

Chapter 2

What Do They Link?

Abstract This chapter introduces the first two upper-elementary classrooms: the students in Mrs. Olson's classroom studying a number of topics in social studies and the students in Mr. Jackson's classroom who were studying the Roman Empire and engaging in a note-taking process. Structural descriptions of prior knowledge, including Piaget's schemes, information-processing schema and semantic networks, provide a foundation to compare how the Mind as Rhizome metaphor prompts for understanding elements of students' knowledge that might vary given individual experiences and may even be labeled as misconceptions. The chapter concludes with an introduction to semiotics, which provides a description of how the linking process works as it does.

2.1 Social Studies and the Students in Mrs. Olson's Classroom

Mrs. Olson's sixth-grade students attended St. Francis School, a K-8 parochial school in a small mid-western city. The city was fairly small with a population around 55,000 and over 100,000 when the surrounding areas were included. The city was home to a large research university. St. Francis had about 450 students, with an average of two classrooms for each grade level, one of which was Ms. Smith's first-grade class. St. Francis had a low minority student rate at about 8 %, and only a 1 % free-reduced hot lunch rate during that year. It was the spring of the year, and these 12- and 13-year-olds were studying the early Middle Ages in social studies. There were 9 boys and 15 girls in the class, 12 of whom agreed to participate in the study. When I arrived on April 8 the class had returned from a church service, which they attended weekly as part of their school day. Mrs. Olson was taking care of routine business (i.e. checking with students who had not yet turned in their report cards, commented on their book reports and when they would be returned, and handed back spelling tests).

This chapter draws on Schuh (2003) and Schuh et al. (2005).

Social studies began with a review of material from the previous day and focused on the Dark Ages. The format of the discussion, including the presentation of new material, included Mrs. Olson guiding the students in identifying the facts that were reported in the social studies textbook. Mrs. Olson's was the first sixth-grade classroom in my studies. In these first observations I took notes on a steno pad as I tried to capture the nature of the students' response and the teacher's prompts that drove the student responses. My notes were sketchy at best, yet the string of content easy to follow. The discussion first focused on a review of the causes of the Dark Ages: the Germans were not good rulers; they were interested in war; not interested in governing well; not interested in learning; messed up because they kept splitting up; not a community; and diseases were contributed to by waste disposal. The discussion continued in much the same way, adding topics and elaborating them with brief bits of information. Their discussion threaded through Clovis, who was remembered because he was a ruthless ruler, had brought Latin into his courts in a way to get more Romans; was also a good ruler because he brought people closer together; converted to Christianity, and was one of the first rulers to become Christian.

"Weren't others also Christian?" someone asked, "Who saw a cross in the sun?" "Constantine," was the answer.

The 30-min discussion ended noting that Hammer (Charles Martel) was a great military leader. The string of details continued about him, the Battle of Tours; he beat the Muslims; they wanted their religion, but Charles wanted Christianity; Pepin (Charles' son, Pepin the Short) took over when he died. Pepin's supporter was the Pope; and Pepin was the first Frankish king to be anointed; he was blessed with oil; something like at confirmation but the oil wasn't green; he had the support of the church. Strings of details documented the Dark Ages for these sixth graders.

Although my first notes failed to capture who was talking, capturing merely the flow of the topics in the discussion, Mrs. Olson's class seemed very traditional and very structured. The next two visits, both during social studies, included the same instructional strategy: Using the text as a guide, Mrs. Olson asked a question that drew directly from the reading in the text, called on a student using a stack of notecards that included the students' names, and waited for the student to respond. The second class session began with routine classroom tasks as before: getting organized, prayer, pledge of allegiance, and identifying students who had papers missing. Mrs. Olson asked the students to skim the pages they were to have read last week (this was Monday, April 13, and followed a 3-day weekend) beginning on page 279, and the question/answer session which followed the book order began. The discussion continued the lineage that had begun the previous week.

Mrs. Olson asked, "In the late 700s Pepin died, his land was divided between his two sons. Then Carloman died and Charlemagne got his. What does his name mean?" Mrs. Olson called on the student whose name was on the top card in her stack

"Charles the great."

Another student raised his hand and commented, "I know what Zimbabwe means. Many houses of stone. We talked about that a few weeks ago. I asked Fr. Andrew." My notes did

not capture if Mrs. Olson had any response to this added information; just noting the continued questioning format.

"What did Charlemagne want to do?" the next student's name was read from the name cards.

"Bring Western Europe under his rule."

"What else?" Mrs. Olson called on another student.

"Make them all Christians."

"How did he achieve that?" Mrs. Olson continued. The name at the top of the card stack belonged to a blonde girl.

"What was the question?" the girl asked. There was a pause as she looked through the book, "Waged several wars," she offered. The questioning continued.

"Where was the first place he defeated?" The next student was called on and answered, "Italy."

Mrs. Olson elaborated, "He defeated the Lombards there, then went to Northern Germany. Who did he conquer there?"

"Saxons" was the response.

"The Saxons also moved into the British Isles," said Mrs. Olson.

"Did they invent the saxophone?" a student asked.

"Does anyone know?" Mrs. Olson asked. The class had a brief discussion about who invented the saxophone; one student offering that it was named after the man who invented it, rather than the place where it was invented.

Given the textbook content focus of the questioning technique that Mrs. Olson used to review the content, it is hard to imagine the individual trajectories of the students and how their individual experiences may link with the content being learned. It seemed the goal of the class, although I did not ask, was to have students memorize the content—the correct answers and interpretations to the questions that Mrs. Olson posed. Yet even in this very structured environment students were linking what they were learning with what they knew, bits of residue that a student knew became knit into the classroom. A few instances are apparent in the narrative. Hearing about what the name Charles the Great meant prompted a student to share "I know what Zimbabwe means," linking it to a conversation with the parish priest. The student who asked the question if the Saxons invented the saxophone was met with encouragement by Mrs. Olson as she offered the question to the rest of the class. Even the brief mention of confirmation oil in my first observation in this class was a link.

After the social studies class was over I interviewed three students. My interviews started with a general question, asking them to tell me what they remembered about Charlemagne and his conquests. I interviewed Claudette, who was 12 years old, right after the class was over. She began,

"OK, he was one of Pepin's two sons and he got all the land because his brother died and he tried to bring all the people together, he tried to get as many people as he could and tried to

bring them under Christianity [um hmm]. So he had a lot of wars to get people together and he said if they [pause] they could keep their freedom if they, if they went under his rule and didn't have wars against him. And one day he was praying on Christmas in the 1800s, 800s, and he" she paused and curiously questioned herself, "1800s? gosh." She laughed, and I joined her laughter, saying, "it's only a 1000 years difference no big deal!"

Claudette continued, "And the pope came in when he was praying and he crowned him and he didn't like that because it made it seem that like the pope was more powerful than God and he didn't like that, and," she paused again. "That's pretty much all I remember." The end of her summary about Charlemagne's dislike of being crowned Holy Roman Emperor was exactly as I had it in my sketchy observation notes.

She continued that topic when I asked her, as became typical in my interviews, if anything else had popped into her mind during class. Claudette was quick to respond, "I don't remember why but, I was thinking if on a test if we had a question on what happened on Christmas day in the 800s, if under it there was the answer that he was crowned the king or that Jesus was born. So I was wondering if it would be both answers, that's what I was thinking about."

The meaning that Claudette made of the content was colored by concerns about a test as well as information that she likely learned at home, in church, and in her parochial school. When asked for any other examples, I provided as an example the question about the saxophone, she added, "I was thinking of that. I was wondering who did that and my friend said that she did a report on it, so it was that guy." Although the saxophone link was brought up in class, Claudette claiming she also thought about it, her concern stemming from the link about Christmas was kept to herself and not shared.

While these overt links were simple in nature, keying off of similar phrases (what a name means) and even similar sounds (Saxon and saxophone), they provide an indication of how meaning-making links are prompted and responded to in a classroom, a process that facilitates the links, and even a look at characteristics of the prior learning. Yet, this classroom environment seemed to provide a minimal look at the linking process, perhaps because of the topic, the instructional methods, or my own constraints of having spent limited time in the classroom. What do the students bring to the classroom? And how are those links prompted? Further, what were the kinds of processes that build together what was in the classroom and what the learner knew? First we turn our attention to *what the students bring with them to the classroom*.

2.2 The Roman Empire and the Students in Mr. Jackson's Classroom

The letter board outside of Carl Ben Eielson Elementary School stated "Raising Capable and Responsible Children." As with the other schools I'd visited, I checked in at the office before going to the classroom. The school itself seemed to be a fairly typical elementary school. The hallways were clean and generally quiet. Overall the

school seemed very organized. When students needed to move between classrooms, went to lunch, or recess, rows of students would line the halls, divvied up by individual class. At the end of the day the lines were formed again, teachers escorting their students out the door and to the busses. Eielson Elementary was across town from St. Francis, on the other side of the highway. This location, farther from the local university, seemed to influence the school population.

Eielson Elementary had 430 students, of which approximately 15 % were minority students. Most of those were African-American (3 Indian students and 4–5 Hispanic who were English proficient). Forty-one percent of the students qualified for free or reduced lunch; a stark contrast to the 1 % at St. Frances. The students in Mr. Jackson's class were one of three sixth-grade classes in the school.

The class was studying the Roman Empire. The instructional method for this two-week unit followed a fairly routine format for this classroom. Mr. Jackson focused on helping the students develop note-taking skills that would be useful to them next year in middle school and they used the textbook as the information source.

On the day of my first visit, the students returned from lunch, immediately went to their desks, were quiet, and ready for social studies. Mr. Jackson asked students what a rectangle was and then called on students to go to the board that included a list of columns of words from their social studies textbook and draw a rectangle around a word in the list that reminded them of Rome. Very quietly, the selected students drew rectangles around gladiator, Julius Caesar, polytheistic, matrilineage, and philosophy.

Mr. Jackson reminded one student that there could be two in one column, maybe three. The boy drew a rectangle around Socrates. "I'm pretty impressed, you found a lot," Mr. Jackson encouraged the class. "I'm glad no one chose domestication; that was from a previous chapter." He asked for a definition of domestication and was given one. "How about monsoon?" he asked. "Gladiators, one of the circled words, should remind you of Rome."

Chuck gave an in-depth definition of gladiators, concluding by saying that it maybe had to do with the Olympics. Mr. Jackson added to the definition, stressing that it was entertainment. I asked Chuck about his definition of gladiators in an interview that followed the observation.

"It was someone who, uh, just like entertained, who was taught to fight to entertain like in sports, to entertain people, like the citizens of Rome," Chuck answered.

"I think you had mentioned something about how it related to the Olympics then or something," I prompted.

"I wasn't really sure about that but I was thinking that maybe it was, that it was," he paused, "maybe the gladiators got in sports in the Olympics, or entered in sports and like just games, and fighting and that kind of stuff."

"How did you kind of build that idea that you thought that might go together?"

"Well, um, I watch, not a lot of TV, but whenever I do I like to watch sports and stuff and um, I heard the announcers on baseball games say 'He's acting like a gladiator.' I don't know if that has anything to do with it or anything, but that's just how I put it together and just from stuff that I already knew."

As in Mrs. Olson's classroom, Mr. Jackson's students were able to offer links beyond the information. Chuck's link between the gladiators and the Olympics seemed to be speculation about the topic given his response in the interview, but even Chuck's initial understandings seemed to make sense. Chuck's trajectory allowed him to speculate about a relationship, drawing on experiences that he had gained through watching baseball games on television. He made it clear in his explanation that he drew on information he already knew to provide the explanation. Chuck's view of the rhizome, his own trajectory, brought other experiences with which to interpret the Roman Empire content. Mr. Jackson took Chuck's idea, adding clarity to the definition of gladiators thus validating Chuck's contribution.

The note-taking process on the Roman Empire began in earnest after the introductory activity. While Mr. Jackson's classroom seemed very similar to Mrs. Olson's, the goal of his social studies activity was different. He wanted the students to develop note-taking skills that would help them in middle school the following year. He elaborated in his interview.

The objective for this particular one was to reinforce the work we had done earlier in taking notes and to have them realize that they could not use their notes on the test. They were going to have to start studying it a lot earlier. My objective in social studies is to get them ready for middle school by being organized and taking notes and even getting them used to this point system because that's what's used in middle school. So, I'm not as interested that they remember all the facts and things about Rome as much as they have learned to take notes, save their notes, be organized with them, study the notes, start early in the year, things like that.

This following day-four excerpt was much like all the others when Mr. Jackson's class was working on their social-studies note taking.

On this Monday, Mr. Jackson reminded the students about the upcoming test, "The test over Rome will be next Wednesday, not this Wednesday. I'm given you nine days' notice, so start studying, you can't use notes. I'm already studying for my final at MWU [Mid-West University, the local university]." Then, Mr. Jackson opened his book, prompting about where they had stopped last Thursday. "Page 233, did we read that?" He called on a student, but a different boy said that he had read that page aloud the other day. Mr. Jackson told him that someone else had been called on. The student who had been called on also confirmed that they had read that page aloud.

Mr. Jackson moved to the next topic in the textbook, "Domestic Slavery," and a girl was called on to read. The children dug through their desks as she read. Another student was called on to read "Life Outside the Home." A few students had their note page out. The girl read a number of pages while Mr. Jackson encouraged her on challenging words. She asked if she should keep going at the end of the second page. "Yes, you're doing fine," Mr. Jackson encouraged. As she read, two students had their hands up. Students were called on to continue reading aloud.

"That's the end of the second section, so now we have to take our notes," Mr. Jackson finally announced. First, they went over the main idea and the vocabulary words noted at the beginning of the section. Then Mr. Jackson moved on to the focus questions.

"The first focus question is found on page 232, what was everyday life like in a Roman household? On this one, it will not have to be in sentence form. We're just going to list the answer." Mr. Jackson wrote in a column on the board: "1, 2, 3, 4," and told the students on

what pages they would find the answer. "Who can tell me about the father? What did the father do?" he asked.

A student said he needed some of the definitions for his list, referring back to the vocabulary list. Mr. Jackson told the student that he could get that later and then called on someone else who answered the question.

"The father made all of the decisions." Mr. Jackson wrote this on the board next to number one, writing the student's answer.

"If the father made all of the decisions, what did," Mr. Jackson started, there was an extra boy in the back of the room who signaled to leave as Mr. Jackson began talking. "You're right, it's later than I thought. There's a special choir rehearsal today." Five choir students and the extra boy left the room.

"We need to hurry. If the father makes all the decisions, what does the wife do?" Sally responded, "She cooked, cleaned and did all the chores."

"Where did you find that in the book?" Mr. Jackson asked.

"I didn't find it in the book," she answered.

Another student offered that women were entitled to property but could not vote.

"She cared for the children," another offered. This was the answer in the book and Mr. Jackson wrote it on the board at number 2: "the care of the children belonged to the wife."

"Who did the chores? Someone said earlier who did all the chores, but I don't think that's right, who did the chores?" Mr. Jackson asked.

A student offered, "I think it's like the family."

"Like the mom and kids?" the teacher sought clarification. That still wasn't right.

"The slaves did the chores," another student said. The teacher asked for the page number in the book, confirmed it, and wrote on the board, "enslaved people did all the chores."

The class continued. "What about the boys and girls, what are they doing?" Mr. Jackson asked.

"Going to school," a student said.

"What page?" he asked.

The student read from the page, "Roman boys and girls from wealthy families attended school from an early age."

"To make it short, since you can't use your notes for the test, let's say wealthy boys and girls went to school. Have to stop." It was 1:30. The students were reminded to get all their books for their next classes and were dismissed.

Sally agreed to an interview after class. I asked her about her answer about the role of the wife. "One of the things, when you were going through the list at the end of class and you had 1, 2, 3, 4 and had the things about what went on in the household, or whatever you were describing, and you did say that the wives,"

"Took care of the kids," she finished my sentence.

"Took care of the kids and did the chores and that kind of stuff."

"No," she said with emphasis, "the enslaved people did the chores."

“OK.”

“They had slaves who did chores,” she reiterated.

“They had slaves to do chores. But first of all did you say something different?” I persisted.

“Oh, yeah, I thought that the wives did the chores,” she remembered.

“So how come you thought that?”

“I don’t know, see that, because usually, I wasn’t like thinking you know, but, usually you know all the wives did it because back then all the wives did the work, so I just figured.”

“So that’s kind of how you figured that it was kind of usual then?” I asked.

“Yeah.”

Residue of both Chuck and Sally’s trajectories were evident in the class discussions in Mr. Jackson’s room. This residue stemmed from their prior experiences and may be considered their prior knowledge. The links that Chuck and Sally created illustrate the use of prior knowledge in the classroom, and how a student may use it to speculate about their understanding of the content once it is prompted by the content. Although differing in content, thus multiple entrances, their links were similar to the links that occurred in Mrs. Olson’s classroom, students wondering about who invented the saxophone, what a name meant, and even how to answer questions on a test when the information from different sources was conflicting. While Chuck’s link was valued in the discussion in Mr. Jackson’s classroom, as had been the link about the saxophone in Mrs. Olson’s class, Sally’s link, and thus her understanding, prompted corrections from Mr. Jackson. Her prior learning, and what she had applied to the new content, did not align with that provided from the textbook about Roman families. Yet Sally was able to adapt her understanding, indicated by her explanation in the interview, as she changed her understanding of the role of particular family members in the early Roman Empire. Her trajectory, as is likely typical for many students, had been created and was colored by her own family life. As Sally’s answer indicated, links from students’ prior knowledge may be viewed as incorrect or in error. While considering an individual as an active trajectory co-constructing the rhizome, more traditional explanations of knowledge also explain how answers like Sally’s have typically been characterized.

2.3 Prior Knowledge and Its Structure

The role of prior knowledge has had a long tradition of study and is most frequently tied to the study of knowledge structures—the kinds of knowledge there are and how that knowledge is organized. These descriptions, typically aligned with a computer metaphor of mind, position knowledge as a “thing,” such “as having structures of information and processes” (Greeno et al. 1996, p. 18) rather than a process itself (Bruner 1990; Cunningham 1992; Dewey and Bentley 1960; Greeno

et al. 1993; Maturana and Varela 1987), and are in contrast to the notion of learners' weaving their trajectories, although the distinction may seem subtle. As Maturana and Varela noted, "to live is to know" (p. 174).

Generally speaking, knowledge structures are hypothetical constructs about what one knows. As such, they imply mental structures, rather than being a biological or neurological structure. Yet, the descriptions of knowledge structures have been described as being unclear (Phillips 1983) or elusive (Lederman et al. 1994), and there is not one agreed on description of what these structures are like. Regardless of these issues, an individual's prior knowledge *is* the knowledge they have retained.

Considering knowledge as a mental structure necessarily requires a number of characteristics or elements. First, there needs to be components (i.e., the knowledge), and second, there needs to be some method by which it is structured. If the mind is considered a container with the knowledge stored in that container, it makes sense to describe what, essentially, is in the container. The components have been described in various ways. Descriptions of knowledge components include elements such as declarative (which may be semantic or episodic), procedural, and conditional knowledge [e.g., descriptions by Bruning et al. (2011)]. These descriptions may also include the various modalities by which knowledge may be stored such as imagery or verbal knowledge (Paivio 1991). Modality is one of a number of qualities of knowledge (level, structure, automation, modality, and generality) and types of knowledge (situations, conceptual, procedural, strategic) as described by de Jong and Ferguson-Hessler (1996). Jonassen (2009) summarized a number of knowledge types, organizing them by philosophical differences (e.g., ontological knowledge types: declarative, structural, conceptual; epistemological knowledge types: procedural, situational, and strategic; and phenomenological knowledge types: tacit, sociocultural, experiential). These elements point to the various forms, in a sense, that knowledge can take. The variety of forms could be used to describe the bits and pieces of information that students shared that peppered their trajectories. While they will not be discussed here, these forms are evident throughout the links that will be shared throughout this book. For example, the string of declarative knowledge that Mrs. Olson's class was to know about the Dark Ages, a student's recall of a particular conversation about what Zimbabwe means, and the development of procedural knowledge that was Mr. Jackson's goal for his students.

These various components indicate that people may know different kinds of things in different ways. If one considers the mind as a rhizome, these forms point to the heterogeneity of knowledge. If one considers the mind a container, the various forms of knowledge are the components inside.

The above itemization of the various types of components in a container may evoke a vision of a container filled with unorganized contents—how could a person find something in a container that includes many components, but no organization? Beyond describing what the components in the container are, making sense of the organization of the contents of the container has prompted a number of descriptions of knowledge structures and how these structures are developed. The variation in

how these knowledge structures may be created, what they represent, and how they may align or not with an “objective” reality, how much they are acknowledged as being an individual interpretation, and the expectation for similar structures among individuals are points on which theoretical descriptions of knowledge structures may vary. Piaget offers a starting point for understanding differences among the various descriptions of knowledge as a structure.

2.3.1 Piaget’s Schemes

Piaget’s work is often remembered as four developmental stages (Sensorimotor, Preoperational, Concrete and Formal Operations, Ginsburg and Oppen 1969), yet, central to these stages is a process of learning or cognitive change. As Cobb (1994) noted about cognitive-constructivism, a theoretical perspective that often draws on Piaget’s descriptions of knowledge and learning, the emphasis in knowing is in the cognitive activity of an individual as he or she makes sense of the world. While the types of knowledge (or operational structures; i.e., what was in the container) that Piaget defined were physical, logical-mathematical, and social (Ginsburg and Oppen 1969), the structure of that knowledge was organized into schemes. A scheme may be behavioral, which Ginsburg and Oppen describe as an “organized pattern of behavior” (p. 20) or a scheme can be mental. This scheme, when it is used, is not only what an individual does, but also the essence of what is done. This distinction indicates that the scheme does not produce a behavior, but rather underlies that behavior. As it underlies the behavior, it may be modified when it is used (or more technically, when there is an instantiation of it) (Ginsburg and Oppen 1969). Interpreting Sally’s family trajectory from a Piagetian perspective, indicates that her family scheme was instantiated in class through the prompt about Roman families. The family scheme was then adapted for Roman families. Broadly, a scheme is our general understanding of or knowledge about something. Although considering the scheme as a structure, Piaget was clear that the action of the child was imperative, a scheme “involves activity on the part of the child” (Ginsburg and Oppen 1969, p. 20); “a child’s mind is active in the process of knowing” (Piaget 1966, p. 238).

This individually-constructed scheme is essentially a lens through which an individual makes sense of the world. In addition to the structural component of Piaget’s theory, he articulated a process (functional aspect) whereby an individual applies his or her most salient scheme to the new situation or learning opportunity as a part of spontaneous assimilation process. In other words, the students in Mrs. Olson’s and Mr. Jackson’s classes did not likely seek their understandings—they did not search for a scheme that would help them understand. Rather what they understood, given their perspective, happened spontaneously as they made sense of the information. As an individual’s scheme provides a satisfactory interpretation of the situation, the individual is making sense of the world (i.e., assimilation). The schemes are further developed based on experiences that contradict that scheme as had happened with Sally’s scheme (e.g., cognitive dissonance, perturbation, or

puzzlement), leading to accommodation of the structure. These changes of the structure, indicate that the individual has “equilibrium” with the environment—meaning that the structures are effective (Ginsburg and Oppen 1969).

Schemes are unique to the individual, based on their experiences. While this might seem to point to a relativism in which any kind of understanding would be deemed appropriate, a scheme needs to provide a viable interpretation given the evidence at hand. In other words, it has to work. As von Glasersfeld (1989) stated, “*knowledge* refers to conceptual structures that epistemic agents, given the range of present experience within their tradition of thought and language, consider *viable*” (p. 124, emphasis in original). Unviable schemes are challenged, either by natural phenomenon (e.g., a young child seeing the moon in the daytime) or by other encounters in the environment (e.g., a teacher asking a student about the role of the mother during the Roman Empire). The scheme that guides these initial interactions is the starting point for the integration of new learning with an existing scheme, thus potentially resulting in changes to the scheme as the learner develops new understandings (von Glasersfeld 1995). Considering Sally’s notion of family roles, from Piaget’s perspective she brings her lens to the classroom and interprets Mr. Jackson’s question without addressing the textbook—she knew the answer given her scheme about family duties. Given the scheme she brought to the classroom, her answer made sense. Given Mr. Jackson’s textbook, the answer was not viable.

2.3.2 *Knowledge as a Structure*

The schemes proposed by Piaget seem similar to the discussion and study of schema¹ that developed in the U.S. during the 1960s and 1970s. These descriptions vary from Piaget’s in an important way; their philosophical foundation is typically noted as objectivism, a perspective that describes both a view of the world (ontology) and a way of knowing about the world (epistemology) (Schuh and Barab 2008). From this perspective the world consists of entities that have fixed properties and relationships with one another. In contrast, from a Piagetian perspective, there certainly is a world to “know,” but what we can know of it is only our own interpretation (von Glasersfeld 1989). Von Glasersfeld (1995), describing Piaget as the “the pioneer of the constructivist approach to cognition in this century,” (p. 54) stated that Piaget’s schemes were adaptable conceptual structures and could never be representations of the real world, always being based on the individual’s experiential world, thus not an objective ontology.

In contrast, from an objectivist perspective, reality exists through the structures of the entities and is independent of any human understanding (Lakoff 1987).

¹I will use the scheme when referring to Piagetian-described structures (see Ginsburg and Oppen 1969 for description of Piaget’s use of the term) and schema for those that have not been developed to align specifically with the epistemology of Piaget’s theory.

In other words, everything *could* be the same from one person to another, as it is the properties of the objects that essentially define what the object is, rather than an individual's interpretation of that object. It seems that, given the strategies of Mrs. Olson and Mr. Jackson that this view would underlie their instruction. There was an implicit assumption that the content had properties that were not contingent on individual interpretation of it. There was a canon to learn, and all would (should) end up with this understanding.

From this perspective, the mind is a mirror of the world. The mind creates representations that require a correspondence to the real world. A number of descriptions of knowledge structures have developed given this objectivist stance, generally aligned with the Mind as Computer metaphor. For example, Atkinson and Shiffrin's (1968) early model assumes our mind is a human information processor. They use a computer analogy to distinguish between structural components that are, essentially, fixed within the system and those processes that are controllable by the operator (the person). The structural components, in this early description include sensory register and short-term and long-term memory. A number of descriptions of knowledge structures were guided by this metaphor, particularly evident in the field of Artificial Intelligence. The field of Artificial Intelligence is interested in how knowledge and the processes that come to bear on it are represented (Rissland 1995). Through the use of computer models researchers strive to understand how humans do cognitive tasks. Examples include Newall and Simon's (1976) implementation of the general problem solver, Anderson's ACT* modeling production systems (1983a), Schank's scripts (1982), and Rummelhart's schema (1980). These early works, inspired by the use of artificial intelligence to model cognition, consider the mind as a symbol manipulation device (Duffy and Cunningham 1996) forming internal representations. In other words, placing inside the mind a copy of what is outside of the mind. These representations are data structures, often studied through computer modeling. These data structures include slots, for example, for characteristics of what the structure represents, the slots being filled with information, the assumption then being that our human information-processing system will work in much the same way. While it seems likely that the researchers themselves would believe that they each had different interpretations of aspects of the world, their own task of describing cognition was conducted through a particular lens that provided a means for them to do their work and descriptive power for the types of explanations they sought. However, the use of this computer analogy, and the descriptions that stem from it, point to the objectivist nature of their roots. When the description is applied to children in classrooms, for example, the developed representations are expected to be similar across individuals (i.e., the students understand the material and can respond appropriately to questions). In contrast to Piaget's interpretivist schemes, the discussion turns to a number of these objective-based descriptions of knowledge structures; in other words, individual knowledge structures that seemingly store mirror images of the objects in the world.

2.3.3 Schema

In contrast to Piaget's description of scheme, Rumelhart (1980) proposed schema as generic concepts stored in memory for objects, situations, events, activities, and sequences of these.. They are "abstract knowledge structure[s]" (Anderson and Pearson 1984). These objectivist-aligned schemata have been described as the building blocks of knowledge and as the fundamental units on which information processing depends (Rumelhart 1980). To better understand the role of this type of schema (rather than the Piagetian), consider the following analogies that Rumelhart described. He suggested that schema were like plays in that they provide a script that can be enacted, often in varying ways, and help us interpret particular situations. This analogy seems related to Schank's notion of scripts that are based on episodic knowledge and provides our lens for typical situational behavior (Schank 1982, 1999). It is fairly straightforward to take this description or lens to the introduced classrooms. You can imagine the classroom script that students have developed and continue to follow. They even know what to do when they violate the script, such as the blonde girl in Mrs. Olson's class. The script is invoked and used. Schema are also like procedures in that they are active and able to evaluate "the quality of their own fit to the available data" (Rumelhart 1980, p. 39) and in a parsing-like process appropriate schema are selected based on component parts, and then are verified as appropriate given a particular situation. Thus, new information can trigger particular schema. Finally, Rumelhart noted that schema were like theories. "Perhaps the central function of schemata is in the construction of an interpretation of an event, object, or situation—that is, in the process of comprehension" (p. 37). When considering a schema as a theory, as with Piaget's schemes, it is like a lens, a means for viewing a situation, intuitively invoking a best fit or interpretation for the situation. Individuals view the situation with their typical expectations (i.e., our stereotype that indicates our generic understanding) and initially use that to understand the information encountered, thus prior knowledge is at work. Schema are invoked and then *implicitly* evaluated to determine whether they are adequate for understanding a particular situation. Rumelhart provided similar functional components to what Piaget described for how schema can adapt and change given experiences. The functions, essentially modes of learning, include (1) accretion, where an existing schema is adequate for interpreting a new experience; (2) tuning, where a schema is modified (either through a small incremental change or by changing a part of the schema that is consistent with a more variable piece); and (3) restructuring, where a new schema is created by copying and modifying an old one (learning by analogy) (Rumelhart 1980). These schema are remarkably similar to Piaget's schemes if ignoring the differing world view that grounds them and the relationship between the developed scheme or schema and the world.

Early descriptions of schema are typically traced back to Bartlett (1967). Anderson and Pearson (1984) summarized the research on schema in general and the role of schema in reading, pointing to the need to engage a child's prior

knowledge before reading. An individual's schema will allow them to make inferences, filling in information that is missing, unclear, or unfamiliar. As in the case of Sally who indicated that the mother would do the chores in a Roman family, in which she drew on prior knowledge, rather than the information that is provide in instruction or in a text. Anderson and Pearson cite Nicholson and Imlach (1981) "They found that when children are given texts about familiar topics they often resorted to prior knowledge to answer inference questions even when the text provided explicit information that could have been used" (p. 35). Clearly, what an individual knows provides a lens through which new information is viewed and provides the point from which that new information could be added into the structure.

Although schemata are generalized concepts, they are typically described as being domain specific. In fact, in cognitive psychology texts (e.g., Bruning et al. 2011) schemata are described as being "domain-organized knowledge structures" (p. 21). A quick search of Google Scholar or an indexed data base such as PsycInfo or ERIC finds thousands of entries including the word "schema" as the underlying unit for study in a variety of subject areas.

Descriptions of information-processing-aligned schema also include their instantiations as semantic networks. A semantic network is a collection of nodes that indicate concepts that are linked, based upon relationships, into hierarchical networks of semantic similarities. While descriptions of schema may seem vague or abstract, a semantic network provides a simple visual of how concepts may be connected in memory. For example, consider the list of words that Mr. Jackson had on the board at the beginning of first observation in his classroom. Although he had listed the information in columns, the terms could have easily been listed in a network format, with Roman Empire as a primary node and other nodes, such as gladiator, being connected to Rome. We could imagine that "entertainment" might be an intermediary node between Roman Empire and gladiator. In semantic networks, properties of concepts can be stored at more than one level of the hierarchy (e.g., Collins and Loftus 1975). Once a concept at a node is activated (perhaps thought about or something in the environment reminds about it), connections to other nodes within the network become active. In this way, the activation of neighboring nodes continues to spread through the network, thereby leading to a focus on relevant information that may be examples of the concept or note particular attributes of the concept. For example, a node "family roles" in a semantic network of the Roman Empire would be connected to the role of the mother, father, and so on. This spreading activation process allows retrieval of related subsets of nodes that are stored and linked together in long pathways. How quickly, or if, activation of a concept in the network occurs, is a function of the distance between related concepts as well as the strength of the connection between them (McKoon and Ratcliff 1992).

If a network is an individual's prior knowledge, then once that prior knowledge is activated (brought into attention), new information can be added to the network via a process in which prior concepts (subsumers) acquire new information by providing a base upon which new instances of a concept, for example, may be

attached (Ausubel 1977). Considering Mr. Jackson's and Mrs. Olson's instructional strategies, one can imagine that information is being attached to a network. For example, in Mr. Jackson's class the focus questions in the textbook provides an organizing structure on which new information may be attached as did Mr. Jackson's initial list of words that might be related to the Roman Empire. Given this process of attaching information, well-organized information can be transferred to a learner (meaning the learner will have the structured knowledge as provided) with the result being meaningful learning in that what has been learned has been made relevant by attaching to an existing structure (Ausubel 1977). While Mr. Jackson sought existing knowledge from this class about what they knew about Rome in the first activity that I observed where students were to identify words that had to do with Rome, it was clear through Chuck and Sally's examples that other information was also attaching to the new information. Fortunately, Sally shared her misconception and Mr. Jackson used that to prompt for viable interpretations of the family in Roman times.

What grounds these information processing description of knowledge is the idea of symbols. If the mind is a computer, its task is to store and process symbols. Even if knowledge is considered to be "constructed" (rather than acquired, for example, which is often the term used from an information-processing perspective), knowledge "is the end product of a series of intervening processes" (Prawat and Floden 1994, p. 41); those processes include interactions among perception and various memory types such as working and long-term memory. While experiences are necessary, symbols (i.e., the stored knowledge) are intermediary between knowledge and experience (Lakoff 1987). In other words, what we know is not directly linked with what we experience, but there is a mediating process—the task of the internal representations. This notion of symbols is a defining component of cognitive science (Gardner 1987) and grounds the Mind as Computer metaphor. Learning, from this perspective, "is the process of acquiring accurate understandings of fixed entities and relationships that are thought to exist independently of human activity" (Prawat and Floden p. 41). Instructionally, external representations, or inscriptions (Norman 1993), of concepts are carefully crafted to represent the important ideas to be learned, as we might interpret Mr. Jackson's instructional strategy. The goal of the learning process is to "get these representations right" as they are internalized by the learner (Prawat and Floden), i.e., the correct network or schema should be activated and then the new information integrated in some fashion.

If we consider the mind as a computer or consider the information-processing framework, problem solving, or the act of using knowledge, is affected by are two independent traits: the knowledge stored in the mind, thus the prior knowledge, and the information-processing capabilities of the individual (Novak 1998). Information-processing capacities include both working memory capacity and duration issues. The duration of working memory, or that which we are thinking about at the time, is often noted as 15–30s. After that point, if what's in mind is not attended to, it will drift away from the forefront of our thoughts in that time span. More important to the discussion here is the capacity, or how much information can

be attended to at one time. While working memory capacity was noted by Miller (1956) at the beginning of the cognitive revolution with his description of the “magical number seven plus or minus two,” more recently Sweller (e.g., 2011) has described the role of working memory in learning tasks, focusing on the cognitive load that is brought to bear when learning. Some of the load is inherent in the content that are being learned (intrinsic cognitive load), meaning that the content itself has complexities that could make it difficult to attend to. Another type of load comes in the instructional materials. For example, instructional materials with decorative enhancements or tangential information would use some of the learner’s cognitive capacity, reducing resources for learning the content. Cognitive load, which can quickly exceed the amount of working memory resources that are at the learner’s disposal, can be managed or reduced through instructional design and also by considering the level of prior knowledge of the learner. Elements leading to excessive cognitive load are among the characteristics that Kirschner et al. (2006) claim are evident in instructional strategies that align with the constructivist perspective. The concern is that contemporary perspectives on learning and the instructional strategies that are aligned with them ignore or do not take into consideration the foundational work on the duration and capacity limits of working memory, for example. Yet, regardless of instructional strategy, learners will be reminded of prior knowledge, even in classrooms using traditional instructional strategies. Sweller (2009) noted that working memory is less tasked when drawing information from long-term memory that is well organized, rather than having the learners seek novel information. This long-term memory is the schema previously described. At issue, then, is the role of the prior knowledge that the learners are bringing with them and if it may, given the source or type of link, contribute to cognitive load or support integration of the knowledge in working memory. Do the personal connections that the learners bring help or hinder their learning process?

2.4 Lenses, Prior Knowledge, and Misconceptions

While this model of schema development may propose consistent knowledge structures across learners, these descriptions of knowledge seem less flexible in terms of accounting for differing prior knowledge that a learner might have. In other words, they do not align with the characteristics noted in the Mind as Rhizome metaphor, and those characteristics seem worth exploring as a way to better understand how learners link what they are learning with what they already know. Personal characteristics do influence what is perceived (Bartlett 1967). Students may come with differing experiences and thus bring differing initial networks. Typically, out-of-school experiences that are not developed through school field trips, for example, that make their way into classrooms are not typically considered a means to help learners develop understanding of content—they may be considered a hindrance. For example, socio-economic factors may inhibit success of some learners (Jimerson et al. 1999; Stipek and Ryan 1997). However, Brophy and

Alleman (2003) found no compelling differences based on SES, as there were more similarities than differences in 216 K-3 students' knowledge about supply utilities (e.g., water, heat, and light), experiences that were related to their home environments. That said, the knowledge of students from disadvantaged backgrounds was described as "quite limited, mostly tacit rather than well-articulated, frequently distorted by misconceptions, and scattered rather than well-organized" (Brophy and Alleman, 2003, p. 104).

This "cup half empty" view of the learners' prior knowledge is not uncommon. Students' cognitions have also been categorized as being "off-task" such as those that may be anxiety related [e.g., as cognitions about self-worth and self-doubt (Mikulincer 1989)] or student verbalizations during a study of cooperative and competitive learning [e.g., relevant talk that was (Wild and Braid 1996)]. Junior high students with learning disabilities have difficulty in identifying story themes, which may be related to their use of more idiosyncratic responses than same age peers without LD (Williams 1993). The early research on spreading activation indicates that as activation spreads through the network, some of the content in the network will not be related to the task at hand, and thus will slow processing (Collins and Loftus 1975), particularly if the information is incorrect or not viable. Yet, in contrast, Alton-Lee and Nuthall (Alton-Lee and Nuthall 1992a, b; Alton-Lee et al. 1993) found that comments students made during classroom lessons, typically considered as being off-task, were often content related. Mirtz (1998) noted that off-task behaviors of students completing a writing task were often indirect talk to find out information and review their writing. More things that students share may be related to the task at hand than commonly believed.

Prior learning that fails to support learners in developing the knowledge canon may be labeled as "preconceptions, misconceptions, naïve theories, or alternative concepts," (Braund 1991, p. 104). However, these non-canonical interpretation are a necessary part of learning (Alexander, 1998, p. 56). Learners do not always get things "right" immediately, but these early interpretations can "pose formidable barriers to learning" (Braund 1991, p. 104) in understanding natural phenomena. Braund noted that adolescents had incomplete experiences with concepts or over- or under-generalized applications. Framing prior learning as alternative conceptions acknowledges that learners do bring prior learning to bear on the learning task and recognizes its relevance, whether accurate or inaccurate, in the learning process. Alexander stated, in her discussion on conceptual change within a domain, that "one's ability to modify or restructure a given concept might be better understood if that concept were viewed from the standpoint of the learner's orientation toward the relevant domain" (p. 56).

Instructional interventions have been helpful in guiding students to more canonical understandings of natural phenomenon (see for example Alparisan et al. 2003; Sneider and Ohadi 1998; Tekkaya 2003; Tsai 1999) and in noting the importance of teachers' developing awareness of students' prior knowledge (Cavalcante et al. 1997; Tekkaya 2003). Yet, for the most part, students' intuitive understandings have been treated as misconceptions (Greeno 1998), and these

intuitive connections may be perceived as being off-task, incorrect, or irrelevant to the learning task at hand (see Derry 1992, for a discussion).

Despite the limitations that some note about students' prior learning, it would be naïve to believe that all those experiences garnered outside the classroom would not be useful in the classroom. "[T]here is deeply meaningful learning, learning that lasts, which takes place in our life experience outside of classrooms" (Lemke 2002, Overview) and certainly these experiences are brought into the classroom. To address this, the philosophical groundings of what knowledge is necessarily moves to a more pragmatic perspective. Rather than knowledge being a structure, it may be better captured as a process.

In contrast to the view of knowledge as a network or structure that the learner has assembled and carried along with them from classroom to classroom, prior knowledge may be considered residue of the path through the rhizome. Again, drawing on the description of rhizomes from biology, some aspects of where we have been are no longer the "living" connections, yet they are there in a type of repository. Begon et al. describe it as "a sort of cemetery in which dead stem tissues of the past are interred" (1990, p. 126). Another way to look at it is the decay that comes from trees (e.g., fallen leaves, etc.). This residue provides nutrients for further growth and development (Begon et al. 2006). Thus, prior knowledge, the experiences that the individual has had, although may not be intentionally used to create the new understanding and interpretation of events, provides the foundation and also the nutrients for the new knowledge that is developed.

The foundation and nutrients (so to speak), or markings on individual trajectories from the various interactions of the individual, are who and what situations have come into play as the individual created her thread. The nature of the learner's trajectory is the interaction between that prior learning and the current situation. While ideally these interactions are useful in future learning, what is only guaranteed is that they stem from a variety of experiences, many coming from outside of school. Just as certainly, the residue of the past shapes the learners' trajectory as it has been sprinkled with various types of experiences, interactions, and generalizations of those. When knowledge is considered a trajectory, rather than a structure in which the goal is that all are similar, the sharings of the students make more sense. Not only does what they say seem less like formidable misconceptions or alternative conceptions, but seem more like a logical extension and interpretation given the students' history. Where they have been may imply how they may link even small elements of the content to what they know.

In the data for this study, the learners' trajectories (or the experiences that developed those trajectories) are described by the trajectory dimensions which note the context of the prior learning. The dimensions of a learners' trajectory can answer where the learner has been and with whom she has engaged. Not surprisingly, the data included information about their friends and family, such as Sally's link about her family, from media (recall Chuck's information about gladiators) and society, and of course from school. These dimensions are similar to those found in research by Birr Moje et al. (2011) in the links that were in discourse spaces—third

spaces that include family, community, peers, and popular culture, or the “where of learning” as noted by Alexander et al. (2009).

While students did share information in class, much of the information about students’ trajectories in the studies came from their writing. As part of my data collection, at the end of my observation in each classroom, students completed an open-ended writing activity. In this activity the students were told to begin by writing about the topic that had been the focus of my observations in their classrooms. If what they were writing happened to remind them of something else they were told that they should follow that topic and write about that, continuing the process of following leads. The open-ended writing activity is further described in the appendix. Excerpts of the students’ writings included in this book have not been edited, and thus contain students’ grammar and spellings. The students were specifically told that “spelling didn’t count” and that they should focus on writing their ideas. Because each learner had the opportunity to share, the writing provided a rich look at the types of prior learning that speckled their lenses as they heard about or explored various aspects of the content. Different than a schema, or even a scheme, that can change, the trajectory notes a fluidness between where the learner has been, in what way that was drawn into their initial interpretation of content, and in some cases how elements of that trajectory continued to weave at that moment and guide the learner’s thoughts.

In the 159 papers that I collected from students, 77 of the students mentioned some aspect of family. Family was evident in a variety of ways in the students writing, noting various aspects of the students’ home life. Students mentioned vacations, experiences at home with family or at other relatives’ homes, siblings, neighbors, babysitters, and pets, things that the student had at home, or things they had at school but had come from a family member. Ideas were as simple as sharing what a student was going to do at home and even what he or she might be having for dinner. While some of these links came as the student continued a stream of thought and moved away from the content that they were to initially address, many others connected directly with the content. For example, a number of students who studied the biomes in Mrs. Chambers’ class, which will be introduced in the next chapter, talked about vacationing with family, providing examples of aspects of the biomes that they had encountered. Many of these were from vacations, providing students’ experiences on which they could draw in understanding the content, whereas others used members of their family or home to make comparisons about aspects of something they were learning. Consider Sheila’s, a student in Mrs. Chambers’ class, description of her sister. “The Tropical Rain Forest doesn’t remind me of much. Maybe my sisters room it has lots of stuff in it. Like colorful clothes on the floor. My younger sister could be an annoying monkey. We have lots of plants in our house. Also outside my house my mom loves to plant flowers.” Alexia, a student in Mrs. Olson’s class wrote, “The Vikings are the coolest. They remind me of my family. We are always fighting, talking, and sometimes being nice.”

While family was the most noted trajectory dimension in the students’ writing, mention of friends was made in 34 of the writing documents. Some were quite silly,

such as Edward's, a student in Mrs. Wilson's class (to be introduced in Chap. 5) link to the orangutan, "I learned that the reason the orangutan has such big cheeks is because it is a bone that help them chew the food that they love. Speaking of cheeks last year me and my best friend went around & grabbed peoples cheeks & said puffy cheeks. This boy had the best puffy cheeks."

Students also mentioned links that were considered within a broader society. These often came in the form of culture, sports, and religion, many of them gained from a variety of media sources such as televisions, movies, and video games. While each student created his or her trajectory, the prior experiences colored what captured their attention and the meaning they initially created with that in the moment. Considering prior learning using semiotics as a lens helps explain this process.

2.5 Prior Learning and Semiotic Understandings

To describe this linking process, I draw on semiotics as a foundation for the role of prior experience. My understanding of semiotics, although novice, provides me an explanation to account for these different meanings given the different trajectories of the students. Semiotics may provide a kindred position to (Cunningham 1992) and "conceptual resources for observing crucial relationships among situated, embodied, connectionist, constructivist, and other aspects within emergent understandings of cognition" (Whitson 1997, p. 98); the role of prior experience is one such conceptual resource. Semiosis describes the use of signs to develop and structure our experiences, and highlights the role of our prior experiences in the understanding of new experiences. The semiotics to which I have been introduced is aligned with that of Charles Sanders Peirce, an American philosopher (1839–1914). Semiotics, as described by Peirce is a "theory of information, representation, communication, and growth of knowledge" (Houser and Kloesel 1992, p. xxii). These are not the symbols of information processing that are stored away and need to mediate our activity, but are elements of a process.

To understand this semiotic process, consider the following example. Imagine looking out your window and seeing smoke off in the distance. To most people, that smoke would mean that there was fire of some sort causing the smoke. In this case, the smoke is a "sign" and the fire is an "object." The smoke and fire together denote an object-sign relationship and they are bound together in this relationship. In an object-sign relationship, a sign (smoke) stands for something that it is not, an object (fire). The sign must be bound, or related, to the object for it to be a sign (smoke is a sign *because* it is bound to fire. Without being bound to fire, smoke is something else) (Deely 1990). An object need not be something physical like fire. An abstract idea such as freedom or a class discussion about bullying, and even a person could be an object. An object is an element of experience (Deely 1990), and only becomes an object in a semiotic sense when it is experienced by someone. Prior to that experience, the object is merely a "thing" (Deely 1990) in the environment.

As such, environments are full of things that may become objects as an individual experiences or interacts with them. Drawing on Deely (1990)

As a thing it merely exists, a node of sustenance for a network of physical relations and actions. As an object it also exists for someone as an element of experience, differentiating a perceptual field in definite ways related to its being as a thing among other elements of the environment. But as a sign it stands not only for itself within experience and in the environment but also for something else as well, something besides itself. It not only exists (thing), it not only stands to someone (object), it also stands to *someone* for something else (sign). And this “something else” may or may not be real in the physical sense. (p. 24, emphasis added)

In other words, even if there is no fire, the smoke remains a sign for fire, if smoke is indeed a sign of fire to someone. Thus, in addition to being in this object-sign bound relationship, for a sign to be a sign there must be some meaning attached to that relationship. In the case of the smoke in the example, the smoke stands for fire. This meaning is called the interpretant. The sign only exists as a sign through the interpretant. The sign is only a sign if we assign meaning to it and it is only a sign if it is bound to an object (Deely 1990).

Objects, signs, and interpretants are components of a mutually-determining tri-chotomic relationship. We understand what an object is through the sign that we have ascribed to it. Recall Chuck in Mr. Jackson’s class. Chuck understands the word “gladiator” by the personally relevant characteristics about gladiators. For Chuck, those characteristics are things he remembers from watching sports on television, baseball games, and the Olympics. The signs are personally relevant characteristics that then enable him to assign meaning (interpretant) to the objects. For Sally, it was not the characteristics of a Roman family that allowed her to assign meaning to the idea of Roman family. Rather, it was a group of characteristics that she added, in that she interpreted family structure as *her* family structure, her meaning differing from what Mr. Jackson was seeking. Just as when smoke is a sign for fire, the interpretant of this sign (i.e., the meaning it has) will vary based on the experiences of the individual. For example, the meaning of smoke for a new firefighter will be different than that of a homeowner or animals in the forest.

And so it is with students in a classroom. The classroom environment, with all of the “things” (e.g., textbooks, ideas, spoken words, and even people) in it, provides the objects that the learners experience and make meaning of that experience. These environmental aspects need not be the entire object, but could be one feature of it. For Chuck it was the entire word “gladiator” that allowed for the meaning he added; for a student in Mrs. Olson’s class, it was the first three letters (sax) of a word that prompted the students’ question and pointed to potential meaning. Written and spoken words can be objects as well, although as language they are also a sign structure. The words stand for the object that it names. For example, the word “gladiator” has been culturally assigned to stand for the physical object of the fellow who, with a sword, would fight other gladiators or animals, typically for others’ entertainment.

To summarize at this point, an object or an element of an object can stand for something and have meaning for an individual. The object is understood through

that sign. As such, the sign is not the same as the object. Further, the object-sign relationship only exists relative to someone's understanding. With this, the student developed her own meaning based on prior experience (i.e., her trajectory) that allowed her to experience the things in the environment, and have them make sense to her given that background. So must every "thing" in the environment be an object with a bound sign and thus have meaning? Deely further noted that "things can represent themselves within experience. To the extent that they do so, they are objects and nothing more To be a sign, it is necessary to represent something other the self" (Deely 1990, p. 35). In other words, not everything in the environment must be a sign. Some "things" are just "things"!

Yet many times, an object (as the learner experiences it) comes laden with meanings that stem from a learner's sign structures. What the object stands for or means is contingent on something in the learner's world—what they bring on their continuing trajectory. In this way, the learner's prior knowledge is the means for interpretation allowing something to become a sign. Current meanings come from prior cultural and personal interpretations constructed in mutually-determining relationships between prior experiences (Lemke 1997), the meaning attached to them, and new experiences. Our understandings of the world at any time are what our sign structures support us in interpreting (Cunningham 1992). We have no alternative but to interpret our world through a lens of what we know. This interpretive interaction between person and world essentially creates the individual as an integral part of that world, or as noted previously, develops the trajectory of the person as we collectively create the rhizome.

This trichotomic relationship of object-sign-interpretant describes a process through which an object may be a sign for something beyond the classroom that provides meaning for the learner within the classroom. Different students bring different meanings to things of the classroom, whether that thing is a word the teacher has spoken, a concept read about in a textbook, or an activity that students engage in individually or collectively. Because students will see things in their own nuanced ways, for a learning environment to be effective, the person who develops and facilitates that environment needs to understand what the learners know. Wertsch (1985) defined this as a situation definition and noted that when a learner was not able to understand or do something in the way that someone else did, their situation definitions differed. If the student in a teacher-student instructional situation could already see the situation from the teacher's point of view, the teacher would not be needed. When the situation definitions do not align, learning may only take place if the teacher moves to the learner's situation definition and can then scaffold the student to a more developed understanding. With this brief, and perhaps simplistic, introduction to semiotics, which provides a foundation for why the linking process works as it does, we consider what it is about particular objects that provide prompts for personal meaning. As Mrs. Chambers' classroom is introduced we begin to address the second question—*how is the linking process prompted?*



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