effort abandoned.

Working memory, described by Baddeley (2001), is a means of temporarily storing and maintaining information during complex cognitive processes. This is particularly relevant to our discussion of predictions and how they are made because, in predicting, the thinker brings forward relevant information from long-term memory and integrates it with any new information already in working memory applying it to the problem at hand. As you remember from the class discussion Mr. Jackson facilitated, Kaila used her working memory (that "Greece isn't a big deal now") to shape her thinking about the text she was reading and the discussion she was having with others.

Long-term Memory and Prior Knowledge

Memories that the thinker has stored for later retrieval may be thought of as long-term. When you remember your first-grade teacher, the smell of a favorite aunt's perfume, the structure of the Bohr atom, or the birthdates of your children, you're using long-term memory. Memories that are stored in a long-term memory reservoir have been characterized in various ways by different researchers. They have been referenced as schemata (Bartlett, 1932), prior knowledge, nonvisual information

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(Smith, 2004), cognitive structure, and learning (Dechant, 1991). Regardless of the label, a common feature of long-term memory is that it changes the structure of neurons. These changes occur through a process of rehearsal and meaningful association between what is already known and the new information being considered. Of course, long-term memory is not always permanent; we all have experience with the natural forgetting process associated with long-term memory.

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Arrangement or organization is the basis of long-term memory. How we organize information is at least as important as the information itself. Without storing information in a particular order or hierarchical structure, the retrieval of relevant information would not be possible.

Types of Long-Term Memory

Theories of long-term memory suggest that humans use classification systems to aid their memory. In these systems, the capability of using memory to organize ideas roughly follows evolutionary lines. Humans use all three types of long-term memory for survival. In addition, humans use all three types of long-term memory for learning. Let's consider each of these and how they related to learning experiences.

Procedural memories, the use of objects or movements of the body, are the most ancient form of memory and the one we share with animals. Organisms that rely solely on procedural memory respond to external stimuli and adapt to the environment accordingly. In school, we use procedural memories to move around, to multiply numbers, to write, and so on. Procedural memory is critical to the basic functioning of a living organism.

Nested inside our procedural memory is something called semantic memory. Semantic memory permits a person to visualize that which is not actually present at the time. Tulving (1985) suggested that semantic memory allows the thinker to construct and manipulate "mental models" (p. 387) of the world.

You can, for example, create a mental model of a pencil and what it's used for, even when the object is not right in front of you. Semantic memory also allows us to create mental models of ideas. Your mental model of summer vacation may be different than those around you, but we can discuss our shared understanding of summer vacations with one another. We can think of semantic memory as the type that allows the thinker to manage and relate memory purposefully.

The third type of memory, episodic, permits a thinker to consider events personally experienced in the past, including the emotions of the experience. Among other things, episodic memory makes it possible for the thinker to recall the past and to use that information in constructing an understanding of the present. Consider, for example, the student who has had wonderful experiences at school interacting with teachers. These episodic memories help the student construct his or her participation in the class. Similarly, readers use episodic memories as they read. For example, recalling fresh snow and the emotions of that experience, serves to activate memories that are used in understanding how a specific character in a specific book might react. In other words, episodic memory influences our background knowledge.

We can see the usefulness of this model if we consider the examples from the beginning of this book and this section. As you read about words that shared the same Latin root as "prediction" you were able to employ semantic memory to associate words and to see the associations between the words we suggested. When you read the opening paragraphs of the introductions, you probably thought of various predictions you made recently, which demonstrated your episodic memory. You might have remembered the last

time the football team played at home, the traffic was terrible. This caused you to predict that the traffic might creep along again today because there is a game. Finally, we should clarify that teachers and linguists often think of semantics in terms of words and their meaningful relations in sentences. Here, the term takes on a much broader meaning, which includes more than just the meanings of words. Semantic memory also includes an understanding of the function of the idea the word names.

Schemata and Existing Knowledge

As we have discussed, there are several theories or models of long-term memory. Each explains aspects of how we clarify, order, and store representations of the world as we perceive it. Memory is such a complex aspect of being human that no single theory can, at present, fully account for it. Therefore, it isn't necessary to think of one theory as being correct, or even more correct, than another. Taken together, we build an increasingly accurate understanding of how memory works and what aspects of memory make us uniquely human. One other theory of memory that makes us uniquely human is how we 'build schema' to order information we take into our long term memories.

A schema (Bartlett, 1932) is a hierarchical representation of knowledge, in other words, a plan for

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memories. The theory explains how long-term memory traces might be structured so that memories might be retrieved as they are needed. Here is how it might work.

Prediction depends on existing knowledge. Imagine that a researcher leads you blindfolded into a classroom after school. The teacher and students are gone. The blindfold is removed and your only task is to determine if the class that meets in the room is a primary or upper elementary grade, a middle school grade, or a high school grade. In just an instant, you would be able to give a fairly accurate assessment of the grade level. You could do this without reading anything that might indicate what the grade level is because the size of the desks and chairs and other room paraphernalia would indicate that the room was designed for a specific age group of children.

To visualize a first-grade classroom, you needed to recognize what you observed as elements of a first-grade room (small desks, big books, etc.), visually sample the rest, and draw your conclusion based on the map or plan you have in your memory for this concept. Organization of the memory traces associated with this concept makes it possible to retrieve all the elements in a search for the overall pattern.

If the first-grade classroom is somewhat familiar to you, then we can draw one of two conclusions. You went to the same first grade classroom that the book's authors attended, or more likely, your first-grade classroom looks a lot like ours. A learning theorist would term the degree of accuracy of the mental model to the reality of the concept as veridical. This concept is important and goes back to our earlier discussion about reducing uncertainty. Increasing veridicality means reduced uncertainty.

It may help you to construct this new schema for "veridical" by thinking of other concepts you know that are similar. As you read the word, you notice that the first three letters are the same as in the word, "very" and, in fact, the "y" and "i" may have similar roots in the way the words are pronounced. Your schema for "very" tells you that it is an adjective or adverb that is used when a speaker or writer wants to emphasize the precision or truth of whatever the topic happens to be. This reminds you that the coat of arms for Harvard University has the word "veritas" on it. Even if you didn't attend Harvard, you may remember that it has something to do with truth and that it is Latin. Simultaneously, you think of the word "veracity" which you read in this morning's paper in an article about a reporter checking to make sure his source

told an accurate story. If you are an English major, you might even remember the word "verisimilitude" which describes a quality of good fiction that appears to represent a truth about the condition of being human. In this process, you are activating several existing schemata for words that share the same root and making predictions about what the word might mean. Of course, readers don't limit their use of schemata to words. As Louise Rosenblatt (1978, 1995) noted, readers construct meaning from text through a transactional process. She believed that what the reader brought to the text was at least as important as what the author may have intended.

Predictions depend on actively transforming knowledge. We can say that without schemata that already exist in the mind of the reader/thinker, reading would not be possible. Nevertheless, readers cannot rely solely on their own existing concepts and experiences when attempting to comprehend a text. Communication would be severely restricted if they did so (Dechant, 1991). Rather, readers must build on what they know and transform it as they read or engage in other ways with the world around them. As readers, we know how to make sense of difficult sentence structures, determine how the author organizes the text or story, or look for clues that might foreshadow future

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events in a narrative. It's just that we don't necessarily think consciously about doing it, but we are able to do so indirectly. In this way, just as you did by examining words that contain the Latin "ver" you were able to construct an increasingly veridical understanding of that term. As you increasingly bring appropriate schemata to bear and gather new information from reading, you reduce uncertainty by making predictions about the word.

The key, then, becomes teaching our students to be more precise in how they predict by making more efficient use of their knowledge or memory. Predicting is a cognitive procedure that is built on both declarative and procedural knowledge, and while it is common for people to predict the uncertain nature of their world, doing so with precision can be taught—precision that will allow students to become expert at predicting.

DEVELOPING EXPERT PREDICTORS

Think for a moment what it means to be an expert at something. What is it that could be described as "expertness?" Expertness requires sophisticated uses of memory. Experts have to mobilize information, the right information, for the situation at hand.

Analogies Help Us Predict

Analogies are tools that help us become experts at learning how to predict. Let's explore a concrete example to see how.

In the late eighteenth century, Robert Burns was collecting songs and writing poems in Scotland. Many of those still are well known today. One poem, also written as song, is "A Red, Red Rose." The opening lines are immediately recognizable for a famous simile they contain:

O My luve's like a red, red rose,

That's newly sprung in June.

In this analogy, readers quickly realize that Burns' love does not have petals or a long stem. In fact, that thought probably does not even occur as we read the poem. Immediately, readers begin mapping the similarities between roses and the ones they love (or the condition of being in love). The reader may be thinking:

- Love is beautiful, just as a rose is
- Love is sweet, like the fragrance of a rose
- Love is delicate and elegant just as the rose is
- Love is new, like a newly blossomed rose and its 'newness' is what makes it delicate like a rose, fragile as of yet

For some readers, these would be relatively shallow comparisons or similarities. Readers can also compare what

they know about roses as they renew themselves every spring, thus love also renews itself and always remains fresh.

In constructing an analogy, the brain first constructs an initial search for similarities between the source and the target analog (the components of the analogy). One way to think about this is to think of the source analog as an already existing schema or as background knowledge. The target analog is the concept or schema that begs to be understood. Once an initial partial map of similarities is made, then the thinker may look for more detailed similarities or extensions of the initial partial mapping.

An interesting series of experiments reported by Holyoak and Thagard (1995) described how a chimpanzee named Sarah learned to make analogies. Sarah was taught to use a series of plastic tokens which were used to represent ideas (or propositions). She learned to use tokens for the concepts of "same" and "different" as well. Many animals can pick out or match items that are the same in physical nature, but Sarah learned to do something far more interesting. She could identify what the relations were between objects that were not the same in physical appearance. For example, Sarah could correctly match objects that were smaller than or larger than a target even

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if physical shape was different. In one experiment, she correctly matched a source analog of a glass half-filled with water to a target analog when given the option of a half of an apple or three-fourths of an apple by correctly choosing the half apple. There is no reason to match a fraction of an apple with a glass of water based solely on physical properties. Sarah had to determine the relation of the glass of water and the apple based on the relation of concepts that are implicit.

Sarah's accomplishments are remarkable for a couple of reasons. One is that Sarah was able to learn something based on the symbolic manipulation of ideas. Another is that such learning was the direct result of her ability to use symbols, an ability she was taught and which other chimps lack, to create abstractions that identify implicit relations between objects. Such implicit relations are the type of thinking that allows humans to compare a rose with one's love. While Sarah used tokens to communicate in a language-like manner, people are much more adept at manipulating symbols. Of course, the symbol system readers most often use is language.

Analogies Clarify Understanding

Analogies help us refine and connect knowledge that we might not have been able to connect otherwise. Gick and

Holyoak (1983) have studied analogies extensively and explain their functions: "The analogist notes correspondences between the known problem and a new unsolved one, and on that basis derives an analogous potential solution. More generally, the function of an analogy is to derive a new solution, hypothesis, or prediction…" (p. 5).

In creating analogies, the thinker must notice that there is a similarity that might prove useful. Then, through a process of abstraction, the thinker completely maps the similarities, which cognitive scientists call identities. The differences are also noted. The possibility of mapping every aspect of a source analog onto the target analog is very small, so identification of differences which are not helpful may also be important. If readers continue thinking about Burns' rose, they might also think that their rose, like their love, is beautiful, elegant, and always fresh. Some readers might then think that roses also have thorns and our love also has… Hmmm, better not finish that analogy unless we want to spend the next week or so sleeping on the couch. Or in the doghouse.

Analogies Help Us Predict with Greater Detail

As noted, analogies can help us understand predictions. An incomplete, partial map of an analogy

requires predictive ability to continue abstracting the rest of the map. However, a mapped analogy – one that provides a link between the source and the target ideas – may be useful in constructing additional analogies with greater detail. We may want to explore, for example, the analogy that human cognition is like the operation of a computer. Initially, we find that there are several identities or similarities that are useful and map them this way (see Table 1.1).

[Insert Table 1.1 about here]

With this initial mapping, we can predict that humans might be overshadowed by computers at some point in the future. However, we also find that there are several differences. If these differences are not relevant to the problem we are trying to solve or the concept we are trying to understand, then the analogy still works. If not, then we will have to abandon the analogy. As we construct this analogy, we remember what Norman (1997) wrote about humans and computers. David Norman (1997) compared humans and computers by addressing the fear that computers will eventually surpass human abilities. Computers, he says, do not present a threat to humans because there are inherent differences in how human systems and computer systems operate. Computers can produce repeatable and accurate

results, but humans follow "a complex-history-dependent mode of operation and yield approximate, variable results" (p. 29). Computers do not handle errors very well, but human systems are adaptable to a changing environment and conditions.

Norman's comparison of computers and humans helps us understand a bit about why people are so good at making predictions and why we have come to rely on our predictive skills. Predictions are the means we use to reduce those elements of our world about which we are uncertain. The way we do that is to continually aggregate or collect information and compare that against other knowledge we have stored away. Without stored information and the ability to gather new information, predictions are little more than wild guesses. Such guesses are useless in making sense of an environment upon which we depend for survival and for meaning. Predictions allow people to examine their past and present situations to make meaningful new estimations about what the future might hold. Let's continue and find some differences:

- Computers handle calculations based on precise algorithms that do not tolerate error.
- Humans seek patterns and process information in spite of errors and ambiguity.

Based on this analogy, we can then use the information comparing humans and computers to predict that computers will not surpass human abilities.

Analogies Provide a Bridge to New Learning

In their experiments with analogies and how people use them, Gick and Holyoak (1983) conducted an instructive experiment. They had participants in the experiment read a story that identified a specific solution to a problem. Next they had those participants read a story that presented a similar problem, but the solution was not provided. In the first story, a military situation is presented. A general must attack a fortress in the center of enemy territory. He can't mount a frontal assault with a large force because the roads leading to the fortress are mined. A large force would not be able to move quickly through the minefield. A solution is to send small groups of soldiers to attack by coming at the fort through the minefields from several directions.

In the next story, the subject will encounter a different domain. Instead of a military problem, it might be a medical problem. In this scenario, a tumor must be removed; however, the dose of radiation needed to kill the tumor will also destroy the surrounding tissue. The subjects were asked then to solve the problem.

Because the source analog (the fortress) was in a different domain (the military) than the tumor problem (medical), Gick and Holyoak found something interesting that is useful for teachers. Their participants were successful 75 percent of the time in mapping the military source analog with the medical target analog to solve the problem. The means for removing the tumor is to target the radiation from several directions so that the surrounding tissue does not receive a lethal dose of radiation, but the tumor does. In each analog, the solution lies in coming at the object of the attack (either with soldiers or radiation) from varying directions. However, Gick and Holyoak were able to achieve the 75 percent rate of correct solutions only when the participants were given a hint. That is, they were told that the military problem could be used to solve the medical problem. Then it was up to the participants to correctly map the two different domains to solve the problem.

This experiment and the resulting conclusions suggest to us as teachers that we need to provide direction, or hints and clues, to help students scaffold their specific predictions about texts they read. We believe that such hints help students learn to construct reasonable and meaningful predictions in specific situations, and also

that this type of help assists students in learning to predict and create other types of analogies as part of a process of making meaning of the challenging texts they read.

Comparison Activities as an Expert Skill

Teachers of English language arts often use Venn diagrams to help students compare information from the books they read. Indeed, Marzano, Pickering, and Pollock (2001) in their meta-analysis of effective classroom strategies found that comparison activities produce the highest effect size of all the strategies studied in increasing student achievement. These researchers identified four important points regarding instruction that makes use of classification based on similarities and comparisons. They are:

1. Present students with explicit guidance in identifying similarities and differences.
2. Ask students to independently identify similarities and differences.
3. Represent similarities and differences in graphic or symbolic form.
4. Identify similarities and differences in a variety of other ways. Such practice helps learners develop

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> a repertoire of approaches and reinforces the use of the cognitive strategy (pp. 15-16).

As these researchers noted, the identification of similarities and differences is a highly robust activity and one that leads to increased student achievement. Making effective predictions involves the use of making comparisons of similar patterns of events, situations, personalities, and geographic locations against new information in order to make an inference about what may happen. To do so with precision and creativity reduces uncertainty on a journey across country, in a movie or novel, and in one's journey through life.

Is Making Predictions Enough?

The simple answer is no. Even as students are taught all of the skills required to make predictions, simply making a prediction will likely not be sufficient for students to think deeply about text. Instead, as teachers, we need to extend the making of predictions to helping students learn from their predictions. For example, Ms. Martinez ensured that her students revisit their predictions and develop a strong sense of which predictions worked and why. She also asked them to figure out what they missed when their predictions were not confirmed. This

critical analysis of predictions can improve student learning.

Similarly, illustrated through Ms. James's classroom, asking students to make predictions when there isn't really anything to predict or when the question in focus has been answered in an obvious way, will not help students learn. Re-focusing student predictions in Ms. James's class might have changed the nature and depth of the classroom discussions about the *Old Man and the Sea* and created a more motivating reason for students to read the text and begin to understand its value for readers. Part II explains several cognitive strategies that students might use to make good predictions. Part III then puts these cognitive strategies in context of the classroom structures teachers might use to promote better thinking through predictions. And finally, Part IV provides an analysis of which students need which types of instruction to be successful.

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Learning from Predictions: I Predict … Now What?

In Part II, several cognitive strategies students might use along with suggestions about how teachers might promote prediction among students are presented. Part III puts predicting to learn in the spotlight of several classroom structures or routines teachers might employ. We

also highlight the idea that readers can learn from predictions. You might say, "Readers learn by making increasingly accurate predictions as they read, learn new information, put that in context of their existing knowledge, and move ahead to see what else there is to learn in the text. Students learn from prediction by making the predictions in the first place." And you are right, but there's more. There are at least two reasons:

1. Readers make predictions because doing so brings relevant existing knowledge to bear as the reader makes meaning.
2. Readers learn from prediction by applying what they know about the text as they read reducing uncertainty about the content, whether it is primarily aesthetic or efferent in nature (Rosenblatt, 1995), as they go.

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Teachers are in the unique position of guiding students' reading, through continuous feedback, direct instruction, modeling, and so on. Through these processes, teachers point out to students what good readers do and assist students to become expert readers. More specifically, through a scaffolding or helping interaction, teachers can assist students to learn what aspects of a text need their attention. Children are less likely to

efficiently regulate attention (Berninger & Richards, 2002), and as a result, require more guidance. The significance for teachers is that it is simply not enough to ask students to make predictions. Instead, teachers must actively show students what needs their attention and how to access that through the cognitive processes explored in Part II and promote those their use through practice and classroom structures or routines like those in Part III. Teachers must also help students learn to attend to the predicting process itself. An example may help.

A popular (but fictional) television personality, Chef Lecteur, has just shown his adoring viewers how to make New England clam chowder. At the beginning, he predicted that a few pinches of salt and few grinds of the pepper mill will suffice. However, in the process of making the chowder, variables crept in: the potatoes weren't as fresh because they've been in storage, the onions had a slightly stronger flavor than usual, and so on. A viewer might predict that Lecteur's was following a recipe that will turn out a delicious soup if the correct ingredients in the correct amounts are assembled. Just as Lecteur is ready to serve the chowder, he dips a spoon into the pots, blows on the soup in the bowl of the spoon, and tries it. Wait! He

reaches for pepper mill again. Didn't he get it right the first time? He's an expert, and his name is on products that fill his fans' kitchens. As he tastes the soup, he points out how important it is to re-season the food prior to serving: the taste may change through the cooking process. The variables have changed the taste and could not be predicted precisely. What is more important, and what his fans admire, is that he tells them what he did and why he did it. In this way, reading is like cooking because the good cook reassesses the taste of the food right up until it's time to serve the food; the reader re-evaluates predictions right up until the cover of the book is closed. Teachers live for the moments when the metaphorical light bulb comes on for students; Lecteur's fans clap and cheer when he grabs the pepper mill. Like our make-believe chef's fans, students will smile, and the lights will illuminate their faces when they understand why revisiting an earlier prediction creates a more meaningful reading experience. They get it.

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Figure 1.1: A Model of Information Processing

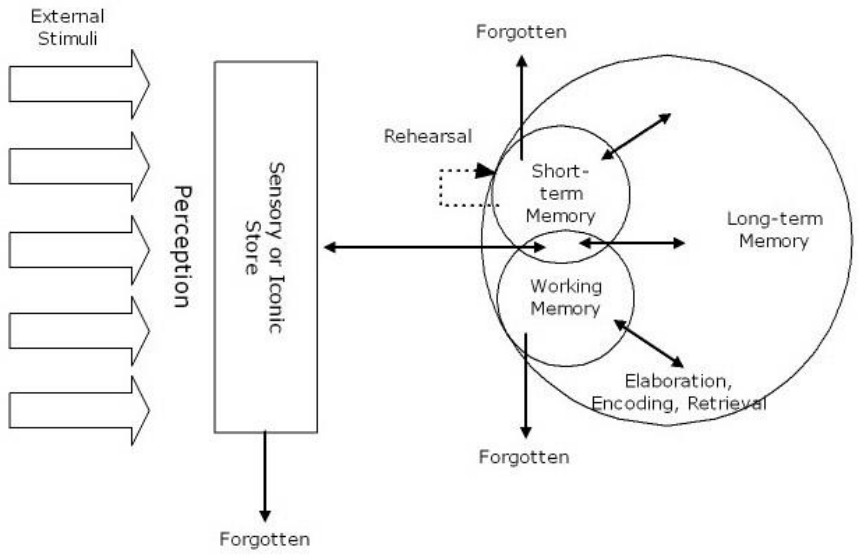

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Table 1.1: Considering the Analogy Between Humans and Computers

Computers	Humans	Similarities
The random access memory (RAM) in a computer is like	Short-term and working memory	Each stores information for temporary processing until it is pushed aside by other information or is no longer needed.
The hard drive is like	Long term memory	Each stores information indefinitely.
The modern computer's processor is very fast	The human brain is very fast	Each processes information through distributed and parallel processes