Kathy L. Schuh

Making Meaning by Making Connections

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ISBN 978-94-024-0991-8 ISBN 978-94-024-0993-2 (eBook)
DOI 10.1007/978-94-024-0993-2

Library of Congress Control Number: 2016952813

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Science+Business Media B.V.
The registered company address is: Van Godewijckstraat 30, 3311 GX Dordrecht, The Netherlands

To Sarah and Maddie

Preface

The case studies in this book are still as vivid and interesting to me as the days when I first visited each of the classrooms and began taking notes. It has been an incredibly long journey. Yet, as I describe the students and teachers it seems as though it were yesterday. It is because of their openness in allowing me into their classrooms that I was able to explore in depth a small part of how learners construct their knowledge based on what they already know. In the grand scheme of learning and instruction, this focus only gets at the tip of how we can support learners as they bring their own experiences, whatever those may be, into the classroom as a potential foundation for further learning.

When all is said and done, this book is ultimately a book that has my research at its core. It could only have been conceived of and developed as a result of the studies I have undertaken. That said, as I consider what the book has developed into, it seems more than a documentation of findings from a research agenda. It is a compilation of case studies of upper-elementary classrooms. It is the documentation of how a theoretical lens allows for particular interpretations. It is the annotation of a research process. Because of those different aspects, this book may serve different purposes for different groups of people.

For those interested in theoretical descriptions of how knowledge may be constructed and meaning made, this book noted primarily a semiotic (although naïve) lens, drawing on the mind as rhizome metaphor, but also includes comparisons to more cognitive lenses of how learning takes place. For those individuals who are interested in the applied nature of the studies, omitting the sections that are more theoretically laden (e.g., sections of Chaps. 1, 2, and 8) should not inhibit usefulness of the book and understanding of the cases.

For teaching practitioners and those who train teachers, this book provides rich cases about classrooms that are diverse in instructional methods. While I have analyzed the cases using an emergent qualitative process, drawing on a semiotics lens and focusing primarily on the initial moments when students and their teachers brought in other elements to weave with the content, the cases could be discussed through a variety of lenses about teaching and learning. In this book, the excerpts from the cases are often longer examples than likely necessary to make my point.

Yet, it is these descriptions that will allow readers to apply various lenses of their own. To aid this process, the index references all excerpts by classroom so that one could revisit just one classroom.

For those interested in research methods, the appendix provides a detailed description of the methods used as the various studies that comprise this book were conducted. As a monograph, this book is perhaps best described as presenting a grounded theory which draws on six case studies of classrooms that include late-elementary children's knowledge linking processes and how those may, or may not, have been fostered in their learning environments.

Iowa City, IA, USA Kathy L. Schuh

Acknowledgments

There are many people who I would like to thank for their connections to this book. First, and most important, thank you to the teachers and students who participated in the studies. Without you, there would be nothing to write. I appreciated how your words, rather than my own, could often best portray what was most important to say. I learned a great deal by being a part of your experiences. Throughout my studies I have strived to honor the data that were collected by providing a comprehensive enough description of them to reflect the commitment and time you made to the project.

Thank you to all the people who were involved along the way in various aspects of data collection and data recording for all of the studies. These include JianLing Liao, Courtney Farrell, Patricia Wade, Tawnya Knupp, Elizabeth Ackerson, Joni Lakin, Matthew Weyer, Marc Halusic, Yue-Jin Li, Ching-Mei Tseng, Julianne St. John, Salim George, Ginna Moreano, Yi-Lung Kuo, Julie Rea, and Julie Moore.

Throughout these studies, I have had opportunity for support in terms of time, graduate student funding that was relevant to the ongoing project, and other expenses. These include funding at various stages of my work: The University of Iowa College of Education Dean's Scholarship, UI COE Research Fund, The University of Iowa Old Gold Fellowship, Obermann Center Fellow in Residence, Iowa Measurement Research Foundation, and the School of Education in Indiana University at Bloomington.

Over the many years that components of this work have been in progress, I have received feedback from faculty while in graduate school, colleagues and friends, article reviewers, and audiences at presentations, on different stages and articles that have contributed to this entire work. Thank you for helping me clarify my thinking.

Thank you to those at Springer who first accepted the idea of this book and have allowed me the extended time to complete the work. In particular, thank you to Bernadette Ohmer for always remaining positive during the process.

Finally, I would like to thank those who are not related to the endeavor of this book, but have helped me in so many ways: My brothers Duane, Bob, and Ron; my good long-time friends Joan, Barb, Barbara, and Darcy, and their families; and my more recent friends and colleagues. And last, but certainly not least, thank you to Sarah and Maddie to whom I dedicate this book. How blessed I am that you are woven into my life trajectory.

Contents

Chapter 1
What Do Students Bring to School?

Abstract In this chapter, I describe the context and overall trajectory for the studies, including my own trajectory as a teacher, learner, and scholar. Following an excerpt from Ms. Smith's first-grade classroom, which provides an introductory example to what student knowledge links are, the guiding metaphor for the studies, Mind as Rhizome, is introduced. Characteristics of the rhizome include that it is dynamic, continually growing in dimension, has heterogeneous features in which there is potential for infinite connection among those features, is not necessarily hierarchically organized, but is a continuous interconnected system that cannot be ruptured, has no inside or outside, yet has multiple entrances. This metaphor it set in contrast to the Mind as Computer metaphor.

Accompanying students to school, along with their backpack and perhaps a carried lunch, is the residue of what they have encountered in their lives—a wealth of personal experiences that allow them to make sense of the world around them. Descriptions of many of these experiences are shared aloud in the classroom if students have a small window of opportunity to do so, while others are only a part of their thoughts while they are to be listening to the teacher or engaging in some other activity. In some cases, these personal links based upon prior experience may be useful for the students' learning, while at other times they may be sources of distraction. In either case, this book points to the importance of understanding the varied array of experiences that are prompted as learners engage with the content they are learning, honoring those experiences as the learners' first link with the content, and acknowledging that the link may be the student's starting point for deeper understandings.

The purpose of this book is to explore those initial links, what they are, and how they may or do not occur overtly in the classroom. This synthesis of studies documents a very small component of how students link what they are learning with what they already know—regardless of where that information came from. The stance taken in this book is that, generally speaking, what a person knows has been

This chapter draws and expands on Schuh and Cunningham (2004) and Schuh (2007).

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_1

gained on a foundation of what that person already knew, guided by a multitude of personal, social, cultural, and environmental characteristics, i.e., the residue of each learner's life experiences to that point. These life experiences create the learner's trajectory, as well as their identities and possible futures (Wenger 2000). The propose of the studies reported here is to describe those aspects of a learner's trajectory that make their way into the classroom and may include those not initially gained through classroom experiences. In this way, learning out of school and learning in school are woven together into a continuing trajectory.

1.1 Trajectories and Metaphors

In its simplest description, a trajectory is a path. There are more formal definitions of trajectory that also shed light on the idea. Mathematically, a trajectory is the curve through space. The curve follows from a series of points and the nature of the trajectory depends on what is determining those points at different times (Norton 1995). This definition points to the dynamic nature of a trajectory and indicates that it is a *process*, rather than something that is stable or unchanging (Lemke 2000). For purposes of the discussion in this book, a trajectory is the path of the learner's life experience; the points that build that trajectory are developed in a variety of contexts and with a variety of people that the learner has encountered (Lemke 2000). The trajectory is not only what has happened to a particular learner at a particular time; but in its entirety, is a path that captures current and future time-scales as well (Lemke 2000)—it is what has been and what can be. That trajectory begins before formal schooling starts and develops through a lifespan. As a child's trajectory encounters schools and classrooms the trajectory provides a lens for the child's interpretations as the trajectory continues to be constructed.

For example, residue of my own trajectory includes a developing understanding of what it means for someone to learn. My trajectory includes the series of studies reported in this book as well as the classes I had taken, books and articles I had read, and discussions I had with my professors as a graduate student and now with my own graduate students. Although I did not realize it at the time, early experiences that influenced the direction of my trajectory began with my career as a K-12 music teacher and a junior high school math teacher. I had been trained to be a fairly traditional teacher—after all, it was the 1980s. I had taken the required educational psychology class as a pre-service teacher and had completed the obligatory micro- and student-teaching. I was an OK teacher; students learned, they seemed interested, were well-behaved for the most part, and generally the parents and administrators were happy with the outcomes.

As my own trajectory continued to develop, exploring computer science and artificial intelligence, I became fascinated with the underpinnings of how people, in particular my former students, learned. The computational model of Mind as Computer, which had followed from the Cognitive Revolution (c.f. Gardner 1987), made sense to me as an explanation of the process. The mind, touted as an

information-processing system, included components analogous to those of a computer—e.g., short-term or working-memory as random access memory and long-term memory as the hard drive. Computers, then, could provide a means to model human information processing (Gardner 1987; Haugeland 1997) which could open doors in terms of studying how individuals may process information. As I reflected on my earlier teaching experiences, I remembered particular students who looked as if they were actively searching their memories for correct answers when I asked them questions—answers, for some, that never seemed to be found.

Then, graduate school (and the 1990s) happened. *Learners have no alternative but to construct their knowledge based upon what they know.* I was intrigued by this cliché. I wondered why, for my own students, this "construction" process in which they built together what they knew with what I was teaching them had not been apparent to me. As I watched them I did not see that they were constructing anything. Instead it did seem that they were *searching* for answers. After some thinking, I finally realized that when students offered their prior learning that was not what I had earlier taught them, I had likely treated their contributions as being off-track or irrelevant to my instructional goals. To come to that realization, I had to consider that their prior learning was not merely traditional classroom learning that had been covered in earlier class sessions or grades, but a wealth of experiences from in and out of school—things that they were so willing to share when given the opportunity.

I had read *In Search of Understanding, The Case of the Constructivist Classroom* (Brooks and Brooks 1993) and many articles about contemporary theories (e.g., constructivism, situated cognition, activity theory). I understood (as well as any graduate student, I suspect) how learners constructed their knowledge given Piaget's (by way of von Glasersfeld's (1989, 1995) foundation for radical constructivism) and Vygotsky's theories [often through secondary sources such as Duffy and Cunningham (1996), Savery and Duffy (1996), the Cognition and Technology Group at Vanderbilt (1992), and Cobb (1994)]. But these readings did not help me understand this process at a grass-roots level—when students in my classroom shared words and ideas. That was the experience I had lived. How could I make sense of this constructive process, given the experiences *I* had? It was this question that prompted my research agenda. I wanted to see this process taking place in classrooms—not classrooms for which some stranger had designed an instructional module to be tested out, but by looking at a classroom in which the teacher was instructing students in his or her own way. After all, this contemporary theory was a lens (Brown 1994; Duffy and Orrill 2004)—a way to look at a learning situation, any learning situation. I should be able to take a "constructivist" lens, watch a teacher who was using techniques that aligned well with behaviorist practices for example, and see that the children were *still* constructing their knowledge. I set out to study my first classrooms.

Given my intent, I conducted a pilot study that focused on what I would later call student knowledge linking. The design for the small qualitative study was to

observe two classrooms, a first- and sixth-grade classroom at St. Francis School,[1] with the wide-eyed hope of noting the links that students were making between what they were learning and what they already knew. I expected to hear those potentially off-track comments and questions that students shared with their teachers and classmates. When a student brought up a tangential comment or question in class I would then ask them to participate in a follow-up interview to explore what their link was about. I was excited! During the first observation I sat with my steno pad, busily jotting notes in a dictation-like way, as the first-grade teacher, Ms. Smith, instructed the children about how to complete two phonics worksheets. The sheets contained pictures of objects for which the children were to write the words. Some of the objects were discussed because they might be unfamiliar, such as "windmill." The teacher prompted the students about the Hans Brinker video, which they had apparently watched earlier.

As I channeled as much of the dialogue to my steno pad as I could, I waited for those "aha" moments that would be crucial to my research; those moments through which constructivism would be operationalized in a classroom. As a novice (or naïve?) researcher, I did not notice Ms. Smith's prompt about their watching of the Hans Brinker video earlier to support the students' understanding of "windmill" at that time as a prompt for building together prior and new information. Perhaps it was luck, then, that in Ms. Smith's first grade classroom, on the first day of my observations, I captured a student linking what he was learning with what he knew that had been developed out of school. Seven students were called to the front of the room for reading group. These children sat around a small table with the teacher while the rest of the class completed their worksheets and worked on an art project. Ms. Smith continued her instruction by first introducing new words that they would find in the story that used the long "i" sound and also what the "ea" sound was like. Before beginning the story Ms. Smith asked the children, "What's a story that you've enjoyed with Frog and Toad?" The children listed a number of stories and were told to open the books to *The Kite*.

As they began the story, Ms. Smith asked what a meadow was. Meadow was a new word in the story (Schuh 2007)[2]

> "A meadow is a place with a few buildings," Brian said.
>
> Ms. Smith paused, "Meadow Wood, where your grandpa lives," she interpreted his response.
>
> "Animals live in a meadow," another student offered.
>
> "There's a fountain in a meadow," Brian said.
>
> Ms. Smith tried to clarify, "They call it Meadow Wood because it looks like a meadow."

[1] All school, teacher, and student names in this book are pseudonyms.

[2] Throughout this book, I will cite relevant publications of mine related to this topic. Because of page limits of journal articles, this book provides an opportunity to include more contextual information about the links that the students made and also allows for a more comprehensive understanding of the phenomenon.

The students offered other descriptors of meadow. "A meadow is flat." "A meadow has flowers." "A meadow has deer." "A meadow has raccoons."

The teacher added, "A meadow has possum.[3]" Still addressing Brian's idea about meadows, she said, "In Meadow Wood sometimes animals come near the buildings and eat the plants. A meadow is a flat, grassy place."

Brian's personal definition of meadow was colored with experiences with his grandfather, and different than the teacher's. His definition, although narrow, was not incorrect from his perspective, as he continued to use it to answer the teacher's questions. I was able to understand Brian's link through the help of Ms. Smith's clarifications. I interviewed Brian following the classroom session, first asking for a summary of *The Kite*, the story his reading group had discussed, which had contained the new reading word, meadow.

Kathy: I remember you were talking about your grandpa. What made you think about that?

Brian: I don't know. When she said "meadow" I thought of that one.

Kathy: Yeah, because he lives in place that's called Meadow [pause, not remembering]

Brian: [quietly] Wood.

Kathy: What was it called, Meadow Wood?

Brian: For old people that have strokes. He had a stroke and he's paralyzed and, um, we just go there to visit him.

Kathy: Oh, sounds like a nice place for him.

Brian: Yeah, it has a water fountain, there's a dining place where he used to be able to go out and get food there, when my great-grandma was alive, but she died. And he can't go there anymore because his foot's too swollen.

Kathy: Oh.

Brian: There's lots of neat things there.

Kathy: Yeah. They called it Meadow Woods and your teacher said that's maybe because it used to be a meadow, right.

Brian: [quietly] Used to be a meadow.

Kathy: So what's a meadow like?

Brian: I don't know. It's pretty calm, quiet.

It was clear that Brian's trajectory that included Meadow Wood had experiences with his grandfather, and likely other family members. Although Meadow Wood was a place with a lot of "neat things," it was also apparent that Brian's trajectory had a strong affective component.

Following this first day of data collection it seemed that operationalizing how students linking what they were learning with what they already knew would be

[3]Possum were prolific in the community. I remember seeing a family of possums walk down a typically very busy street one morning; the same street as St. Francis School.

straightforward and simple. I returned to Ms. Smith's class a number of weeks later, optimistic about finding more links given the outcome of my first observation. Ms. Smith was teaching her first-grade class about equal parts in their math class.

> "Have you ever said 'fair share?'" she asked.
>
> "When mom was giving my brother all the good stuff."
>
> "When I wanted the middle seat in the car."
>
> "When my sister got lots of candy."
>
> "Have you ever been asked to be in charge of fair shares? It is a responsibility," Ms. Smith asked her class. She prompted the students about how imaginary pretzels could be divided to make a fair share.
>
> "Split them in two groups," one child offered.
>
> "Add them," said another.
>
> "Do you mean count them?" Ms. Smith asked for clarification.
>
> "Yes, split them so they make sense."
>
> This discussion continued until the teacher expanded the idea of fair share by holding up a piece of lavender paper. "What if four children are to make Easter eggs out of one piece of paper. How can that happen?"
>
> "Get an Easter egg and trace it."
>
> "What about the others? What would the others have to do?" she prompted about the other three children who would share the paper.
>
> "Each could draw in a corner."
>
> "Draw two up here and two in the middle." (Schuh 2007)

In that observation I did not hear anything that seemed tangential or off-track, which was my intended indicator that the student was drawing on personal experience. I was disappointed and concerned. Who would I interview? I randomly chose students to interview, a backup process noted in my IRB-approved plan. I asked Mary, a 7-year-old girl who was the first student I randomly chose for an interview, if there was anything else she wanted to tell me about fair share, which was how the teacher had referred to equal parts that they had talked about in class. A vault opened. "Well, there's one thing about yesterday I want to tell you. Yesterday we found a Gap bag and it wasn't a suitcase or anything. And it had a shirt in it and a pair of shorts and my mom said that she [later I figured out that 'she' meant Tina, her sister] could keep the shorts but not me" (Schuh 2007). As it turned out, when I studied my own notes after leaving the research site, I found that Mary *had* shared her comment in the classroom [which immediately followed the excerpt noted previously], "We saw a bag this weekend," she had said. But Mary's comment was not elaborated and Ms. Smith continued with the math topic. Seemingly random, off-track comments that may have been shared and dismissed in class, or were never shared aloud, were stories students wanted to share. The fascinating

piece was that the prompts in the classroom and the links the students made seemed transparent once they were shared and described.

Ms. Smith's class was the first classroom that I visited. While I used the same recording process in the sixth-grade class at St. Francis School, the comments shared in class were even fewer than those in the first grade. However, given student interviews and also a writing activity that I had the sixth-grade students complete, it became clear that these students often had experiences that they could bring to bear on what they were learning. As I continued reviewing the data I began to see that this linking process was the norm.

As my own trajectory continued to evolve, based on this early study, I realized that although the same information might be provided to a student, what sense they made of it varied widely. As I considered my own learning as a graduate student, I realized that this had been my own experience as well. How many times had I sat through a seminar discussion believing I had read the wrong article? My lens, given my background as an older student who had taught in rural North Dakota schools, was clearly different than other graduate students and prompted a different interpretation of many articles. My personal trajectory prompted my personal interpretation. How could that not be the case in elementary classrooms? My own learning process prompted my exploration.

What struck me in my first few years of my graduate studies was that my earlier conceptions of knowledge seemed two-dimensional. As I began my studies I thought I had embraced the idea of constructivism, and had shed (I assumed) the notion that the mind was a computer. Yet, my own initial working model, despite my apparent understanding of constructivism, was that knowledge seemed much like a concept map (Novak 1998), a diagram of circles or boxes used to represent concepts with connecting lines to capture the relationships among those concepts. Concept mapping was a technique for accessing hypothetical knowledge structures, capturing the presumed content and organization of that content that the individual knew. In fact, the research on spreading activation—the process by which one element or idea in our memory structure may then lead to another as we retrieve information (e.g. Anderson 1983b; Collins and Loftus 1975; McKoon and Ratcliff 1992) was compelling. With my background in computer science and neural networks it made sense. Yet, what did not make sense was that when I tried to draw concept maps as part of my analysis with the data from Ms. Smith's school, the maps did not just contain concepts. The child's perspectives stepped outside of the boundaries and beyond the school walls. I wanted something that was multi-dimensional and would help me better visualize this. Enter the Mind as Rhizome metaphor.

In contrast to viewing the mind as a computer, the Mind as Rhizome is a metaphor that captures a more dynamic description of what mind is like. The concept of rhizome has been used in the interpretation of writing and language (Burnett and Dresang 1999; Deleuze and Guattari 1983) and provides a metaphor that has been used from a semiotic perspective (Cunningham 1992; Rossi 1987). It has also been used to describe the design of hyper and multimedia (Burnett 1992), discussions of the Internet (Hess 2008; Warmkessel 1994), e-learning (Polsari

2002) and as a means to differently interpret personal constructions of self (Sermijn et al. 2008).

While most know what a computer is and aspects of how it operates so to map how the mind works onto the functions of a computer, a rhizome may be unfamiliar to those without a background in biology. Physically, a rhizome is a mass of roots, which also contains buds, nodes, and scale-like leaves (common examples are iris, ginger, strawberries, crab grass) and is considered a modular organism, rather than a unitary organism. In other words, the organism grows through a construction process where it builds more modules (Begon et al. 2006), rather than being a single, isolated plant.

Some rhizomatous plants spread vertically (i.e., taller), while others spread their roots laterally, thereby producing new root stems. Some animals also have rhizomatous characteristics, such as the obelia, which is a marine animal that reproduces by constructing modules. In addition, aspects of some animal living arrangements are rhizomatous, such as packs of animals living together as rats do. Their burrows in themselves are rhizomatous, being a habitat as well as a means of provision, movement, evasion, and escape (Deleuze and Guattari 1983). Eco's (1980) description of the labyrinth of the library in his *The Name of the Rose* also captures the nature of a rhizome.

Just as considering the mind as a computer prompted a framework for exploration and interpretation of the mind and how one processes information, using a different metaphor, such as mind as rhizome can prompt different explorations and interpretations. Technically, a metaphor is a literary device that figuratively specifies that *X* (a target) *is Y* (a source) (Finke et al. 1992), thus providing a map of one concept to another. For example, when considering the mind as a computer, the computer (source domain) maps to the mind (target domain); the functions of the computer (a system of component parts) map to the mental capacities of the mind (e.g., short-term memory, long-term memory) (Frenandez-Duque and Johnson 1999).

Just as understanding of the components and processes of a computer propelled and prompted understanding of the mind and how it processes and stores information given an information-processing perspective, understanding the components and processes of a rhizome can prompt expanded understanding of what mind is. To do this, consider the characteristics of a rhizome. A rhizome is (1) *dynamic*, *continually growing in dimension*, has (2) *heterogeneous features* in which there is potential for (3) *infinite connection among those features*, is (4) *not necessarily hierarchically organized*, but is a continuous interconnected system that (5) *cannot be ruptured*, has (6) *no inside or outside,* yet has (7) *multiple entrances* (Deleuze and Guattari 1983; Duffy and Cunningham 1996; Eco 1984; Hess 2008; Schuh and Cunningham 2004).[4]

[4]I have expanded this description in Schuh and Cunningham (2004).

1.1.1 Dynamic

The rhizome, as a modular organism (Begon et al. 2006), continuously grows in dimension, changing its own nature as it increases connections (Deleuze and Guattari 1983; Duffy and Cunningham 1996). It undergoes continuous modification (Eco 1984) and is dynamic. Knowledge has also been described as dynamic and self-organizing (e.g., Greeno 1998; Lemke 1997; Schank 1999; Shore 1996). Given this, what we know will continually grow and change its nature in that process. As a continuous dynamic process, learning, or the process whereby we change what we know, is not reserved for classrooms and schools, and is not merely in the realm of what a teacher guides. What we know is a continuous process of change happening in and out of school.

1.1.2 Heterogeneous Features

In the rhizome organism, modular growth involves the repetition of units that make up the organism. There are a variety of module types. For example, buds will produce leaves, which themselves bear buds. Modified module types may also emerge, in particular those that may be associated with reproduction (e.g., flowers) (Begon et al. 2006). Likewise, explanations of knowledge that exhibit characteristics of heterogeneity are those that describe *dimensions* in knowledge. Jonassen (2009) summarized and distinguished among ontological (which includes declarative, structural, conceptual knowledge), epistemological (procedural, situational, and strategic), and phenomenological (tacit, sociocultural, experiential) knowledge types. Others have talked about interactive dimensions of knowledge (Alexander and Murphy 1998) and meaning-based connections among knowledge (Lemke 1997), individual and cultural meanings (Shore 1996), and emotional components (Ginsburg 1997). As Dewey stated nearly a century ago (1938), "Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying" (p. 48). It is now widely acknowledged that any learning experience generates multiple interactive learning outcomes including, but not limited to attitudes, affect, emotion, orientation, pertinence, and so forth. These various dimensions all contribute to the heterogeneity of knowledge and, in fact, heterogeneity seems to be the norm, as was typical of the links that the students described in this book are.

1.1.3 Connectability and Infinite Juxtaposition

Among these different dimensions, then, lies the possibility of connectability and infinite juxtaposition. The structure of the obelia, a modular marine animal,

demonstrates this characteristic of infinite connectability. As the obelia reproduces, a free-swimming larva, which attaches to a solid object, a root-like structure develops and spawns branched stalks. Then, modules (polyps) are borne on branched stalks. "The terminal polyp of each branch is temporarily the youngest, but is overgrown by the next one to develop, which arises as a bud at its base. The branched stalks *remain as an interconnecting network* between all the polyps in a colony" (Begon et al. 1990, p. 126, my emphasis). As a metaphor for mind, every path has the potential to be connected with every other path, thereby also providing for infinite juxtaposition among the heterogeneous features (Deleuze and Guattari 1983; Duffy and Cunningham 1996; Duffy and Orrill 2004; Eco 1984). In considering knowledge, this characteristic allows for idiosyncratic or unique perspectives or interpretations of information. While each student trajectory continues to develop as they link what is in their classroom with their own prior experiences; the connections that are possible differ from learner to learner. Yet, as members of the same classroom they are also connected at that point, multiply connecting with the various elements available in the learning environment (e.g., teacher, resources, visitors).

1.1.4 Resists Rupture

Given the connectability and infinite juxtaposition, the rhizome cannot be ruptured (broken) in that if something should break it begins anew or connects with other lines. If one part is broken, another begins (Have you ever tried to remove a rhizomatous plant from a garden? It's near impossible to remove all the pieces, it keeps coming back). However, in the rhizome organism the modules within a system do have the potential for separate existence. Connecting pieces among modules may rot away, for example, leaving separate and independent pieces. In this, the organisms may disperse through water, for example, to cover a vast area, not unlike the information dissemination practices of a research field. The rhizome includes the lines of segmentation (defining itself, its territory, so to speak) or lines of flight (lines by which it may move beyond, or flee, its territory), as described by Deleuze and Guattari (1983). Although being physically separate, there is a connectedness that remains. For the students, the residue of the classroom comes with them as the move from the school to home (and back again). In terms of the metaphor, this seems to be the foundation for the notion of transfer for learning.

1.1.5 No Hierarchy

The rhizomatous organism is almost always branched (Begon et al. 2006), but there need not be hierarchy, genealogy, or superordinate points (Deleuze and Guattari 1983; Duffy and Cunningham 1996; Eco 1984). Given the heterogenous nature of

knowledge, it would seem difficult to assume that there must be a hierarchy among the varied elements. Hierarchies *may* exist although it is not inevitable that they occur (Cunningham 1992). Further, those that do exist, are artificially cut from the rhizome (Eco 1984). Knowledge has often been described as existing in hierarchical structures (e.g., semantic networks such as those described by Collins and Loftus (1975) and concept maps such as those by Novak (1998)). These are often bounded by subject-matter domains. Further, models such as that described by Ausubel (1977) propose that new knowledge is attached directly into a hierarchical system through an active process whereby prior concepts (subsumers) acquire new information, thus providing a base upon which new instances of a concept, for example, may be attached. Because of this linking process, hierarchy can be imposed, although it is not mandatory. This element of the rhizome seems in contrast to many of the computer models that aligned with the Mind as Computer metaphor (see Chap. 2).

1.1.6 No Outside

The rhizome has no outside, but is an open network in which everything is connected to something else in a multidimensional space. Without an outside, it can only be looked at and described from a position on the inside (Duffy and Cunningham 1996; Eco 1984). Given that the rhizome is dynamic, has infinite connectability, and defies rupture, should a perceived "edge" be imagined it cannot be an "end" but rather another position or path from which change and connectivity must occur by extending modules. A bud produces leaves, which in turn, has buds, and so on. There can be no point where there exists no connection potential, as that would violate the characteristic of infinite connectability. This metaphorical rhizome is not something from which we can step outside and examine, because we are within as part of the dynamic process. Essentially, we can only describe the rhizome from an internal perspective. This argument is essentially that from which naturalistic research methodologies stem (e.g., Lincoln and Guba 1985). In practical terms, although researchers strive to be objective, there is no point, no place, at which they do not have a perspective. It is impossible to be outside of something in which you exist as an internal interconnected piece.

1.1.7 Multiple Entrances

Given that a rhizome is interpreted as something without an edge, it seems impossible that there would be any entrance into it. However, rather than no entrance, there are many. In the rhizome organism, each bulb, leave, stem, etc. is a potential entrance for the rhizome as new connections are spawned. This final characteristic of rhizome, i.e., multiple entrances, is perhaps one of the most

important characteristics of the rhizome (Deleuze and Guattari 1983), allowing for individuals viewing the rhizome from unique or personal perspectives (Cunningham 1992). This personal view of the rhizome, an individual's Umwelt (von Uexkull 1957), is the time, place, and features of how the world is viewed by a particular organism. Each individual, every student in every classroom, has a unique view. Thus, the rhizome metaphor provides for variation among individuals and in fact, states that it must be so. If each view must be different, then idiosyncratic knowledge becomes the norm. Each learner's trajectory brings with it a vantage point within the rhizome, bringing with them not only what has been learned in school, but a wealth of experiences, although varied, from outside of school.

1.2 Traces and Trajectories

Given my own development as a researcher, these characteristics of the rhizome seemed to capture better the vision of knowledge that I wanted to explore. With the rhizome now as the context, the concept of trajectory had not only a place to be, but also a purpose. What a trajectory *is* becomes more apparent when considering how a rhizome, relative to mind, might be moved through or traversed. A rhizome can be traversed, or moved through, in two ways. The first is as a tracing of something that exists (Deleuze and Guattari 1983), i.e., a reproduction or a copy. For example, the traditional notion of a concept map might be considered a tracing. When a concept map is considered a representation of what an individual knows, the knowledge is extracted and inspected as an intact item. The view fits well with my understanding of the Mind as Computer metaphor where knowledge is viewed as an entity, or thing. When considered in isolation, the information in the concept map may imply a hierarchical structure to the information. This is essentially the foundation for Ausubel's (1977) meaningful reception learning and the notion of how well-crafted instruction that prompts new knowledge is attached directly into a hierarchical system. While a trace provides an opportunity to study the structure of knowledge at a particular point in time, the information extracted seems to lose any characteristics of interconnectivity that linked the information in the concept map to information beyond the boundaries of the map. In many instances, a trace reflected in the concept map may be appropriate for studying knowledge as it does provide a snapshot of a particular instance in time. It captures a picture of a piece of the rhizome at a given time.

Yet, considering that learners do bring varied experiences with them to the classroom, a trace seems limited in capturing what they could know. I use the term trajectory to describe the second means of traversing a rhizome (note: Deleuze and Guattari (1983) use the word map; I have chosen to use trajectory to avoid confusion with the notion of a concept map). A trajectory is a path through the rhizome. This path is *constructing rather than reproducing*; and thus is not a static permanent tracing.

To illustrate, consider this thought exercise. Breaking one of the premises of the rhizome, assume you *can* step outside of the rhizome. Assume you have a birds-eye view of a community's life span (you may define community as you wish, but make sure it is something large and rich with opportunities, people, tools, interactions, etc.). Imagine that space as a multi-dimensional space (attempt at least four dimensions, for example, as you imagine a three-dimensional space moving through time). Fill that space with a very complex web—many points interconnecting with many other points, simultaneously and sequentially. Also envision that at a particular point in the time-scale an infinite number of different interconnections could happen at once. For example, perhaps in this complex web there is a point in time in which there is a formal meeting of a number of members of the community. Imagine the many connections that could take place at this point—the various people, things they bring in terms of prior experiences, topics they interact about, what they do, etc. Now, imagine a single person moving through this web from the beginning of the community to the end of your imagined space. As this person moves through the web, rather than merely following the threads of the web that you have spun and placed there, she weaves her own thread. At each point of intersection, this girl's thread intersects with others, perhaps twining together for a bit, and then maybe moving on to interact in other intersections. Where her thread is created, little snags of others' threads attach to her own, as well as her depositing little bits to others' threads as well. This person's thread, as it has interwoven with each thread it has touched, has changed the nature of her thread, as well as the others' threads. Finally, consider that each individual, as part of the rhizome, is doing the same thing. In this way, rather than a pre-existing web, the web is actually created as each thread within the rhizome is created.

The web in the thought experiment is the rhizome structure of the metaphor, and despite the many paths, there is only one rhizome. Each individual's thread, given our exercise, is a trajectory that is constructing that integrated rhizome, not reproducing, as each is interwoven with others. Given the characteristics of the rhizome metaphor, the activity of mind is no longer viewed as information processing, something that receives input and processes information given an algorithm. Further, it is not a container. The rhizome prompts for a process for which each agent is a part. It more appropriately aligns with the concept of 'knowing' (Bruner 1990; Cunningham 1992; Dewey and Bentley 1960; Duffy and Orrill 2004; Greeno et al. 1993; Maturana and Varela 1987). As a process, movement within the rhizome is required (Schuh and Cunningham 2004).

Each child in a classroom, then, *is* a trajectory. That trajectory is colored with the child's interactions from throughout his or her life space to date. Each trajectory must be unique as it turns and weaves, following one of a multitude of connections that are available at any point, building the personal world, which is the embodiment of mind.

Although traces can and do exist, they must always be transferred onto a trajectory (Deleuze and Guattari 1983) in order to grasp more complete meaning. The concept map, or more specifically the knowledge that it represents, is only complete and can only be completely understood, when placed within the rest of the rhizome,

complete with all potential points of connection. A tracing, captured at a particular moment, appears to be static and is constrained by its own artificial boundaries. With a trace, all of the potential connections that existed with the trajectory are lost or obscured, and likely, the full meaning of the trace as well. Boundaries are imposed as the trace is severed from the rhizome in which it existed. To illustrate, return to our thought exercise. Imagine choosing one small component of the web to inspect. This can be pulled out, and you can imagine the threads still binding it to the full web. If those connections are ignored (i.e., seemingly severed), much of the information about that extracted section seems lost. The full meaning is only obtained when moving the piece back into the web; the piece being complete in its full interconnectivity. Consider Brian's understanding of meadow. The trace may be (instructionally speaking) the elements of his understanding of meadow—calm, quiet. However, some of the elements (such as the fountain) only make sense when that trace is returned to Brian's trajectory within the rhizome. Fortunately, Ms. Smith allowed for that. A trajectory relies on the existence of the unlimited connections; a trace prunes them. Perhaps Eco's (1984) description clarifies the distinction between a trajectory and a trace. A trace appears as a tree-like structure. However, '[a trajectory] is *simpler* than a tree; it is a skein, and, as one unwinds the skein, one obtains a continuous line' (Eco 1984, p. 80, my emphasis). This trajectory is the unwound skein, complete with the residue of the interconnections as the rhizome was created. In this way, the rhizome metaphor focuses on knowledge as a process rather than a structure.

The rhizome helped me to understand the richness of Mary's and Brian's connections in Ms. Smith's class. Mary's understanding, or her knowing about it, was not based only on the information that Ms. Smith presented, but was colored and seemingly pre-empted with her own notion based on residue of her own trajectory that she brought to the class and tried to weave in. Brian's situation was similar and points to how Ms. Smith's own trajectory had tangled with pieces of Brian's life, perhaps through his parents or other opportunities, which allowed her to help Brian make sense of the word meadow.

The rhizome helped me envision the theoretical promise of constructivism—that learners will link what they are learning with what they know—but in my pilot study there was so little shared, and little that the students offered seemed to be used in a way that strongly supported constructivism as a pervasive description of how we make sense of the world, particularly as a lens for learning. Despite a few interesting links such as Brian's and Mary's, the comments and questions that I hoped to hear were, at best, minimal in the classrooms. However, they were more apparent in the interviews I conducted and in the writing activity I used with the older students. I struggled; perhaps the few examples that occurred overtly in the classrooms of my pilot study were anomalies. Maybe students did not construct their knowledge in classrooms after all.

It was disheartening to have my idea dashed, particularly as a graduate student seeking a dissertation. How could I push forward on something that was not audible or apparent in the classrooms? One of the most critical questions in my research career, asked to me by Joyce Alexander, a faculty member who took a few minutes

to hear my lament about the absence of these comments and questions in the classrooms, prompted me. "Why *didn't* you hear anything in those classrooms?"

This set the stage for three case studies of classrooms that differed in terms of learner centeredness, a perspective on learners and instruction that fosters opportunities for learners to draw on their own experiences and interpretations (McCombs 1997; Wagner and McCombs 1995) and aligns with the constructivist perspective (Bonk and Cunningham 1998; Wagner and McCombs 1995). Although the students in Ms. Smith's first-grade class had been interesting and fun to visit with, the writing opportunity that was possible with the sixth-grade students at St. Francis provided a rich data source. I had asked those sixth-grade students to free write about the topic they had studied, telling them that if something else came to mind while writing it was OK to write about that topic. This writing allowed me access to links that had not been overt in the classroom. Because of this additional data source, I chose to focus my second study on sixth-grade students.

In the sixth-grade classrooms in that second study, students had more spontaneous connections between what they were learning and what they brought with them to the classroom. But findings from those case studies indicated that there were differences in students sharing those connections aloud in class. My analytic lens continued to evolve with the second study and the findings continued to show consistencies with the earlier pilot study as well as new understandings about these spontaneous contributions of the students, and what allowed them to potentially be overt in the classroom.

As my research continued as a new faculty member, I continued to explore learners in their classrooms, typically with a dual purpose—studying some type of instruction (for example, a writing unit) but always keeping my ears open for links, asking students about their links, and having them write about them. In these later studies, I found the same types of links again and again. While the content was different because of the unique experiences of each student, conceptually there were similarities in the kinds of links that the students made.

It is these similarities and consistencies that are documented in this book. Similarities and consistencies that occurred in what and how students linked what they were learning with what they knew despite differences in instructional methods and opportunities to share experiences aloud. This book documents a grounded theory (Strauss and Corbin 1998) of knowledge linking–one that is drawn from what these students said in their classrooms, shared through their regular classroom activities, or revealed in interviews or an open-ended writing activity. Formally, the purpose of this overall study synthesis was to capture those aspects of a learner's trajectory that made their way into the classroom that may not have been initially gained through classroom experiences, thereby operationalizing a component of a constructive learning process. While the overarching question that guided the research was "How do these fifth- and sixth-grade students make meaning given their own experiences?" more specifically, the question that guided the synthesis was "What is the nature and occurrence of learners' links to prior learning in their classroom, what characteristics of the classroom environment were associated with

the learners' opportunity to share those links, and how might those links be valued in the learning process?"

The study synthesis includes data drawn from upper-elementary classrooms that included fifth- and sixth-grade students in six schools in two states in the U.S. These classrooms were chosen for reasons that were logical for the smaller studies in which they participated. For example, as my first sixth-grade classroom, Mrs. Olson's classroom was chosen largely by convenience, as had been Ms. Smith's first-grade class. Mrs. Chambers', Mrs. Schneider's, and Mr. Jackson's classrooms were chosen because they varied in terms of learner centeredness, as indicated by their students' completion of the Learner-Centered Battery (McCombs et al. 1997). Finally, Mr. Ritter's and Mrs. Wilson's classrooms were selected because of the kinds of open-ended activities that their students completed. Because of this individualized selection process, the classrooms as a group illustrate a variety of different instructional methods, some more teacher centered and others more learner centered.

Data collection was similar in all of these classrooms. I typically observed the classroom for a unit of study that had been defined by the teacher. Because of this, topics the students studied varied. In Mrs. Chambers' classroom I observed a two-week unit in science on biomes and in Mr. Jackson's classroom I observed a unit on the Roman Empire that spanned nearly two weeks. Mrs. Schneider's students engaged in a nearly seven-week interdisciplinary unit on the Middle Ages. In Mr. Ritter's classroom the students worked on a writing project about the culture of China that spanned three weeks and I also observed a number of their conversations about current events drawn from reading the newspaper. I also observed three classes of Mrs. Wilson's where they engaged in interdisciplinary expository writing tasks over a two-year period. One of Mrs. Wilson's classes was the class from across the hall, a typical happening in many U.S. elementary schools as children in upper-elementary grades exchange classroom teachers for particular subject areas; the other was her homeroom class. Mrs. Olson was a colleague of Ms. Smith and her classroom participated in the first study. In her classroom I observed 3 lessons on various social studies units including the Vikings, Charlemagne, and the Middle Ages. This was the only upper-elementary class in which I did not observe a complete unit of study.

The students in Mrs. Olson's, Mr. Jackson's, Mrs. Chambers', and Mrs. Schneider's classroom were all sixth-grade students, generally 11–12 years old. Mr. Ritter's classroom and Mrs. Wilson's classrooms were combined fifth-sixth grade classrooms, with students as young as 10 years old. Because the studies in Mrs. Wilson's classroom took place in two different years, some students in this combined classroom participated in the study for the two years.

In addition to the observations I also interviewed children from each classroom, as I had with students in Ms. Smith's class. These interviews were fairly short, often lasting less than 15 min. The interviews in Mrs. Olson's, Chambers', Schneider's, and Mr. Jackson's classroom were pointedly on knowledge linking, whereas those in Mr. Ritter's and Mrs. Wilson's class also included other questions about their writing projects and their writing process.

The students provided another source of data through a writing task that I implemented with them. In this open-ended writing task, the students were given instructions to first write about the content that I had observed in their classroom. The instructions then informed them that if something else came to mind it was OK to write about the new idea, although they were to try to share why they had come up with that new idea. The study descriptions, data sources, questions that guided the individual studies, and analysis procedures are included in the appendix.

The book is certainly not about my own trajectory and exploration of understanding how students learn or how that might be explored using qualitative research methods. Everyone has a path to his or her understanding, and mine is likely quite typical—I had a lens that I applied to learning and instructional situations that continued to evolve and change given various interactions, experiences, and opportunities. Those interactions exposed me to cognitive theory, constructivist theories, Peircian semiotics, and dynamic systems models. This book is also not about any of these stances in particular, although notions about these will be woven throughout. Aspects of particular theoretical slants clearly have informed my thinking as I have progressed through this work. For example, my own introduction to constructivism colored my own trajectory and propelled me in the direction of the studies I report here and provided a theoretical lens as I started my work. This book is also not about constructivist instructional strategies pitted against more traditional strategies. The teachers in the book were all experienced teachers, having taught for many years. What may look like a spectrum of different teaching techniques is not meant to be portrayed as superior versus inferior. Rather than documenting what the children learned and how well they learned it, or how the teacher taught or how well he or she taught it, these studies document those first moments as learners encounter information in their classrooms and what comes into their minds. Some of these links, when shared overtly in class, may be treated as off-task or irrelevant. Whether shared aloud in class, or quietly thought and later shared in the interview or the open-ended writing, these links are where learning begins—a point on each student's trajectory.

Through these six teachers' classrooms the initial links that these students created between what they were learning and their other experiences are brought to life. Their links are often rich in describing who these individuals are, where they are in their learning process, and what is meaningful to them. Many times, these links point to what has been learned, both in and out of school, and the contexts when and where that learning took place. As the rhizome metaphor grounds the interpretation, each learner has a rich trajectory, influenced by prior learning, impacting current learning and the environment in which it takes place, and is a shared multi-dimensional space that spans time and place.

In the next seven chapters, these classrooms will be incrementally introduced so the reader can become familiar with them, the overall atmosphere in the classroom, and the instructional activity and unit of study that was observed. Through these narratives the components of the knowledge links that were apparent in the data analysis will be introduced and woven into a story of how students link what they were learning with what they knew. In crafting the chapters, I tried to achieve a

careful balance between too much narrative information versus not enough to gain a type of vicarious experience. That said, the narratives may error on the side of over inclusion; my intention being that the cases provide a strong sense of what these classrooms were like, how these knowledge links were or were not realized, why that happened, and ultimately reflect the classrooms in an accurate way that honors the extensive commitment the students and teachers made to the research studies in which they were involved. Through these descriptions, given the variation in the instructional styles and interactions with the students, readers may recognize classrooms in which they have studied, in which they have taught, or classrooms where they would like to be.

1.3 The Book

The following chapter addresses the question *what do the students' link*, which is illustrated through an introduction of Mrs. Olson's classroom in social studies class and Mr. Jackson's class studying the Roman Empire. With these classrooms as a basis, a metaphor of mind (mind as rhizome) and the notion of a learners' trajectory and its dimensions are described. Following a brief summary of knowledge structures, prior knowledge, and a description of semiotics as used in this research, the narrative turns to *how is the linking process prompted?* in Chap. 3. In this chapter an introduction to Mrs. Chambers' classroom and their study of the biomes in science sets the stage for introducing the kinds of cues that prompted the students' linking. Cue types are further expanded in the description of Mrs. Schneider's classroom's Middle Ages unit. In the fourth chapter, following a brief narrative from Mr. Ritter's classroom and a discussion of current events, *how do the students' link?* is addressed. Mrs. Wilson's classrooms' writing expository papers on animals of the rainforest and sea mammals in Chap. 5 complete the introduction to the cases and illustrate *what kinds of school content and contexts link*.

Following the chapters that introduce the cases and address how the links are prompted, and what and how the students' linked, three chapters provide a synthesis of further elements of the study. Chapter 6 addresses *how is the linking process supported or inhibited in the classroom?* and focuses on the differences in the instructional and facilitative elements in each classroom. *Of what value are they? SKLs as potential for learning* is discussed in Chap. 7. Chapter 8 considers *How is linking (and thus learning) like unlimited semiosis?* drawing on a particular cue-trajectory dimension pairing. This final chapter points to transfer of learning as a mutually-reciprocating relationship between environments where learning takes place and provides further discussion on the Mind as Rhizome as a dynamic system. A formal methods section for the studies is included in the appendix for interested readers.

While the studies reported here represent an array of instructional formats, the first classrooms introduced are very teacher directed in terms of instructional strategy and will provide the stage for considering the first question–*what do students link?* We begin with Mrs. Olson's sixth-grade classroom.

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).

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_2

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 Opper 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 Opper 1969), the structure of that knowledge was organized into schemes. A scheme may be behavioral, which Ginsburg and Opper 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 Opper 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 Opper 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 Opper 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 schema[1] 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).

[1]I will use the scheme when referring to Piagetian-described structures (see Ginsburg and Opper 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 contract 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 trichotomic 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*?

Chapter 3
How Is the Linking Process Prompted?

Abstract In this chapter the students in Mrs. Chambers' sixth-grade class and their study of the biomes are introduced to illustrate the links that students make with sensory cues. These sensory cues were those aural, visual, function, and tactile "things" in the environment that may be part of the object-sign relationship. After an introduction to the students in Mrs. Schneider's classroom, who studied the Middle Ages in a 7-week unit, conceptual links are described. Conceptual links in the data set included concrete and abstract concepts, structure, and processes. A structure cue is illustrated through an extended role play example in Mrs. Schneider's classroom as she and her students compare the hierarchies that existed in the Middle Ages and the game of chess that many of the students were playing.

3.1 The Biomes and the Students in Mrs. Chambers' Classroom

The variety of prior knowledge that students bring to school is not surprising. More interesting is the question of what brings these various elements of a students' trajectory into the classroom at particular times. Semiotically, the question becomes "what elements of a potential object in the classroom will be a sign that allows for interpretation for a learner?" In other words, what aspects of the classroom will have meaning given the prior knowledge that a learner has? We meet Mrs. Chambers' classroom as we begin to explore "*how is the linking process prompted?*"

I observed the students in Mrs. Chambers' classroom at Meriwether Lewis Elementary School for a 2-week unit on biomes during science class. The students in Mrs. Chambers' classroom were one of three sixth-grade classes at Meriwether Lewis Elementary School. Lewis School was in a growing bedroom community (a suburb of a large mid-western city). Because of the growing population, Lewis School had opened three years earlier, now having 770 students in grades K-6. In my first visit to the school I passed through hallways lined

This chapter draws on Schuh (2003) for some of the narrative excerpts.

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_3

with bulletin boards displaying student work. Display cases showed work that was not easily hung on the wall, like shadow box displays for stories completed by younger students and caves by older students. The school still had a sense of "newness"—everything was neat and tidy; the halls were carpeted and quiet. Video monitors suspended from the ceiling in a number of the hallway areas displayed school announcements as well as the "pledge" of the school. I passed a number of small groups of children with adults working in the hallways, expanding their classrooms.

My first day of observation was Monday, March 15; it was two weeks before their spring break. The students would work on a group project as a means to study the biomes. On my first day of the observation after reviewing their previous unit on owl pellets, Mrs. Chambers introduced the biomes project to the students, explaining that the new project would take them up to spring break.

> The students sat quietly as Mrs. Chambers explained the unit and the options that they would have for completing it. Their research should include the textbook, but should also include information that was not found in the book, including the option of selecting a video from the library. She explained to the students that they would be teaching the other students the content, "you're going to present your biome as a report, as a group to the class. You're really teaching everyone in the class about your biome because they haven't read about it. I want you to find some interesting facts about your biome that aren't in the book. Some of them are pretty puny. The textbook is a good place to start. I don't just want plants and animal from a book, I want to know why they [the plants and animals] are in that biome." Students asked a number of questions about options and ideas they had and Mrs. Chambers encouraged, "Yes, you have freedom in this."
>
> "Can you do other things besides read out of the book?" a student asked.
>
> "Yes," Mrs. Chambers responded to the question. "Don't read out of the book. You can't make it too long."
>
> "Are we going to start this today?" a student asked.
>
> "Today, we're going to get organized." She asked the students to look at the map of the entire world on pages 126 and 127 of their science textbook. "Do you notice anything about them? Look at the temperate deciduous forest? Do you notice anything about the locations of that biome? Is it all over the world?"
>
> "It's on the shore line."
>
> "How about in relation to the equator?" she probed. "Some people just think that biomes are just one place in the world, but they are not, they're usually equal distance from the equator. Which biome is going to be the coldest?"
>
> "The one the farthest away from the equator."
>
> "What about where it's white in Greenland?" a student asked about Greenland. Biomes on the map were identified by different colors. White indicated that no biome had been assigned.
>
> "I haven't been able to figure it out," she admitted, "maybe nothing grows in it."
>
> "How many biomes are there?" a girl asked.
>
> "Eight."

"I only see six," the student challenged.

Mrs. Chambers looked through her handout on the biomes, "Are the fresh and saltwater biomes on there?"

"No."

Mrs. Chambers continued talking about the project, how she would get them maps of the world that they could use for coloring their biomes.

"I'm not trying to be funny," Mark started, "how come in Green Bay they call it the frozen tundra?" Mrs. Chambers asked him to repeat his question. "Why do they call it a tundra when it isn't?" Mark was 12 years old and a football fan.

During an interview later that day I prompted him, "you asked something about Green Bay."

"Yeah, in Wisconsin, the Packers they play football in the Lambeau Field and it's always cold and snowy there and they call it the frozen tundra. But, it's not really in the tundra, it's in the grasslands.

"Oh, OK, grasslands according to the map that was in your book?" I asked.

"Yeah, I think that was it. Or it was the, I forget what it was, not the grasslands, but the forest that Indiana's in, it's like up around there and then they call it the frozen tundra. I know it's really cold there, but I don't know why they call it that because it's not really the tundra."

"So, what made that pop in your mind?"

"I don't know, I just remembered watching the Packers and 49ers game on the wild card playoff and they called it the frozen tundra and it just popped in my mind," he explained.

Mrs. Chambers continued describing what was expected of the students in their presentations to the class and where they would find the information they needed. The students were quiet, with little fidgeting; some with their heads on their desks as Mrs. Chambers talked—unusual in that some did not use their arms as a cushion between the desktop and their head—the side of the head flattened on the desk. Mrs. Chambers asked questions that would prompt them to consider different aspects of their biome such as types of plants and animals included in the biome. Students were assigned to groups of three to work together, and each group was assigned a biome. At 11:58, nearly an hour after the students had returned to their room from specials (specials are classes such as music, art, and physical education which are typically taught by a teacher specifically trained in that content area) and began science class, they got into their groups and started working on their biome. I wandered around the room, catching snippets of conversations as the students organized themselves. The freshwater biome group was deciding who would make the speech. They would all make part of it, they decided. One of the girls would make a collage. The taiga biome group was working quietly, jotting down information from the book. In the tropical rainforest group, the girl was writing down information. The temperate deciduous forest group was sitting on the floor in the front of the room. "Let's start reading," Wendy, the girl in the group, said and started reading aloud from the textbook. The students worked for just short of 10 min and then were told to take their seats.

"OK," Mrs. Chambers said to her class at 12:06, signaling the end of the activity. The classroom was quiet immediately. I was surprised and I think Mrs. Chambers was as well. The students were told to take their seats and they did so right away.

My first observation was over; the session had provided a number of examples of students linking what they were learning with their prior knowledge. Mark's link to the frozen tundra wove his trajectory that included sports, gained through media sources, with an object in the classroom. The prompt for his link was the word "tundra"—the "thing" in the environment with which Mark engaged. The name of the biome (used as a label on the map) prompted his understanding of tundra, the map prompting his understanding of Wisconsin. Mark's understanding seemed in conflict with the map in the textbook, and the location of Lambeau field in Wisconsin. Mark had an understanding of the word tundra from a context different than the schoolbook description and map, although Green Bay can be cold and snowy. Tundra was a cue, the term that I have used throughout my research to label an element or thing on which a student made a link with his prior knowledge.

The term cue is often used when considering spreading activation, as described in Chap. 2. When a particular node of a network is activated, the cue is considered the source of the activation (McKoon and Ratcliff 1992). The cue may be presented as a "prime," meaning that it primes a particular aspect of the network which then spreads activation to related nodes (Collins and Loftus 1975). In my studies, a cue was defined as a stimulus that prompted these children to digress from the current topic to engage a personally defined, but related (at least in their view) concept. Given a semiotic lens, a cue was an element of an object-sign relationship; it was a thing in the environment. Tundra was an object for Mark that had meaning. Through Mark's question to Mrs. Chambers, he shared his interpretation of tundra [i.e., the meaning tundra had for him], and where it geographically may be located or not. For other learners, the word tundra and the associated map of its location may not prompt that interpretation. While some learners had object/sign interpretations, for some learners the object was merely a thing and offered no such meaning. In other words, there were various types of environmental stimuli (things) that functioned as cues (had meaning for the student) that linked seemingly tangential information that the students had to the content being studied. For other students there were no such links.

The forms of the cues fell into three broad categories: sensory, conceptual, and processes/structures. Further, some of these cues were from the content, whereas others were from other elements of the environment.

3.2 Sensory Cues

Although few in number, sensory cues were realized in a number of ways. First, aural cues were those cues that prompted the learner through sounds. These sounds did not generally include spoken words unless the *sounds* in the words were the cue. Some of the aural cues were direct sounds, such as a girl in Mrs. Olson's class writing that she looked up anytime she heard chalk on the chalkboard. The sound was just a "thing" in the environment, but the sound for this girl was an object embedded with meaning. It was a cue, linking something in the environment to

something that had meaning for the girl, that captured that complexity. Another way that an aural cue was apparent was in how something sounded like something else. Recall the link in Mrs. Olson's room between Saxons and the saxophone based on the "sax" part of the word or a first grader in Ms. Smith's class saying that walrus reminded him of recess (both of these cues likely stemmed from school dimension aspects of the students' trajectory). In some cases, cues that were aural in nature could be useful for learning. For example, in Mrs. Schneider's class, which will be introduced later in this chapter, a girl commented how the word "manuscript" reminded her of "a planetarium. No reason, it just does." Mrs. Schneider offered an interpretation noting the Latin roots of words. Homophones also fit within this category, such as when a girl in Mrs. Chambers' class was reminded of Honey-comb cereal when overhearing Mark talk about animals in the tropics eating wild bees and honeycombs.

Rather than the sound of a word linking to another word, the sounds of an activity can also link to music. Consider Jeffrey in the Temperate Deciduous Forest (TDF) biome in Mrs. Chambers' class as his group worked on their project in the following narrative.

> On Monday at 11:00, my second week of observation in Mrs. Chambers' classroom, the students were waiting to be dismissed small groups at a time to use the bathroom and get a drink of water before the school pictures were taken. During this waiting time, Mrs. Chambers explained about the presentations in general and students asked questions about their specific presentations. For example, Wendy from the temperate deciduous forest asked, "Do we have to memorize things, like on our cards?"
>
> "You don't have to memorize; you can use your notes. For some of the facts like rainfall, you will need them."
>
> Discussion continued about students being absent from school the day of their upcoming presentations and when they would make those up, mingled with ongoing discussion about the school pictures. When it was time for the class to have their pictures taken, they lined up by the door, tallest to shortest. They were in clumps, two boys, two girls, a bunch of boys, a bunch of girls, and three boys. Two girls come in and got in with the big clump of boys. "No talking," their teacher kept reminding them.
>
> Ten minutes later the students were back in their desks. "OK, so you know what you're supposed to do?" Mrs. Chambers continued the science lesson.
>
> "I left this on my desk," Roger said, holding up his picture money.
>
> Mrs. Chambers addressed Roger's comment and continued to ask if there were any questions. Once the students began working in their groups and practicing their presentations I watched the TDF group again, having watched the Fresh Water and Topical Rainforest groups on previous days. They were practicing their presentation, passing around note cards that they took turns reading. They had their textbook, an encyclopedia, and two books on the temperate deciduous forest scattered around them.
>
> "Time out," Brandon said and they organized their pictures a little better. Brandon read his note card. While he read, Jeffrey was looking around the room and Wendy was fiddling with her note card. Brandon had trouble reading some of the words on the cards; Wendy had handwritten them. They continued passing around cards, next to Jeffrey, then to Wendy, and back to Brandon. As he read, Wendy held up the collage and said "We'll show this at the end."

"What?" Brandon asked. She repeated her comment. He continued to read his card and she fiddled with the overhead.

Brandon stumbled over another word on the handwritten card. The three students tried to figure out the word that started with an "R". All of a sudden, Jeffrey, who was 12 years old, started singing the tune of "R E S P E C T" (a song sung by Aretha Franklin) using the letters in the word that they were trying to figure out. Later in an interview with Jeffrey I commented that he had sung during my observation of his group.

"Sang?" he asked.

"Yeah, did you know you sang?"

"Umm mm," he dragged out his verbalism for the word "no."

"Do you know the song Respect?"

"Mm umm," he repeated. "OH, YEAH," he exclaimed. "Well we just, they thought that that respifiging word or something and I tried to spell it out using those words so I just go be be deet duh de de deet," scat singing the tune he'd used.

"How come that popped in your head all of a sudden?"

"I don't know, I just,. .. that's just what came to mind. I was trying to figure out what word it was. And so I tried to take it one letter at a time."

"You never did figure it out did you?" I asked, "Do you sing a lot?"

"Mmmmm, not really."

The process of trying to figure out the word that started with "r", trying to decipher the letters one at a time, cued Jeffrey aurally and linked with Aretha Franklin's song. As their TDF presentation practice continued Jeffrey illustrated another sensory cue type, the function cue.

Wendy explained she did not know what the word was that they were trying to figure out; she just copied them from a book. Jeffrey looked in the book, "Are you sure, you got it from the book? Maybe it was from the computer?" They eventually decided that they would just leave a part of the card out because they could not figure it out. Wendy giggled as Brandon continued to read and stumbled over her writing again. Jeffrey read the next card, stumbling over words as well.

Wendy continued their presentation practice, "Now we're going to show some pictures of our biome." They had chosen their pictures on day three of my observation. Choosing pictures helped them better understand their biome. As they selected pictures of trees that would grow in cold environments (not palm trees for example), Jeffrey had consulted a handout they had about the TDF. "All we got is evergreen, and in the winter all the leaves fall off." Brandon thought about this, then saying "Oh, oh," as they started to search for pictures based on the new criteria.

Brandon picked up the collage they had made to show in their presentation. Jeffrey said they should all point at the pictures they would use in their presentation. He went to find something to point with, returning with half of a chalkboard compass—the type used to draw large circles and arcs on a chalkboard. Brandon went to the collage, saying what each picture was an example of, as Jeffrey used the chalked end of the compass to point at the pictures. Then, Jeffrey said something about a drum, tapping the compass part.

Initially, as Jeffrey sought a pointer for his group to use while they were practicing their presentation, the broken compass was a function cue, the object itself matching the meaning that Jeffrey had for a pointer. This was the case for Brandon later as well. When the group presented their information on the TDF on day 8, Brandon commented, "I need my pointer," and then got a small flag that was in the classroom. The two-foot pole that held the flag cued a particular function for use.

Although for Jeffrey in Mrs. Chambers class, the broken compass was identified for use based on a function cue, once Jeffrey had the compass in hand, another cue followed, his mention of a drum making this transition more transparent. I asked Jeffrey later in his interview, "What do you know about drums?"

> "Not a lot."
>
> "Because I saw you," I demonstrated by tapping my pen.
>
> "Oh, that's what they were doing, that's what that lady from Washington School came in and did. She said the Ireland drum and I sort of know how to do that," he showed how his hand would be to hold the stick. "You have to take your hand like that and go shwwwshh," he demonstrated.
>
> "OK, you said something when you were doing that, when you first got that chalk thing, you said something about some kind of drum?"
>
> "Ireland drum," he clarified.

Jeffrey's drum was realized as a tactile cue. The compass used as a pointer became a drum stick because of the tactile element that Jeffrey captured as he grasped the stick. This element, coupled with Jeffrey having recently seen a presentation on an Ireland drum provided the meaning for him.

Visual cues, another type of sensory cue, prompted students in a number of ways. These included visual cues that were merely the identification of an object, typically unrelated to the content, in the learning environment that tugged the learner away from discussing the content. For example, a student noted during the writing activity, "My hand is starting to hurt, I wish this were on the computer instead. Then when I saw my hands drooping I would think "oh no! must not get carpel tunnel!" My dad has that, and he has to wear those braces when he sleeps or types." Another girl mentioned, "I just happened to look at my mountain of books under my filebox and there is this really funny, cool, interesting book called The Measly Middle Ages." (underline in original). These visual cues point to visual aspects of the environment that link to personal meaning.

Although there were few visual cues identified in the sixth-grade data, an interesting one came from Ms. Smith's first grade class and points to how a visual cue can provide a "looks like" link for the student (Schuh 2007). Recall the excerpt described in Chap. 1 that included Mary's comment about the Gap bag. As Ms. Smith and the children continued the lesson Ms. Smith had held up a lavender sheet of paper, asking students how they could divide it fairly.

> "We saw a bag this weekend," Mary said. The teacher quickly acknowledged the comment and continued with the topic. She gave the piece of lavender paper to a boy, pointing out three children that the paper would have to be shared with.

> "Cut the paper," William, who was sitting in the front row, said.
>
> "William got the biggest clue," said Ms. Smith as she picked up the scissors that was lying on the table in the front of the room close to where William was sitting. "We could cut the paper to make a fair share. How would you do it?"
>
> "I would cut one like this and one like this," a girl demonstrated with her hands, tracing a horizontal and vertical cut on her hand. At the teacher's request the girl demonstrated again, drawing a cross with one finger in the air.
>
> The teacher cut the paper, cutting equally along the vertical, but unequally across the horizontal. "Do you notice anything?" she asked.
>
> "The bottom is long and the top, looks like an 'i'," Jesse said. The teacher was holding a smaller block above a larger block in each hand. The teacher acknowledged his comment in an off-hand way and continued her lesson.

Ms. Smith acknowledged William's function cue–his identification of the scissors to do the needed task for sharing the paper. After the piece of paper had been cut into the uneven pieces, Jesse encountered a visual cue and stated that the paper looked like the letter "i" rather than providing the answer Ms. Smith sought: that the two pieces were unequal. Jesse's interpretation of the two pieces of paper illustrates the importance that an object is defined from something in the environment when it is engaged by a particular individual. I was seated next to Jesse and it was also clear to me—although perhaps not from all areas of the room—that the two pieces did make an "i." Jesse's response was not a guess, but a reasonable explanation given what he knew (school trajectory dimension) and what was contextually appropriate given that a primary task of first-grade students was to learn letters. Although each child was physically seated in the same learning environment, things in the environment may be different objects for different individuals. What an object is may vary by seemingly small elements such as classroom seating.

Other visual cues came from the particular content that the students were studying. For example, many students in Mrs. Wilson's class, who were writing expository reports about a rainforest animal or sea mammal (Mrs. Wilson's class will be further introduced in Chap. 5), noted relationships in their writing between the animals they had studied and other people they knew. For example, a tarsier "grew fur like my nextdoor neighbor's head," and "The Proboscis monkey has a really long nose. It uses his nose to call out to each other. My dad has a big nose so dose my granddad" stem from family trajectory dimensions. "Belugas [a type of whale] have beady little eyes, like golf balls" and "My whale was the Minke whale. When it breeches it reminds me of a person doing the worm. Because the breach sort of looks like someone break dancing." While these students would have seen their animals in various resources while they worked on their expository papers, the open-ended writing assignment provided no visual cues. These visual cues were prompted from mental images as they worked on the writing. It was difficult to know if the students made these kinds of links as they worked on their expository projects.

The sensory cues were limited in the data set, which is surprising given how visually rich the environments in U.S. elementary schools typically are. Elements of

the visual things in the classroom seemed to prompt little personal meaning to the students, given what was shared aloud in class and in my interviews. The most prevalent cues noted in the studies were cues that were prompted by the words and phrases that the students wrote about or heard in the learning environment. These words could be cues for links, meaning they were potential objects, and as noted with the examples from Mrs. Olson's and Mr. Jackson's classrooms, that had particular meaning (a sign) that was different than what may typically be ascribed to the object. Mrs. Schneider's classroom is introduced next to provide a foundation for the discussion of conceptual cues.

3.3 The Middle Ages and the Students in Mrs. Schneider's Classroom

It was almost like going through a jungle. The entry way into Theodore Roosevelt Elementary was filled with huge green plants. Enrollment at Roosevelt Elementary School was approximately 600 students of which about one third of the students were from campus housing from the nearby Mid-Western University, a relatively transient population. The school was proud of their diversity and as I walked to Mrs. Schneider's classroom I noticed the huge map of the world on the wall, marking the homelands of Roosevelt's students.

The 26 students in Mrs. Schneider's class made up one of the three Advanced Curriculum for Elementary Students (ACES) classrooms in the school. Thirty-two percent of the students in this school received reduced/free hot lunch—only three of those students were in Mrs. Schneider's class. In addition to the three ACES classes (grades 4, 5, and 6), the school had five fulltime faculty/staff in special education and two pre-school classes, plus the "regular classrooms" for each of the seven grades (K-6).

This seven-week unit on the Middle Ages would continue from April 9 until the end of the school year. "You will be reading from now until the end of the school year. Two students are helping to organize the books on the Middle Ages. A lot of books here, so you might not need to go elsewhere but you can go to the library, they have stuff," Mrs. Schneider explained to the students. She was standing near the table piled with a variety of books on the Middle Ages in the back corner of the room by the aquarium and sink.

> Mrs. Schneider continued her introduction to the new unit, comparing how things would be similar to and different than the Africa unit that they had just completed. "In the bibliography, you need to give a main point. You need to say what you learned, not just that you learned a lot. Your assignment will be typed and completed by April 30, which is not too long from now. The second one is due by the end of May. You don't want to read randomly, you want it to tie into other things that you are going to do. You're going to be learning the vocabulary. You probably know a lot of them."
>
> "Oh boy," a girl said flatly.

"There will be a test on the vocabulary," Mrs. Schneider continued.

"This says Middle Age Vocabulary Number One," a student commented, looking at the handout they had been given on the unit, "is there another?"

"Yes, at least one more. I have five of them if we need them. You will put on a mini-play with other people." This evoked some noise from a student. "Let me know if you need to talk to me about it [working with other people], but you have to do casting and writing in class. In the past, they've done things on the Black Death. What do you know about the Black Death?" A student gave a summary saying that it was about rats and that many people got sick.

"What was the main thing that happened?"

"It killed one third of the population," a student offered.

Mrs. Schneider added, "From some specific areas. Also, the roles of women could be used in the mini-play, people think that women have been oppressed forever, but actually they weren't."

Another student shared what she knew about the Black Death. Another clarified that it wasn't rats, but fleas.

The teacher gave more ideas for the mini-play: knights, crusades, groups of people such as Jews being expelled during the Middle Ages, Moors in Spain, treatment of different cultural and ethnic groups. In addition to the vocabulary tests and the 10-minute mini-plays the students would also read historical fiction set in the Middle Ages, develop an annotated bibliography that used 10 sources, complete a craft project, and participate in a medieval feast.

Because this unit spanned 7 weeks, I chose not to observe Mrs. Schneider's classroom each time they worked on their unit. I observed 19 times. On the second day, Mrs. Schneider talked with the students about the blocks of time they had to work on their Middle Ages unit, "This morning we'll have a long work time while I work with literature groups. What do we need to do during work time?" The students listed a number of projects on where they needed to spend time. Mrs. Schneider continued to prompt them, "What else do you need to be working on?"

"Math," a student said.

"Everyone is missing what I'm thinking," Mrs. Schneider prompted.

"Middle Ages reading."

"Yes, what's due tomorrow?"

"Craft idea," someone said and discussion about that followed.

"You have to give a proposal on the file card," Mrs. Schneider reminded them. Questions and comments about the work and activities continued. Finally, Mrs. Schneider said that they had to get started with literature meetings, reminded them about signing out literature books, and then told them to keep voices and noise down. "We will meet with *King's Shadow* first, get your books out." Three boys and four girls moved to the table in the front of the room where they would have their reading discussion about *The King's Shadow* from which they had had assigned reading. A girl was sent to take the attendance slip to the office.

The students in the literature group started talking immediately as they got to the table. One student asked something about the book cover and they continued to talk about that. "First tell about the book and then I'll answer questions and I have some for you, too," Mrs. Schneider began. A girl gave a summary of the book, talking very quickly. She mentioned a raven in the book "He sees a man in a black cloak who was passed by a raven" and that this was a sign of bad luck. Someone else added, "a raven is supposed to appear when somebody else dies," and another, "A raven is supposed to take your spirit away when a person dies."

"Some birds are birds of prey," a student said.

Someone mentioned black as a symbol of death and Mrs. Schneider added that owls were considered a symbol of death. Lots of discussion continued including that only witches and outlaws were out at night in the forest.

"What do you think about their culture as far as their beliefs?" Mrs. Schneider asked. The students in the group said they were kind of superstitious.

"The mockingbird or raven sort of just reminds me of a black cat," Todd added and went on to talk about what people do when they have superstitions, adding that a canary would not have the effect.

"What else is associated with black?" Mrs. Schneider asked. A girl added that it was associated with death, evilness, and represented the devil.

The girl continued with the summary. "I knew right away I didn't like that one guy." Mrs. Schneider prompted with questions to help the students elaborate and understand the summary. The summary continued as Tracy and then Todd were called on to continue the summary of what they had read. As they continued to talk about Evan, the character in the story, and the incidents had happened to him, a girl commented, "I thought it was sad, I guess it was the time, he thought that his uncle was just leaving him there to die, and I think it's sad that he would think that. Like now in this time it wouldn't be like that. I understand but it's really hard for me to think about how it was."

The teacher explained, and said, "I'm sure you feel that way because you are empathetic; they thought it was punishment from God."

"I don't know if it was the Middle Ages, but they believe that if a baby died, it was because she was going to grow up to be a sinner," one girl said. Another supported this.

As *The King's Shadow* reading group neared its ending time, Mrs. Schneider said "Let's finish up," and asked another girl to continue with the summary. The other girls interjected, expanding on this ending summary. One girl physically demonstrated how the uncle wouldn't touch Evan while he fed him bread.

"I don't know what I feel about the lady," Todd said, "even though she seems mean, she seems comforting too. I think opinions of the characters will change."

"They call him Shadow, what kind of a name is Shadow?" a student asked.

"I was going to ask you that," was Mrs. Schneider's comment.

"It's like a slave name, a dog, she pets his head," a student explained, describing the indicator from the book. The discussion continued and a girl offered a prediction about what would happen in the book stating that "Evan becomes accomplished and has a good life and is not stuck as a slave for all eternity and then his uncle is going to come crying back asking for money for how I took care of you."

> "That ruins the whole book when they are nice to the bad people, like in Cinderella, where they forgive the bad person," Tracy exclaimed about the prediction that was made.

3.4 Conceptual Cues

In contrast to the sensory cues described previously, the students in the literature group in Mrs. Schneider's class linked on a number of conceptual cues as they discussed the story. Consider the discussion about symbols of death, black cats, and superstitions that was prompted from the story. As the students brought in their ideas they wove in their own meanings and interpretations based on their own experiences. Tracy's link to Cinderella was also a conceptual link. I had asked Tracy what made Cinderella come to mind when I interviewed her following the class.

> I don't know. When I'm in literature I just try to think of other things because lots of the sheets she gives us says try to think of other experiences that match with the book and, um, we were just making predictions, and we were saying, "Oh, the uncle is going to come crawling back to Evan when he learns to read." And that's sort of like Cinderella, and well, I said that Evan was going to forgive him and that's sort of like Cinderella forgiving her evil step sisters. She continued, "You know I've related a lot of them to Disney movies."

The cues were the words, and the words were the objects. However, in addition to the words having the cultural meaning given in language, semiotically the words also had a particular meaning that allowed the students to link what they were learning with what they knew. These verbal (in the classroom) or written (embedded in the students' own writing) were different than sensory cues in that they were conceptual labels. As in the example above, the children did not see the color black, rather they were talking about black as a concept that had some particular meanings relevant to their conversation, which stemmed from cultural understanding that they had gained elsewhere. For this study a conceptual cue was broadly defined to include anything that represented a similar "idea." Relative to classroom content, these concepts on which the students linked were the "ideas" or "things" they were talking about (for example, the salt-water biome, in this case is a concept, as is slavery). For the purposes here, even a person may be considered a concept in that a person has characteristics that define him or her (e.g., Lady Godiva is a concept). The conceptual links the students made varied in terms of being concrete, such as the ocean, or more abstract such as the human rights. They also included processes and structures, such as Tracy's link to Cinderella based on the structure of the story they were discussing (e.g., someone is ill-treated and then forgiven), indicating another type of conceptual linking.

Generally, in the classroom observations, these conceptual cues stemmed from the content, just as was the case in Mrs. Schneider's class. Content-related conceptual links were also evident in the open-ended writing. Students had been instructed to begin writing about the topic that they had studied during the research

study and many linked with that content. But as the students continued to write, many moved beyond the content, following paths of non-content related conceptual links. The student-added meaning came from a variety of trajectory dimensions.

3.4.1 Concrete Conceptual Links

In the student writing in Mrs. Chambers' class, students provided a number of links that stemmed from concrete conceptual cues that linked with family trajectory dimensions. One boy wrote, "The salt water biome reminds me of the ocean I went to on Winter Break in Jamaica." A girl elaborated about her experience with the ocean, "This [salt water] biome reminds me of when I went on my cruise in 1998. We skimmed across the ocean as if there was nothing there to stop us. It was wonderful! This biome also reminds me of when I went to Florida with my friend. Our condo was right on the edge of the ocean. We played in it every day."

Other students had experiences closer to home. For example, this student from Mrs. Chambers' class wrote about a nearby camping experience. "I thought the Temperate Deciduous Forest was very interesting. It reminds me a lot about camping last weekend when I went to Pinetree State Forest. I liked how the trees know when to let their leaves fall. I liked camping a lot." Another described his taiga experience, which was linked with his extended family.

> Taiga is the biome that I did. I liked learning about Taiga and all the other biomes. Tiaga is warm in the summer and cold in the winter it has large trees and little trees unlike the Tundra the Tundra has permafrost so big trees don't grow in it. But little trees do. Also Taiga has many different animals so do all the other biomes. Some biomes people live there some don't. One of my favorite animals in the taiga is the deer because I've had a little experience with deers and that experience was my aunt and uncle live down on the Westside and everytime I go down there I see the deer on the side of the road eating at the trees or laying down its realy fun to see because their right on the side of the rood in the grass.

Although this student did not live in the taiga (the taiga only touches the extreme northern parts of the lower 48 US states), he had an understanding of a component of the taiga. Another student in his biome group also had experiences with something similar to a Taiga occupant.

> TAIGA The Taiga forest has a lot of wood and animals. Animals include weasels, wasps, and many others. Once I was stung by an African hornet. I was stung in the leg, neck, and foot. I was fine but it was scary and it burned when I was stung.

Notice that in the first two examples about the salt-water biome, the students had experienced the biome itself and were linking to the entire ocean in general. In the Taiga examples, the cue for the learner was not the entire biome, but rather one animal (or insect) that had been identified with it. At times, it is the entire object that functions as the cue, at others it is merely an element of it that linked to personal meanings. While it might seem simple to have examples or experiences with an

environment (such as a biome), students in Mrs. Schneider's class who studied the Middle Ages also had examples from travels and other experiences.

This girl explained in her interview her experiences on a trip that her family took to Europe.

> But we went to this big fancy cathedral, and we went and saw the crypts and they were really gross because they find these huge blankets to just like drape over these people's bodies and there might be head, skull sticking out. It was really gross. But, there were all these people who were worshipping them I guess so we just stood respectfully silent in the back. And then we went to another cathed, another thing that, it was like a modern church type thing but it had these, and they had three saints and it was just gross. But it was kind of interesting. [What brought that to mind?] Um, well they were talking about getting the saint's bones so that people would take pilgrimages so I guess I didn't know it at the time that these people were taking their pilgrimages to see the saints and so I just remembered that.

Another girl in Mrs. Schneider's class wrote about the concept of cleanliness and fleas, other concrete concepts with which she had personal links.

> Most if not all people [in the Middle Ages] didn't bathe, and many didn't see pink hands on the end of their arms. Only brown and black hands [i.e., covered with dirt]. People ate off of these hands. And they wondered why they got diseases. This makes me think of an article I read (from a newspaper) it was about how people in France bathe a lot less than Americans. They use perfumes and cologns to cover the smell up. There were also problem such as [during Middle Ages] fleas and the cold. Even in Castles! I used to let my cat sleep on my bed. She had fleas and they jumped of off her. When I slept I would get dozens of flea bites. Never again will she sleep in my room.

For the students in these studies, most of the concept links were concrete links. There were a few links that were more abstract, e.g., human rights, or the ideas of slavery seemed most common, which will be described later.

3.4.2 Structure Cues

Some of the conceptual cues were structure and process cues, meaning that rather than the cue being a particular object, such as an animal or place, the cue was a structure or a process. Structures cues linked on how something was organized while process cues linked on how something was done. Tracy's Cinderella link about people being nice to bad people was based on the literary structure. A part of another book in Mrs. Schneider's class was noted as being similar in structure to a soap opera. Brenda in Mrs. Schneider's class found the structure of the Brother Cadfael mysteries to be like that of the plots in *Diagnosis Murder* (a U.S. television series). She shared in her interview,

> Yeah, because there was these guys that died and then the monk-religious guy reminded me of Dick Van Dyke [the actor who played the leading character in the show], and like he's trying to figure out who it was and he followed all of the little clues and everything. And the one part that reminded me a lot of Diagnosis Murder was when they were figuring out that

Simon was the killer and he ran away and they always do that in Diagnosis Murder. And, that just really reminded me of that.

Structure cues also made their way into the classroom instruction. In the following narrative from Mrs. Schneider's classroom, Mrs. Schneider leads the students in a discussion of the hierarchy of power in the Middle Ages. Note near the end of the narrative the embedded structure cue (relationship among chess markers) that is elaborated by the group. An extended narrative is included to further illustrate the culture of Mrs. Schneider's classroom.

Following a literature group on day 6, the discussion of the epic poem ended and Mrs. Schneider moved to the next topic, "I need a volunteer and it has to be a boy. I'm not telling you what it is. You just have to volunteer. He has to move to the front of the room." The girls who were sitting around the front table were moved and Todd was chosen. He moved the tall chair that was near Mrs. Schneider's desk to the front and center of the room. As he did this, the top of the chair pulled apart from the base. Some of the class laughed.

Mrs. Schneider called for another volunteer, "It doesn't have to be a girl." A girl was chosen. She moved to the front of the room. There was talking and laughing. This was Todd's wife. "5, 4." [this countdown was what that Mrs. Schneider's used for quieting the classroom, an object given the students response to it—it had meaning].

"The boy is the lord, the girl is the lady," Mrs. Schneider set the context. "It's a small manor. He does have knights and some vassals, what's a vassal?"

"I'll tell you if you let me be a knight," a girl said.

"What's a vassal?" Mrs. Schneider responded to her.

"Someone who vows loyalty to the lord," she said.

"Or to anyone who is above him," Mrs. Schneider adds.

"Pays the lord with fiefs," another added.

"What's a fief? This is all in your reading."

"It's a piece of land."

"Why is it a piece of land, and not like $500?"

"More valuable," was the answer.

"What can you do with land that you couldn't do with money?" Mrs. Schneider asked.

"Raise food."

Mrs. Schneider continued, "He's responsible for all the people on this land. He is also a vassal to who?"

The class replied in unison, "The king."

"Remember, feudalism started in France and it only slowly crept into the English system," Mrs. Schneider said.

"Where do the serfs fit in?" a student asked.

"We'll have to figure that out. They have children," the teacher chose a few girls, they were to pull up chairs, they could not sit on the floor. "Serfs go there," the teacher explained about the space on the floor. "The lord doesn't have any sons to secure his land, so he has to

think about that. The lord has a younger brother." She chose Tim, he was to sit up front but somewhat to the side. Tim was the second son. "What is his role?" she asked.

"He is an oblate," a student said and explained what she meant. Mrs. Schneider said that he was probably higher than that. The class started talking again. "You're not listening, I'm going to ask you to redraw this so please pay attention." The second son was a minor bishop since he was from a wealthy family.

"I wanna be. .," students hollered out.

"I don't want to hear that, next one I hear is out in the hall." The students quieted down. "The lord wants to secure his land, so will marry his daughters off to some nice knights here." Even the girls in the class wanted to be knights. Two boys were chosen to stand by the daughters. The class laughed at the matches.

"Can we try to be mature about this?" Bishop Tim said.

Mrs. Schneider agreed. She appointed another boy to accompany one of those knights, so if the lord went to battle, they would both have to go. "Who are we missing in this picture?" she asked.

"Serfs."

The role play continued and although the students only stood or sat in their role play, they were engaged in the discussion. The conversation continued as more members were added and their roles, as well as roles of other relevant people to the hierarchy such as the middle class, were mentioned but not depicted in the living representation.

Later in the role play, Mrs. Schneider explained, "If the lord had a son, he would ship him off to another's house to be a page."

"It would unify the community," a student added.

"Girls were sent off at age 11 or 12, a little bit later, to be ladies in waiting, trained in the arts on how to work. So you establish a community because if your son is living in someone else's house, then they are less likely to attack. So, you secure your land by securing people in strategic places. Very much like what? A game you're playing."

"Chess," the class said together.

"Who wrote about that in their paper?" Mrs. Schneider said.

"In chess, like, the queen can do the most. A lot of them can't do anything," a student commented about the queen's role in the game.

"No, women are very powerful in the way that they are used," Mrs. Schneider challenged.

"They're protecting the king," a student said.

"I just read a thing about women's roles and actually, the lady would rule the household, would take over the whole job if the lord was gone," a student commented, referring now to the people and not the game. "She would do the whole thing."

"And she would also, in his absence, she would have the right to make marriage contracts for the daughters. So there were roles. Moving the women around is what made them powerful and that's what the queen is on the chessboard, it's the movements she can make," Mrs. Schneider returned to the game of chess.

"How come the knight can jump?" a student asked.

"They move in these funny ways," another student added.

"Think about it, part of the movements are all different and that is exactly what they are trying to set up, that the movements of all these people in the feudalistic system are all very different that's how they're set up," Mrs. Schneider explained.

Bishop Tim clarified, "It's not the movement, it's the purpose of the people."

Another added, "I don't know if this is real, but I think the pawns are like the serfs, they are in the front line, and they can't go back from the front line, and they can be killed easily."

"And if they make it all the way across the board they get rewarded," the lord added.

"They can move up," Mrs. Schneider added.

A girl exclaimed, "They can become queen!"

"It's like you know how knights can go in the little L-shape over people and it's the purpose of the people," Susan clarified.

The bishop interrupted, "They make the movements different because everyone in that serves a different purpose."

Susan kept explaining her idea, "I know it isn't the movement, it's like the knights can go over people because they are going from one place to another, like getting a ransom and fighting for the king.

The bishop disagreed saying, "That's not it at all."

"Quietly push in the chairs," Mrs. Schneider said to the class. They were to have their snacks and get ready to go to art.

While Mrs. Schneider prompted the structure cue, the link between the classroom role play and the game that was one of the activities included in the unit, it was clear that once prompted the students linked based on their understanding of the game. Certainly, in terms of instructional design, Mrs. Schneider was strategic about the activities that she chose. However, that objects with attached meanings that were created stemmed from the students' engagement. Structure cues, such as this one, may be considered analogies. Analogic thinking may be considered in terms of depth; this example showing deep mechanisms of similarities (Brown 1992).

3.4.3 Process Cues

Another type of conceptual cue was process cues. Process cues captured similarities in how something was done. Very few of these were identified in students' activity. One was in Mrs. Chambers' classroom when the students began to work on their biome projects. Recall my first notes about the temperate deciduous forest as they began their project: "The temperate deciduous forest group was sitting on the floor in the front of the room. 'Let's start reading,' Wendy, the girl in the group, said and started reading aloud." In terms of the trichotomic semiotic system, the object in this was likely something similar to "learning science." Wendy's and the other students' trajectories were woven with understanding of previous science learning

in school and this guided their more independent learning. Gaining information by reading aloud was the process that this classroom used to gain information. Amy, another student in the class, described the typical science class, "Sometimes she teaches them fun but mostly it's boring, just reading out of the book." Wendy described the routine class in her interview as well, "She [Mrs. Chambers] mostly like, goes, like we do one lesson and she talks about it and she asks us questions and sometimes she just calls on people." When Mrs. Chambers introduced the project, explaining the parameters of it, a student asked "Can you do other things besides read out of the book?" also implying that the normal process for studying science was to read aloud out of a book. The particular object–learning science–meant a particular process to the students.

In Mr. Ritter's class (which will be introduced in the next chapter), two students drew on process cues in their computer use while working on their research project about China. Giana, who was writing about the Great Wall of China, copied information from Internet documents that she found through a web search into a word processing document. This was a different process than most of the other students used, who printed documents found on the Internet and then read and highlighted the information they wanted to use. During an interview with Giana later on the day that I had observed her work at the computer on her research paper, I asked her how she came up with the idea to copy information from the internet into her Word document: "Well at first I didn't really know of that and I was on the Internet one day, and I wanted to copy a picture and another student showed me how and I figured I can also do that with typing. And I figured I could just highlight it and do it like I am on a document." Likewise, Tyrone was going to include a picture of Confucius in his report. He had shared with Mr. Ritter, "In Kindergarten my dad had taken a picture and put it on something and it looked real neat." While Giana's cue was something like "using electronic attributes of information" that allowed her to link the new process with the prior learning, Tyrone's cue was something similar to "putting a picture in a report" and he actually lacked knowledge to understand how the process would work. Fortunately, another student who also was able to use the electronic attributes as an object, addressed this issue.

Although a large number of cues were noted in the data and they typically were unique in specific content given the particular learner and the content of the classroom, the forms of the cues were quite limited. There were sensory cues that were not word forms. There were conceptual cues, that also included process and structural cues. Using a semiotic lens, these cues were aspects of objects. And these objects *were* objects because of the engagement of the learner had with the information in the classroom. This experiencing of the content was tightly linked to the learner's prior learning. Given the examples in these first four cases (the classrooms of Mrs. Olson, Mr. Jackson, Mrs. Chambers, and Mrs. Schneider), the cues were generally concrete. If the concept itself was not, such as the literary structure cue of Tracy, the related experience given the learners background added concreteness. This is not surprising given the ages of the students, as they are moving from concrete to more abstract types of thinking (Piaget 1966). The students' prior learning that was linked via the cue was denoted by a small number of dimensions:

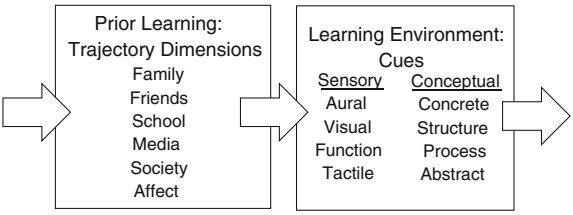

Fig. 3.1 Things in the environments may become part of an object/sign relationship or a cue given the learner's trajectory which is colored by residue from past experiences that includes encounters with various people and contexts (trajectory dimensions)

family, friends, school, and media. Other trajectory dimensions also included society, and affect, capturing the multidimensionality of what they knew, the heterogeneous features, and allowing for multiple entrances of the rhizome. Figure 3.1 provides a summary.

While knowing what the cues are like is useful in seeing that the students can be prompted to link what they are learning with what they know, considering *how are school content and what the students link related?* helps illuminate how the knowledge construction process takes place. We turn to that topic in the next chapter following the introduction to Mr. Ritter's classroom.

Chapter 4
How Are School Content and What the Students Link Related?

Abstract The students in Mr. Ritter's classroom are introduced with a discussion about current events facilitated by newspaper reading. The relationship between the elements of the students' prior learning and the new learning are described as being by example, by shared characteristics, spanning time (now-and-then), and spanning location (here-and-there), noting analogous links. Here-and-there links are illustrated through an extended example of Mr. Ritter's introduction to their unit on expository writing about the culture of China.

4.1 Current Events and Studying China in Mr. Ritter's Classroom

William Clark Elementary School was relatively new, now in its fourth year and was in a different state than the previous schools. Similar to St. Francis, Eielson, and Roosevelt schools, the local community had a large research university. Clark, with an enrollment of 450 students in grades K-6, had been built on the outskirts of town, awaiting an expanding population for the growing community. It had been architecturally designed to support teams of students (four teams) in four pods of the building extending from a centrally located library/media center.

Clark was a Basic School. The school's principal shared that the framework for the Basic school focused on the "Four C's": community, curriculum of coherence, climate for learning, and a building-wide plan for commitment to character (Boyer 1995). Although the school was new the teachers in the school were not all new teachers, but seasoned teachers from around the school district, a "wonderful staff," as described by the principal. She described the teachers as "persons who are willing to take risks," Mr. Ritter had taught for 15 years, 14 of which had been with fifth- and/or sixth-grade students. Because his classroom was a combined fifth-sixth

Schuh (2002) is a related article about Mr. Ritter's classroom and their expository writing.

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_4

grade classroom, this was the second year that the sixth-grade students had had Mr. Ritter as their teacher. Mr. Ritter's class included a number of students who were in the accelerated learning program (i.e., gifted and talented), and had no students with special needs who required IEPs.

> The 11 girls and 14 boys in Mr. Ritter's combined fifth- and sixth-grade class spent the first part of the morning talking about current events in the *New York Times* that Mr. Ritter had brought in. Mr. Ritter was causal in manner and dress, often wearing jeans and his hair buzzed close to his head. This was my first day in Mr. Ritter's classroom, a spring day—as had been all of my other first days of observations. The day began at 8:35; the day's schedule noted on the chalkboard. "Good morning class," Mr. Ritter said.
>
> The students responded in a kind of bored unison voice, "Good morning Mr. Ritter."
>
> Why, thank you. Say good morning to Dr. Schuh.
>
> They replied in the same bored unison response. "Good morning Dr. Schuh."
>
> I said "Hi" and continued taking notes on the laptop I had brought with me.
>
> "She's going to be hanging out this morning with you guys and to help me find my coffee cup, where is it?" Mr. Ritter said as he looked around the room. He found it and shared, "For something a little bit different this morning I bought a *New York Times* for news and then I'll get you into your newspaper assignment, talk about Jackie Hoover a little bit, have a nice Writer's Workshop, have a nice break outside—a nice day, come back in and do a block, eat your lunch, do another block, I'm not exactly sure, I think today is our day for the prairie barn [Clark is situated on a large outdoor area that includes a creek, woods, and prairie near the school] since we didn't have it yesterday. It may happen today." He glanced at the board where the days' schedule was written as he talked. A lot of the students started talking all at once. "I heard it was today, but we'll be flexible as usual. Let's find out who's here."
>
> Mr. Ritter took attendance and a student was asked to read the lunch menu selections of the day. Mr. Ritter counted how many students wanted cheese sticks and the alternate—a sun butter sandwich. Mr. Ritter's classroom seemed fairly similar to the other classrooms I had been in except that there was a sink and water fountain inside the classroom to the right of the door. To the left of the door were three built-in cupboards, followed by a counter with cabinets above and below. On the adjacent wall was the chalkboard, with a low bookcase holding various encyclopedias, other reference and textbooks, and a boom box on top. In the front corner of the room was a television. Mr. Ritter's work area was on the next wall. Not an official desk, but more of a modular counter top against the wall with a computer on it. In addition to his work area, the wall opposite the door had a big window, two big plants, a globe, some bones and skulls, and more counters and cabinets. On the fourth wall in the room, the wall that I sat near, there was a bulletin board and an aquarium with gold fish.
>
> Mr. Ritter continued, "The *New York Times* is a newspaper that's published in ["New York," someone interjected], New York primarily but also in different parts of the country. This is a national edition, which means that it's a little more on world news and not so much focused on news from the state of New York and New York City. It's an interesting paper, printed in Chicago so it can be delivered to Midwest sites on a timely basis. There's a whole heck of a lot of world and national news in the cover sections. I picked an article that I'll share briefly with you that's rather interesting. It happens to take place in New York. The title of it is "For Mentally Ill, Chaos in an Intended Refuge." Mr. Ritter went on to read the story.

Students listened while he read the article, many of them with head cocked to the side and head in hand so they faced him in the chair in the front of the room that was placed to the side of their desks.

"And this story actually goes on to page 20 where it takes about two whole pages, it's rather interesting." Allen had had his hand up for quite some time and was called on.

"Speaking of mentally ill people, this was someplace in town, this person was standing outside a house with a blanket and had all these garbage bags around her, then took it off. It was really weird. I didn't know if it was joke or she was mentally ill." Mr. Ritter turned pages of the paper as Allen spoke.

"Yeah," Mr. Ritter commented, "that's common in this area because of the treatment facilities that we have. Well, I'm going to leave this laying around, if you have time today and would like to look at it, feel free to. It's an interesting paper. Not much in the way of local news that would be more pertinent to you. But, it's still a good paper to look at." He put the paper down. "Speaking of local news I'm going to have you look at," a student interjected, announcing that this isn't local, but there had been someone inducted in the Hall of Fame.

"Oh yeah, I heard that on the news," Mr. Ritter acknowledged. "What's going on along the Mississippi?" Students commented about the flood.

"Flood," he repeated. "Aren't they expecting even higher waters than 1993?" A student shared how it might be two feet higher.

"It's hard for me to imagine this, look how nice it's been around here the last couple of weeks. We haven't had heavy rains particularly. All our snow is melted, yet we're looking at these record floods. Muriel, are you," Mr. Ritter began.

"This is about something different." Muriel commented.

"Go for it," the teacher said.

Muriel mentioned that she had heard about the smoking ban that was being proposed for restaurants.

Mr. Ritter explained further, "I think a lot of the local restaurants may voluntarily have a smoking ban, I know a lot of them do. It may become an official policy. Emily?"

Emily returned to the topic of the flood.

"Right," Mr. Ritter said. "Along the Mississippi river there is an island just north of Guttenberg," Mr. Ritter got up from his chair and pulled down the state map in the front of the room, "where a friend has a vacation home and the whole island was voluntarily evacuated. Where did Guttenberg go?" He located it on the map and pointed. "Arial photographs of the island showed that you couldn't get to the houses unless you had a boat. You couldn't walk it, you couldn't drive it. Real nasty situation. A house soaked in water will never be the same. We'll keep going, I'll pass out some local papers." Mr. Ritter passed out a copy of the local newspaper to each student as he talked. On Wednesdays they received a full classroom set.

Allen returned to the topic of smoking, "… you know if you get throat cancer because of cigarettes, you know how they have to put a hole right there, [points to throat] because your whole throat, you can't breathe through it. My dad, he's a doctor, when he was just becoming a doctor he had this one patient, he was so addicted to smoking he would stick the cigarette in the little hole and smoke it. He died of throat cancer, lung cancer, and some other smoking-related illness."

"Makes you think of the power of addictive substances, like nicotine," Mr. Ritter added. "It's a legal drug and it's one of the most, as far as lives lost to disease and healthcare cost, right up there with alcohol as most popular and lethal drugs. Joey?"

The local papers that the students received each week were distributed and Mr. Ritter was back in the chair at the front of the room as Joey continued the conversation about smoking, "You know that smoking thing, there's a commercial that comes on and this woman talks about when she started smoking when she was 16, and she's talking how bad it is. Then you look down, well the camera looks down, to the hole in her neck and she puts a cigarette up there, and takes it out, and the smoke comes out. It is so nasty."

Students started thumbing through the papers.

"Jade what do you have?" Mr. Ritter asked.

Jade shared a story about the flood water that she'd seen on Good Morning America where a person was standing waist deep in flood water in a parking lot.

"Nasty," Mr. Ritter commented on the story. "One more, then we'll look at this paper and I'll tell you what your assignment is going to be. Jared, what do you think?"

Jared returned to the topic of cigarettes as well, although it was impossible to hear the details of what he said because of the nearby sound of a student sharpening a pencil.

"That's a good one," Mr. Ritter said. "Take a look at the paper, at the cover page; I'm going to give you an assignment that is due on Friday. Just want to look at the paper a little bit to let you know what's in here. I want you to pick some articles and somehow show that you read them. Maybe a summary, maybe a critique, maybe an opinion. There are a lot of good things to look at in the paper today.

Mr. Ritter's class seems to follow a number of topic threads on current events at one time including mentally ill, a flood, and smoking. As students bring up their ideas and comments, they are cued by either the notion of sharing news, which brings topics such as Hall of Fame and smoking to the table for discussion, or cued by the content itself, such as elaborations about smoking and the flood. These cues are conceptual cues, rather than sensory cues, and the students are sharing aspects of their trajectories that deal with family, society, and media.

Given a student with prior learning, a potential cue in a learning environment prompts an integration of what the student is learning with what they already know. Labeling the forms of the cues and the trajectory dimension provides limited information. What is missing in this interpretation is how the new learning and the prior learning relate to one another. In other words, what is the relationship between the learners' trajectory and what is being talked about in the learning environment? How do they mesh? What does the prior learning add?

4.2 Linking by Example

In this first narrative from Mr. Ritter's class the discussion on current events provided an opportunity for students to provide additional information about the topics that were introduced. Allen's link to Muriel's news item about a smoking ban

follows from the cue "smoking;" but includes added information about the hazards of smoking, given information he had learned from his father. Then, Joey continued and added further to the discussion drawing on a media source and provided another example of the hazards that Allen had identified and Mr. Ritter had supported. Students often had examples to share that linked with the cues; what allowed them to experience the object in the classroom was the experience that they had regarding the cue from various dimensions of their trajectory. In fact, in my second observation of Mr. Ritter's class, another student returned to the topic of the smoking ban, sharing that she had gone to Wisconsin and every restaurant was smoke free. Joey added another example related to the smoking ban in that conversation, "Well, we know a person, um, like my mom, she's a dentist, she had a patient who didn't have a filter and her teeth were all black and they were all charcoal so when you hit one it would crumble. It was really weird." Recall the concept cue examples from Mrs. Chambers' class mentioned in Chap. 3 about the biomes the students studied. Many of the students had traveled to areas that exemplified the characteristics of the biome, some gained through traveling with their family and others through more local experiences. This was the case as well for the student in Mrs. Schneider's class who had visited the crypts in Italy. Students had other examples pertaining to Middle Ages topics in her class as well. A student and Mrs. Schneider had been to places where there were monasteries. A student in Mrs. Olson's class recalled the Chicago Museum of Art in her writing, linking to the art that was mentioned in their discussion of Charlemagne in the Middle Ages. While Mrs. Wilson's class (who will be introduced in Chap. 5) studied sea mammals, some students had seen dolphins and whales at places like Seaworld, had read about them in books like Moby Dick, or had seen the movie *The Whale Riders*.

4.3 Linking by Shared Characteristics

Many times the learner did not have a full example about the link between the content in the learning environment and the prior learning, but rather noted shared characteristics between the content in the learning environment and something from their trajectory. For example, Brother Cadfiel, the character in the reading books in Mrs. Schneider's classroom was observant like Sherlock Holmes was. These shared characteristics links were prevalent in the open-ended writing activity in Mrs. Wilson's classroom where students had written about sea mammals and animals of the rainforest. Students often made these links in the writing activity for this research project, typically beginning their paper with descriptions of their animals, just as they had typically opened their expository paper with descriptions of their animals. As they considered their description of their animal, their understanding of the characteristic was revealed through their link with someone else. A fifth-grade girl related many characteristics of the howler monkey she studied with characteristics of her father.

> My rainforest animal was the howler monkey. Howler monkeys are named for their very loud howl. Their howl reminds me of my dad when he sings opera. My dad sings opera a lot!… The howler monkey is very independent. My dad is also very independent. He does everything inside and outside of the house. My dad cooks, cleans, and gardens. Howler monkeys don't garden or clean but they do hunt for themselves and for their loved ones.

In the second year of the study in Mrs. Wilson's room, this same girl, as a sixth grader, continued to link her learning to characteristics of her father. "The sea otter is very handy. They use tools to fix their meal. The sea otter reminds me of my dad because he really likes to cook but he has little hair on his head. My dad likes to fix things. Bob the Builder fixed things too." Many students typically showed the same kind of links again and again in their writing. Surprisingly for this girl was the strength of family in that in both years of her open-ended writing she linked to her father.

Students linked the animals studied with other family members based on shared characteristics as well. "The jaguar reminds me of my sister, because she is very mean…. The toucan reminds me of my mom because she is usually very snappy" and "Blue whales are very, very loud-they are the loudest animal in the world, and my baby sister is very loud too. She screams and cries and talks a lot." They also linked characteristics to friends and neighbors. For example, "The beluga whale is like my neighbor; they are both curious and annoying. Sort of like sponge bob," and this more elaborated comparison.

> When I think about the Bottlenose dolphin I think of my neighbor. She is always playful and she always wants to help people out of trouble and she is always curious and wants to know things she doesn't know. If we are hiding something from her, she always wants to know what it is, just like dolphins. They always are curious and go into places they have never been to… Dolphins remind me a lot of humans because they are mammals and humans are too. They all act the same. My sister is a very jumpy girl and she gets into a lot of trouble. Just like dolphins."

Friends links included, "The squirrel monkey has a lot of angry. Like my friend" and

> I picked the tarsier because he has a unique name to him. The tarsier is interesting because he hunts at night and is nocturnal. That reminds me my freind never goes to sleep so hes like nocturnal to But the tarsier has very good eyes and only sleeps during the day why that reminded me because the tarsier only sleeps during the day and go gets its food at night that what my freind dos because theres nothing to do at night for him.

Students also compared their animals to pets, noting similar characteristics such as fur texture or color or behaviors. One student in Mrs. Wilson's class provided a list of cues himself as he described the Narwhal (his sea mammal), which prompted links to his animal of the rain forest from the previous year, the spider monkey. In this compare and contrast (see Table 4.1) between the two animals the student himself provided the object in his own writing. That writing provided a conceptual cue, which then prompted his prior knowledge of the spider monkey from the previous year based on characteristics.

While Mrs. Wilson's students' remindings in which the links were of shared characteristics were interesting and entertaining to read, students in Mrs.

Table 4.1 Students self-generated cues that prompted a compare and contrast between content across two different years of school linked by shared characteristics

Narwhal (student's writing)	Hypothesized concept cue (researcher added)	Spider monkey (student's writing)
Narwhal has a tusk which is its left tooth	Unique characteristic	The spider monkey has a prehensile tale
Narwhals have been here for centuries	Location	Spider monkeys is a new world monkey
It is a member of the white whale family	Membership	Spider monkey is a Clapicun
The narwhal lives in the ocean	Habitat	Spider monkeys live in the jungle
Narwhals live in a group of 20	Social group	Spider monkeys live in groups of 20
Narwhals get hunted easily	Endangerment	Spider monkeys avoid danger on the jungle floor
Narwhals can swim real well	Swim	Spider monkeys probably can't swim
Narwhals have two teeth	Teeth quantity	The spider monkey has more
The Narwhals tusk is made of ivory	Teeth material	The spider monkey's teeth are bone
Narwhals are endangered	Endangered	Spider monkeys aren't
Narwhals are brown with dark brown spots	Color	Spider monkey has black fur and white fur on its side
The narwhal means "corpse whale" in old Norse	Means	The spider monkey doesn't have a meaning
The narwhal can hold its breath for 20 min	Breathing	The spider monkey can hold its breath a lot less
The narwhal does not use its tusk for barely anything-	Function of special feature	The spider monkey uses its tail to swim on trees
The narwhal's life expectancy is 50 years	Life	The spider monkey hits puberty when its 5
Females do not have a tusk	Gender differences	Male and females both have same Features
Narwhals turn whiter with age	Age	The spider monkeys don't show signs of aging
Narwhals are valuable	Valuable	Spider monkeys are valuable to, just not as valuable
Narwhal's skin is rich in vitamins	Skin's strong feature	Spider monkey's skin is rich in fur
Narwhals predators are polar bears and Orcas	Predator	The spider monkey's predator is a eagle
Narwhal's tusk spirals in a counterclockwise direction	Unique characteristic and direction	The spider monkey's tail can bend in any Direction

(continued)

Table 4.1 (continued)

Narwhal (student's writing)	Hypothesized concept cue (researcher added)	Spider monkey (student's writing)
Narwhals are small	Size	The spider monkeys are even smaller
Narwhals are hunted by Eskimos	Hunted	Spider monkeys are hunted by poachers

Schneider's class made links with other events in history that they had learned. Although the students often did not mention where they had learned the information, it seemed likely that these shared characteristics links were built with other school or church learning. For example, Brenda noted in her writing that, "It [Middle Ages] sort of reminds me of my church's history. Mormons were not liked by many in the 1800s. They were expelled, killed, persecuted, although millions didn't die like the Jews did in World War II. They didn't do anything like the Moors. Neither group did anything! But that's life."

Other students make more abstract conceptual links between the plight of serfs in the Middle Ages and slavery in the United States. For example, one girl noted in her writing,

> From what I have learned, the Middle Ages were a big influence on the modern world. The Middle Ages had lots of war. Women were not usually treated fairly. By that I mean that they were beaten, "bought" for marriage, and had to obey their lord. This reminds me of slaves, here (when there were slaves), except it wasn't just women, but also men and children who were "bought" and beaten.

Another student in Mrs. Schneider's class also make a similar link in her writing first talking about the serfs and finally ending with a comparison of Middle Age peasants and merchants being like our middle class.

> I liked learning about the Middle Ages because it taught me about life before telephones! The society interested me most, because your status depend entirily on how much land you owned or were heir to. The lowest in society were the serfs.
>
> They owned no land. They had to live off of a lord's land and eat their lord's food in exchange for his labor and his families.
>
> They were not considered free.
>
> They were almost like slaves.
>
> Slaves remind me of the way African-American's were treated in America not so long ago. How awful that was! They did not have rights and were not treated well, either. Anyway, serfs were the lowest in society. Then came common peasants and merchants. They only owned a small plot of land, and they had to earn a living by either farming or making crafts to sell at markets. life was very hard for them as well. They lived in small houses made mostly of wood (They had a curfew, which means "cover fire." This was a time of night when all fires were put out so the wooden houses wouldn't burn down). These people that worked for a living are considered part of a middle class that began to grow rapidly during the Middle Ages. These people were sort of like the working class in modern times.

Because of elements identified by students providing the linking cue, they were self-linked with what they knew. Although the learner identified these links, some experiences, such as the comparison of the narwhal and the spider monkey, and the Middle Ages and slavery were based on previously learned school content. Of course, these links have varying levels of sophistication, which will be discussed in Chap. 7.

4.4 Linking Now and Then

The relationships that the students in Mr. Jackson's class made often employed a linking strategy that compared their current life with their understanding of Roman life. Recall the class note-taking session in Mr. Jackson's classroom in Chap. 2 in which the students discussed the role of family members in the Roman Empire. While Mr. Jackson focused the discussion on the Roman family, the students were making comparisons using shared characteristics with their own families. This was apparent for Sally in the class session, and she had corrected her misaligned understanding by the time I interviewed her. Other students noted their comparisons in their writing. "It reminds me of my dad because the Roman dad makes all the decisions. I think it is the same in (our city) because goods were sold there, laws were made, and ceremonies were performed. This makes me think of my sister and I because the Roman children go to school like we do." Cindy also noted differences in the roles of family members in her writing,

> In the Roman household the father made all the decisions, the mother took care of the children, the wealthy children when to school and slaves did all the chores. In my house it's quite different because my mom does the decision making my dad goes to work, my brother and I got to school, and I do the chores.

Cindy was adept at linking family and pieces of her trajectory with Roman history in now-and-then links. In addition to the link about family roles, she noted that her aunt Betty was "pretty wealthy" making a comparison with patricians in Roman times being wealthy nobility. Notice how, in her open-ended writing, she linked (conceptual links and an aural link) through a number of topics (including a video game) and then returned to her aunt Betty and relevant information about Roman society.

> An atrium was like a collaseum. I would have liked to see a gladiator fight, mostly cause I love big cats. The gladiator would fight lions and tigers. That makes me think of this game Tomb Raider cause in that game there's a coloseum and there's underground cages where they kept lions, and Lara Croft got to go down there but she had to kill lions!? ☹ I love tigers and I really want to be a personal vet for 200 animals like lions, dolphins, killer whales, and especially TIGERs, cause these are my favorite animals! I'm an animal person if you can't tell. Tiger remind me of Tiber and that's where Rome was situated, along the Tiber River! I guess the Romans got there water from there through aqueducts. I would have liked to take a bath in one of their baths. I suppose it would be like getting in my aunt's new Jacuzzi and gossiping with her. It's nice too, so I can't wait till I can remember my bathing suit and goget in it.

As she ended, it was clear she understood the role of the public baths in Rome, being large tubs of water in which multiple people would sit and socialize. Mr. Jackson had pointed out the social role of water in class while indicating that the pictures in the books had information for notes as well, found in the day 5 narrative,

> "The second question on page 236, what was the relationship between water and community in Roman life?"
>
> A girl read a number of sentences. "OK," Mr. Jackson said, and called on the boy in the first row.
>
> "Didn't get that far," he said.
>
> Then he called on Chuck who read that "the relationship between water and community was that water helped build the roman culture," stating that he found it on page 236.
>
> "OK," Mr. Jackson confirmed and called on another student.
>
> The girl who was looking for something read an answer similar to the first girl's.
>
> "One more person; one more brave volunteer," Mr. Jackson urged.
>
> "The aqueducts provided water to the town," a boy answered.
>
> "Well, I say actually, you are both on the right track, my first part says that aqueducts brought water to Roman baths. Remember the question," Mr. Jackson repeated the question, "What was the relationship between water and community in Roman life," stressing the word of community. "Community makes you think of groups of people, what did we say yesterday, look at the size of the bathtub. Yesterday we said it looked more like our modern-day pools. Remember they said, it was in the book, I remember we talked about it, it was not just to get them clean, but what else was the bath for?"
>
> "It was a place to socialize," a girl offered. "That's exactly right, it was a place where they could socialize. It was mentioned in the movie last Friday, it was mentioned in the book so that's how I finished it," Mr. Jackson read the answer he had in his note, ending with "it's a social center." He explained how people would get caught up on the news, "who's doing what, who's going with whom, who broke up with who." A few kids laughed.

Although we do not know if Cindy was remembering this conversation when she completed her open-ended writing or if perhaps it was Cindy who commented about the baths being a place to socialize, the same kind of link occurred in a number of different sources, pointing to the salience of the link. This 12-year-old girl used as strategy similar to the one used for the narwhal-spider monkey comparison described previously, linking the Roman family with her own on many characteristics and evaluating her own personal attributes related to the characteristics of the Roman family.

> This Roman life is strange because we don't call ourself plebians or patricians, we just call ourself ordinary people. It's also kind of similar to our lifes because they go to work just like us. They also go to school. Another thing that is differ is that only the father goes to work in Rome, and the mother and the father both go to work. The mother stays home and does house work, like they do laundry and clean up what is messy. The children go to school and try to get an education…. I would definetly have to say that I would hate to be a mother in Rome. I don't think that I would have enough patience to do something like that. I would not have the patience to clean up after my kids like that every single day. I would

> not like to fix supper, lunch, or breakfast because I would not like it. Especially not breakfast I am not a morning person. I am sorry that I only talked about the household, but that was the only think that popped into my head."

The now-and-then linking among Mr. Jackson's students included not only family characteristics, but also other components of Roman life. Others had linked to the idea of the community bath, as Cindy had. One student mentioned in his open-ended writing that his aunt's hot tub was like the Roman baths, both used for socializing, while another student stated, "Romans have a bigger bath tub than we do. We can only fit about two but their bath tub is like a swimming pool." Others linked the gladiators in the Roman Empire with American gladiators that they have seen on television. Marcus noted in his writing that "In the gladiators there in Rome they fight till the death here in America we don't." The content of Mr. Jackson's class lent itself to these comparisons, as did the content of Mrs. Olson's class. Yet, there were few now-and-then links in Mrs. Olson's class, although one student linked the Vikings burning of homes and churches linking with the current rash of church fires that was taking place in their town. Other students did make links between the Vikings and current times, but not in a seemingly intentional way. For example, that Vikings used boats reminded students of a party on a boat.

The content in Mrs. Schneider's class also positioned the students well for now-and-then links. One linked the idea of Black Death with AIDS in her writing ("once you got it, you never recover"). Another noted the role of men and how boys currently play,

> The Middle ages was a time of warfare all the warfare was, done by the men, even now boys play with guns (fake) and swards, they always play "shoot um' up games. I should know, I have two older brothers (YAY!)

Another talked about the differences between marriages now and then–how they were previously arranged and how young the girls were, noting that young girls her age were often married through arrangement in the Middle Ages explaining, "yes, that is one of the bad things about being a lady. if I lived in the Middle Ages, by now I would be married to a guy who is 10 years older than me. Now THAT is scary!"

Brenda also used the now-and-then link in her writing.

> I think that the Middle Ages was a good time, despite what other people think. It wasn't perfect, but neither is our time. I guess there might have been just as much violence, but they did not have the technology to enhance it. No bombs, no guns. Knifes, axes, more gruesome things.
>
> People threw their slop in the streets, many people died. Other people had a good old time. Rich people. No money, no fun. It's like now, too. Poorer people live in simple houses, huts, shacks. If you don't have money, you have nothing, here, anyway. In some countries, in small villages and such, do people care how much money you have? No, it's land, family, and worldly posessions.
>
> That's the way wealth was measured in the Middle Ages. The Middles Ages was like now, in so many ways! People were the same too. In our literature books, for example, they had

> feelings. In plays, in pictures. But the people expressed themselves in art, music, writing, the same ways people do now.

Brenda elaborated a now-and-then link in the day 6 class session I had observed as well (described in previous chapter). Mrs. Schneider explained after she had appointed a monk and three nuns in the role play which later became the discussion that linked chess and the structure of power, "The middle class is separate from the manor, but have an obligation because they would have to pay taxes to the manor.

> A student commented, "Some pay tithes to churches, some of us still do."

> Brenda further explained, "you pay a certain percent of your income to the church."

Now-and-then linking drew on various trajectories of the students, oftentimes as in Brenda's comparison of the Middle Ages and now, the prior knowledge was generalized, stemming from living her life.

Earlier in that day 6 observation in Mrs. Schneider's classroom, the students themselves turned the discussion to share their now-and-then linking.

> A girl was called on to give one point: "Charlemagne fought for seven years against the Muslims in Spain but he still couldn't conquer them." The Mrs. Schneider called on another group.
>
> Tracy spoke, "The king of the Muslims pretended to make peace ["Marsile is the name of the king," the teacher interjected] with Charlemagne." Mrs. Schneider wrote "King/Saracens" on the board; adding that he pretended to make peace with Charlemagne, although they didn't.
>
> The next group added that they wanted Roland dead. "Why?" Mrs. Schneider asked. The student explained who Roland was, the nephew of Charlemagne.
>
> "The legend says that," the teacher corrected.
>
> "He was one of Charlemagne's chief people, one of his advisors," Brenda added. Another group added something about his knights before Brenda continued, "One point not from the story was that he blew on his horn, and now they have their communication horn systems, so they have… it's very different but still the same,"
>
> Mrs. Schneider first quieted a group down that was talking, then commented that Brenda "makes an interesting point, how it is the same?"
>
> "They are still fighting," Brenda added.
>
> "They still fight over power," Ivy said.
>
> Mrs. Schneider wrote "power" on the board and commented about the communication that Brenda had brought up. Ivy mentioned again that it was power, but Nicole said that it was land.

I asked Ivy about this class discussion in an interview. After she affirmed the comparison I asked her what made that come to mind,

> "Um, I just sort of, well, it's something I kind of think about a lot, I just, I, well, because, well, because of what we're studying in social studies and, you know, I look at it and say, well the wars are really different because no one had what they have now, but it's still the same idea."

When I asked her if anything else had come to mind during class, she noted that sometimes things did, but she often forgot them before she shared them. She then outlined her linking process,

> Well, sometimes this isn't really the same idea, but [pause] oh, I'll, a lot of times I'll make comparisons with today and then like, for instance, like we were talking about today, how there were all the different, how there were the lords and then, and the ladies and all that. Um, well, I thought about how it's not, people don't really do that much anymore, but there's still like poor people who we don't really respect that much. And, basically, that kind of thing.

Thus, as with general characteristics, linking now and then was a strategy that students used to link what they were learning with what they knew given appropriate content. While the social studies content in class seemed to lend itself well to prompt now-and-then links, content in other classes prompted more here-and-there links.

4.5 Linking Here and There

While there were fewer examples of here-and-there links in the data than now-and-then links, they were prompted when discussions and content focused on other places. Here-and-there links did not span time as much as they spanned locations. A student in Mrs. Olson's class commented in her writing,

> When I think about different countries, it makes me things [think] of last spring break when my parents went to London. They went to all the major places and ate alot of English food. When they were there they visited one of there friends that lived in the country side. Her daughter (who was three) came downstairs and asked for an apricot. My parents thought that that was funny because my sister and I would never ask for an apricot for dessert. My parents called us to tell us about the stuff they did.

Students in Mrs. Chambers class also linked between locations, for example this student's link about the Taiga, "I also like the tiga because it reminds me of here the weather is always changing."

Mr. Ritter's sharing of the article about mental illness from New York Times in his class and Allen's link to a presumably mentally ill person near his neighborhood was a here-and-there link as well. However, it was not just in current events that Mr. Ritter fostered integration of ideas—in other words, creating links across content. Although the links in Mr. Ritter's current events discussion were their own developed here-and-there links, Mr. Ritter crafted the first day of the students' discussion on the China unit to foster that type of linking process. Mr. Ritter used a type of Writer's Workshop where students were provided an autonomy-supportive writing environment in which students could choose tools for writing, drawing on electronic and/or print resources located in the centralized school media center. The writing task was introduced directly following the current events discussion described earlier on my first day of observation in Mr. Ritter's class.

"OK, I want to switch gears a little bit, remember Jackie Hoover, my former student, who is in Beijing. What I want to do is start a research project that you will identify for yourselves. We may have 26 different projects and that's OK. About something in China so we can better understand what she's doing over there and how she fits in the culture there or how she doesn't fit into the culture. But, I think a good place to start might be to identify some components of a culture. Don't think about China right now, think about the United States. We batted this around before." Mr. Ritter wrote the word culture on the board. "What makes us a culture? Are there different components of a culture that identify us in some way as Americans? Allen, start us out."

"Our media," Allen said.

Mr. Ritter wrote media on the board and expanded Allen's idea, "Which would include newspaper, print media, movies, cable. That's all considered media. We talked about this yesterday a little bit; we talked about in the context of how media influences our action."

"Our rights as human beings," a student suggested.

"Yeah, how can I write that down on the board, how can I write that?"

"Government," someone offered.

"Good, I know that government is very board but through our government we have many rights as citizens that as we start to compare it with other countries, other countries don't have near as many rights. We have the right to speech, we have the right to comment on and criticize our government if we choose to do so. Remember in her e-mail Jackie sent a couple days ago, saying that she thought she found pen pals but they need to get special permission from the government to e-mail you guys. Do we have to do that? No, absolutely not. Interesting. What else? We have media, we have government. What other, what do you do? Think of your daily lives."

"What we eat," another student said.

"Take a look at our food," Mr. Ritter said as he wrote food on the board. "Our eating is different than other countries; we have a lot of fast food. Lots of our food is not considered healthy, a lot of saturated fat. You're not going to see that in a lot of other counties."

The students continued to offer ideas, Mr. Ritter accepting them and writing them on the board, often commenting on what it might be like in America or that the topic was something that he didn't know about. As the students shared topics Mr. Ritter also pointed to the types of varying resources that could be available for information.

"Would violence be one of them?" Jared asked.

"Ooooo," Mr. Ritter drew out the sound.

Allen interjected, "They have violence there too."

"Still, not as much," Jared commented.

"That would be interesting," Mr. Ritter said while the boys' conversation continued around him.

"Not as much as America," Allen said skeptically.

Mr. Ritter's voice dominated, "That would be interesting to compare violent crime between the China and the United States or violent crime between Beijing and New York City."

Allen tried to speak aloud as the conversation continued around him, "All communist countries, all communist countries, it's all communist counties are run by the military so there are a lot of people don't like communist countries. Because most of China, there's like civil war," his voice trailed off.

> "OK, that would be a real interesting one to follow up on," Mr. Ritter said. "Maybe compare a country with a country or a big city with a big city. I wonder how much the country of China, the national controls that kind of information, if it's easily accessible. We can get on things like the US Bureau of the Census and Center for Disease Control in Atlanta that would give you information on things like gunshot victims and homicides. I don't know if there's an equivalent in China, I don't know if you can readily access that information but it would be fun to try."

While Mr. Ritter prompted the here-and-there links through whole-class discussion, some students built these connections as they continued the unit. For example, in Carey's open-ended writing in Mr. Ritter's class, she noted the difference between schools here and schools in China.

> In china the preschoolers every day get lessons in math, language, and cultural presentations are given in small groups. I thought that this was very unusual, because in the United States the children get to play games and learn at the same time, but they don't get strict lessons in anything spisific. Some times they even get to go swimming, wich reminds me that next year in junior high in Phis Ed for 1 trymester I get to go swimming.

Unfortunately, the site that Carey used was about a Montessori school in China, leading to likely misconceptions about Chinese schooling in general coloring her interpretation of Chinese schools.

4.6 Linking by Analogy

While the types of links, such as here-and-there and now-and-then seem almost too simplistic, they are straightforward in capturing the essence of how the students linked. The previous discussion of conceptual cues in this and the previous chapter reflect only a small representative sample of the instances of links from cues in the data. While there would likely be a number of ways that those cues could be understood, what became apparent as I considered and reconsidered the data was that the students' links could often be considered analogies. Certainly, given a simple description of analogy in which there existed a similarity between features of two different things, it seems reasonable to consider many of these linked relationships between what the learner knows and what they are encountered as analogous. Brown (1992) noted a developmental progression in terms of analogical thinking, where first students notice a common theme of some sort between examples. This seems similar to many of the conceptual links that the students in these studies shared. Later, students may explicate analogical relationships that noted deep similarities between things that share a common theme. In other words, the links created moved from simple or surface to deeper relationships. The depth of the relationships will be further explored in Chap. 7.

Up to this point, the data have indicated *what the students linked*, *how the linking process was prompted*, and *the various ways in which the students linked* (see Fig. 4.1). This linking process, given how knowledge construction was operationalized for these studies, is one of a cue (semiotically, a thing that becomes an

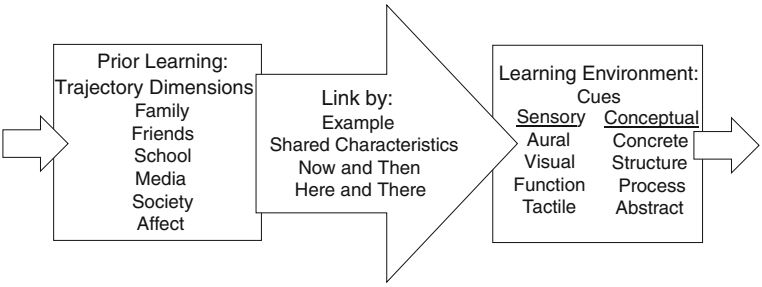

Fig. 4.1 When these students linked what they were learning (developed cues from things in the environment based on personal meaning) with what they knew as captured through the dimensions of their trajectories, they linked in a number of straightforward ways

object and sign because of meaning that it had for the learner) that is an aspect of something they were studying, That cue then allowed past residue of the learner's trajectory to provide additional meaning to the content, via an element in common between what the learner knew and something he or she was learning. There was meaning for the learner. At times the meaning added from prior learning came in the way of an example, or examples of characteristics of a larger thing. Depending on the content being studied, now-and-then or here-and-there comparisons were used. While many of the trajectory dimensions have been implicated in the examples in the previous chapters, with links to family and family-related experiences being prevalent, there was little discussion of links within the school context (with the exception of the implied comparisons between slavery and the Middle Ages and also the comparison between the two animals that were talked about in Mrs. Wilson's class).

While the idea of a cue being an element in both the environment and the learner's prior knowledge, thus semiotically creating an object/sign with meaning, it provides a picture of a learner's meaning-making process in action. Returning to the metaphor that grounded my thinking, the excerpts provide but a trace of the rhizome, a moment in an encounter of the learner's trajectory in the learning environment. Even as a trace we can see the heterogeneous features and the multiple opportunities for connectivity to the same element in the environment by different individuals, how prior knowledge allowed for collectively an untold numbers of links. Each learner was positioned at his or her own vantage point because of where their personal trajectory had been, different from other learners, although may share some categorical similarities of type. Prior knowledge, identified by dimensions of where and when the learner had gained the experiences drew on both in- and out-of-school experiences. It is to this topic, the context in which the learning trajectory had been that is further elaborated in Mrs. Wilson's classrooms at Jefferson Elementary School, the final classroom to be introduced. While the trajectory dimensions to this point have largely indicated residue from out of school, Mrs. Wilson's class points to linking that can occur in the school context. We consider, *what kinds of school contexts and school content link?*

Chapter 5
What Kinds of School Content and School Contexts Link?

Abstract In this chapter the final teacher, Mrs. Wilson, is introduced. Mrs. Wilson's students participated in studies for two years. These students participated in expository writing projects on the animals of the rainforest and sea mammals. This classroom provided the prompt to begin looking at links that students made with experiences that took place in school. These school-developed links allowed students to link across school years, across different content areas, and across activities that explored the content in different ways. The links that were prominent from the students, rather than those that the teachers made, were those that the students made with the activities in which they engaged in the class, rather than the teacher merely telling the students about the content.

5.1 Sea Mammals and Animals of the Rainforest in Mrs. Wilson's Classrooms

The floor plan of Thomas Jefferson Elementary School was nearly identical to Clark Elementary where Mr. Ritter taught his class. As with Clark, Jefferson was architecturally designed to support four teams of students in four pods that extended from a centrally located library/media center. This central facility included a large room resembling a typical elementary library with books, worktables, and a few computers. The adjoining computer lab was a skinny room with 16 green and purple iMacs stretched along the two long walls. Mrs. Wilson's classroom was in team 4, the wing containing five combined fifth-sixth-grade classrooms and a special needs classroom. Mrs. Wilson had taught at Jefferson for ten years–the first ten years that it was open. In addition to 14 years in fifth-sixth grade classrooms, Mrs. Wilson had 30 years of teaching experience that included high school, grade four, and enhanced learning classrooms. Jefferson was a Basic school, as was Clark, implementing the Four C's": community, curriculum of coherence, climate for learning, and a building-wide plan for commitment to character (Boyer 1995). Cultural/ethnic diversity in this K-6 school of 495 students included 66% white students, the remaining 34 % reflecting the cultural mix of the community's large

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_5

research university. Free or reduced hot lunch was available to 17 % of the students.

Mrs. Wilson's classes participated in the study for two years as part of a research study that included looking at the students' writing process as a context for me to consider their knowledge linking. In the first year of the study, 54 students worked on an expository writing project where they researched animals of the rainforest. Two classrooms were involved in the study that year; one was her homeroom (the morning class which included 27 students, of which 11 boys and 9 girls participated in the study) and the other was the class from across the hall (the afternoon class that included 27 students of which 6 girls and 8 boys participated). As Mrs. Wilson's students crossed the hall to go to math class, those students came to Mrs. Wilson's room for social studies. Like Mr. Ritter's class, these were combined fifth-sixth grade classes. The sixth-grade students in both classes had completed a similar expository writing project the previous year about sea mammals.

The second year of the project included only Mrs. Wilson's homeroom, with 11 girls and 11 boys consenting to be in the study. In this second year, her combined classroom of fifth and sixth graders included eight sixth-grade students who had been in the study the previous year. Mrs. Wilson' process was to alternate topics for the expository writing project from year to year. In this second year of the study, student wrote papers about sea mammals. Mrs. Wilson taught a process of expository writing adapted from a "trash and treasure" method of note taking (Jansen 1996). In this narrative I will treat Mrs. Wilson's classes as a single entity, while making it clear the class and year from which a particular piece of data was captured. This seems appropriate in that the overall process and how she structured the classes were similar. Although there were different class dynamics given different students, scrutiny of the data did not indicate large differences in the classroom activities and student engagement.

> My first day in Mrs. Wilson's classroom was an observation of the afternoon class, the students from across the hall who came to Mrs. Wilson's classroom for social studies. There was a new seating chart today, as these students were reassigned to desks that belonged to Mrs. Wilson's homeroom students. When I arrived Mrs. Wilson was telling students where their new seats were. After they'd settled, they viewed a video tape called *Rain Forest Rap* (World Wildlife Fund), which used rap music to share information about the rain forest. The actors rapped about types of animals and ecology issues; the students laughed at some of the people in the video–because of their actions perhaps–the actors were dancing while they were rapping. Some of the students picked up the chorus of the rap as it was repeated ("The rainforest, the tropical rainforest") and sang along.
>
> After the video, Mrs. Wilson began, "On your table there is a paper [the paper was 11 × 17 inches] and a marker. Pick a reporter, one reporter. With your group I want you to write down all the things that you know about the rain forest. Some of you had this while you were working on your biome." After she further explained, the students began to work. The students were divided into six groups via the pods of four or five desks, each group with a large piece of paper on it. There were 26 students in this afternoon class. Students were talking, listing things from the video. As I looked around the room, I noticed there were pictures of the rainforest on the bulletin board.

"OK," Mrs. Wilson's directed their attention, "this is what I would like you to do. Put your last idea down. Then, we're going to see what we know. Someone who did not write, someone who wasn't doing recording is going to do stand-up sharing."

As she was talking a student walked up to Mrs. Wilson and asked her about adding something to their list if he wasn't sure about whether it was the rainforest or not. "If you're not sure put it down as a question," she answered and then continued her directions, again asking the students to choose someone who did not write the questions. The students were noisy; Mrs. Wilson shushed them when she was ready for them to begin.

"We're going to start here, if they say something that you have on your list, whoever has the paper in your group, put a star or a check by it, so when it gets to your team you don't have to repeat the same thing."

The first group began, "there are five layers to the rainforest, it's wet, the trees are being cut down, 15 million plants and animals, an animal species gets extinct every 15 min." The speaker added how much rain there was per day. "A year," someone corrected. "It [the rainforest] is huge and getting smaller," the speaker finished. After the other groups shared what they knew Mrs. Wilson asked them to turn over their big paper and brainstorm questions they had about the rainforest.

Mrs. Wilson's mention of biomes and the group process had been learned in school. Perhaps because the classroom was a combined classroom of fifth- and sixth-grade students, and Mrs. Wilson included the same type of expository writing project each year while varying the group of animals, Mrs. Wilson was adept at reminding the students about previous course work that was related to their expository writing. In other words, she explicitly prompted links between what students were learning or doing and what they had previously done. While many of the links discussed in the previous chapters were from out of school, these links were within school. Before going deeper into these types of links we return to the narrative from Mrs. Wilson's classroom as she introduced the students to research writing.

Mrs. Wilson introduced the question-writing activity on my second day of observation of her morning class, as that class was a bit behind schedule compared to the afternoon class. In that class, the writing project began with the students having an opportunity to become familiar with the rainforest as well. The unit began with the student teacher (a college student in the last stage of the teacher-preparation program) reading the students a story about the Yotomami, a group indigenous to the rainforest. The students were asked to jot down questions that they had during the reading. After that, students were given the opportunity to explore topics for their papers, browsing books about different animals of the rainforest that had been collected from various libraries and were in baskets in the classroom.

"Today," Mrs. Wilson said in my second observation, "we're going to start down the road to our research, our serious research. And so, the first thing I want to do is I'm going to give you a little check key—what the project entails. So the first thing I want you to do is on the very top of this paper I want you to put your name and I want you to put your research number [I had assigned the research numbers to anonymously identify students' work]. So go ahead and put your name and number on the top of this paper." She handed out a sheet to each student that included a schedule for the full project. After explaining the planning sheet for the unit, she introduced the research process.

"OK. When we research—we, everybody—you start with the question. There's no point in doing research unless you have something you want to find out. So, this morning, we are going to do some brainstorming of what we think we would want to find out about animals. And we're going to talk about what makes good questions and what doesn't. So, what's one thing you would want to find out about an animal?"

"Physical appearance," Jessica began.

"OK. So I'm going to write it as a question, "What does animal x look like?" Mrs. Wilson wrote the question on the overhead as she repeated the question. "OK. What are some other questions you want to find out?"

"What does x eat?"

"OK," Mrs. Wilson said, "What does x eat?" She added this to the overhead.

"Is it a prey or predator," another student offered.

"Oh! That's good! Is it a prey–and remember this is not the one where you go to church and do it [Mrs. Wilson shared her own society link to help the children with the homophone]—or predator? OK. What else?"

"What's its habitat like?" a student offered. Billie added, "Does it live in the canopy or what level?"

"Let me say it the way you said it, 'What level of the rain forest does it live in?'" Mrs. Wilson wrote on the overhead the students' questions.

The list of questions continued, students offering questions about a range of characteristics or interactions first about rainforest animals in general and then about the specific animal they would study. Mrs. Wilson finished the discussion (my observation transcript indicates the discussion ended 10 pages of captured text later) by prompting the students about what she called "big idea questions."

"So far I think we've got a really good mix of questions. We have questions that I know that you are going to find in your books or in your Internet sites. We've got things about habitats, about living, about extinction numbers. Do we have any questions that we would call big idea questions? Things that you are not going to find exactly in the book, but by reading and learning about your animal, you may have some big idea question? Let me give you an example. There is pink dolphin living in the rain forest. We don't know a lot about it. Scientists have theories about it. So Jessica is going to have some questions that she probably isn't going to find answers to. But she can make some hypotheses. Remember in science we're making hypotheses about what's happening under the microscope. I want you to do that with your animal. I want you to be so expert in your animal that you, if you don't know something, you could make a very good guess. A really good hypothesis about what you think. That's one thing. Or I want you ask some questions about your animal that you won't find in black and white, you might have to combine everything you read and everything you think about it to answer. So something might be like, does my animal demonstrate interdependence? Does that animal need something, and does that animal in some way help something else in the rainforest? Is it part of a cycle or something? So as you are working on your questions this morning, I want you to write a whole lot of them that you know you can find in black and white and a couple of them that you might have to think really hard about."

Mrs. Wilson finished, "So as you're researching I'm expecting that more and more questions are going to pop in your head. So this is just our beginning. Here's your task. If you need to come back up and look at some questions up here, that's fine with me. On the lined paper on this table I want you to brainstorm at least 10 or 15 questions for your specific

animal. That's the first task. Go ahead and do that. Write yourself 10 to 15 questions for your specific animal. If you want to come back and look [at the questions on the overhead] or if you want to work with a partner you can do that."

As my observation of the writing process continued over the next few weeks, the students engaged in various activities, typically with Mrs. Wilson modeling the process first as she did with the questioning process, and then the students working independently. After the students developed their questions, they color-coded them into categories using different colored highlighters. During the second year, as the students categorized their questions about sea mammals, Mrs. Wilson reminded the students, "Make sure you have descriptions, at a minimum you should have those six up there, food, feeding, habitat, descriptions of what it looks like, personality, habitat, life cycle," indicating potential categories to be at the top of the paper.

After giving the students a few more minutes to continue to classify their questions with the highlighters, she moved onto the next step in the expository writing process that she used. "In order to do this you have to be really good listeners. For the people who were here last year and did whale research, this will be familiar. These are for your notes, for your notes to go on." Mrs. Wilson made sure each student grabbed a piece of 18 × 24 inch blank newsprint paper. "We're going to make up our notes charts. Take your big paper, lay it on your desk, it fits perfectly on your desk. Fold it into two hotdog rolls by folding it the long way." She held up her example, folding the paper horizontally and then again.

"OK, good job," she continued, "Two hotdogs good, everybody looks like they've got it. Now, fold it the half hamburger way, then again, so you have a nice little square that looks like that," holding up a small square, approximately 4.5 × 6 inches, of folded paper. "OK, this is the way that you can put your notes in the pocket of your social studies folder. This is how you can keep them folded up. Now open it up and lay it on your desk on the big horizontal." As the students unfolded their papers on the desk, the creases from the folds formed a 4 by 4 grid on the paper.

"I remember this," one sixth-grade student said, relating to the similar progress used the previous year in this combined-grade classroom.

"Good," said Mrs. Wilson as she began to explain how they would write their category names across the top row of the paper, starting in the second square, using the overhead to demonstrate.

The previous narrative shows how easily Mrs. Wilson's classrooms included links across different times and related contexts. Rather than student-generated links, she helped the students link what they were learning with what they already knew or had been previously introduced to. As mentioned, she linked the topic of the writing unit, the rainforest, to the study of biomes and developing hypotheses in science class. She shared a link about the note-taking process for students who were in her class the previous year and had completed research on whales. Mrs. Wilson's link was then echoed by a student who had been in the class the previous year, noting that she remembered this aspect of the writing process as well. In the previous chapter, one of Mrs. Wilson's students shared in his writing a comparison of animal characteristics after being in Mrs. Wilson's class for two years and the writing of one of Mrs. Schneider's students indicated a linking between social studies time periods and how people were treated. Links within the school walls also provided valuable indicators of and prompts for students' learning.

5.2 Contexts Within the School Walls

Context, as used in these studies, were largely described as being out-of-school. For example, family members, neighbors, and many encounters with friends happened outside of school time. Larger society links such as pro-sports and religion, although potentially having overlap with school, were typically examples of out-of-school encounters. However, there were a number of examples where the links were made between school experiences. In these data, the school trajectory dimension was evident in a number of ways. These in-school contexts included those links that were made with content to previous years (such as Mrs. Wilson reminding the sixth-grade students who were in her class last year about folding the note paper) and links that were made with content in the current year. Those latter links connected different content areas—the content being studied and other content (such as Mrs. Wilson comment about science class), or different activities in the same content area. These links were about content (typically conceptual cues) as well as processes. The cues mentioned in the introductions to Mrs. Schneider's and Mr. Ritter's classroom were largely links to the content, or aspects of it. For example, the cue that was in the classroom, often in conversation, were words about topics and content that the students were studying that brought to mind related ideas. In other words, the cues in the environment could become objects, in a semiotics sense, because there was meaning attached via experiences the student had in school. There were other cues that were based on processes in which the student had engaged—those processes through which students engaged in particular school activities such as writing an expository paper or conducting a science experiment, as well as those broad general processes like "how do I learn science" (recall the students in Mrs. Chambers' classroom who started to learn about their biome by sitting down and reading aloud to one another from the textbook). School should color a students' trajectory in ways that should be apparent across their trajectory, indicating that learning had occurred and the student reaped the benefits of that learning in a school environment.

5.2.1 Linking Across School Years

Although Mrs. Wilson prompted process links for sixth-grade students, only a few students shared those links between what they were learning and something they had learned the previous year. The student writing in the open-ended writing activity provided opportunities for them to share these links. For example, recall the boy in Mrs. Wilson's class (noted in Chap. 4) who wrote a detailed comparison between the narwhal and the spider monkey, drawing on elements of one animal as cues to link to the animal studied in the previous year. The student who had studied the boto dophin as a rainforest animal mentioned her writing about the spinner dolphin the previous year. Two students in Mrs. Olson's class made links between

the Viking's treatment of people to World War II and Hitler's treatment of Jews. In her writing, this 12-year-old girl wrote,

> The conquest of the vikings… The Vikings conquered a lot of people. While they were conquering people, they burned things, killed people, and took people into slavery, stole things (goods) and destroyed almost everything. That reminds me of World War II they killed people in gas chambers or enslaved people that they captured. The Jews prayed that that Nazi's wouldn't find them like all Europe feared the Vikings.

Another girl wrote,

> The Vikings lived in Schandinavia which has rough coast. I remember reading a book about a girl who went to Maine which has a rough coast. The Vikings were mean people who conquired different lands and killed many people or enslaved them. They sort of remind me of Hitler and the Nazis who killed a lot of Jews or enslaved them. The white people enslaved blacks. In the early 1900s and we did not treat them very well.

Another of Mrs. Olson's students linked to the Philippines in his writing, about which he had written a report the previous year. Two of these links that included specific information from previous school years occurred in Mr. Ritter's class drawing on a China unit covered in the third grade, as had students from Mrs. Chambers classroom writing about studying owl pellets the previous year and that the pellets they found last year "were a little bit bigger" indicating details enough of the previous trajectory element to note a comparison. Cues that prompted an across-school-year trajectory dimension happened overtly in the classroom, but were minimal there, as they were in the writing.

Links with other years were most prevalent in Mrs. Wilson's classroom, likely because of how she developed the curriculum in her combined classroom. Students were exposed to the same writing process for two consecutive years and it made sense that reminders for the sixth-grade students pointed back to the previous year. She did more of this in the second year of my studies in her classroom, so these prompts may have been because I was in the room. However, Mrs. Wilson did not know what I was specifically looking for in my research, the IRB documents indicated research that generally studied meaning making using different resources, and she also had these links in the first year of the study. The cues Mrs. Wilson provided were process cues, helping the students create links to the process that they had previously learned. Her cues prompted links about folding the note paper, as well as writing the opener and closing for the paper, and using resources from up the taxonomy for studying a particular animal. For example, Mrs. Wilson had the students read *The Great Whales: Gentle Giant* by Lauber (1993), take notes on each chapter, and then answer questions. This book was an introductory book in the second year to provide an overview of the topics–much as *Rainforest Rap* video had been used the year on rainforest animals. One boy had completed the first chapter questions, which was the assignment for the day and asked Mrs. Wilson want he should next do. He's told to browse book for blue dolphin, his topic, and get some ideas to start. If he found a book on blue dolphins, then he should read it. "Don't forget," she added, "that like last year you might have to take the book on whales and then find what you need." In the second year of my study in Mrs. Wilson's

classroom, she also used a process link and prompted the students to do more than they had done previously. The following narrative is from the first day of the study of sea mammals.

> "Take out that checklist so you can take a look at what the expectations are for this year. For those of you who were here last year and did the rainforest animals, it's a similar process." Later Mrs. Wilson introduced the question writing activity. "And we're going to write some questions that are related to your topic. What do you really want to find out? Now last year those of you who did this, we pretty much stayed with 'What did it look like? What did it eat? Where did it live? How did it survive in the rainforest? Who were its enemies? This year, for those who did it last year, my expectations are much higher. What is really interesting to you about this animal? What is happening currently? Is your animal in danger? What does your animal sing? Are the songs the same in this sea and that sea? Is the any new research going on about your animal? So we'll take the plane one step higher and not just do an animal report. We're going to see if we can get ourselves entwined with something about your animal that is unique or something that is going on research-wise."

5.2.2 Linking Across Content Areas

In addition to process links across years, Mrs. Wilson also prompted students to link to other content areas from the current year. As she prompted the students who were studying rainforest animals to develop questions from their own reading she asked them, "When you see something that's unique or unusual you're going to say, 'Oh gosh, why did they do that' or, 'Why did they have big lips'; remember we talked about the Mayans flattening their heads. That was a sign of beauty for their culture." For the students writing expository papers about sea mammals, she frequently mentioned other content areas in which the similar processes were used as they wrote questions and gathered their notes. In this third observation narrative in my second year in her classroom, Mrs. Wilson had stopped the students as they were generating and categorizing questions about their sea mammal.

> So each of these categories that you've come up with should lead to more and more questions. So if you say, 'What does it eat?' Alright, what does it eat, but how does it get the food? Or does it work with another partner, like some whales work in partner with another whale to get food. Bet you didn't know that, but they do. So that's why I'm asking you to keep reading even though you're writing down, 'Where does it live?' maybe as you read about, 'Where does it live?' you're gonna say, 'well gee, I wonder how it sleeps or does it sleep or does it have to keep moving all the time?' 'Or how does it get air, if it breathes air, does it pop up?' So see I'm trying to get you to do with your nonfiction what you did with your novels. You're reading along and a question comes to mind. Or you say [Thank you for listening – she interjects], you say to yourself. I wonder about, let's take our novel. Today a bunch of people said, 'I wonder who wrote the note?' And 'this is in very fancy handwriting.' So as you were reading something came to mind and you had a question. That's what I'd like you to do with the whale book. If all you're going to do is copy down what it eats and where it sleeps, you might as well read the book like we just did. I want you to get beyond that. I want you to be intrigued by your animal. I want you to love your animal. I want you to say this is the coolest thing I ever did. I want you to think about it all the time.

Mrs. Wilson continued prompting process cues to support students in their note taking in this fourth observation of their writing in the second year as well.

> "Now, let's talk about how to proceed. You all pretty much have a topic picked out, I believe. Is that right? And you all did a little reading yesterday and we'll certainly be able to do some more reading in a few minutes. One of the most important things about being a researcher is writing the questions. Cause if you don't have the questions then what's the point of doing the research in the first place? Unless of course you're in school and then they say you have to," she joked, and then continued, her voice sharing excitement. "But you should be excited about it and it should be just like when you're reading your novels and you come to something that's new or unusual or different and you ask yourself a question in your head. Now most of the time we don't write it down. Occasionally I'll say to you, 'Write down your questions.' A lot of you are doing a very good job in your novels doing, 'I wonder why or I wonder if.' And you're almost making a prediction. And that's exactly the same thing you need to do when you're reading about your whale. So let's pretend we're reading along about our whale and we're on a section called food and feeding."

Mrs. Wilson revisited the idea in my eighth observation during the second year, linking to another reading activity.

> Just exactly the same process we went through when we were summarizing is what you need to do with your whale. So for example, if you have a page that looks like this [she held up a page with a number of pictures that included text captions] in your whale research you need to read around the page. Just like we do when we read *Kids Discover* magazine. We want to read under the picture…. There's a lot of good notes in the picture, under the picture, in the caption. Remember. Think back when we did *Great Whales Gentle Giants*. The only way you would have been able to answer the question about, what is a spy-hop? Spy-hopping and breaching? whatever it was, was if you read under the picture captions. So do not neglect the picture captions or graphs that are in your book. They give you valuable information.

While other links existed in these cases that connected content across the curriculum in the current year, only one other captured link stemmed from a process cue and was shared by a student. In his open-ended writing, a boy in Mr. Jackson's class had likened the Roman process of oratory to that of election of student council at Roosevelt school. "When classmates stand up in front of the class and speak what they think. Then the classmates vote on the best person to go into student councle. That why it reminded me of oratory."

In addition to process links, other links included conceptual links, many capturing one small aspect of learning in school. Recall the links in Mrs. Olson's classroom about what Zimbabwe meant and where the student had gained that information. The classroom discussion provided a means for student to briefly link to language arts through example and a brief mention to math as Mrs. Wilson mentioned "The land of the rain forest is 10 % of the earth's land, but 90 % of the earth's species live there. Think about that—I know you are doing percents in math and are good at those." Mrs. Schneider also provided brief links in class discussion, linking to the periodic table of elements that they had seen, noting that there were the four elements of the Middle Ages alchemist (air, water, fire, and earth), pointing out to the students that given their prior knowledge, they "know that those four are

hardly basic elements." While she linked to the Africa unit they had studied previously (see the beginning of the classroom narrative in Chap. 3), she returned to that in my tenth observation of her classroom as they discussed life spans in the Middle Ages, prompting the students to remember the shorter lifespans when they had studied Africa earlier in the year.

Many of the links across subject areas included mention of larger projects or hands-on projects. Students in Mrs. Schneider's classroom conducted inquiry projects earlier in the year. In this narrative in my third observation in Mrs. Schneider's classroom, Ellen linked to her inquiry project as part of the class discussion on contributions that developed during the Middle Ages.

> Mrs. Schneider added. "It is a myth that they didn't wash at all, but less than you. But when they went to the east they found out that the Arabs pride themselves on bathing and scented ointments, things like that, so they brought some of those things back, perfumes and things."
>
> "Because Muslims really like to be clean, tell me if this is wrong or right, but during the Middle Ages, did people in the Middle Ages really care about being clean?" a student asked.
>
> "Not like here how we do today," the teacher answered. "One of the queens prided herself that she had only had 2 baths in her entire life."
>
> "That's disgusting!" someone exclaimed.
>
> Mrs. Schneider clarified that it didn't mean that she didn't wash, explaining about the lack of heat in the places they lived, even castles were "pretty miserable places. They were made out of stone; they were damp and cold and windy," then referring to a little article they could read. "You'll see, even in the nobility it was not the best of times to be warm."
>
> "They had pillows and blankets," a student added.
>
> "With fleas," Mrs. Schneider said. A student continued saying someone had picked up twelve fleas, apparently referring to something she had read.
>
> "Different fruits," another student shared about contributions of the Middle Ages.
>
> "What kinds?" Mrs. Schneider asked. Citrus fruits, lemons, oranges are listed by the students. "Why would things like citrus fruits be important? What could they change?" Mrs. Schneider asked.
>
> Two students tried to give answers, but then said they didn't know. Ellen said, "They have a lot of vitamin C."
>
> "That's important for what? What's vitamin C important for?" Mrs. Schneider continued to prompt.
>
> "You can get really weird diseases," a student said.
>
> Ellen was able to continue, "I was going to say what vitamin C does, when you eat or drink citrus fruits with something that has iron in it, it helps it absorb so you can have more iron in your body which gives more energy." She continued, explaining the enhancing effects of vitamin C on iron.
>
> "I don't know where people find out this stuff," Tim commented.

"It's part of her inquiry; I'm glad you shared that," Mrs. Schneider first addressed Tim, then Ellen. The students in Mrs. Schneider's class were all completing a year-long independent inquiry project. The discussion continued.

"I was just going to say, you get diseases like scurvy and," a student started, and another interrupted, "What's that?" More students echoed the question.

"We talked about that in explorers last year," Mrs. Schneider linked back and called on a student to explain what scurvy was.

When pilgrims and people came to America they, a lot of people got sick and died and it was because of lack of vitamin C and they called it scurvy; they didn't know it was lack of vitamin C.

"It was common on ships because they took things on ships that didn't spoil," another added. "And finally it was, sour cream, I think it was, was something they had because it didn't spoil and it had vitamin C in it so less people got sick."

"We need to look that up, because I don't think it was sour cream," Mrs. Schneider said.

"Well, it was something like that," the student ended.

"One of the things that was important for travelers was if they had enough vitamin C. Most was found in fresh fruits and vegetables and it was very difficult to carry them on long journeys," Mrs. Schneider continued.

Tim added, "I get my vitamin C out of a little Sunkist orange tablet." Many students started sharing where they got their vitamin C from.

While Ellen's link to another subject area and her inquiry project garnered her expertise, Tim created a link as well, not from the classroom, but from home on how he gets vitamins now. In her open-ended writing Tracy linked her independent project on the role of women in sports with the role of women in the Middle Ages. Another linked the Middle Ages with the plight of women as well, focusing on women's rights in the Middle East using a now-and-then linking process with information that had been covered in their unit on South Africa.

Brandon, who was in the temperate deciduous forest group in Mrs. Chambers' class also indicated a fairly deep conceptual understanding of the implications of school life that affected the biome that he studied as he wrote about Earth Week that they had been celebrating in school and the irony of the conversation the students had about saving the rainforest.

The biome we are going to talk about is the temperate disiduous [deciduous] forest. We live in it. and it is in highly wooded areas. Oh thinking of that the week after Spring Break we have earth week and we were talking about how we can save things and Roger [who studied the salt-water biome] said our school should buy some of the rainforest so know one can cut it down. But then how are we going to do that because our school is so poor. And everyone is complaning because we are poor. then I said why do we have plastic forks and spoons if we are poor and because they will stay in a land fill for thousands of years.

Not all links about content indicated depth; other students had more trivial links, such as another student in Mrs. Chambers' class commenting about the tundra in his writing, "The Tundra reminds me of a project I did in Social Studies about the Inuit Indians. I had to do a report and a diorama on them. My report was about 2 pages.

My diarama had porcilan figures and fake trees. I built and igloo out of sugar cubes."

Students' trajectories will include aspects of their school learning from prior years and between subject areas, as curriculum builds from year to year and there are similarities in some processes and concepts between subjects. The expectation, for example, is that when students learn to add they will continue to use that skill in subsequent years. The links documented here move beyond that implicit base of knowledge and note specific aspects of prior learning that are memorable. While Mrs. Wilson prompted for linking with the previous year's writing activity, reminding students about the process, other students in her class linked to the same subject area in the previous year drawing on the content of their expository writing project.

Links that were made across different subject areas or topics in school were noted by both students and teachers. Mrs. Wilson and Mrs. Schneider shared links to other content areas, but students made those links as well. Although the links across content areas should allow for learning opportunities that would include cross-curricular projects, the examples in these classrooms were limited. Yet the few that were made were striking in that the links were with active forms of learning such as inquiry and art projects. Integrating language arts via a writing process served as a vehicle for social studies content that provided the backbone for Mrs. Wilson's expository writing unit. While Mrs. Wilson prompted for reminding of the same process in previous years, what the students came away with was a writing process through which they could explore content.

5.2.3 Linking Within Content Areas

The use of different activities related to the same content areas that may bridge subject areas, such as linking across literature and social studies, or art and social studies was evident in these data as well. For example, the students in the second year of Mrs. Wilson's class had watched *The Mimi*, a documentary exploring humpback whales, and also had all read *Great Whales: The Gentle Giants* (Lauber 1993), which Mrs. Wilson had brought up when they discussed flippers and tails of whales.

Art projects were also integrated in their content area, and in their open-ended writing students mentioned these as well. While the content was not learned in art, the art activities were vehicles for further exploration of content from other classes. For example, students in Mr. Jackson's classroom made castles, one boy moved to this topic from writing about the Roman Empire.

> … The Romans had weird houses. The house was built around a central space open to the sky called an atrium. Kind of like the castle I made in Social Studies. Our student teacher taught a Social Studies lesson. It was about the Middle Ages. I made my castle out of wood. It is in the library because it is so big. The rooms and stuff in my castle are built around the courtyard, which could be the atrium. We also made some coat of arms, which you

> probably saw on our desk. He had to take some things to school to show, but my castle was to big so he took my shield.

Students in Mrs. Wilson's class were also making clay whistles of animals in art class; Jessica chose to make a boto dolphin. As she described the dolphin she had written about in her open-ended writing, she linked to that art project.

> My rainforest animal was the Boto Dolphin. It is a river dolphin and it is pink. I really like dolphins. Last year when we were studying whales I picked a dolphin. It was the spinner dolphin. It was pretty cool. It was very athletic and did lots of flips and jumps. It is almost the opposite of the Boto. I'm also doing the Boto in art. We had to make clay whistles of an animal so I picked the Boto. I picked it because I think Dolphins are pretty easy to draw and sculpt. The only hard part to do was making the flippers

> They turned out too trianglish at first. So I had to redo them. Then when I was done with the dolphin My teacher put a whistle in it since the dolphin had a tail in the back she had to put the whistle on the side. Most people had them on the back.

The students in Mrs. Schneider's class had a variety of activities that allowed them to work with the content of the Middle Ages. In addition to creating annotated bibliographies and working on vocabulary the students also wrote and produced plays about the Middle Ages and hosted a Middle Ages feast. Students wrote about these activities in their open-ended writing, linking these after first sharing content about the Middle Ages. For example, a girl in Mrs. Schneider's class wrote, "Today we did our play. It was on the life of a serf. I liked it. In our play, the daughter dies of starvation. It was a common cause of death. So was disease." A boy wrote about the feast. "I could have been a knight for the Medieval Feast but instead chose to be a monk. Monks are so cool, because they wear a hood, given them a mysterious atmosphere. Knights of course don't wear hoods, but carry a sword and shield. A knight's horse is of great importance, or else they can't go into battle, or bring themselves honor and fame." In cases like this, recalling the activity became a vehicle for linking, or mediated, what they had learned allowing them to provide details of that learning.

What was striking about the links in Mrs. Schneider's class was the amount of in-school links through trade books that the students had read for their reading groups and the ease with which students spontaneously shared information from those books outside of the reading groups. The following excerpt on my ninth day of observation in Mrs. Schneider's class showed the students unprompted willingness to link their literature reading in the large group discussions. An extended excerpt is included because of the many instances of this link type during this session. The discussion in Mrs. Schneider's classroom was particularly difficult to capture because of the free flowing conversation. What follows is very much an outline of the flow of the conversation and includes of variety of different kinds of links to prior knowledge. However, notice the references to the literature books (italics) that were integrated into the Middle Ages unit as a literature component.

> "The video is called *The Church*. We'll watch another part of the video tomorrow," Mrs. Schneider said before she began the film.

"Is this like an information film?" a student asked.

"Yes, it is." While the video played the teacher jotted words on the board. A few students were writing and some were working on stitching which they had chosen as their craft projects. All of them were quiet and seated.

After the video Mrs. Schneider guided a discussion. "What are reasons to go on a pilgrimage?"

"To ask for forgiveness," a student said.

"Ask for healing," another added.

"I don't see how someone can take someone else's sins for them," Nicole said.

"You would just have to believe," Mrs. Schneider said.

"I just don't get it," Nicole answered.

"*In Ramsey*, he took the sins of Ramsey with him, in a little packet," a student referred to their literature book.

"I didn't get it, a packet?" a student expressed confusion.

"Where's Santiago de Compestela? He said he knew where one of the places was, but not the other," a student said.

"It's one place, in northern Spain," Nicole answered.

"Because the church would tell people that they had to do this," a student said.

"Why?" Mrs. Schneider asked.

"Because they wanted them to?"

"If you'd like committed a crime they'd force you to," one student explained.

"Like the guy who was a gambler [in the movie] had to do it as penance," the teacher said, referring to the video.

"*That's like in The Ramsey Scallop*, they had a prisoner. There were people on the pilgrimage who were prisoners as well."

"There was an economic reason as well," Mrs. Schneider added.

"*Also in Ramsey Scallop*, they would go up a cliff thing on their knees," a student drew an example from her literature book.

"Santiago," Mrs. Schneider said, "when I lived there in Spain, they still go up on their knees." There was a knock on the door and the librarian dropped something by for Mrs. Schneider. The students started talking among themselves. The words I could hear seemed to be related to the topic about which they were discussing.

"So, like in," a student started.

"Wait, there isn't an audience paying attention," Mrs. Schneider stopped her. "They bring the packet of sins, what do they do with them?"

"They leave them."

"Has anyone been to one of those places?" Mrs. Schneider asked. A student had been to Jerusalem. "At Santiago they have a place to leave them." The teacher brought up Lourdes,

"people believed they were healed, and would leave their crutches because they were cured."

"What were the responsibilities of the church?" Mrs. Schneider asked.

"They did the stuff that the government usually does now—education, helping the poor with food and clothing, hospitals."

"The church still does that but not to such a large extent. They did hospitals."

"Hospitals actually grew up during the Middle Ages as did a number of things," Mrs. Schneider added.

"They had their own courts,"someone added.

"What else with courts?" Mrs. Schneider asked and then answered her own question, "The laws."

"The individual monks had to help the poor and they thought that if you followed all the prayers and worked outside and did all the labor, they would go to heaven, and they listened to people's sins," Tracy said.

"The priests, there is a difference between priests and monks," Mrs. Schneider corrected.

"They housed the pilgrims," Brenda added.

"Think. If you're traveling in the Middle Ages, there was not the Holiday Inn," Mrs. Schneider said.

"There were inns," a student clarified.

Tracy, who was Jewish, shared, "If you touch the cross or the knuckle bone of St. Peter, he's the guy who is at the gates of heaven."

"He was a disciple," Mrs. Schneider explained. "To do that sometimes you have to pay to have your sins forgiven. You got so many days taken off of your penance in purgatory. People started cheating others."

"*For my annotated bibliography* I was reading about 14th century towns, and holidays, for example, they carried around a box with a knuckle," a student shared.

"Who is St. Peter?" Mrs. Schneider asked.

"Supposedly at the gates," a student said.

"He's a disciple," Mrs. Schneider repeated.

"He was the first pope," another said.

"I don't know this," Tracy said, sounding worried and frustrated.

"You're not supposed to know it, that's why we're talking about it," Mrs. Schneider tried to reassure her.

Nicole commented about the saints, giving an *example of a book* that had mentioned saints. Mrs. Schneider listed some books about saints, asking students if they had read them. Many of the students had.

"Why did they declare Joan of Arc a saint?" Nicole asked.

A student answered, "She was kind of murdered for France."

Mrs. Schneider explained a little bit more, "There is a whole list of things that would have had to have happened to become a saint, it's a lot tougher now. Beatified, that is the first step. Then canonized."

"My brother said that if Mother Theresa had been made a saint she would have lived longer," Susan shared.

Nicole, who sat next to her commented, "People aren't as dogmatic as they were in the Middle Ages."

"Explain," Mrs. Schneider said.

"We don't just accept things now," she replied.

Mrs. Schneider explained further, "They started to believe a lot and are very careful about what they did, dominated by the beliefs."

"I'm guessing that not everyone fully believed everything," Susan speculated. "There are places where the bible contradicted itself. But they [monks who found contradictions] couldn't say anything, because they would get killed. I don't think you could say you didn't believe it, you had to follow the church so you couldn't really say that you didn't believe it."

"You'd be excommunicated from the church and you would be ostracized," Mrs. Schneider said, explaining what would happen.

"In *our literature book*, Eleanor, if she were alive today, she would probably, she's not as attached to the church as most people are, but then if she was a Christian today I think she would travel around the world today," Nicole repeated her comment that she has shared the previous day in her reading group.

The links by the students that were based on their school readings shows the ease with which they could use their school learning, which was likely enhanced by an environment that allowed free-flowing conversation. In addition, discussion was peppered with out-of-school links by the teacher and students. These added to the richness of the discussion, but also likely to the understanding of the content by the individual students. While some links that students shared may lead to frustration (e.g., Tracy) or be incorrect (e.g., Susan's mention about Mother Theresa—saints are not among the living) because of differences in prior knowledge, Mrs. Schneider was helpful in guiding that discussion of unfamiliar ideas to lead to potential learning.

Two types of links with school trajectory dimension were prominent–those that were linked by process, as were those that Mrs. Wilson reminded her students of, but many more were content related such as these in Mrs. Schneider's class. These school-developed links allowed students to link across school years, across different content areas, and across activities that explored the content in different ways. The links that were prominent from the students, rather than those that the teachers made, were those that the students made with the activities in which they engaged in the class, rather than the teacher merely telling the students about the content. While students in all of the classes had links that they could make with the content, some captured during discussions in class while many of them only evident in the open-ended writing, curricular and instructional design can provide an opportunity for students to gain experiences about the content incorporated with a class venue

that allows the students to share those links, as was done in Mrs. Schneider's classroom. Knowledge, it is claimed, is indexed by experience; further, given its dynamic nature, experience is central to the weaving of a trajectory. From the links that these students have made, it seemed that the experiences that were salient in school were those in which they have an opportunity to gain an aspect of the information, through a variety of media, so that they can then link it to the formal content in the curriculum. In this way, the students were able to link what they were learning with what they knew, and much of what they knew had been gained through various activities and opportunities that had taken place during that school year. This points to the next question, *how is the linking process supported or inhibited in the classroom*? which is addressed in the next chapter.

Chapter 6
How Is the Linking Process Supported or Inhibited in the Classroom?

Abstract In this chapter the data from the six classrooms are explored to consider how the linking process is supported or limited in the classroom and what may contribute to the linking. The role of the teacher and what or who constitutes authority of content and processes point to the opportunity for overt links in the classroom. The discussion points to developed culture of the classroom as one that may provide opportunity and experiences to create links and acceptance of shared links. The chapter concludes with examples of varied responses to the student-shared links and also how students may preface their links to be heard.

That all students will make links is consistent with the premise of constructivism. This constructive process is how individuals make sense of the world. Information in the classroom is interpreted through each student's lens; a lens developed through prior experiences. A semiotic interpretation points to how different elements of the environment may have different meanings for the students. Some of these links may be potentially relevant for learning, while others seem less so. In addition, some teachers seem to foster the use of potentially relevant links while dealing appropriately with those student-offered links that may not foster further understanding of the content. Each of the six teachers introduced in this book, although all highly experienced, created different learning environments and used different methods of instruction to foster student learning of the content. These crafted learning environments fostered and inhibited the development and sharing of links in various ways.

Typically, in schools in the U.S. the teacher is the designer of the learning environment. Teachers prescribe their own roles in their classrooms, ideally teaching in ways that align with their own individual beliefs about learning (Duffy and Orrill 2004; Fang 1996), which includes what constitutes authority sources in the classroom. They structure the kinds of questions asked and the openness of the dialogue, many times through their own modeling of the processes and techniques they would like the students to use. In other words, the teacher lays a foundation on

This chapter expands on elements of Schuh (2003).

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_6

which the culture of the learning environment develops and essentially defines what learning is. Given this foundation and the students' prior experiences, the culture of any classroom is then co-created by the students participating in ways that are fueled by their prior experiences coupled with the environment that the teacher has initially developed. How learning is defined, the culture that has been co-created, and the individual experiences of the learners provide the context for the emergence of student knowledge links—those links that students make between what they are learning and what they already know. Note that I am ignoring individual propensities of the children (intrapersonal characteristics, etc.). All of the data from these studies were gathered in the spring of the school year after the classroom routines and classroom cultures had evolved. My assumption was that at that point the environments were fairly well-defined in terms of teacher and student roles and expectations, with the caveat that each learning environment would certainly continue to evolve through the end of the school year given different instructional topics, environmental factors (e.g., spring weather), or general development of the children, for example.

To explore how the learning environment might foster or inhibit this linking process the data from each classroom were revisited noting teacher's and students' roles and the nature of authority regarding content. These characteristics are couched in a discussion of the types of activities, discussions, and teacher modeling that provided the current instruction and learning opportunities for the students. In addition, two temporal aspects of the knowledge linking process in the classroom will be noted–what may happen before a link and after a link. We begin with Mrs. Schneider's class.

6.1 Roles of Teachers and Learners

Because Mrs. Schneider's class was an ACES class (accelerated curriculum for exceptional students; i.e., a gifted class), the students had completed the traditional social studies curriculum during the fall semester, allowing the spring semester for an extended unit on the Middle Ages that included a variety of activities. Students wrote annotated bibliographies, developed craft projects, wrote and performed plays, held a feast, and encountered the content through a variety of written sources including textbook excerpts, epic poems, trade books, and videos. With this variety of information sources, no one source or person was the holder of knowledge. In particular, Mrs. Schneider did not see herself as the information provider for the class; in her interview she stated about her interactions with her students,

> I mean I guide more than I teach. I have been known to give long lectures, but not too often because sixth graders don't like to sit very much and I really don't think teachers ought to be standing up here talking all the time. It should be more self-directed.

As the designer of the learning environment she had students learn material in ways that might be noted as being more traditional, such as having students

"memorize the capitals and be able to locate them on maps and be able to identify geography, rivers," for example. She wanted the student to know how to find information.

Her role, she stated, was to "grade papers. More of a record keeper and facilitator than anything else… I try to put the burden of teaching other people on the kids." This statement, rather than being one of a teacher dismissing her duties, captured her unique role within the classroom. Students learned from one another. Given that, her role was not as a primary individual from which learning in her classroom stemmed, but was as an individual who supported the learners as they supported one another—providing feedback and facilitating the learning process. She was not a primary information source, but one of many.

Mrs. Chambers and Mrs. Wilson described similar helping stances in their interviews, noting a desire for a "hands off" role in the learning process for the students. Mrs. Chambers saw herself as a

> Helper. You know, you have to facilitate sometimes, but I really try to go around, listen, see what they're doing. If they're not doing, you know, if they're not on task I try to, not just to yell at them or whatever, I try to say "now show me what you're doing" and sometimes they couldn't show me much. So, I would maybe suggest something or ask them what they thought would be better…. But, I feel that I can only do so much and then they need to learn on their own.

While both Mrs. Chambers and Mrs. Schneider place the responsibility for the learning process with the learner. Mrs. Schneider's focused more on how learning takes place in collaboration/consultation with a variety of sources, while Mrs. Chambers' pointed to her role when a student's task management fails.

Mrs. Wilson used the word "mentor" to describe the relationship she would prefer between teacher and learner. Although Mrs. Wilson would have preferred to be a mentor to the students, she acknowledged that that was not always possible. In the interview during the second year of the studies in her room Mrs. Wilson stated,

> I'd love it to just be the mentor. But sometimes I have to take over more than I want because they need, I'd like them to feel proud of a success. I want it completed. I'd like to see my role more as lead them to it. Sometimes I have to drag them to it. I'd like to be more of a mentor in that I'm a little more didactic through that initial process so that everybody has some experience. We do a kind of guided practice and then I'll let them, depending on who they are, go in different directions. But I wish I could be more mentory. I spend a little bit too much time editing things I shouldn't. But again, it depends on the group.

My rough observation notes in my fifth day of Year 1 indicated her mentoring style. Mrs. Wilson prompted students, without providing the particular information, to expand their searching to find additional sources for their expository papers.

> I'm in the lab. Mrs. Wilson is helping a student look at the encyclopedia for anaconda. She says he will need A and S volumes and then she opens the S volume and finds snake. She asks what kind of snake it is, "a squeezing snake?" The boy says yes, she starts looking through, "Look at all that information." They look through it a little bit and talk about the good information that that encyclopedia has.

> One boy said that he's scoured all of the print books. Mrs. Wilson says that's good, that we will start doing some drafting of Friday, so he should scour a little bit more. She asks what family his animal is in, he says primate. She suggests that he look for that and see if he can find anything else. He and another boy ask if they can use the card catalog (this is online). She says yes.
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> He comes back later and says there is nothing about a primate in the card catalog. She said in the encyclopedia. He says that he had already done it and has the information. She suggests he look in the rain forest coloring book that is in the room, and thumb through it. If there is nothing there then he should come back and he can start on drafting since he did that last year.

Despite their helping stances, there was a subtle contrast between these three teachers in terms of the role of learning and how that should proceed. While Mrs. Schneider placed the burden of teaching one another on the students, Mrs. Chambers took on that burden, but then implied that there was only so much she can do. In contrast, Mrs. Wilson would like to mentor or help guide students as they learn, but was tugged into more directive roles depending on the needs of the learners. Certainly, characteristics of learners should guide what happens in the classroom and a responsible teacher will be attuned to that. Mr. Jackson, who provided a very structured classroom to teach a note-taking process, talked about possibilities in his interview.

> When I was at my previous school I was there for 12, 13, 14 years and you changed things each year but a lot of times it's the ability of the kids, the behavior of the kids that limit things that you can do. You know, I've had classes that were very cooperative, very well behaved, seems like the chief thing is whether the kids themselves like each other and if they do like each other and have support from home. You know, I've had years where language arts was taught through making movies and doing plays and fun things like that. Then, maybe the next year you couldn't even think about making a movie because there was just no way, you know. I've had years where science was taught hands on with experiments mainly or activities but then the next year there's no way you'd do that, so I think a lot of it really depends on the students in the class. But, as far as being a textbook led teacher I would say that I am textbook led. I know some teachers that never use textbooks and I couldn't do that. I don't think I'm smart enough to do that. So, I usually use textbooks and start out and then as the class develops, if they allow you, then you can leave the textbook and do fun things and interesting things if they allow you to, but if they don't you can't.

In contrast to the other teachers, Mr. Ritter described himself as a resource, noting in his interview,

> Well, I kind of float around and- and check with- with uh- I try to check in with everybody during the course of the 50-minute time block and, I think they use me as a resource, ask questions about gathering information and once they have it, you know will this work, what won't work, you know what do you think of this, some, some proof reading and editing, and that's about it.

Similar to Mrs. Schneider, he wanted the students to be independent learners. He stated,

> Because I think our ultimate goal is to teach them to be learners forever and how to find the information and how to produce it because, really, in ten years it doesn't matter whether

> they know what the folk tales are from Scotland or what, how many people live in this capital, although I do make them memorize the capitals and be able to locate them on maps and be able to identify geography, rivers, and I make them do that stuff, but I know it's more than a discipline than, and how to find the information.

What was apparent in this description of his role was that he was not a resource regarding the content, but a resource about aspects of the writing tasks. Yet it was clear that there were a variety of different types of sources that could be used. The expectation for more than one source of information brings to question what the authority sources of information in each classroom were and then how those meshed with the opportunity for students linking what they were learning to what they knew.

6.2 Authority Sources in the Classroom

The responsibilities placed on the learners for the learning process and how that process was mentored or facilitated seemed tied to what constituted an authority source of information in the classroom. For example, Mr. Jackson made it clear that the textbook was the source of information that determined the content for his class, while Mrs. Schneider felt that there were a variety of information sources, including other students. Mrs. Schneider prompted students to seek various sources. She described in her interview,

> Because I'll give them maps where they have to identify things. "But it's not it's not in my geography book." And I'll say, "Well, have you checked all the fifty atlases that are sitting on the reference shelf? Have you checked the Internet? Have you checked." And so until they're checked at least three other things, I won't let them tell me that they don't know. And usually that's my rule for everything else; they have to ask three other people before they ask me anything when they're trying to find information.

Not only were various resources to be used, she was adamant about not being an information source, pointing students towards finding the information.

> "What's an embroidery?" a boy asked.
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> "Stitching," a girl answered.
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> "Genteel women did it, not so much boys. This is a small example," Mrs. Schneider said, holding up the example she had found.
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> "What about knights?"
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> "You'll have to read to find out," Mrs. Schneider answered.

Also recall the discussion in Chap. 5 about inquiry projects and Mrs. Schneider's prompt to look up if it was, indeed, sour cream that was common on ships.

In contrast, my observations in Mr. Jackson's classroom indicated that the textbook was the only source for the note-taking process. There were two other

sources of information during the 2-week period that I observed his class during the Roman Empire unit: Friday afternoon videos. Viewing these two videos was a reward for a reading program wherein the students in the class had a goal to read a particular number of pages each week. The movie on the first Friday was a travel movie about Rome; during my third observation Mr. Jackson shared with the students, "I've found a film about Rome, it will show you an atrium. It will show what ancient Rome looks like and then also what modern Rome looks like. When they do sports, they would do football, but what would it be called?" Mr. Jackson's use of a now-and-then conceptual link indicated that useful examples can come from outside of the textbook.

The second movie on day 7 in his classroom was prompted by a personal link that Mr. Jackson shared. He again made it clear that this video linked to the class content.

> Following a review of the previous days' notes, Mr. Jackson mentioned that they had a serious movie last week and in that movie they said something about a chariot. "That reminded me about *Ben Hur*. It's too long to watch the whole thing. I checked it out from the library. It's free, so if you like it, you can check out the whole thing. The part I'm going to show is the most exciting, the chariot race." He put the tape in and started the movie. Some boys moved closer to the TV monitor that was suspended from the ceiling in the front corner of the room. Mr. Jackson continued talking about the movie, giving the context, also pointing out that what was going on in this movie was what they were studying, fast forwarding the video as he spoke and describing who the people in the movie were. Students were talking to each other. One girl sat on the floor. Mountain Dew (caffeine free) was handed out to the students because they had met their writing goal that week. Finally the students settled down and watched the movie excerpt. The race began; the students watched intently. They cheered when people were run over.

Although these other sources of information were included, they were not given any authority in terms of presenting information. They were viewed and provided examples (now-and-then, here-and-there) but were in contrast to how Mrs. Schneider used historical fiction as viable sources for adding to the classroom discussion and student-made links.

I did not interview Mrs. Olson as I had the other teachers, so I was unsure of how she characterized her role in the classroom. However, her view of authority sources, at least in social studies, seemed clear. Similar to Mr. Jackson, Mrs. Olson offered the textbook as the only source of information in the classroom during the three days of my observation. Although the time of my observation in this first sixth-grade classroom in my study was limited, the format of the class was so similarly structured during the three classes that it led me to believe that the format was typical—at least for learning social studies. Mrs. Olson may have moved from the single authority source for other classes.

In contrast, using newspapers in Mr. Ritter's classroom allowed students to bring in their own views and share them related to the news articles. By discussing articles in the newspaper, he helped students understand the varying perspectives that some people might have, supporting that the source should be heard and their voice made available. For example, on the first day of the current events discussion he noted,

> "There's a lot of good stuff in the paper today. Go to the opinion page. I want to read one more page and then give you the paper and give you your assignment. Look at the letters to the editor under those two cartoons. And there's one entitled *Questions on Salary*, remember a few weeks ago the paper had their section on state salaries of people who make $40,000 or more in the public arena?" He reads part of the article. "This gentleman has a letter to the editor about once a month. He's real outspoken on political issues. He asked some good questions. Maybe something to think about."

Recall that Mr. Ritter's students were writing expository papers on the Culture of China. After their first day topic-identifying discussion (Chap. 4) students identified topics and Mr. Ritter continued to prompt them with here-and-there cultural comparisons between China and the United States. The students' first day on the project ended with their work in the media center, trying to find resources. When I returned the next day, Mr. Ritter had asked the students to share their search efforts. Students described the usefulness of the resources that they had found, whether on the Internet or in traditional print texts. Mr. Ritter began the discussion,

> I tried to get around and see everybody yesterday in the Writer's Workshop and I don't know that I caught everybody, so I would like to, give you a chance to share with me and share with everybody else, maybe your topic and what works. You can also share what doesn't work for your research topic because I know Maddie and I were looking for a certain topic on the Internet, and we kept running into dead ends and really couldn't get to where we wanted to get. It was a little bit frustrating. Let's start with Becca."
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> "Well, I'm doing religion. And I just usually use encyclopedias, never really bother with the Internet because it doesn't really work for me that much. I mean, you search and never really find anything," Becca explained while Mr. Ritter jotted notes on the board about her efforts.
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> "That might be consistent with my use of Internet, I love it as a research tool but it certainly has limitations and a lot of the research that I have done recently for my college classes [Mr. Ritter was working on a Masters' degree] has not been on the Internet because it just doesn't give me the information that I really need. But I've gotten some good stuff off the Internet. I can't rely solely on that for my purposes. Elsa, where are you?"
>
> The discussion continued as Mr. Ritter called on students, they shared their success and challenges in findings resourses, with the message always being that there were multiple sources of relevant information.

As students found information through the school resources, Mr. Ritter, on day 3, added information that was in the local newspaper about crime in China, further indicating the types of sources that could provide viable information. "Wait a minute; I know that I brought this paper in for another reason. Jared's researching crime rates in China and not having a whole lot of success, but I did find an article in the Sunday paper about crime in China and it looks like the government in China just executed fourteen people," demonstrating the multiple sources can bring information to a topic.

Mrs. Chambers' self-defined role as a helper did not address the role of information in the classroom and its authority. Her role regarding information sources, for both herself and for learning materials, seemed to change throughout the two-week unit that I observed. Recall in Chap. 3 when Mrs. Chambers introduced the unit, stating that the students should not just read from the book, implying that

there were a variety of sources that would be relevant for finding information. She mentioned including a video, using an encyclopedia (suggesting that there was one on the classroom computer), and a pamphlet that she had developed. Mrs. Chambers did not want just the textbook. Her introduction to the unit on day 1 also indicated that students could learn from one another, given that the students were to be "teaching everyone" in the classroom because the other students would not have read the textbook. At that point in the unit, the textbook was positioned as a source that did not need to be addressed.

As the unit continued, Mrs. Chambers provided students with information from sources of which she approved, in that she found the information, announced it, and then passed it on to students. The content was authority and the students embraced it, trying to find ways to use the approved sources of information. Consider this day 6 excerpt.

> The temperate deciduous forest group went through their presentation for a fourth time, showing the pictures more this time. "Could I have your attention for a minute," Mrs. Chambers announced. She was holding an encyclopedia with a picture of the biomes in it. "Probably you haven't seen this."
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> Mrs. Chambers was standing near Brandon so he took the encyclopedia and looked at it. "We could show this at the end," he said.
>
> "How?" Wendy asked.
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> "Maybe we won't," he said and asked Mrs. Chambers if they could put this picture on an overhead.
>
> "With the levels? I think that would be extremely interesting." They spent the rest of the class period looking with Mrs. Chambers for an overhead of the picture.

Mrs. Chambers' authority role had also occurred during a question and answer session for the grasslands biome. Mrs. Chambers was the authority, right or wrong. Notice my own assessment of the content recorded within my day 8 observation notes.

> "How high does the grass grow?" another question from the class.
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> "Tall, but not taller than people," was the answer.
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> Mrs. Chambers tried to convince them that the animals would eat the grass off, so the girl in the group changed the answer that she'd given the student. They continued talking about the grass and fires. They didn't seem to have accurate information and the teacher was adding to the problem.
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> "Isn't that what happened on *The Lion King*? The grass started on fire," William asked.
>
> "What were the two types of grasslands?" Mrs. Chambers asked.
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> She prompted one of the boys after the girl didn't have an answer. "The Savannah, was that one?" he answered with a question.
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> "The two different kinds, one had more rain than the other," she asked again. The girl tried again to answer, but didn't know and tried to make up an answer. "Asia has the most," she finally said.

"It must be hotter," the teacher said.

"I thought you said that grasslands were cut down by people," a student asked.

"No, by animals," they said.

"Is there any in United States at all?" Mrs. Chambers asked.

"A little," they said.

"They probably build houses there," Mrs. Chambers added.

In Mrs. Chambers' class, students gathered information and pictures, seeking correct answers within an outline that she had specified. Although Mrs. Chambers did acknowledge that the students had provided correct information in the presentations, by the end of unit the presentation seemed to be secondary and Mrs. Chambers' role as information provider (or perhaps a coordinator) reemerged. On day 7, as Mrs. Chambers handed out the study guide she added to her recommendations to read the book for the test,

I don't know if you know what you need. I'm also going to give you a study guide today. Make sure that you have it." She handed out the study guide. "…This [the study guide] has lots and lots of help. If you can do this and answer the questions in the book, you'll be OK because this is a really good study guide."

However, Mrs. Chambers, herself, readily accepted the role of information provider when asked to be an information provider. In the following day 9 excerpt, notice how this played out. Even when the student challenged her, Mrs. Chambers persisted.

"I have a question," a student got out his study guide. "What are the two things about climate?"

"Altitude and latitude," Mrs. Chambers said.

We put temperature and precipitation.

"I looked on the test, it's not even on there," Mrs. Chambers said. "But think of the climate and going through things [through distance]."

"We had habitat and location," another answer was offered.

Mrs. Chambers decided that location was latitude and habitat was determined by the climate. "Do you know the difference between producer and consumer?" she asked.

A student answered her question and asked another. "Could a decomposer be a producer *and* a consumer? It gets its energy from the sun, and the animal it decomposes."

At first Mrs. Chambers said yes, then she said she didn't know. She started looking through the book. "Be sure to look at how people affect communities, I don't know if I put that on there," she mentioned about the study guide. She also mentioned EPA, another topic that might be on the test. "I forgot what you asked," she asked the boy.

He repeated his question. She continued looking through her book, reading some of it aloud and some to herself. The students sat quietly. "I'd say no. They are consumers. It doesn't say anything about direct energy from the sun."

"They do get their energy both ways," the student challenged.

"Not from the sun," she corrected.

"Not directly," the student agreed.

Thus, while Mrs. Chambers was well-intentioned about having students use various sources for information at the beginning of the activity, by the end of the unit it became clear there were particular authority sources and processes for extracting the "correct" information from those. It was Mrs. Chambers and the sources that she helped interpret. Mrs. Chambers opened the unit with an accepting view that included a variety of sources, limiting her own role as an information provider. However, as the unit progressed she took on that role. She and the book were information sources that were not to be challenged.

Mrs. Chambers was an authority in contrast to the give and take in Mrs. Schneider's and Mr. Ritter's classes. They did, as well, have information that was contrary to information the students provided. However, the manner in presenting the information allowed for student comment, although it may be incorrect or unsupported. For example, the following excerpt occurred in a discussion from Mrs. Schneider's class on day 3. The students were discussing a video on the Middle Ages that they had just watched. As they discussed the social structure, Justin brought up Robin Hood.

"Who's the main guy in Robin Hood?" a student asked. John was identified as another offspring.

"What is he famous for?" the teacher asked.

"He was putting really high taxes and people couldn't kill animals in his forest."

"He also developed Magna Carta," Mrs. Schneider added.

"When was Robin Hood's time?" Justin asked.

"If there was one," was Mrs. Schneider's response.

"There was," he countered.

"So you were introduced to other people (in the video). You could think about these people in your plays," Mrs. Schneider added before continuing the discussion. "Why is the justice system important?"

"Because it became ours," a student shared. Mrs. Schneider clarified that it became the basis for the English system, which then became the basis for ours.

Sarah returned to the topic of Robin Hood, reading from a book and describing him.

"There's a lot of theories about it," Mrs. Schneider commented.

I wrote in my notes that the teacher left their ideas pretty much be about the existence of Robin Hood, but does not say that he did not exist, just calls it to question.

Given a constructivist view of learning, of course, all that one shares, even if built on their own interpretations and understandings, need not be considered correct. What may differ, of course, is how the potential misconceptions or unsupported information are addressed. Unfortunately, at times the links that students make through varied sources of information may be incorrect and covert,

as many links are. Recall the video the Mr. Jackson's students viewed that compared and contrasted modern day Rome with the earlier Rome that they studied. A discussion of the information could have been useful in that misconceptions about Rome occurred from the video. Marcus shared information about the Roman Empire during his interview, explaining how things in early Rome were handled differently than they were now. He shared,

> Like they have, like you know how I just thought about the gladiators? They have gladiators there, we don't have gladiators here, only on TV. But, they don't kill each other. And, um, they have smaller cars than us, a lot smaller cars, because we watched the show yesterday, and the cars were about, I don't, but the cars were smaller than the cars we have today. And, the motorcycles looked like those, you know those little bikes that look like scooters? ["Kind of like moped things?" I interjected.] Yeah, mopeds. That's the only kind of motorcycle they had mainly. And they had like many stained glasses in the church.

As Marcus talked it became apparent that the video was perceived as being about the Roman Empire and what Rome was like nearly 2000 years ago, rather than being a video about Rome in modern times. Marcus had only a now-and-then link, but the video provided potential for both here-and-there and a now-and-then link, given the relevance of the differing timeframe of the video and the content. The textbook in Mr. Jackson's classroom remained the authority source, the videos provided examples. Yet, as add-ons to the content, they were not well-interpreted by some students. While a meaningful discussion could add to their value, as presented they remained, at least for Marcus, poorly used surface links.

Of course, as with Marcus in his understanding of the travel video about Rome in Mr. Jackson's classroom, tangential examples or allowing too open of a conversation process require more student support so that misconceptions do not occur. Whether few or many information sources, misconceptions can occur if unchecked. In Mr. Ritter's classroom, students did not always find the best sources, or even viable ones. For example, as mentioned in Chap. 4, in the main room of the media center I had observed a girl was working on the computer copying/summarizing information on Chinese education. She had found information on the web on a Montessori schools that started in China in 1991. She told me she found information about the pre-school and the elementary school. When asked if she had found other information on schools in China. "Not yet," she said. This student never did find another school, just using the information on the a-typical Montessori school in China. In this way, once a student found a source, although the sources for the information varied from student to student in terms of content and medium, in the China project students were not seeking multiple sources to inform a topic, as they seemed to in their discussions of newspaper articles. Students were not critical evaluators of their information sources.

Students in Mrs. Wilson's classroom often found discrepant information about their animals on which they wrote their expository papers. How students were to assess the discrepant information that they found provided an opportunity for discussion about different sources and how they should be treated. This was prompted by Mrs. Wilson's question about students having difficulty finding

information, just as students had difficulty finding information in Mr. Ritter's class. A girl shared that we "can't always rely on the websites."

> Mrs. Wilson asked, "How many of you on the Internet found discrepancies? Found, you know, one site said one thing and another site said another thing?" Lots of students raised their hands. She continued, "So, in the end, what did you do about it? What happened when you found it? What did you think or what did you do?"
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> One student said she found an average. Another said he took the most recent. Another said that he ignored it.

In the first of my two year in Mrs. Wilson's classroom, the students' expository papers were constrained by my research study in terms of the media of the resources that could be used for their papers on the animals of the rainforest. Students wrote two papers. For the first paper, half of the students were randomly assigned to use only print resources (e.g., books, print encyclopedias, fact files) and the other half was to use electronic resources (e.g., internet or an seldom used computer encyclopedia). For the second paper, the students swapped the types of resources that they could use. In that way, the media of the sources were constrained for the students. Within those media parameters, the sources of information that a student used depended largely on what the student found and was appropriate for them. Mrs. Wilson did provide information about recommended websites that students should check (the school system had a webpage listing engines for students, which most of the student ignored, as had those in Mr. Ritter's class). Mrs. Wilson also commented when she modeled note taking, the importance of finding "something that was at my reading level, that I was comfortable reading, so I could start finding out the answers to my questions" (day 1 of year 2). In this way, authority in materials was narrowed by being at the right level for the student.

While resources were open for selection, the process of writing that Mrs. Wilson had her students follow was quite structured to allow for consistency and thus linking across school years. As noted in Chap. 5, the unit started with a general way of developing a broad understanding of the topic, via a video or books, students browsed books to gain some background information and interest (no notetaking), and then wrote questions about their animal that they had selected for the study. These questions were grouped in broad categories such as description, habitat, food and feeding, life cycle, etc., and writing then occurred in stages. In contrast to the content sources, the process was the authority.

6.3 Authority as Process

Both Mrs. Wilson and Mr. Jackson presented authority roles on the processes in which they wanted the students to engage. Certainly, Mr. Ritter, for example, would have included some writing process earlier in the year, but my observation did not show the process as clearly as did my observations in Mrs. Wilson's and Mr. Jackson's classrooms. This could have been because of the goals for their

instruction was specifically to teach a particular process, whereas Mrs. Olson's and Mrs. Chambers', for example, goals seemed to be content development.

Recall from Chap. 2 Mr. Jackson's clarity on his goal for the note-taking process. He made clear that they had worked on a particular note-taking process earlier and that he was adding a component to the process as they studied the Roman Empire. Students would not be able to use their notes while taking the test. His goal was not that students remembered the content about the Roman Empire, but that they developed a process for note taking that they would be able to use next year in junior high school.

He was as clear in the classroom as well, reminding students that they were preparing for junior high school where they would have to take notes. He shared with the students, "I hope all of you will remember these note-taking skills and use them next year." Mr. Jackson shared how his daughter in college took notes, "Susan would outline every chapter in a book until the end of the semester when she didn't have time. She did real well." He indicated the relevance and value of the note-taking process.

While Mr. Jackson was the model for the note-taking process, he did provide a bit of flexibility on how the content was summarized, as long as the student version met his goal of parsimony. Students should capture the meaning of the note in as few words as possible. On day six, Mr. Jackson indicated how many words could sufficiently capture the desired note.

> Mr. Jackson started, "Now as we talked about before, the first page is like an introduction and so there's, other than the main idea, no notes to be found on page 241. Now when we get to page 242,… why don't we just take care of the vocabulary words for now;" he called on a student, "can you tell us what gospel means?"
>
> "Good news," someone said.
>
> "That's right, that's all I want you to write down. I've been trying to have you keep it short, because you will have four lessons, four sets of notes, so we've got to make these easy to remember all of them. So, gospel just means 'good news' and it's found on the top of page 242 and I don't see any more words in bold print until we get to page 243. I do see disciple." Mr. Jackson called on a student to define the word.
>
> A boy read, "traveled throughout the province known as Galilee."
>
> "Ok, how can you make that shorter? I'm thinking three words," Mr. Jackson says. Students gave a number of ideas, then finally one said "Followers of Jesus."
>
> "At the bottom of the page is parable," Mr. Jackson continued, "it can be answered with two words."
>
> "Simple story," someone said.
>
> "Simple story, excellent," Mr. Jackson confirmed her two words.
>
> Mr. Jackson read through the three vocabulary words that they'd covered thus far and repeated their definitions. "Turn the page, we can find a couple more vocabulary words. Crucifixion." He calls on a student, giving guidelines, "four words, four words."

> "Roman method of execution," a boy said and then added, "I was going to say 'A Roman method of execution.'" Mr. Jackson commented that it would make it too long, agreeing with the student on the shorter form.

However, just as with the content, the process of note taking was largely from one source, Mr. Jackson. The note-taking process was completed in lock-step manner; with Mr. Jackson encouraging the process. On day 5 he encouraged the students,

> "Some people are catching on to this pretty quick. Chuck is doing a good job up there in the corner. What you might want to think is 'what would mean old Mr. Jackson think is important?'" Mr. Jackson shared an example from his class at MWU, and how when he was studying he tried to decide what the professor would think was important, "And you should do the same."

This is not to say that the process that Mr. Jackson taught was incorrect or should have been left open for the students to create on their own. Rather, given how students link what they are learning with what they know, what is needed in understanding processes are links to similar processes that have been learned, as had been the case with Mrs. Wilson's classroom. This was Mr. Jackson's hope for his students next year as seventh graders, providing experiences that will foster useful links in the future.

The expository writing process in Mrs. Wilson's class was adhered to by all students, unless a student had a learning challenge that prompted the use of a different note-taking tool such as screen reader and special note-taking software. Students engaged in the steps of the process, while using a variety of resources to gather information on their animals. While Mr. Jackson and Mrs. Wilson both had authority in terms of the process; they differed in authority in terms of content.

The role of authority sources seems important in the building of knowledge links in that if there is only a single source of authority, then the process of making links with other sources of information, including oneself, would be limited. In this way, the development of the rhizome, is limited, as the individual trajectories are constrained. While limiting resources may seem to limit incorrect interpretations of information, or support the goal of similar understandings, given the multiple entrances or vantage points within the rhizome, even a single source is not guaranteed to garner mirrored interpretations. Mrs. Schneider and Mr. Ritter were open to information from various sources (including students); Mr. Jackson and Mrs. Olson were clear about the single authority sources in their rooms. Mrs. Chambers, while initially providing the opportunity for the student to use various sources, during the period of the unit changed that stance–what needed to be learned came from one information source–a study sheet, which was written and interpreted by Mrs. Chambers. Interestingly, while Mr. Jackson and Mrs. Wilson provided models of authority in learning processes, meaning that they provided a very specific process that the students were to follow in their note-taking or expository-writing projects, Mrs. Wilson allowed students choices on the animals and in the resources they chose for the report, as had Mr. Ritter and Mrs. Schneider provided choices on

aspects of projects as well. Mrs. Chambers, on the other hand, controlled the content sources (although seemingly allowing for varied sources initially), but also controlled the learning process through enculturation.

6.4 The Culture for Sharing Links

While more than one authority source of information can open the door for links, what of the students who have no background or experiences in a particular area? Previous research indicates the role of prior knowledge in understanding new content (Bransford et al. 1999; Sawyer 2006); prior knowledge provides the foundation for what we do and learn. Development and use of prior knowledge can be orchestrated through well-sequenced instruction; for example, teaching addition before multiplication to ensure the students have the prior knowledge on which to build.

But, what of those personal links that might provide personal relevance for a student? A teacher likely cannot provide all of her students with a vacation to different biomes so they will have experiences on which to draw. The trajectory dimensions of family, media, friends, and society point to the usefulness of rich environments and opportunities that students have had the privilege to engage. Realize that a rich environment does not imply it needs to be financially supported. For example, in Mrs. Chambers' classroom, Teddy studying the fresh water biome was well acquainted with the types of animals from the creek in his backyard. His open-ended writing shows the use of relevant links from his home environment that he was able to weave in with the content from the class.

> Less organisms live in this biome [fresh water] than the saltwater biome. The freshwater remind me of the creek behind my house. I don't go back there anymore because my friends and I once built a tree house back by the creek and this real mean guy tore it down because it was his land. Someone also shot a gun in the woods and he restricted it from people coming into the woods. The Freshwater in the woods has a whole lot of tadpoles and crawdads. Once I caught a crawdad back there and I named him Cruddy. One week later he died and he smelled so I threw him in the sewer. Like the other animals in the creek he had small fins and a weir lookin' body that I guess help him swim. The creek in the woods was dirty, unlike the ponds. The ponds are probably the most unknown kind of freshwater, because the lakes, rivers, and creeks are more larger and spread around the U. S. A. other than ponds. Rivers are the most common because they have more numbers of them around the globe, and because some are very famous. The Nile is the longest river in the world and most famous, which gives freshwater a good name.

6.4.1 Providing Experiences

Teachers have no control over the experiences that children will bring to the classroom; they will be as varied as the children themselves. But, as Mrs. Wilson stated in her interview, "I'd like to be more of a mentor in that I'm a little more

didactic through that initial process so that *everybody has some experience*" (my italics). While she was talking about the writing process, she also wanted to ensure that students had some exposure to the content before they began writing. Each year Mrs. Wilson's expository writing unit included an instructional activity that allowed the students to gain experience with the content. In the first year she included *The Rainforest Rap* and browsing books about the animals of the rainforest. In the second year all of the students read *The Mimi* and *The Great Whale: Gentle Giant* as they started their unit on sea mammals. Also, recall my first day of observation in Mr. Jackson's classroom with his list of terms of the board. This pre-instructional technique tapped the students' prior knowledge, such as Chuck's link to the Olympics. Certainly pre-instructional activities that provide a prompt and activate prior knowledge are appropriate for a number of reasons. Recall in Chap. 2, the discussion of structure of knowledge; from that perspective without prior knowledge, new knowledge is left floating rather than becoming securely integrated. Given the rhizome metaphor, the trajectory would not be a linked path through the rhizome. Semiotically, for prior knowledge to do its work an object/sign relationship must occur. In other words, what is being learned, must somehow have some meaning or recognition to be a useful component of new learning.

Mrs. Schneider, as well, provided students a number of opportunities including use of historical fiction trade books on the Middle Ages in her class and provided the students with vicarious experiences about the Middle Ages on which the students actively drew. Recall in the previous chapter, the narrative in which students spontaneously referenced the historical fiction books they had been reading as part of their discussion to better understand life in the Middle Ages. Nicole had even speculated about what Eleanor, a character in the book, would be like today, which had been an expectation in one of their assignments for their reading group. I interviewed Nicole based on her ties in her literature writing assignment. I include an extended excerpt to show the strength of the personal link that Nicole had with the character in the book she had read in Mrs. Schneider's class.

> As we walked to the interview room I asked her how she was doing. She said she was doing fine and then she asked me the same question. She was the first student to return that question to me. Nicole was the twentieth student I'd interviewed for the study. When I explained at the beginning of the interview that I wasn't going to show the interviews to Mrs. Schneider she laughed, "I don't care." She laughed again, "She can hear me. She can't do anything to me if you do." Her whole manner during the interview was quite relaxed and casual, with a little bit of sauciness mixed in. She sat with her knees up against the tabletop, crossed at the ankles. After hearing her summary of the book she was reading in her literature group I started my questions.
>
> "I guess a couple things caught my ear. One was," I paused, "you had mentioned something about how there, these people were bad but they shouldn't, in the bible it said that they were supposed to be good to each other."
>
> Yeah, I was just getting on the technical side on that, see because, basically they had a bad relationship, if you can call it, because Ferdinand kicked them out of Spain so they weren't exactly friendly to each other. And, um, you just kind of get the impression that they hate each other, but technically they couldn't hate each other because they both follow about the same book, which, you know, says you're not supposed to hate anyone. So, they can

greatly dislike someone, but they can't hate them. [OK] It really didn't have much to do with the book, but I just figured I'd put it into make it longer.

"Oh, that's why. What made you kind of, we know you didn't just put it into make it longer, I mean you might of, so what do you think made you think of that in the first place?" I asked

I don't know, I was just, 'cause I, I don't know you just, oh boy, um, well you can tell that Eleanor was tense about it and she had been told stories that the Moors were evil and they carried knives in their pants and so, and by the report I did, Ferdinand wanted to start the cleansing of Spain and so the Moors weren't particularly happy with the Christians and the Christians were weren't [she corrected herself] particularly happy with the Moors and so I put, I thought it was different that Eleanor really didn't hate the Moors. I mean, if it were me, I'd be scared to death, running off, 'Oh my God, he's got a knife, he's going to kill me' [she said in a higher voice] but Eleanor was just so calm and, and then it occurred to me that she can't really hate him can she, 'well why couldn't she hate him?' 'Oh, duh, she's Christian.' You can't really hate anyone even though people say you really do hate them.

OK. The report thing that you did on the Moors, was that recently?

Yeah, it was last reading. She just wanted to get a basic clue before we actually encountered the Saracen.

OK. And another thing that you had mentioned, you kind of, what was the girl's name in the book?

Eleanor.

Eleanor, there we go. You talked about, like, if she were alive today what she would do. How did you come up with that?

She just seems kind of spunky and out of whack with her time. I suppose that's because the book wasn't written back then. I mean, if she was, I just see, she just wants to learn about stuff that, if her parents were alive she wouldn't really be allowed to do, and so she just seems like the person who would pretty much rebel against her parents and just go off and learn different languages and learn as much as she could.

Given Nicole's nature, it seemed clear that she related to Eleanor in the story or in some way was interested in her. Nicole's mannerisms indicated the kind of spirit that she apparently saw in Eleanor (note the beginning of her interview). I did not think to pursue this relationship at the time. Given the time period from the first remark about Eleanor on April 29 and the second on May 5 in class, it became clear that the trajectory Nicole had developed was meaningful and useful in her understanding of the material.

Nicole's example, along with other others in Mrs. Schneider's room in particular, point to the ease at which related, relevant, and curricular-based activities can provide experiences on which students can link what they are learning with what they already know to develop personal links. In this way, the classroom experience becomes a prior experience that the students are able to later use to elaborate course content (notice Nicole's comment that Mrs. Schneider wanted to "get a basic clue before we actually encountered the Saracen"). Equally important in allowing this to happen was the open definition of what was considered an authority source in the classroom. In some of the classrooms, students and the materials they chose were sources of authority. That did not imply that anything a student stated was always

considered an authority (recall discussion about Robin Hood for example). Rather, students had the opportunity to add information that was viable given a reliable source and the apparent relevant and usefulness of that information. In addition, the conversational openness in a number of the classrooms then allowed for the sharing of these various authority sources.

As demonstrated in the excerpts throughout the book, the conversation itself becomes a vehicle, a mediator, for the linking process. The content provided the cues and thus the potential links between the new learning and other opportunities. Mr. Ritter and Mrs. Schneider allowed links to occur; the links were part of the learning conversation and they were skilled at facilitating the conversation. Mrs. Schneider, in particular, was adept at managing the conversation. She added brief bits of information where appropriate, prompted the students for further information, explanations, and related experiences, reassured students, managed the classroom, and made clear how the experiences could help them, such as positioning the viewing of the movie as an experience that would help the students better complete a next phase of their study on the Middle Ages—writing and directing a play. The activities served multiple purposes; positioning the students well to build their own understandings.

Overall, this mix of support provided a classroom environment that allowed students to link what they were learning with what they already knew. In a number of these classrooms, these links were not seen as tangents, but parts of a potentially meaningful conversation. What happened around the links reflected the classroom environment in which the relative value of linking was apparent.

6.4.2 Responses to Student Links

A preconception or bias that I had before I started this series of studies was that knowledge construction links (comments or questions by students that are tangential) were often treated as off-track by teachers. This bias was likely a reflection of my own early teaching as I described in Chap. 1. However, in the analysis of the observation data in which students shared links and teachers may have responded in some way, not all links were considered off-track by the teachers. What became of interest in the analysis of these links was what happened prior to and after each link, and how that seemed to mesh with the nature or culture of the classroom that had developed over the course of the year.

Because of the rapid nature of the dialog in the classes, and because my initial intention was to capture the students' comments rather than the teachers, I often missed the teacher's response to the student's comment that was a link. Those reactions that were captured fell into four emergent types.

The Link was an Error The students' links, particularly if idiosyncratic to content, could be treated as errors. A link as an error indicated that the teacher perceived it as inappropriate at that time. It did not, however, need to indicate that the information shared was incorrect. The error was that the student shared the

information or asked the question at all. Typically, in Mrs. Chambers' classroom, as indicated in this day 1 excerpt, the shared links identified as errors were from one student, Mark.

> As Mrs. Chambers continued, I noticed that the students were quiet and seemed to be paying attention. There was little fidgeting. "If you make a group diorama by March 25 you will get extra credit in science. It's on this paper, March 23 I believe that's next Wednesday, is it next Tuesday? As soon as you get the biomes done and you give the reports, then I'll shuffle you around and put you into different groups so you can study alone on the biomes, then you can take an individual test. Then the group that has the highest average score will get a certificate and maybe a little surprise. I'm going to hand this out now, and will tell you who is in what group. I'm going to hand it out to one person in that group, and then you're free to start. I don't want you to go out in the hall. Today all you'll probably be able to do is work on your plans."
>
> Mark interjected, "On this map how come it doesn't show Hawaii?" Later in his interview he told me about the map,
>
> Yeah, just, it had all of America, all of the other countries, and the whole map, and it had Alaska and everything. It just didn't have Hawaii…. I was just staring at the map. Just looking around, and I was looking for Hawaii and it wasn't on there.
>
> "I don't know," Mrs. Chambers answered him. "I'm going to tell you what biomes you have—I don't want any mumbling or grumbling. I think you'll find it very interesting."

Mark's question was likely a viable question, with the map being the cue and his own prior knowledge prompting the question. Although Mrs. Chambers acknowledged the question in an abrupt way, it seemed an error that it was asked as she continued on with her agenda. Later in the unit on day 4 Mrs. Chambers directed a response to Mark about report cards.

> Mrs. Chambers continued describing the presentations for their biome unit. "The main thing you want to think of is what the audience needs to know: what's in the book because that's what's on the test, and interesting facts like that one book that I have about the rainforest—the stuff is actually made out of the rainforests. You have to get down to business. Collages are not the main thing. Yes, they're pretty, but don't over do it. First of all you're teaching the information from the textbook. You have to prepare them for the test. You're the teacher. Do you understand? You have to make sure that they understand everything in your biome. They won't have read the chapter on your biome. In the end we may, we will have a study day, at least part of a study day. It may be the last day before we get to the test. We may do more than one report per day. We're not usually pressed for time like this, but I want to be done before spring break. You have today and tomorrow to prepare. Make sure they know what your biome is. On Monday I would practice if I were you."
>
> The students had an assortment of questions. "What if one person in our group is sick that day?" "Is anyone else watching their movie today?" "When is science over?"
>
> "When do we get report cards?" Mark asked.
>
> "What does that have anything to do with anything?" Mrs. Chambers replied.

Of course the developed culture in the classroom with Mark also lent to Mrs. Chambers disapproval of his comments. While the comments that were links between school elements, such as report cards, seemed inappropriate and off task, Mark had also shared comments that were quite thoughtful, such as his link about

the frozen tundra mentioned in Chap. 3. On the last day of the observation as the students went over the test, Mrs. Chambers prompted a link for the class. Yet the student's response was treated as an error—it should not have been expressed.

> As they went through each question, Mrs. Chambers made a comment about the question and answer, mainly about students who had missed the questions in the review.
>
> "What is not a biome?" The answer was beach. "How many of you are going to the beach [for spring break]?" The students all started talking about their break. Mark said that he was going to Ethiopia. "Please Mark," Mrs. Chambers said, giving him a critical look

Given the open dialogue in Mrs. Schneider's classroom the expectation might be that there were no "errors" in terms of students sharing links. There were three link-sharing errors in Mrs. Schneider's class. However, her response to the students was slightly different than that of Mrs. Chambers as shown in this day 10 excerpt.

> "This is really off the subject," a student announced.
>
> "How off?" Mrs. Schneider asked the student.
>
> "It has nothing to do with the Middle Ages, it's about the Challenger project."
>
> "We'll come back to that," Mrs. Schneider said.

In this day 7 excerpt, Mrs. Schneider implied that sharing the link was an error at that time. However, the student continued.

> "Because she was supposed to stay on the trail and not have possessions," a student shared as they continued to discuss Eleanor's pilgrimage.
>
> "Martin is weird," a student said.
>
> "Let's get back to that point," Mrs. Schneider said and then told the students at the computer they had to whisper because the literature group couldn't hear.
>
> The student continued talking about Martin, "He's weird, I can't explain it."

In his interview I had asked Mr. Jackson what his comment would be to an off track-question. He paused before answering, "I'll tell them we're having math right now, could you ask me that during recess. That's the not the topic at this point." On the first day of my observation in Mr. Jackson's class there occurred the only incident of an error link that I heard in his class. A student had asked about accepting maps for an assignment and Mr. Jackson stated that they would talk about that another day, which he did. The students apparently had an understanding of what was off-track and that they should not bring up the points. Cindy commented about what had popped in her mind during the lesson on Christianity in the Roman Empire.

> Mostly when we would talk about Jesus and stuff a lot of things, like when they were talking about, um, Joseph and Mary, it popped in my head that Mary had a virgin birth and it wasn't really Joseph's but that's kind of like getting into the whole bible so I didn't really say anything about it because we'd get off track. And, like other things when they would talk about when he crucified and he floated on a cloud to heaven, I would think about how

> they actually buried him inside a cave and put a boulder over it and he still rose from there, but I didn't raise my hand because it's off the subject.

Many of these error instances were of students seeking information. In that way, the created link was often prompted by something, often school related, but not relevant given the time or content. What is of interest is the tone of the teacher towards the students. As noted, Mrs. Chambers' style was quite different from Mrs. Schneider's. Mrs. Schneider's comment indicated that sharing the trajectory link was an error (even hers), Mrs. Chambers more so indicated that the student, Mark in particular, was implicated along with the trajectory. Treating links as errors did not occur in Mr. Jackson's class, they were constrained by the environment. In contrast, in Mr. Ritter's classroom, similar to Mrs. Schneider's, it was unusual for a link to be an error. He commented in his interview,

> Well, I think in my situation it might be a little more difficult for a student to be off track because I do my best to–to see what…I um—that's kind of a hard one. They do think for a reason, you know especially when they—when they look for certain types of information or ask for certain types of information, and the last thing I want to do is say "Hey don't go in that direction because it's not exactly where I want you to go." Um, I might say "Hey don't go in that direction because it'll be real difficult to find information, but let's try it anyway."

The Link was Ignored Rather than treating the link as an error, at times the link was not responded to at all; it was ignored. Given limitations of the observation data collection, it was difficult to tell if a shared link was really ignored or just not captured. The data that fell into this category were those in which I had included a note that stated that something else had happened next, or that I had written that the comment was ignored in some way. Although there were few of the instances, these links did seem to be the type of things that a teacher would simply choose to ignore. For example, in my second day in Mrs. Schneider's class in a reading group, the students' singing was ignored and the small group session continued as though it was not heard.

> A girl commented that she liked how the chapters started and gave an example. They talked about the lady in the book and started singing, "Who's that Lady" from the TV commercial. Mrs. Schneider ended the literature meeting, clarifying the assignment for their next meeting. "How long should the answer be?" a boy asked about a writing assignment.
>
> "Probably about a half page typed," Mrs. Schneider said.
>
> "Long enough to cover the subject," the other boy added.

As learning opportunities, links like singing commercial jingles should be ignored. They are surface links that, even if probed, would not add to the students' understanding of the content. In my first day of observation of the students in Mrs. Chambers' classroom there was an incident of this type of response. The class was reviewing their previous unit in science in which they had done an owl pellet project in groups of two. The following excerpt comes after the review.

"We did owl pellets in the fourth grade," one student stated.

"When we did them with another teacher, they were a little bit bigger," another student added.

"Let's move onto biomes," Mrs. Chambers responded. "My dog got into my book last night, page 124. Let me tell you how we are going to do this. It's a little boring to just read about the biomes and answer questions. Divide into three people teams. I've already divided up the teams, so I don't want any moaning and groaning. Get out your science folders because you're going to have to take notes, actually you might be able to take notes on the paper that I give you. You might want to do both. Let me tell you want I expect, then we'll hand out the groups, and at least get the groups together and get started. You have lots of options. What do I mean by options?

While the student had a link across school years, Mrs. Chambers went on to make a link of her own that did not align with the content or was not information seeking. The culture of the classroom was that tangential, non-content related links could be made, but they would be considered errors or ignored. In fact, Mrs. Chambers' class had also learned how to respond to Mark's links as indicated in the next excerpt. On my third observation day I had written in my observation notes as I watched the temperate deciduous forest group work on their project.

From across the room, Mark announced to the class, "Do you think Barbara Streisand is in the jungle?" Everyone seemed to pretty much ignore him. Brandon shook his head.

In this example we see the culture adapting to Mark. Over the year, the students had learned to also ignore him, or perhaps treat his links as inappropriate or errors. Yet, the culture of the classroom can also support the use of links in a number of ways.

The Link was Acknowledged When a shared link from a student's trajectory was acknowledged it was neither treated as an error nor ignored. It was commented on by the teacher or perhaps by a student, and although it may provide information on the topic, was not used in any other way. In Mr. Jackson's classroom there was one occurrence on day 4, a student commenting on a sentence in the book that was read that it contained an appositive. Mr. Jackson confirmed the student's observation and the lesson continued about the Roman Empire.

Mrs. Chambers acknowledged students' non-content related questions when they were seeking information about school-related activities. For example, a student in Mrs. Chambers' room had left their school picture money on his desk. The cue was the envelope itself. Mrs. Chambers provided the information, but the link added nothing to the discussion about the biome project. Mrs. Chambers addressed the student's question and then moved on. She also acknowledged students' questions about students who might be missing on the day of the presentation, saying that they would be scheduled around.

Mrs. Schneider responded to the students similarly, addressing the comment or question. Recall the aural link from day 13.

"You should know where the word manuscript came from," Mrs. Schneider told them.

"Hand."

Mrs. Schneider gave more examples of words with "manu" as root.

"It reminds me of a planetarium. No reason, it just does," a student offered.

Mrs. Schneider was adept at finding the potential relationship, even if the student was not aware of the source of the link; acknowledging the student's comment by noting the Latin roots of words. In another example, Mrs. Schneider acknowledged, but did not build on, the content understanding although she helped the student build additional understanding.

"This is sort of off the subject," Tracy started, "is *Jackaroo* from the Middle Ages?"

He was. *Jackaroo* was a fantasy book that the students had read earlier in the year. The setting, although a fictional land, was like the Middle Ages. Mrs. Schneider told them that she had had them read that book for different reasons, not for information on the Middle Ages.

In the newspaper discussions, Mr. Ritter was also acknowledged students' links during the newspaper discussions and then moved on. Recall that Mr. Ritter encouraged students to share news ("go for it"), providing a single word comment ("interesting" or "nasty"), and at times adding a sentence of comment. For example, on day 1 a student noted that someone had been inducted into the Hall of Fame and Mr. Ritter acknowledged the comment by stating that he had heard that on the news. These responses to links allow business to be accomplished, such as in Mrs. Chambers' classroom, providing brief explanations to students for content-related links they have, and indicating that their questions and comments, although perhaps not about the content, are appropriate to be shared. In this way the student may feel comfortable in sharing links that come to mind. However, links that are used for depth of learning for all students in the classroom were met with greater inclusion in the classroom dialogue.

Although few links occurred in his class, Mr. Jackson did acknowledge Marcus's efforts to share information from a different source—first saying the information must be from the textbook (recall what was the authority source for content in his classroom), but then supporting the link that Marcus had made. The link was acknowledged in a more elaborative way. This day 6 excerpt follows Mr. Jackson and the students defining the vocabulary and writing down the brief definitions.

Mr. Jackson read the first focus question in the lesson, "Who was Jesus of Nazareth and what did he believe? I found five simple statements that I think will answer this," Mr. Jackson explained as he wrote the numbers 1 through 5 on the board. While he's writing a lone hand is raised among the students.

"I know this from Sunday school," Marcus started after he was called on and listed a number of items for "He believed in spreading the word of God." Mr. Jackson moved closer to Marcus giving affirmation. Marcus continued, "Jesus of Nazareth was like the son of God."

Mr. Jackson explained, "Okay, now," and paused before continuing. "Marcus says that he knows this from Sunday school and there's a lot I think we all can tell from what we've learned in Sunday school. But remember that law class I'm taking? ["Yah," Marcus

interjected]. "I cannot tell you what *I've* learned in Sunday school. We have to get it from the book, OK? I can't proselytize students, force my ideas on you. That's illegal, I can't do that. So,"

Cindy said, "Like the big bang theory."

"We're going to have to go with what the book says. Let me give you one and kind of get you started. The first one says," Mr. Jackson wrote on the board: "1. Jesus was a carpenter from Nazareth." "That's in the bible and it's also in our social studies book, and since it's in our social studies book none of us will get in trouble about that," Mr. Jackson commented after writing. "So, it doesn't just say that he was a carpenter, what else does it say?"

"Jesus was a teacher," a student added, Mr. Jackson repeated the statement, and wrote it on the board.

"The next thing, the people who started, we'll talk about the disciples, but they call them Christians, so people who followed him were called Christians. This kind of goes with what Marcus said. Who did the Christians believe that Jesus was?" Mr. Jackson tried to tie Marcus's response with what is in the book, prompting him to complete "Christians believed Jesus was."

Marcus guessed, "The Christ?" "The Lord," "The,"

Mr. Jackson chuckled and continued to give physical prompting gestures with his arms, finally Marcus said, "The son of God."

"You're right," Mr. Jackson repeated the statement and wrote it on the board, "3. Christians believed Jesus was the son of God."

Mr. Jackson continued with the next point, "Marcus already answered a couple of these too, what were some of the things, from our social studies book, that he would tell people to, other people, should do?"

The Link was Respected and Validated Marcus' link indicates the continuum on which the response to a learner sharing links that had developed on his or her own personal trajectory. While Mr. Jackson acknowledged Marcus's link, although initially dismissing the source, he did help Marcus potentially draw on information that could have been garnered either in school or out of school. That said, it was support for Marcus in the acknowledgement of the link, but the link was not woven into the understanding. The next level of reaction to a shared link of the students' trajectory provided more than a brief acknowledgment. In this case, the link, the content attached to it, and thus the learner's trajectory, was respected and validated by being accepted as a meaningful part of the current conversation. The tangent to the conversation in the class was used to add information. There were no documented instances of this overtly in the whole group discussion in Mrs. Chambers' or Mrs. Olson's classrooms. When students provided links in Mrs. Chambers' classroom, the links were not integrated into any types of extended conversation that would indicate validation. However, that could be because of the small group work that was predominant and the small number of links that actually appeared overtly.

Consider Mrs. Schneider's response on day 5, which followed a day in which the students had a substitute teacher, Mrs. Schneider not only validated this student's link and the trajectory that followed related to cheating on exams, but allowed the student to continue speaking, and verbally stated that it was important.

"What about the social studies test? We didn't have time to finish," a student said.

Mrs. Schneider commented about the day's work schedule on the board, and said that they will have some time after recess. "I know things didn't go exactly the way we wanted, but we will work with that." She explained about how they would be allowed to fill in answers to finish the test, but not change what they had already written. There was discussion about honesty in this. A girl suggested that they should Xerox them, and gave an example of what happened with her dad. Mrs. Schneider talked more about trust, and said that she "trusts that you will follow directions, you can't blame her [the sub] because she was interrupted."

The same girl continued talking about the situation her dad ran into and that he was being accused of being racist. Another student asked about the point to the girl's comment. Mrs. Schneider supported the girl who was sharing, saying that it was important.

On day 17, in a conceptual link related to the content of the Middle Ages and a discussion of alchemy that followed from a student-written and produced play on the topic, Mrs. Schneider prompted with a question that drew information about a subject that the student had identified as not being related.

"This is not related to alchemy," Todd said, "but there was something called the devils stone—gun power, brought blood, etc."

"When did they start using gunpowder in Europe?" Someone had mentioned that it began in China as Mrs. Schneider finished asking the question.

The group decided that maybe it was the 1300s.

"When did alchemy turn into chemistry? I suppose it happened gradually," a student said.

"After the Middle Ages," Todd answered.

"It was probably the 1700s," Mrs. Schneider said. "You who have been to Europe, did you have to get medicine? It's still the same, you get it from a chemist, like our pharmacists."

As now may seem typical in Mrs. Schneider's classroom, links were acknowledged, with Mrs. Schneider adding information, but also prompting to students to consider other links that they may have that would add further information. Mr. Ritter, as well, expanded some of the students' ideas into more formal discussions about the topics. Recall the discussion about smoking to which the students continually returned that Mr. Ritter's class addressed on multiple days. As students brainstormed ideas about what they could explore about the culture of China, those ideas themselves likely linked to their own prior knowledge about what culture was, Mr. Ritter acknowledged each student's contribution, adding bits of information to each.

Although the process focus of Mrs. Wilson's and Mr. Jackson's classes perhaps limited opportunities for validating links by their integration into the classroom conversation, they did occur. Mrs. Wilson provided an expanded commentary on a research question that a student posed, also acknowledging the value of that question in the study of the animal in day 4 of my second year in her room. In this way, the student provided the cue and Mrs. Wilson provided the link given that cue.

"If their main food source became extinct would they get another food source?" Yolanda suggested as a question to study about the sea mammals.

"Good question!" Mrs. Wilson exclaimed. "Say it again really loud." Yolanda repeated the question, more loudly this time. "OK." Mrs. Wilson slowly repeated the questions as she wrote it on the transparency sheet for all to see, "If their main food source, let's say I'm gonna put extinct or disappeared. I'll tell you about that in a minute. Say it again," as she asked Yolanda to repeat her question again.

"What would they eat? Or would they be able to eat something else?" Mrs. Wilson asked. "Here's an interesting sidelight on that. There are seals in Alaska that feed on a fish called pollock. And pollock is a fish they use to make that imitation crab meat. Have you ever seen that in the store? [note her prompt for an experience link] Imitation crab? Well there's so much fishing of that pollock in Alaska that the young seals are starving to death because they can't dive deep enough to get the big ones. And the fishermen have wiped out all the pollock at the level where the young seals can. So they have a terrible problem with their seal population declining. So it will be an interesting question to find out. Good!" Mrs. Wilson ended by again commenting on Yolanda's question and then called on the next student.

Similar to the discussion in Mr. Ritter's classroom, the instructional activity prompted students to think about topics, ideas, or questions that related to the content. These questions pointed to potential links that the students may have had and provided opportunity to acknowledge and validate the students' contributions to the classroom conversations.

Some links that were addressed by the teachers were exemplar in how they were then used to support the knowledge construction efforts of the students. These exemplars may be considered trajectory integration or theory building; the shared element of the personal trajectory was not only valid and respected, but was used in such a way to gain new understanding. The links were used and elaborated, but there was something more.

These types of acknowledgements were most common in Mrs. Schneider's class. Again, recall the scurvy and vitamin C example from her class discussion. The link that the student made between her inquiry project and the Middle Ages developed into an involved dialog about the topic. Mr. Ritter's class included an extended example in a conversation about Chinese currency on day 2 as the students were brainstorming about aspects of culture that could be studied for their projects.

"I'm doing money," Rita said. Mr. Ritter wrote currency on the board.

"Ah!" Mr. Ritter said as he wrote currency on the board. "That could be kind of fun, looking at the exchange rate, what an American dollar is worth versus the Chinese equivalent. See which has more buying power. Allen?"

Allen talked Chinese dollars and its equivalent in our money system that they had found out from Jackie Hoover.

"Yeah, OK, the Chinese dollar is the equivalent of about 12 American cents, so not a real equal exchange rate there," Mr. Ritter figured. "Amanda?"

Amanda added more information, sharing what $5 would buy.

Mr. Ritter tried to recall the information that Jackie, his former student in China, had sent them.

"Yah, she said 100 dollars, 100 US dollars would last you a year," Allen added.

Mr. Ritter clarified, "Yah, and she was referring to meals and everyday kinds of expenses. Yah, $100 around here wouldn't last you very long at all if you were purchasing meals and everyday kinds of stuff.

A student commented about what you could buy with $100 American dollars.

"Depending on how you used it. You could spend it easily on two meals," Mr. Ritter commented.

"Wouldn't it be the other way around though? If one Chinese dollar was 12 US cents wouldn't it have to be more?" Allen asked.

Mr. Ritter paused. "We should go back and really examine that." Allen tried to explain the logic of the comparison, "Um, like, let's say like, I don't know how many Chinese dollars equals American dollars, but more Chinese dollars would equal American dollars," concluding that the Chinese dollar would be worth less than American.

Later in the discussion after students have brought up other topics, Ryan returned to the topic of money. "I was looking at this," as he showed a paper that he had about exchange of money.

"It had to be more than that," Allen added, "My dad brought me back Chinese money, like a lot of it, and I traded it, I got like 50 bucks."

"Exchange rates can vary from day to day. I don't know how that's calculated. It's not a fixed rate. It can change within a day and it fluctuates a bit. Well, let's do this. Anybody else what to share what they worked with so far?"

Again, no overt examples of trajectory integration occurred in Mrs. Chambers' or Mrs. Olson's classes in the large group discussions. However, the students were capable of using this reaction to student's links on their own. The saltwater group on day 2 of my observation in Mrs. Chambers' classroom were browsing their science book and the encyclopedia for plants and animals that were in the salt water biome.

William read from the encyclopedia about the ice caps. They talked about the ice caps melting again and how much the ocean would rise if that happened. Roger wrote down the information.

"What else does it say? What about New York?" William asked. They looked at the book. The first life was in the ocean. They listed the oceans and seas that were in their biome as Amy copied them down.

William suggested, "We could put the kind of boats that go in each." I asked William about the boats in an interview that day.

"Yeah, I was talking about the oil tankers. We were trying to figure out how many gallons of oil were pumped out every year and I said, 'we could also list different kinds of oil tankers and boats that are in the ocean.' Just as, I don't know, I had an idea," he trailed off, sounding somewhat apologetic…. "Well, 'cause most, well we're looking through the encyclopedia and we saw that it was showing oil, that most of the oil was on, in the ocean. So, I said we ought to list, or see if we can find how many gallons, or whatever, are pumped out each year or something. We looked through it and we actually found it. I guess we just, because it, basically it may be an important resource from the ocean, it's just one of those things," he explained.

"What do you know about oil tankers and stuff?" I asked.

"Let's see, they're very big, of course. Most of them, or some of them, never mind, I won't even say that, some of them get caught up or they wreck, but um, they have lots of people on them. They drill into the ocean surface, people can get hurt on them sometimes, maybe from the oil. That's all."

I probed further, "So, where'd you find out about oil tankers from?"

"The encyclopedia. When I was some age, I don't remember, I think first grade, we did a report on oil tankers and I had to look something up in the encyclopedia. That's where I found all of my information. I have no idea what half of it said, but. I mean I knew what an oil tanker was, like it was a big boat. But," he trailed off.

The group continued their work. Roger asked, "Where's the video? We'll watch that tomorrow, right?"

Amy had finished writing the list of seas. "What about crustaceans?" she asked.

The boys began discussing the depth of the ocean. Amy repeated, "We need to add crustaceans." They continued talking about the depth of the ocean and started talking about where the Titanic was on the map that they were looking at. William explained in his interview about the Titanic.

"Yeah, we were going to do, like the ocean levels and I guess Amy went to go look, like the ocean levels, and then we tried to figure out what the deepest point is and Amy said, 'Well, look it up in this book' and well, 'No, that has the Titanic in it.' And then we were talking about, because we thought the deepest point was two miles, but we were wrong. Because it's five and half miles. And well, we were just talking about Titanic for some reason, I have no idea why. But, I guess, Amy kind of brought it up so we started talking about it. I don't know why she brought it up."

I interviewed Amy the following day. She remembered her Titanic idea, "What made you bring that up?" I asked.

"Because it's at the bottom of the ocean."

"So, what made you think of it? Just because it's at the bottom of the ocean?" I asked.

"Yeah, because we're doing an ocean project, and like 'well we could do Titanic at the bottom of the water level thing.'"

"Ok, what do you know about Titanic?"

"That it sank in 19," she paused, "14, I thought," almost questioning herself. "And, a lot of people died. And I've seen that movie like a zillion times."

As the salt water group continued to work, Roger told William, "See if you can find the highest and lowest point—the highest would be by the shore." They continued to look in the encyclopedia.

William said that it's 17 miles, the other two didn't seem to believe him. "Oh wait, that wasn't right, it took 17 years to make." They continued talking about the time, one mentioned that it was 7 days, but those were in God years. After finally finding the deepest point, the discussion continued about what unit of measure it should be, should it be in feet? All three left, Amy returned first with a book and found something helpful in it. The group continued to refer to the Titanic and the depth, trying to get it into the measure that they wanted—miles. "Do they have it in meters behind it in parentheses?" Roger asked.

They continued looking for information. "130,000,000 gallons of oil are pumped out of the ocean," they read. "I wonder how much the pressure would be," Amy asked.

"A mile of water you'd die," Roger answered.

"I'm trying to find out how many gallons are in the ocean," stated William. "Oh, here's something on the food cycle."

At 11:55 the bell on Mrs. Chambers' desk was tapped to signal for the class's attention. I could hardly hear it. Today the class took longer to quiet down than it did yesterday after only her quick "OK." She told the students to move back to their desks.

These students, their weaving together what they knew with what they were learning, were building theories about the size, volume, and age of the ocean using cues from the encyclopedia and acknowledging and building off of one another's tangents.

The response to the links that students made in the classes varied—they varied based on the culture of the classroom, the relationship of the teacher and the student, as well as the responses of the teachers in their in vivo assessment of the link and its potential. For example, the responses in Mr. Jackson's class perhaps indicated the control and structure of his classroom. Students were aware of what they were to do and what was appropriate. Because the study occurred near the end of the school year, we can assume that the students had adjusted to the classroom environment and knew what were appropriate comments (from the teacher's perspective) and generally did not offer those that were not. Thus, when comments were made, they were often acknowledged because they had already been censored by the students themselves. Students in Mr. Ritter's and Mrs. Schneider's class seemed to benefit from the greatest scaffolding of their links via integration into conversations relevant to the content. But, as the salt-water biome group demonstrated, students integrate relevant links into their discussion without teacher scaffolding (although they may have benefited from teacher support). Figure 6.1 notes the environmental response that can then support or inhibit further links by students.

The responses to links may be considered an order of acceptance, with responding to the link as an error as the least validating and having it being fully integrated as the most. Although some sharing of links were responded to as an error, it was typically not the student who was in error, merely a component of the trajectory, generally the time at which it took place. The above examples indicate

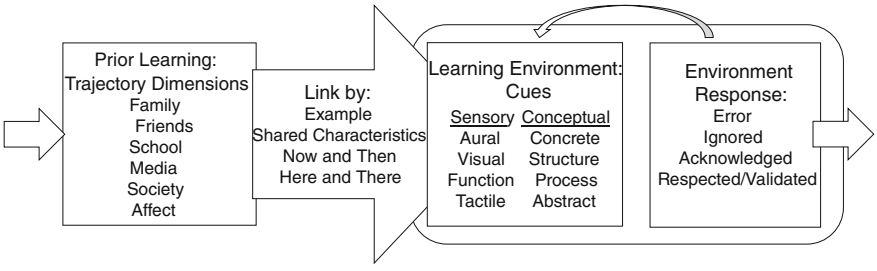

Fig. 6.1 Responses to links, as well as the overall nature of the environment, support or inhibit further overt sharing of students' links

that the different classrooms cultures had developed varied ways of dealing with the links. Given that the students in these classes had been in their classroom environment for nearly a year, they had perhaps grown to anticipate their teachers' reactions to tangential comments and questions, accounting for the paucity or prevalence of links in the classrooms.

6.4.3 Prefaces to Student Links

In data collection, capturing a link and what followed was often a challenge, given the pace of the conversation, but capturing what happened prior to a link was even more difficult in that it seemed that anything could precede a link given the wide variety of examples by which students linked. However, at times students announced their intention to move to a tangential topic. Recall Tracy, in Mrs. Schneider's class, announcing "this is sort of off the subject" before asking her question about *Jackaroo*. In Mrs. Chambers' class, the overt links were predominantly from Mark. He announced his intention to link to something tangential. Recall his preface to his frozen tundra comment in which he announced, "I'm not trying to be funny; how come in Green Bay they call it the frozen tundra?" Mark also provided another example on day 7, when Mrs. Chambers distributed the study guide. She had prompted,

> "I know something we need to talk about tomorrow, we need to talk about the estuary. This [the study guide] has lots and lots of help. If you can do this and answer the questions in the book, you'll be OK because this is a really good study guide." The lunch menu for April was handed out as well. "This is really excellent, even if I did make it," she added about the study guide. "On Thursday you can get together and question one another. I don't think there's going to be enough," she said about the handouts.
>
> "I have a question," Mark announced. "It's not about science but it's about the lunch menu, what's an Italian Hoagy?"
>
> Mrs. Chambers answered him and then made sure that each student had a handout.

When Mark prefaced his trajectories, it seemed that Mrs. Chambers was less likely to treat them as errors (as she typically did) and would answer the question or respond to the comment. I asked Mrs. Chambers' about Mark in her interview.

> "I think Mark is very intelligent. I think Mark loves attention, he craves attention. His parents are divorced. I've had one of his brothers. He has two brothers, I had one. And they're both very similar, very likable kids. Sometimes you'd like to strangle them, but you can't get angry with them because they're too funny. I really like Mark. Mark does not pay attention and I think if he would pay attention better, and we've had some little talks about it but it does not seem to make any difference. He's just too busy doing his cute little things, and then he'll say, 'I'm just dumb, I don't know.' And I'll say, "Now, Mark, you know better than that" and then we'll break it down into parts and he'll know. Like the math, once we broke one of those problems down, he knew. But you know, if you're not paying attention and then you just look up there, you're lost. But, I think, quite frankly, he could do much better work. I think he'll be OK though."

> "It seemed to me that he was probably a very creative kid," I commented.
>
> "Very. And I think he could be even more so if he'd just take the time to do it, but he hops around like a butterfly," she laughed.

Mark was bright. He had adapted to the classroom environment, realizing that if he wanted an answer to a tangential question he needed to preface it as such. When they were prefaced, they were more likely to be answered, and thus, not treated as errors.

In Mr. Jackson's class, there were no prefaces. Students knew what was acceptable and so no apology or announcement was needed. The classroom environment reinforced the controlled, convergent, closed atmosphere. Mrs. Wilson's class, as well, had no prefaces to links that were shared. This seems reasonable, of course, given the small number of links that occurred in her classrooms overall, the direct instruction that she used in modeling the note taking and writing process, and that much of the observation was of students working on their writing projects. Mrs. Olson's classroom format was so structured, at least during the social studies visits that I attended, there was little room for sharing.

In Mrs. Schneider's class students prefaced comments in two ways. They were used to clarify the students' intention to go off topic, just as occurred in Mrs. Chamber's class, as when she responded to Tracy's question about *Jackaroo*. In addition, there was an instance of a student stating that what followed was *not* a question. Thus, although the environment appeared to be open, perhaps there were covert feelings on the part of the students in what they could offer, questions being more acceptable. However, the observation data did not support that such a perception existed among the students in that they were very willing to provide comments and questions, tangential or not. For example, as Mrs. Schneider described the historical fiction trade-book groups that her class would read in small reading groups for the Middle Ages, a student interjected,

> "It's not really a question, I have a book that has all the adventures of King Arthur, it's in paperback, do you want me to bring it in?" Mrs. Schneider had mentioned about how many books there are available on the period and that some good ones about King Arthur were only available in hard cover.
>
> "You could bring it into share," Mrs. Schneider continued describing the books for the reading groups.

In Mrs. Schneider's class students also provided disclaimers such as announcing that their comment was stupid. I had asked Mrs. Schneider if she felt her students were overly critical of themselves. She agreed that they were critical. The preface statements by her students may well be individual characteristics that were present regardless of the classroom or may be attributed to ACES students.

Even Mr. Ritter's classroom, which included the open conversational style of interactions during the sessions that I observed, included a number of prefaces by students. When a sixth-grade girl announced that "This is about something different" in their newspaper discussion, Mr. Ritter told her to "go for it," and she returned to the topic of the smoking ban.

Given these varying environments, the question becomes, is it better to have an environment that is too open, in which students may link too much with their prior experience in ways that are not useful for understanding, or one that is too constrained, where the format does not allow for this active engagement? As Professor David Lohman, a colleague, shared with me after reading one of the studies, "I do see something of a tradeoff here in the extent to which one encourages students to make personally meaningful connections with everyday experience rather than model a process of elaborating the concepts of the domain of inquiry within that space of ideas. Much of becoming a professional in different domains involves learning to carry on discourse using the language, rules of evidence, etc., that characterize the domain. The initial grounding must surely be in what one already knows about the world outside of the domain. But eventually we must transition to the place where we make both types of elaborations–the one that connects our understandings to the complex web of ideas within the domain and the other that connects these ideas to our broader (especially everyday) understandings of the world. Those who can only do the latter never really seem to learn to think within the constraints (and affordances) of the domain. Those who can do only the former become academics who are unable to communicate with the rest of the world" (Dave Lohman, personal communication).

There is a balance that any teacher needs to maintain in allowing students to share their links of personal understandings, while also fostering linking within the field of study. For these elementary students these links perhaps indicate a current way of thinking, but also their knowledge within the domain. The types of links they make indicate a facility with the domain—for example, if a student has limited exposure to the domain what are they to do but link the tangential elements that seem closest to the information. Clearly, given increasing exposure and a well-intending student, links within the domain should become more salient then other surface links with outside information. Thus, not all links are created equal in developing an understanding in the domain of study; next we consider *of what value are student links*?

Chapter 7
Of What Value Are Student Links?

Abstract The research on generative learning and depth of processing provides grounding for considering the value of the links that students make as potential for learning—the focus of this chapter. First, three levels of links indicating their value to potential learning are described. Then, results of a quantitative study that followed the cases described in this book point to relationships among characteristics of the learning environments, students' perceptions of their strategies to link, and achievement. These findings are woven with existing research on particular learning strategies and the cases reported throughout this book. The chapter concludes with a nod to the importance of students learning to regulate their linking processes; to ignore those surface links that may be a hindrance to learning and use strategies to purposefully explore useful links.

7.1 Generative Learning and Depth of Processing

Although all students will create links, not all links that a learner makes are useful for understanding the content. In other words, what comes to mind for a learner as he or she initially encounters information may be useful for learning or it may be a distracter or a hindrance. The value of creating these links seems well-aligned with the notion of generative learning as well as depth of processing.

Generative learning, as described by Wittrock (1992) provides a functional look at learning, rather than a structural look. Rather than looking at what is being stored, in one's mind so to speak, in terms of knowledge structure (see Chap. 2), generative learning considers the generation of relations among information that the learner knows and what is being learned. Wittrock distinguished functional forms from structural forms: "Schemata store general information; scripts store specific experience. However schema theory informs us less about cognitive functions. Schema theory implies only that learning involves slotting new information into schemata,

This chapter draws on Schuh (2004b), Schuh et al. (2005), Schuh and Kuo (2014a, b) and Schuh et al. (2013, 2014).

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_7

or relating new information to scripts. In brief, this line of research informs us much less well about *how* learning occurs and how teaching can be facilitated" (p. 536, my emphasis). The functional model proposes that people use generative processes to "generate meaning of events by constructing relations between new or incoming information and previously acquired information, conceptions, and background knowledge" (p. 532). Thus, the idea of generative learning fits well with the active nature of a learner's trajectory, weaving meaning based upon what they know as they engage in learning opportunities. When learners are asked to generate relations between what they are learning and what they know, they can increase comprehension and understanding. As the links, called Student Knowledge Links (SKLs), described in this book indicate, students are ready resources for developing these links, although they are not always asked to create these links—they just do. The links that have been described in the classrooms and in the learners' individual writing can be useful in that they are opportunities for students to develop these connections. The processes of the generation are important and can include analogies, metaphors, and summaries (Wittrock 1990).

The functional view of generative learning seems to capture the nature of SKLs as students spontaneously link what they are learning with what they know. Considering the variety of links that students created that were documented in this study, not all of the links would be equally useful in fostering understanding and comprehension. Depth of processing, although aligned with the research on knowledge structures, provides a means to consider how the potential for these links will vary.

Descriptions of depth of processing seem to point to two different aspects of the process. First, depth of processing has implications for encoding and storing of information. Students who have processed information more deeply have gained learning benefits. For example, early research on depth of processing, aligned with the research on semantic networks and spreading activation (Craik and Lockhart 1972) considers depth of processing as a component of memory traces and how meaning is extracted. Once a word, for example, is recognized, then other links may be activated, or retrieved from memory (i.e., the learners' prior knowledge). This, then, provides the meaning that an individual has. Craik and Lockhart noted that the memory trace (see Chap. 2) and how it persists and is available to prompt and support meaning is contingent upon depth of processing. Thus, depth of processing points to what learners previously have learned and how well they have learned it. Consider the students in the case studies presented in this book. In every classroom, there were students whose links indicated some depth to their knowledge and understanding. Once a cue was available, there were strong, and often rich, memory traces that allowed them to engage in conversations or expand on an idea in their open-ended writing. In these same classrooms there were students who had little to say about their topic or anything related to it.

The second aspect of depth of processing moves from the cognitive structure and points to depth of processing as linked to student activity. Beyond the storage of a knowledge structure learners themselves may engage in *processes* that may be surface or deep. Students who process information at a surface level may focus on

memorizing for recall (Biggs 1989, 1999; Marton and Säljö 1976), using repetition and reproduction. Surface processing is often aligned with considering specific facts or information that is disconnected or not well integrated (Watkins 1983), focusing on specific content, thus having a narrow approach (Campbell et al. 2001). For example, Marton and Säjiö noted that when reading a text, students who indicated surface-level engagement directed attention to learning the presented text; resulting in recalling lists of disjointed ideas and missing the point of the author. This seems the way, for example, that Mrs. Chambers eventually prompted her students to engage with the content.

In contrast, students may process information deeply whereby they seek to relate, apply, and even theorize about what they learn (Alexander 2003; Biggs 1989, 1999; Marton and Säljö 1976; Watkins 1983). They consider the underlying meaning of what is being learned (Watkins 1983). These students have a more active role in the classroom, richer appreciation for what they learned, relate to broader issues, and exhibit personal change (Campbell et al. 2001). In reading, students who indicated deep engagement directed their efforts towards what the author of the text had to say, grasping the larger point of the text, the details supporting their interpretation (Marton and Säljö).

While deep processing includes relating new information or text, for example, to prior knowledge (Murphy and Alexander 2002; Willingham 2009), in this study, depth of processing considers how relevant the prior knowledge may be when linked to what is to be learned, rather than if someone had deep or surface understanding of particular content being studied (Willingham 2009). Of course, the depth of the initial link may be related to the depth of processing of the prior learning and thus, the potential to support generative learning.

The links that students initially make, as described in this book, reflect not only what they knew, but also the potential for developing deep processing given that prior knowledge. The cue, a shared element between prior knowledge and environment that allows meaning, provides the prompt for the link, whereby it can undergo further elaboration—thus this elaboration (of meaning) is what may be described as deep processing. This should not be based on only a sensory analysis or pattern recognition, meaning that the learner has recognized something; but should push for, what Craik and Lockhart (1972) called, stimulus elaboration, wherein learners mix the stimulus with what they know, elaborate it so that it can be better understood and thus, learned. They described stimulus elaboration as the deepest level of processing in which learners move beyond just sensory analysis, such as mere sensory cues, and elaborate the stimulus so that it can be better remembered; thus what will be future knowledge developing on the spine of prior knowledge.

The goal, of course, is deep processing where the prior knowledge provides a viable option. However the initial relationship between the cue in the environment and the prior knowledge provides the initial starting point from which elaboration can, if it should, begin.

7.2 Potential for Understanding

The students' open-ended writing, referred to throughout the book, was subjected to further data analysis, to explore the possible potential for learning that may accompany the student links. These data were chosen because each student who participated in the study had opportunity to share their links, rather than being constrained perhaps by the classroom environment or personal characteristics such as quietness in the classroom. The process for analysis of the data is described elsewhere (Schuh et al. 2005). Briefly, each piece of writing was first reviewed to see if the student had (1) written about the content *and* (2) also included a link. Content varied across classrooms, but was the same within each classroom. For example, the content in Mrs. Wilson's classrooms were animals of the rainforest and sea mammals (depending on year), while the content for Mrs. Chambers' classroom was the biomes. Writing that included no content or only content (meaning the students did not include a single link) were excluded from further analysis.

Some students made many links in their papers, while others made few. What was similar among them was how each student interwove his or her own links and the content. Once a student started making links, the kind of link they made was quite similar. Given this, only that first link in each paper was analyzed; that initial cue in their own writing that prompted a link.

7.2.1 Simple Links

Three levels of links emerged from the student data. In a simple link, the student's cue stemmed from a surface characteristic of the content and the link seemed to have no potential to add to the student's understanding of the content. These seemed to be the type that, although they would pop into a learner's mind in school, would not be helpful in the learning experience. They can certainly be explained by principles such as spreading activation (McKoon and Ratcliff 1992), for example, but seem to not be a very useful application of prior learning/experiences to enhance understanding. Simple links drew on only surface elements shared between the information being learned and prior learning. These simple links noted shallow, surface details that did not capture critical characteristics of the new information and seemed to have little value for developing further understanding of the content. This type of cue, that to which the learner was initially attuned in the learning opportunity, seems limited for making progress towards the learning goal. For example, noting that an orca is black and white as is a newspaper is a simple link that is limited in its usefulness in understanding this sea mammal in a deep way. This type of surface knowledge is often aligned with traditional school scheduling practices (Brown 2001) and early development of analogic thinking (Brown 1992). However, even these simple links can be useful in the instructional process in that they may portray the most salient characteristics of the new content for a particular learner at a

particular time. These characteristics, although limited, help define the learner's situation definition, the way that they are able to view the learning opportunity (Wertsch 1985) and capture how the learner may initially approach the content using surface features. It is his or her starting point, albeit limited, for his or her learning.

For example, "… The manatee is gray and it reminds me of the school cupboards in the classroom…" or "A desert has sand. A softball field does also …" are simple links that seem unlikely to support better understanding of manatees or the desert biome. In an earlier paper (Schuh, 2004b) I explored the links that students had made with media sources—e.g., television, movies, video games. While the types of media sources change over time, the content may not. For example, consider a link with the Vikings to Madonna's *Frozen* that would now likely be nonexistent for an upper elementary student where the idea of *frozen* would now bring up pictures of Disney's adventures of Elsa, Anna, and Olaf. The types of links remain; the content of the links being colored by the learner's trajectory. The surface links that built together content from the classroom and information gained from a media source, typically from out of school, were often based upon a single modality of the media source (e.g., auditory or visual elements). For example, recall the practice session of the temperate deciduous forest of the students in Mrs. Chambers' classroom, when Jeffrey started singing RESPECT by Aretha Franklin as their group tried to unravel a word written with poor penmanship and spelling. In Mrs. Schneider's classroom, a small group of students were discussing an historical fiction book set in the Middle Ages. As they began to discuss the "lady" in the book they started singing "Who's that Lady" from a hair product commercial. These auditory links are merely spontaneous reactions with no relevance to learning the content, other than perhaps indicating a degree of personal expression and comfort in the learning environment.

Students may link to a purely visual feature in media as well. A boy in Mrs. Chambers' classroom related the visual representation of a line of ants that he had seen in a movie on the rain forest in class to seeing a line of ants crawling to the top of his house. This visual image linked with a television show that is "called Beast Wars. It was a computer animated show about Robots that take the form of animals but they transform back and forth," as he described in his writing.

The simple links, developed via mere surface characteristics, do not appear to be helpful in the learning process, and in fact, may be characterized as ramblings of mind, with the students being off-track or distracted. Although not useful for learning, they do present some of the challenges of learning and, of course, instruction. What is clear is how quickly they can materialize in the day-to-day activity of a classroom and that they do exist. Kids' thoughts wander.

7.2.2 Potential for Elaboration

The second level of link potential included those links that seemed to offer potential for learning but the depth was not made explicit by the learner. These links did

seem to provide the potential to foster understanding of a particular topic, and thus the potential for deeper engagement with the content. With this mid-level classification, the learners brought relevance with them, but did not elaborate the links (Wittrock 1985). As with simple links, the value of these links may lie in the potential they provide by identifying the learners' initial situation definition and prompting appropriate scaffolding. However, beyond noting the situation definition, these were more sophisticated spontaneous links that could potentially build understanding in a number of ways. In these, the relationship between the two sources was typically a conceptual link in that the learner related similar ideas. For example, recall Teddy from Mrs. Chambers classroom who had the potential to better understand the freshwater biome based on his own experiences; "Less organisms live in this biome [freshwater] than the saltwater biome. The freshwater remind me of the creek behind my house."

These links can provide basic prior knowledge that allow a student to better understand a concept. For example, in Mr. Ritter's classroom, a number of girls were sitting around a table in the media lab, exploring print resources (e.g., encyclopedia) for their topics. As one girl read about religion, she came across the word "exorcist" and asked another, "Did you see the Exorcist?" "Yeah, scary," the other answered. In Mrs. Chambers' classroom, in a discussion of how high grass can grow in the grasslands biome and the possibility of fire, a boy asked, "Isn't that what happened in the Lion King? The grass started in fire." Although these links seem simple, they provide these learners, and perhaps others in the class as well, a means to better understand the content.

Recall discussion by the students in Mrs. Chamber's classroom that used the Titanic to understand the saltwater biome. The students' discussion of the depth of the ocean was actually quite involved; the Titanic providing a marker for them to better understand the saltwater biome. However, this link points to the role of scaffolding that often is used in strategies of contemporary learning environments. A more knowledgeable individual, either a teacher or someone else, could help problematize (Reiser 2004) the students' discussion of the ocean floor and the information their understanding of the Titanic provided, pointing out discrepancies, adding information to challenge those understandings. On their own, it may be difficult to push the value added besides providing relevance.

Other students drew upon larger aspects (themes) of the content in the media sources. In Mrs. Schneider's classroom, students read Brother Cadfiel mysteries as part of their unit on the Middle Ages. Recall that Brenda understood the investigation process (linking by process) in that book as it mirrored how crimes were solved on *Diagnosis Murder*.

In Mrs. Schneider's classroom, Tracy's link with Cinderella also provided potential for elaboration. While in the classroom she merely shared a comment and the teacher commented on the Tracy's empathy. As Tracy indicated in her interview, her link also included story structure.

A boy in Mr. Jackson's classroom compared the behavior of his reading teacher to an underlying theme in a movie. "… reminds me of [reading class and the teacher] telling my class to listen. We are always talking or at least that's what she

claims. Claims reminds me of a movie called Air Bud.…" He continued by explaining the movie and how the clown had told the judge that the boy had stolen his dog. While the girls in Mrs. Schneider's classroom had identified and compared themes of story genres, he was able to understand a very subtle message in the movie and relate it to an example in his own school.

Although links to movies and television were the primary media by which students linked, a few students linked to computer games. This media example was still linked by concept, but in the case of computer simulations learners had an opportunity to understand because they had "experienced" something similar via the computer. For example, a student in Mr. Jackson's class wrote about gladiators fighting in a coliseum and then continued, "That makes me think of this game Tomb Raider cause in that game there's a coliseum and there's underground cages where they kept lions, and Lara Croft got to go down there but she had to kill lions!" In Mrs. Olson's classroom, a student mentioned a computer game in her description of how the Irish were converted to Christianity in the middle 400s AD, setting up monasteries. She had played a computer game "where I went into a monetary and talked to a drunken abbot." Although the visit with the drunken abbot may not be the desired interpretation of a monastery, she wrote of the encounter as her own experience.

Although these examples provide potential for understanding, they are limited in that there was not opportunity for continued discussion and sharing in which the information was linked further in the learning process. There was no opportunity for acknowledgment or to have them validated as relevant and useful to foster depth of processing. Yet, they do indicate that the learner may have prior knowledge relevant to a topic of study that, with appropriate scaffolding, may be helpful to the learner.

7.2.3 Linking for Understanding

The final level were those links that had been elaborated by the learner, thus making clear that the learner had built a relationship; integrating what they brought with them to the learning experience. These links potentially fostered deeper understanding of the new content. Focusing on deeper characteristics of the content may indicate an understanding or an intention to understand (Biggs 1999). For example, a student in Mrs. Schneider's classroom wrote,

> ….When I started to really research, however, a more realistic picture of the Middle Ages began to take place in my mind. One of dirty streets, poor people, women who bear a child every other second, pointless crusades, rich minorities, and other injustices. It really reminds me lot in some ways of the Apartheidera in Southern Africa. Europeans, the minority, had so much control over the black Africans. I think that the Apartheid system and the feudalism system have many similarities in this sense….

Media sources again provide a catalyst for seeing how understanding can be fostered by links; the teacher providing the scaffolding to weave the media links, based on a concept of authenticity and accuracy. The students had read the *Song of Roland*, a poem about one of Charlemagne's generals. One student pointed out that the poem was also in her group's literature book about the Middle Ages. The teacher corrected that the book was actually based upon another poem, and that "we don't know how much of that is true."

> "But is it still based on historical facts. They just add things to make it sound cool," a student said.
>
> "And they emphasize certain facts. They wanted to make it look better because he was Charlemagne's advisor," the teacher clarified.
>
> A student mentioned how things were changed and how many changes there were in the movie about the Kennedy assassination. Another student mentioned the Titanic. "How can we know if it's true?" a student asked.
>
> "There were journals kept at the time," the teacher responded.
>
> "But how do you know that it was an honest person?" a student asked.
>
> "It's all biased," the teacher said.

This conversation, noting a critical view of both traditional and more modern media sources, was not a lesson on how to evaluate media sources, but rather, occurred as part of an open-ended conversation about the *Song of Roland*. Mrs. Schneider challenged sources and the links made with their content and encouraged students to do the same.

Recall the discussion in Mr. Ritter's classroom about the hazards of smoking (see Chap. 4). One of the Mr. Ritter's goals for using the newspaper in the classroom was for the students to be critical consumers of information, "to look carefully at what they read and question what they read. I want them to develop opinions about societal issues."

Joey had talked about a commercial that showed a woman who had started smoking at the age of 16. Later in the spring, the students reviewed a health packet about tobacco. In class, a second boy brought up Homer Simpson as they were talking about tobacco products. In his interview Joey explained,

> There's an episode where Homer decides to buy a farm, his grandpa's—his old grandpa's farm. Well he just moves in, and his-like um they set it like to get the house ready and he plants tobacco and tomatoes and he figures. .. and the tobacco and the tomatoes grow together… …Yeah, then he calls them tomacco and he sells them, and the police guy stops by and he's like "I'll have a thing of tomacco." And then he's like, "Ooooh, this taste awful, but I'll have like a bushel more!" And like, and then like Marlboro comes and they're like, "we'd like to make you an offer for two hundred million dollars" and then all his um, all the animals eat his tomacco, and um, he has one plant left, and then Marlboro steals it and he doesn't get any money.

While Homer's story may not provide educational information, as would be found in a school health packet, about the dangers of smoking, the issues with tobacco use were clearly embedded in Joey's account of the animated comedy

woven into his trajectory, and thus could provide a springboard for extended discussion on important relevant issues. As noted in the previous chapter, classrooms in which students have opportunities to share these links allow students to build on their prior knowledge with the support of the teacher.

7.3 Linking, Learning Environments, and Achievement

A limitation of the qualitative studies was that they did not include evidence of individual student achievement, just their linking. Following completion of the qualitative studies reported in this monograph, a group of graduate students and I drew on the work to develop three instruments to look at the links that students could make in a quantitative way. The developed instruments, the Student Knowledge Linking Instrument (SKLI, Schuh et al. 2013), the Student Knowledge Linking Instrument—Perceptions (SKLIP, Schuh et al. 2014), and the Survey of Contemporary Learning Environment (SoCLE, Schuh and Kuo 2014a) allowed us to consider the relationships among student knowledge linking, the classroom environment, and student achievement, which had not been addressed in the qualitative studies.

The SKLI (Schuh et al. 2013) captures SKLs that students make between brief reading passages and a series of "reminding" choices that were developed to align with the types of links that students made in the qualitative studies. Student completion of this instrument proposes to capture the students' situation definition (Wertsch 1985), specifically their initial links with the information. Students are presented 15 items in which they read brief passages. Then, they are asked to choose the topic or idea that best matches what they thought of when they read the passage. They are presented with 8 different options, which include a range of potential link levels. For example, a student may read a brief excerpt about life cycles ["Like all living things, fish have a life cycle. A life cycle is all of the stages in the life of a living thing. During their life cycles, living things grow and change" (Mallinson et al. 1993, p. 72, used with permission)] with choices of what came to mind being recycle, cocoon, another animal, fish, a play, some place I've been, people, or going fishing. Following that, the student was asked to choose from eight options why they thought the topic came to mind (e.g., the words sounded alike, they look alike, they both have stages, it's part of a life cycle, I like it, the process is the same, they both go through a life cycle, I have one as a pet). Students were told that if none of the choices match exactly, they were to choose the one that was closest to their idea, marking only one choice in each area. Through a coding development process, the 64 pairs that could emerge from each question were assigned a link level as described previously: a surface link; a link that, with scaffolding, could potentially be useful; or a link that indicated that the student had a deeper conceptual understanding of the reading passage and their initial link. Each student, given the coding, was then assigned a link profile that indicated his or her typical linking profile.

For this study, participants included 461 late-elementary school students (grades five and six) and their teachers in 26 classrooms, in ten school buildings, in seven school districts. These seven school districts were generally rural, with three in communities of less than 3000 people, three with less than 11,000, and one in a community of approximately 26,000. All of these communities were smaller than the communities in which the qualitative data were collected. Of the nine school buildings providing school/community demographic information, minority population ranged from 4 to 20 % (M = 13.9 %) and free/reduced school lunch rates ranging from 33 to 86 % (M = 53.8 %).

From this research, eight student linking profiles were defined based on combinations of numbers of responses that indicated surface links, links that showed potential to aid in understanding the text, and links that indicated that the students had a deeper conceptual understanding. These eight profiles indicated clusters of students who had, for example, more surface links than the other two types, or perhaps near similar amounts of the first and last link levels and more responses that indicated the middle level. While there was not a clear developmental sequence as demonstrated by the occurrence of different levels of links, in this study of fifth and sixth grade students (admittedly too small of a grade range to demonstrate developmental differences), more sixth grade students had greater occurrences of high-level links.

7.3.1 SKL and Achievement

Along with the SKLI, students completed a demographic survey, the SKLIP, and the SoCLE, so to consider how students' perceptions of their own linking might be implicated with classroom environment and achievement. In this section I discuss findings from a study that considered the interaction among student knowledge linking, classroom environment, and student achievement as measured on standardized assessments using the SKLIP and SoCLE.

The Student Knowledge Linking Instrument—Perceptions (SKLIP) (Schuh et al. 2014) measures late-elementary students' perceptions of their creation of SKLs. The items in the Student Knowledge Linking Instrument—Perceptions (SKLIP) were developed through consideration of the types of SKLs that student had made in the qualitative studies. With an overall reliability of 0.80, it includes three subscales. *Seeking Relationships* (5 questions with a reliability of 0.68) captures students' intentionality in making general relationships between what they are learning and what they already know. *School Learning Across Time and Content* (4 questions, $\alpha = 0.64$) captures students' relating new learning to prior school learning. *Contextual Remindings* (4 questions, $\alpha = 0.59$) captures specific comparisons that students made with information that was typically gained out of school.

The SoCLE (Schuh and Kuo 2014a) was designed to assess students' perceptions of their classrooms in terms of characteristics typically aligned with

contemporary classrooms. Constructivism or situated cognition/situativity theory are often useful theoretical lenses for contemporary classrooms. We initially explored a number of characteristics for those classrooms: learning anchored to a larger task, ownership, multiple perspectives, negotiation of meaning, environment, authentic tasks, reflection, learning goals, assessment, and teacher's role (Duffy and Orrill 2004; Honebein et al. 1993; Savery and Duffy 1996). From this, five (learning anchored to a larger task, ownership, multiple perspectives, negotiation of meaning, and reflection) were explored in depth, considering how they linked to the epistemological foundations of constructivism. For our purposes, we drew on a socio-constructivist view that stemmed from Vygotsky and was also linked to situativity theory (i.e., Greeno et al. (1996) situative/pragmatist-sociohistoric perspective). In this, what individuals "construct" is afforded and constrained by the environments and the interactions in which they engage. In this way, how one comes to know is mediated through elements of the environment including specific cultural aspects such as language (Wertsch 1984). Understandings are deemed viable and useful in a variety of different ways as they meet individual and collective goals. Following factor analyses, three variables remained to capture the contemporary learning environment. The overall reliability of the SoCLE was 0.76 and included the *Ownership* subscale (7 questions, $\alpha = 0.65$), *Reflective Processes* (6 items, $\alpha = 0.68$), and *Multiple Perspectives* (3 items, $\alpha = 0.53$). Ownership captures personal control and value of the students' projects. Reflective Processes captures not only reflection-on-action that is typical of descriptions of reflection (Schon 1987) but also reflective consideration of ideas in action. Multiple Perspectives captures opportunities to share and negotiate differing and related views (Schuh and Kuo 2014a).

Characteristics of contemporary learning environments as measured by the SoCLE did significantly predict three types of student knowledge links (as measured by the SKLIP) to varying degrees. A small effect size was noted for Contextual Remindings ($R^2 = 0.08$), while Student Learning Across Time and Context ($R^2 = 0.16$) and Seeking Relationships ($R^2 = 0.18$) indicated medium effect sizes (Cohen 1988 R^2: small = 0.03; medium = 0.10; large = 0.30). In other words, the more a student perceived a classroom to include more contemporary characteristics such as fostering ownership of learning, encouraging use of reflective processes and allowing multiple perspectives, the more likely that they were to use particular linking strategies.

Given that the SKLIP notes different linking strategies through the individual subscales, we also considered the total score of the SKLIP. The SoCLE subscales predicted this overall score as well ($R^2 = 0.21$). In all of these, SoCLE Reflective Processes contributed most to the prediction models, followed by SoCLE Ownership. SoCLE Multiple Perspectives did not contribute to the prediction models. In other words, the perception of having ownership in learning and engaging in reflective process predicted the perception of using linking strategies for the students who participated in this study (Schuh and Kuo 2014b).

Student perceptions of the linking in which they engaged was also related to students' achievement. In this study achievement was measured by the Iowa Test of

Basic Skills (ITBS). Not all schools in the study used the ITBS, therefore this analysis included 251 students. The ITBS is a collection of standardized achievement tests in content areas including reading, vocabulary, math, social studies, and science (Hoover et al. 2003). Variables from this assessment included in our analysis were: Vocabulary, Reading Comprehension, Total Reading, Language, Social Studies, Science, and a Composite Score. ITBS scores used in our analysis were National Grade Equivalent scores (NGE). Assessment data from classrooms that submitted the ITBS indicated that those students varied in Vocabulary, Total Reading, Language, Social Studies, and the Composite Score.

One subscale of the SKLIP, Seeking Relationships, was related to more positive outcomes on the ITBS, significant at $\alpha < 0.05$. This linking strategy was significantly related to Reading Comprehension ($r = 0.14$), Language ($r = 0.28$), Social Studies ($r = 0.22$), and the Composite score ($r = 0.21$) (Schuh and Kuo 2014b).

Aspects of contemporary classrooms were associated with higher achievement as well. Multiple Perspectives was significantly positively correlated with Language ($r = 0.22$). Ownership was positively correlated with all ITBS scores except Vocabulary (Comprehension $r = 0.23$; Total Reading $r = 0.20$; Language $r = 0.26$; Social Studies $r = 0.35$; Science $r = 0.18$, and Composite $r = 0.30$). None of the other assessments indicated relationships among achievement scores and subscales of the SoCLE (Schuh and Kuo 2014b).

Finally, considering the relationship between students' perception of linking, the classroom environment, and achievement, the role of Seeking Relationships and Ownership significantly contributed to prediction of the composite score on the achievement test ($R^2 = 0.40$).

This research indicated that there are aspects of learning environments that foster student links, and that they may also be implicated with some aspects of student academic achievement. The research on contemporary classrooms and achievement has been varied. For example, the discussion about the limitations of guided instruction (Kirschner et al. 2006; Tobias and Duffy 2009) as well as Maddux and Cummings' (1999) question of whether constructivist teaching goals are developmentally appropriate for younger learners, also pointed to the need to begin to look at how these young students perceive their classrooms given characteristics of contemporary learning environments. This study that considered perceptions of creating links and classroom environment helps to increase our understanding of possibilities.

Hattie (2009), in his synthesis of meta-analyses, noted the effects of a variety of teaching strategies related to educational achievement. For example, direct instruction, when properly implemented using seven major steps, indicated an effect size of 0.59 (effect sizes over 0.60 were considered high in his analysis) given 4 meta-analyses including 304 studies. This discussion, while it points to the value of what may be viewed as traditional teaching methods, needs to ensure that they are executed in a legitimate way. For the studies reported in this book, there was no evaluation conducted to ensure that the methods of any of the teachers, including the more traditional methods of Mrs. Olson, Mrs. Chambers, and Mr. Jackson, were well done. For that matter, there was no evaluation of how well Mrs. Schneider's

and Mr. Ritter's more contemporary classrooms prompted student learning. Perhaps the case narratives allow the reader to make that call. Direct instruction is not typically aligned with constructivism, although the theory itself would not exclude its use, but prompts consideration of when and why it might be appropriate for a particular learner (Savery and Duffy 1996). Hattie's synthesis also included a number of strategies often aligned with contemporary views of learning such as constructivism. For example, the effect size for reciprocal teaching was high ($d = 0.74$ given 2 meta-analyses including 38 studies). Cooperative learning ($d = 0.41$ given 10 meta-analyses including 306 studies) had a medium effect when compared to individual methods of instruction and when compared to competitive methods as well. That said, cooperative learning had less of an effect when the goal was for lower-level tasks such as rote memorization. Strategies that align with the use of ill-structured problems, such as inquiry-based teaching and problem-based learning, did not fare as well when compared to traditional instruction. Inquiry-based teaching ($d = 0.31$ given 4 meta-analyses including 205 studies), did show greater effects for student understanding of process than for understanding of content. Hattie's analyses also indicated larger effects might occur when students are given the opportunity to think critically, when previously they had not had that opportunity. Problem-based learning ($d = 0.15$ given 8 meta-analyses including 285 studies) also fared poorly when considered with traditional instruction. However, the type of content to be attained (e.g., basic factual knowledge/surface knowledge versus deeper processing) influenced the effect; as with inquiry, the effects were greater when considering application of knowledge rather than development of knowledge. A recent meta-analysis which included 225 studies of college STEM courses that included active learning compared to more traditional lecture courses, also noted a similar difference when outcomes were of higher versus lower cognitive tasks. This meta-analysis also found student outcomes scores increased by nearly half of a standard deviation in the active-learning courses. This effect did not vary depending on discipline (science, math, or engineering) or whether the students were majors or non-majors. Further, the lecture format showed an increase in student failure rates (Freeman et al. 2014).

Studies of classrooms that engage more contemporary methods, such as Mrs. Schneider's and Mr. Ritter's classrooms, do show that contemporary classrooms (i.e., those typically using constructivist—or situated-aligned strategies) can have positive effects, as students in these types of classrooms are more likely than students in traditional classrooms to show high levels of thinking in areas such as applying information (Gijbels et al. 2005), and greater use of science-related concepts in responses, accuracy in problem diagnosis, and coherence in causal arguments (Hmelo 1998). In a study of anchored instruction, a constructivist-aligned strategy, 19 third–through fifth-grade math classes showed larger gains on two higher-level math achievement subtests. Further, this difference was more pronounced for low SES schools (Hickey et al. 2001). In addition, there is no indication that students' academic achievement was disadvantaged by more contemporary methods (Verhoeven and Verwijnen 1998). The results of the quantitative study on SKLs point to what aspects of the environment may be useful

to support students to build links as they engage in generative learning and construct their knowledge. Learning environments that may promise development of problem solving and critical thinking skills may actually provide elements that can be useful when viewed through a generative learning lens.

Students will construct knowledge; the challenge is to better understand how to support them in that process. How can students be engaged in ways that allow them to link various elements of their learning with their prior knowledge and to expand that prior knowledge as they develop more expertise in domain knowledge. This essentially points to distinguishing between descriptions of how we learn or come to know (i.e., is it a process of conditioning? acquisition? construction?) and how that may best be fostered (whether through more open contemporary methods or not). I am reminded of a lively discussion at the AERA Annual Conference in 2007 about constructivist practices and whether they are appropriate for fostering effective and efficient learning. It is not such a simple dichotomous debate. Those who advocate contemporary learning environments as ones that provide viable opportunities to learners, motivate them, and allow some sense of learner autonomy have long endorsed the need for scaffolding (e.g., Wood et al. 1976). Students will link what they are learning with what they know. What is more important is what happens in the learning environment to support those students to make sense of their initial links and then develop abilities to create and regulate that process to build deeper understanding of the content. To assume that students are not linking, even in a learning environment that is governed by direct instruction, undermines the heart of learning.

Although I have argued throughout this book that links that students make do come from their prior knowledge, aspects of their own trajectory weaving with the information and opportunities provided in the learning environment, there are aspects that can be viewed as distractions or at least inhibitors for the learning process. As the types of links indicate, not all links are of equal use. In the larger study, Contextual Remindings, a subscale of the SKLIP that captures specific comparisons that students made with information that are typically gained out of school, contributed negatively as a predictor to the national grade equivalent outcome (Schuh et al. 2014). In other words, some of the contextualized remindings that students have, such as from media sources, may negatively impact learning outcomes.

7.4 When Links Are not Useful

In the data from the students presented in this book, there were a number of links that occurred in which the students linked ideas that were clearly not useful to learning the content, although they may be useful for other purposes; for example asking about the envelope for school pictures or finding out what a menu item for school lunch was. Others were perhaps viewed as distractions that captured some of the complexity of schooling for kids and what they bring with them. Recall Jeffrey

in Mrs. Chambers' classroom (RESPECT and drumming). In an interview with him he shared that during the reading quiz they had that day he was thinking about his brother and if he was getting in trouble. Roger, one of the boys in Mrs. Chambers classroom who was studying the salt water biome and discussed the Titanic, linked to the idea of the ocean being five miles deep,

> Any way the ocean's deepest points is about 5 miles. I would hate to run 5 miles in guy because the gym teacher is so mean. I am very glad I'm leaving this school because it is so boring. I mean we have to be silent in the halls, no gum chewing, awful cafiteria food, and having to be quiet in the lunch room!!! Go figure. The Ocean's depth was known after we knew the distance to the moon.

A girl in Mrs. Chambers classroom likewise moved from the biome topic to science being boring. "I think science is **very BORING**! I really hate it. I almost fall asleep during science **sometimes**. That is absolutely all I have to say about that" (her emphasis).

Because students' minds will wander and aspects of the classrooms will have meaning for them that are not related to the content, students need to develop self-regulation of potential links in the learning process, i.e., content regulation as a part of the self-regulation process, which I point to as an opportunity for further research.

As noted, prior learning from particular contexts may vary in usefulness as elements of a generative learning process, particularly for learners of this age, who may be lacking self-regulation strategies. Pintrich and Zusho (2002) note a developmental aspect to self-regulation that hinges on prior learning. This development of regulation processes is then coupled with the potential development of links, similar to the development of analogical thinking. Learners who are self-regulated direct their processing, motivations, and behaviors towards learning outcomes (Pintrich 1999; Pintrich and Zusho 2002; Zimmerman and Martinez-Pons 1990). They use a number of strategies to plan, monitor, and regulate their activities and behavior. A well-regulated student can make adjustments to their efforts to foster alignment with tasks and the related goals that might accompany those tasks (Pintrich 1999). While self-regulation often includes tasks such as following through on and completing their work, specifically, learners who regulate their own learning (1) recognize the factors associated with a learning task, (2) set goals for that task, (3) enact plans for studying and problem solving, and (4) reflect on the process either mid task or at its conclusion (Winne and Hadwin 1998).

SKLs point to one element of the regulatory process—evaluating personal links prompted by the content a student is studying. This might be considered content regulation. A well-regulated learner may choose to follow links that might be useful by thinking about the relationship, asking questions, or offering a comment in an elaborative way. Elaboration strategies provide opportunity for deeper processing of information (Pintrich 1999). A well-regulated learner may ignore those links that seem irrelevant. In contrast, learners with poor regulation skills may choose to follow irrelevant links and abandon the content being learned or may never elaborate potentially useful links.

What seems to be equally important, prior to regulating tasks, is the role of selective attention based upon the potential for elaborating content based on what an individual knows. Pre-instructional strategies such as KWL, where students begin a new learning opportunity noting what they know, or instructional strategies such as Mr. Jackson's asking what words might belong to the study of the Roman Empire, prompts the learner to consider information that may be relevant to the topic of study. However, what may or may not be useful are the tangential links that all students create because of their own past life trajectory.

For example, in the larger quantitative study, students were asked to respond to the following question:

When I am learning something new, if something else comes to mind, I

- ignore what has come to mind **and** keep paying attention to the new things I'm learning.
- try to figure out if what has come to mind will be helpful in learning about the new things.
- start thinking about what came to mind **and** stop paying attention to the new things I'm supposed to be learning.
- I don't do any of these.

Student responses to this question were compared to their responses to questions in the Contextual Remindings subscale. Although item comparisons are not typically statistically informative, the results provided interesting food for thought. Students who chose the different options to the question about what happens when they learn something new differed in their responses to a SKLIP question about being reminded of places ($F(3, 461) = 5.09$, $p = 0.002$), a SKLIP question about being reminded of movies or TV shows ($F(3, 461) = 3.63$, $p = 0.013$), and a SKLIP question regarding people the student knew ($F(3, 461) = 3.87$, $p = 0.009$). The results indicated that students who tried to figure out if the link was helpful were more likely to have school information remind them of places they have been or people they knew than students who indicated that they would stop paying attention to the information presented in school. In contrast, students who were more likely to indicate that they *would* stop paying attention to the school content were more likely to be reminded of TV shows or movies. This is particularly interesting given the many media links that the students in the qualitative studies shared, some of which did indicate insightful relationships. That said, developing skills to regulate links of whatever type, seems important.

Providing an environment that allows for exploration of and perceived value in this linking process seems useful in helping students build their personal understanding while also more deeply processing the content. Modeling useful links, prompting questions about useful links, and ignoring or redirecting are strategies that can support students' efforts. The need for developing regulation skills seems important given that learners will engage in a process of unlimited semiosis. With that topic we return to the notion of traversing a rhizome and the role of semiotics in that process. We consider *how is linking (and thus learning) like unlimited semiosis?*

Chapter 8
How Is Linking (and Thus Learning) Like Unlimited Semiosis?

Abstract In this final chapter the linking process of two students' writings are dissected to indicate how the meaning they shared illustrates a process of unlimited semiosis, grounded in the notion of a semiotics sign system. The trajectory dimension of emotion/affect is used as an illustration of how an element of one's trajectory may become the next cue, and thus guide the trajectory as it continues. Further discussion of trajectories and how they progress is then supported with a brief discussion of dynamic systems. The chapter concludes with a return to the rhizome metaphor and a summary of the grounded theory.

8.1 Operationalizing Unlimited Semiosis

Although my own trajectory in the development of these case studies reported here was informed at various stages by differing, but related, lenses and theories, semiotics provided a foundation for a small, but important, aspect of the work—why the link that the learner (or teacher) made between the environmental cue and the prior learning had meaning for the learner and should be valued as such. In addition, further describing the role of semiotics in my interpretation of my studies prompts consideration of what unlimited semiosis might be like for learners in a classroom.

As described earlier (see Chap. 2), from a Peircian semiotics perspective (Peirce 1985), an interpretant is essentially the meaning that someone has ascribed to a particular thing. Eco (1984) described a network of interpretants as a process of unlimited semiosis. This network, or rhizome, describes the universe of human culture (i.e., semiosis). In a process of unlimited semiosis, the interpretant (the meaning) of a sign (something that stands for something else—an object) may become a sign itself. In other words, a sign may point to another sign (or in the words of this study, a cue prompts the trajectory in a particular way), given

This chapter draws on and expands on research reported in Schuh (2000), Schuh and Rea (2001) and Schuh et al. (2005).

K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2_8

something in the environment that has meaning, which then prompts something else. This new sign leads to further meaning and thus, another interpretant, capturing a semiotic cycle. The students' open-ended writing provided a venue to capture this process for essentially all students as they linked from one topic to the next. But, the process was also evident in the classroom discussion as a collective process of semiosis, consider particularly the flow of the conversations in Mr. Ritter's and Mrs. Schneider's classrooms as the students were cued within the conversation by other's comments.

This semiotic process can increase comprehension, with each added interpretant providing further explanation and meaning for the sign (and hence the object) involved. The implications of this process are important. As Sebeok (1994) noted, "Each further interpretant tends to amplify intelligence and afford opportunity for a cascade of semantic innovation and therefore change" (p. 13). In other words, this process has the potential to capture learning and transfer. It captures how learners weave their understandings given new information and what they know, and points to what they take away, linking to what they will later understand given opportunities because new cues (other things in the environment, whether it be an instructional material or a teacher talking) now have meaning. In the studies reported here, the in vivo interactions begin to illuminate elements of a meaning-making process that capture this process of unlimited semiosis. As students link what they are learning with what they know, they potentially develop new understanding which provides a lens through which they interact with the next bit of information from the learning environment and the process of meaning-making continues. If at any point along the way the student has no conceptual links (i.e., no or limited prior knowledge), the links are surface in nature and the potential for deep links is reduced.

My initial interest in the understanding of this process was prompted by a figure that I had seen in a graphic (i.e., comic) series. In the volume on semiotics, Cobley and Jansz (1999) provided a graphic representation, which helped me consider the process of unlimited semiosis. The graphic was a picture of a star. The star was made up of triangles, with one at the top, another at the right arm, then the right leg, left leg, and left arm. At that point, more triangles wound through the center of the star, capturing that look of something moving into infinity as the triangles got smaller and smaller. On this figure they had labeled the vertices of the triangles as object, sign, or interpretant. I believed this graphic showed the principle of unlimited semiosis in that it captured not only interpretant to sign transformation (represented by the labels at the vertices) but the notion of unlimited as well as I perceived the center of the diagram to move infinitely.

In a second illustration, Cobley and Jansz provided an example of this process using images. Each triangle of the graphic now included a picture. In my review of this graphic I could identify relationships between adjacent images that would propel the process of unlimited semiosis forward. The first image was a star that looked as though it were shining (in the top triangle); in the next triangle, at the right arm was a mother and infant, which I perceived to be Mary and Jesus. The next was a person on a cross, which I perceived as Jesus's crucifixion; in the left leg

triangle was a burning cross, then the left arm include hooded faces (Ku Klux Klan). In the smaller interior triangles there were pictures I recognized; Martin Luther King, John F. Kennedy, Marilyn Monroe, a cigarette. In an earlier article (Schuh 2000) I documented my narrative of how I interpreted that second figure which included the pictures, talking my way through the links between the triangles, noting what the object in each triangle could be, and then, considering what the sign and interpretant were. My captured thoughts were something like "First the star—was this an object? An object can be something known to exist, believed to exist, expected to exist, or a collection of such things, perhaps the star in the first picture would be an object. Was the star a sign? A sign stands for the object, perhaps not in all ways, but in reference to some idea about the object. Certainly, it had to be a sign relating to a particular star—the one that was over the stable in Bethlehem—otherwise I would not be able to link to the next picture" (Schuh 2000, p. 7).

It became clear to me as I progressed was that my analysis (i.e., my interpretation) of Cobley and Jansz's illustration was heavily cloaked in *my own* interpretation. While my own experiences coloring my interpretations supported the premise that everyone has a lens (whether called a lens, schema, theory, or any other description that has been issued for the role of prior learning in our understanding of our current experiences), it made it clear that students, certainly, would have this as well. How could they not include their own understandings in the interpretation of events and content such as the Middle Ages, the Roman Empire, biomes of the earth, or animals of the tropical rainforest?

When I first encountered Cobley and Jansz's book, the example had reminded me of the research data that I had gathered in elementary classrooms as I conducted my first studies about student knowledge linking (Mrs. Olson, Mrs. Chambers, Mr. Jackson, and Mrs. Schneider). The cue and trajectory dimension system as I have described throughout this book that had emerged from the data set through my analysis seemed similar to this type of cycle. This was particularly evident in the open-ended writing of the students as they moved from topic to topic linked together by cues that co-occurred in various environments, some in and some out of school. In an earlier article I explored how two students' writings showed this process of unlimited semiosis (Schuh 2000). I had previously analyzed the data from a typical qualitative stance looking for themes (and thus the emergence of cues, trajectory dimensions, and the context around those occurrences). Although I had always tried to gain the learner's perspective in considering their learning in the classrooms, I often believed that I had fallen short. As I reconsidered the data using this semiotic lens, I sought understanding of that data from the learner's perspective anew. The task I undertook in that earlier paper was to try to better understand the semiotic process as well as gain some insight into the learners' perspectives given their open-ended writing. The reflexive narrative in that paper described my own process of trying to untangle what, in the students' writing, might be an object, what might be a sign, and what was then the resulting interpretant—trying to describe the meaning-making process. Recall that in Peircian semiotics 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 it was merely a "thing" in the environment). The open-ended writing that the students created, in which they were given permission to move from the school topic that they had been studying to other things that came to mind, was documentation, in a sense, of the objects that the student had experienced. The signs were then bound to those objects, and thus indicative of some meaning (the interpretant) for the student.

In that article I re-analyzed the writing of two students–Troy, whose initial writing prompt was the Roman Empire, and Helen, whose prompt was the Middle Ages. As I used both of these students' examples to consider what might be an object, sign, and interpretant, I noted the difficulty in pinpointing any of these elements because of their interconnectedness. What became apparent was how the students' lens and their prior experiences were pivotal in the thread that ran through their papers, just as mine had been when I had interpreted Cobley and Jansz's graphic.

Troy, a sixth-grade student in Mr. Jackson's class, was one of the examples that I explored. His writing linked across surface elements.

> My favorite topic in social studies was when we were talking about the gladiator times. Gladiators were slaves, or criminals who were forced to fight. Often they fought to the death. Speaking of death there's a show on MTV called Celebrity Deathmatch that's a show where they make clay celebrities and make them fight to the death. Talking about clay reminds me of a show I used to watch called Gumby. Gumby is a clay figure who always is happy. Speaking about happy I was so happy when I got an A++ on my science project last month. Speaking of months, my birthday is in July. July reminds me of football because football really starts in August but conditioning starts in July. I play football.… I've been playing football since I was five in the first grade. First grade was a bad year for me I was getting in trouble for little stupid stuff. I came to first grade about 1 month into the school year. I was in kindergarten for that month in preschool but they weren't sure I knew my first-grade material. But I proved them wrong and finished the year.

Troy's narrative continued as he talked about computers, computer games, movies, and making claims as elements of his trajectory were shared. What became clear in my analysis as I tried to literally sketch overlapping triangles of the content in Troy's writing to understand it, was that the rather odd assortment of topics in the paper were not merely adjacent to one another, but overlapping. For example, the idea of fighting to the death was a key characteristic of both gladiators and Celebrity Deathmatch—according to Troy. Understanding the links between the topics was critical for understanding his interpretation of the topic at that moment. Many of Troy's connections pointed to surface links, as noted in the previous chapter, ones that would not be useful in understanding the Roman Empire, the topic on which he began his writing.

Helen, a student in Mrs. Schneider's classroom, was prompted to begin her writing with the Middle Ages.

> This is a story about a woman in the middle ages who thought that the taxes might be too high. So, she went to her husband (who was the lord) and asked him to lower the taxes. He told her that he would lower the taxes only if she rode naked on a white horse through the town. So, she did, but she was clever. She arranged her long hair about her so that no on could see anything but her arms and bare feet.

> This story reminds me of the Women's Rights Movement because women had to be clever and sly to get men to listen to them. Women had to stand up for their rights, know what they wanted, know how to ask. This reminds me (on a smaller scale) my own personal rights movement. I did this with a good friend –. We had a vice principal that was sort of choosy. When I say, choosy, I mean that she chose who she wanted to get into trouble. Well, one day she was talking to us about some pithy rule we had broken, something like pushing each other on the swing. This wouldn't be so bad, except while she was giving us a lecture, two boys were audibly swearing at one another. With one look at each other, we knew what we were going to do. "You've got to live a little," said –,
>
> "Yeah," I said, "you can't go around being safe all the time! Life is so short that you can't waste it! I'd risk a broken leg for a good, and exciting life."
>
> "I don't know about that," said the vice principal.
>
> "Well we do!" shouted –, and on that cue we shot by her and raced down the slippery pavement shoving each other. Later we wrote a poem to her, and set it on her desk anonymously.
>
> I don't know if it worked, but I know that I learned about asking, and living.
>
> Time for lunch!

Helen's writing had pieces about Lady Godiva, the current Women's Rights Movement, and her own personal rights movement. I identified the transitions or relationships between the pieces of the story (the glue that linked them together). These were the semiotic link, the prompt for unlimited semiosis. My goal was to consider the links from the learner's perspectives and the clues that were provided. In the writing these may be made explicit or buried within the description. The mere words on the page were only part of the entire context in which the writer was making meaning. Not all points (potential cues) were captured within the writing itself (a discussion with the student, if possible, would alleviate this problem).

Finally, I considered the sections before and after the transition, focusing on how the interpretant existed (given that it was the trichotomic relationship—then the other pieces must be mixed in, not as dyads, but as descriptive pieces). In the first piece, the story of Lady Godiva was itself a sign (and an object as well). In addition, it was first an interpretant—based upon a sign, given the assignment of writing on the Middle Ages. It was an example of Helen's interpretation of the Middle Ages. Implicit in this section was that Lady Godiva had qualities of being clever and sly that got her husband to listen to her. It was this meaning of Lady Godiva in particular that propelled Helen into the next piece of the story.

In the second section, where Helen briefly mentioned the Women's Rights Movements, this interpretant—or the meaning of the first piece—became a sign. Again, the relationship between object and sign were so intermingled that they were difficult to distinguish. By definition, the three elements, object, signifier, and interpretant, *are* tightly bound (Deely 1990; Peirce 1985). Further, the sign of clever and sly appeared as a quality of women in their rights movement. In her meaning, at this point Helen focused on the result of that clever and slyness, it provided a way to get things done.

Finally, in her third section, this idea was exemplified in a story about her own personal perspective. Without Helen's clue ("This reminds me (on a smaller scale) my own personal rights movement.") this section might not seem to be about rights at all. But with the intrepretant that led to this piece, the meaning was captured that there were ways of getting things that you wanted and Helen listed what she wanted. The assumptions from which I worked was that this linking—the connections as interpretant becomes a new sign to continue the process—provided for increased comprehension. Thus, it seemed that Helen's description of related events and her interpretations from which they were built provided for a personal meaning. Helen created a more developed sign and a deeper meaning, in this case relating the theme directly to her own life. As noted in the previous chapter, the types of links that Helen made in her writing captured not only her meaning given her prior experiences, but also indicated the depth of her processing of these ideas. Her writing, and thus the meaning that she ascribed, had more depth than Troy's, for example.

This complexity was indicated through a simple illustration of the students' writing using overlapping triangles. Consider that to draw out Troy's understanding, triangles would need to overlap to capture the meaning that propelled him to the next topic (Fig. 8.1).

Helen's thinking indicated a more sophisticated thread in that not only did the triangles need to overlap, but her explanation of the shared meaning must be contained within the intersection. Further, there was an overlap between the first and third triangles, indicating the continuous theme in her meaning making (Fig. 8.2). Notice that this was not the case with Troy's examples. For example, clay figures and Gumby were not a factor in his meaning of gladiators.

These writing examples illustrate the thinking process, the stream of consciousness (James 1984) as these two learners wrote beginning with the content they were studying and moving onto other elements that linked with them. When comparing Troy's efforts with Helen's there appeared to be differences in the complexity of their links, and thus the usefulness of those connections. As noted in Chap. 7 , not all links are useful in understanding the content. But, as indicators of

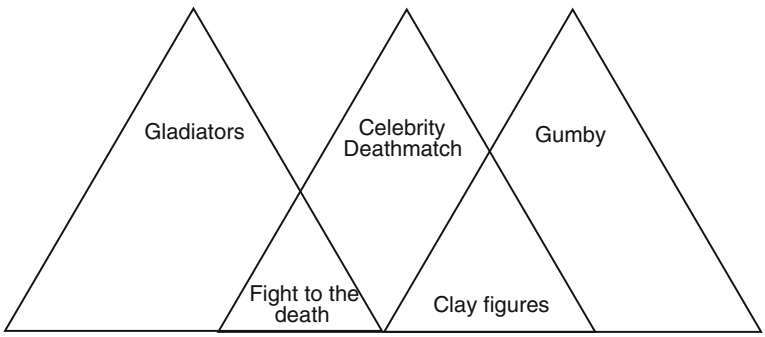

Fig. 8.1 Capturing Troy's linking process

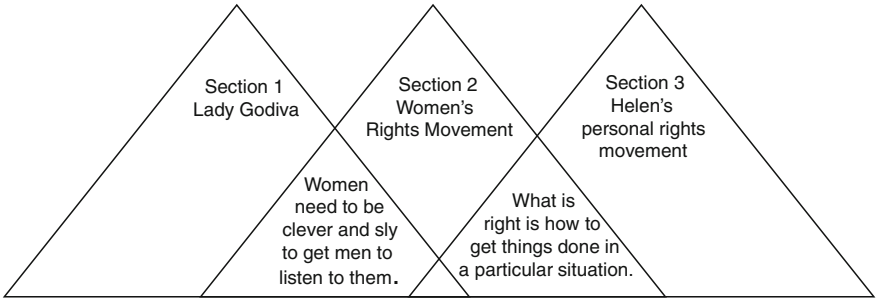

Fig. 8.2 Capturing Helen's linking process

the process of unlimited semiosis, they provide a model of how the process continues—how we continue to make meaning given information that are cues from the environment coupled with prior knowledge.

Yet, the open-ended writing was a different venue for capturing meaning making than the classrooms themselves as the teachers provided opportunities for students to share links. The examples from the students' writing seemed much different than the day-to-day happenings in a classroom. However, the process remains the same. Consider how the conversations in the classrooms, particularly Mrs. Schneider's and Mr. Ritter's, allowed for the students to engage in the content they were studying in much the same way that this open-ended writing process allowed. As students listened to or interacted with the content, they used their prior knowledge to make sense of it. While not jotted down as an open-ended writing activity, students' attempts at engaging with the content and making sense of it was much like the writing process. In interviews, students were asked to share what else came to their minds—whether shared aloud in class or not; some had little to say, others would weave a tale of what they were learning as it linked with other experiences. Each student has a trajectory, with all the residue from where they have been in their traversing the rhizome.

Throughout the book I have described a cue/trajectory-dimension system through which students bring in information that is relevant to them from their personal lives and with other school work. These links are the students' meaning-making efforts and could be graphed as I did with Troy's and Helen's writings. They are an aspect of a topic in class that lends itself to linking to particular aspects of their lives. Rather than an unwieldy stream of consciousness as one moved from one topic to another, as it seemed in the open-ended writing, or continuously trying to interject a conversational component in a classroom as seemed the case with the smoking topic in Mr. Ritter's class, for example, the semiotic process denotes a particular lens for a student that prompts a particular meaning to a cue that is created in his or her interaction with the environment. That cue is interpreted in a particular way, prompting a meaning that stems from an earlier experience. That experience, then is linked into the interpretation of what happens next. In this way, the semiotic cycle is rich and complex in that what

resonates may be anything that is on the learners' trajectory (physical, cognitive, affective, etc.).

In a learning environment, then, this personal priming provides the lens through which a learner *will* interact with the content. Through this process of unlimited semiosis, the influence of the lens, various things the environment become objects or are cues because of meanings that the student has, and prompts various interpretations. This process was particularly evident in the data that were coded as affect in the analysis process for this entire study, illustrating the profound effect the meaning different students ascribed to created cues and how that then influenced how they interpreted what happened next.

8.2 Affect and Emotion

Affect/emotion was coded very broadly in these studies, the category defined as an indication of some sense of emotion or feeling about what they were describing. Affect was identified by choice of words (I like, I hate, I love) or through descriptions of what is perceived to be an emotional topic, such as talking about death or illness, or self-esteem or worth (Schuh and Rea 2001). While the terms affect and emotion were chosen to broadly capture potentially emotional elements in the students' speech and writing, there are differences between them. For example, emotions are short lived, typically arise from significant life experiences, are involuntary, and influence an individual's behavior and action (Ekman 1994; Reeve 2009). For affect (i.e., mood) the cause may be unknown or not well-defined or articulated. Mood comes from thinking, and could last for hours, days (Ekman 1994; Reeve 2009), or even months (Newton 2013).

While a discussion of the many facets of emotion and affect is outside of the scope of this book, the study of emotion with cognition supports its role in linking environmental cues with prior experiences. Emotion has been shown to link behavior to experience in models of operant conditioning where emotions have been trained to evoke responses to stimuli that did not originally elicit them (Estes and Skinner 1941). More recently, the field of cognition and learning has begun to consider the relevance of emotion as a modality through which individuals build knowledge. Knowledge can be built and recalled based on emotional relevance, or association, as well as cognitive association (Lakoff and Johnson 1980; Wicklegren 1997). In this, a sensory *or* cognitive event can trigger knowledge through emotional relevance to the stimulating event. For example, a recollection of a tornado may be prompted by a discussion of weather or a discussion of scary experiences. Lubert and Getz (1999) describe an emotional resonance mechanism that accounts for the activation of experiences related emotionally that may not be directly related as would be for cognitive activation (i.e., spreading activation). While, as noted in Chap. 2, spreading activation will move along connections to related nodes of content, the emotional resonance seems to link not through the connections; but perhaps like a bell vibrating in which the vibration activates similar emotions that

are not linked in any other way to the content. In this, a particular emotion associated with an experience "resonates" when recalled. This resonance causes sympathetic vibrations to similar emotions, thus activating other experiences that, on the surface, may not seem related to the first experience. While Lubert and Getz's description seems well aligned with information processing description of cognition, it can as easily be described from a semiotic perspective. The process of ongoing semiosis, as signs are generated from an interpretant, provides a mechanism for considering how modalities, in particular emotion, provide an impetus for meaning-making.[1]

8.2.1 Indicators of Affect/Emotion Trajectory Dimension

While there were some affect/emotion elements that occurred in the classroom, many more were found in the students' open-ended writing, oftentimes the original link to the content being lost in the description of the affect. Although affect had been noted in the early analyses of the data as a single trajectory dimension, deeper analysis of that particular trajectory dimension indicated that it was realized in four ways. First, the affect/emotion (A/E) trajectory dimension was readily identified when students used affect words (identified *by word*), and was common in the different classrooms. Students' links between their learned topic and something experienced on their life trajectory would include an affective word. For example, in Mr. Ritter's classroom, a girl linked from clothing in China, which she studied for her paper, to her own experiences with clothing and wrote,

> My idea of clothing is going to the mall and going to Weathervane, Abercrombie, and American Eagle and buying clothes like [she included the asterisks in her writing]
>
> * long pants
>
> * cool t-shirts/long sleaved
>
> * halter tops
>
> * jean shorts - not with big pockets-
>
> * cool jackets
>
> I love going to the mall.

[1]During the early data analysis stages of my studies, affect was initially noted as a trajectory dimension. Julie Rea, who had served as a second coder on the research project that included Mrs. Chambers, Mr. Jackson, and Mrs. Schneider, and had a background in counseling, was particularly attuned to the students' affective links. As the student brought up links in class or writing we noted when the trajectory dimension they described had an affective component. The discussion of how the affective characteristics of the trajectory dimensions were realized expands on an article we developed early in my suite of studies (Schuh and Rea 2001).

Of course, not all of the affect was positive. Recall Roger's link, who was in the salt-water biome group in Mrs. Chambers' classroom, in his writing between the depth of the ocean and running 5 miles in gym class. Likewise, in Mr. Jackson's classroom a student wrote, "I wasn't really here that much over this chapter. I don't think I will do very good on this test. That reminds me of my first little league game. I was so scared at first, but I actually did pretty good. I hope I do as good on the test as in that game," using the word scared, and also including a hopefulness of good as a potential outcome. While examples such as these were apparently affective given the students' choice of words, students also indicted affect in subtler ways.

In the second type, affect/emotion appeared without using an affect word (identified *by inflection*). This was communicated through written (e.g., using an explanation point) or verbal (e.g., talking louder and faster). In observation and interview data these examples were captured via researcher description. For example, a student in Mr. Jackson's class placing emphasis on "this Wednesday" when talking about an upcoming test, which was apparently too soon. In Mrs. Schneider's classroom, recall that I had captured this affective tone in my observation notes, "That ruins the whole book when they are nice to the bad people, like in Cinderella, where they forgive the bad person," Tracy exclaimed about the prediction that was made. My notes indicate the Tracy exclaimed; my perception of her affect at the time I conducted the observation. Although Tracy's affect link in class was by inflection, in her interview after she reiterated the link, she continued with affect as she talked about this link.

On day 7 in Mrs. Schneider's classroom, affect—embarrassment in particular—was apparent in a girl's non-verbal actions. Students in a small reading groups were sharing their reactions and dialogues they had written as if they were pilgrims on a journey, such as those in *The Ramsay Scallop*, the book they were reading. One student read hers and ended it with saying that "Jesus is the son of God" as she held her notebook over her face. Mrs. Schneider affirmed her response, "that's your point of view that's what I asked you to write from," reacting to the student's affective response. Tracy, as well, felt embarrassment about her own links, "You know I've related a lot of them [books] to Disney movies, and everybody, sort of like, making fun of me and stuff, but [How come? I unfortunately interject, cutting off her thought.] It's just sort of Disney movies, you know" continuing that she doesn't "really watch them anymore because, I don't know, I usually watch comedies or something and um, and those just have a lot of things in them and they're a lot of experiences in different movies that relate to books." Tracy was the second youngest student in Mrs. Schneider's class.

Examples of affect by inflection in observation and interviews were limited, despite the large data set. There were more instances in the writing of the students. As a girl wrote in Mrs. Olson' class, "That [a computer game which was prompted by her starting her paper noting that the Irish had set up monasteries on Iona, northern England, northern Europe] reminds me of another game called Riven. You've probably heard of it before, it's the sequel to Myst. In this one I'm trying to free this woman from her prison cell, but there are lots of problems to go through

and it's very hard!" A girl in Mrs. Wilson's class wrote, as she started with her topic of the long-nosed Proboscis monkey, linking then to her dad and granddad who also had long noses,

> My Grandad lives in P.A. we don't get to see them a lot but we might be able to see them this summer! Last summer we went on a long west coast trip it went for three weeks! We drove in our car all over the west. I broke my arm when we went on that vocation when I went to my cousins house. So when I went to my other cousins house I couldn't surf! That really made me mad! My cousins got a dog. They got their dog at my cousins soccer game! Someone just said do you want a dog and she gave it to them! I got a dog too! Just 2 days ago! Its name is Lucky! He is so cute! He likes to sleep a lot but when he wakes up he is hipper [hyper].

This student, although using one affect word—"mad"—conveys positive emotion through the use of explanation points. The enthusiasm continued throughout her writing.

The third indicator of A/E trajectory dimension in the data was students' describing an emotional topic or experience such as death or illness (identified *by topic*). Recall Mr. Ritter's class discussion on smoking and throat cancer (Chap. 4), Joey finally ends with an added identification by word, "It is so nasty." But prior to that assessment, it was clear that the topic was not merely a discussion of smoking, but included students' emotional relationship to the content.

Because social studies was a focus in a number of the classrooms during the study, some students in these classes made links about some of the injustices that have happened in the history of United States and in the world. By topic, these seemed to be affective. Consider this student in Mrs. Olson's class who linked from the behavior of the Vikings,

> The conquest of the vikings… The Vikings conquered a lot of people. While they were conquering people, they burned things, killed people, and took people into slavery, stole things (goods) and destroyed almost everything. That reminds me of World War II they killed people in gas chambers or enslaved people that they captured. The Jews prayed that that Nazi's wouldn't find them like all Europe feared the Vikings.

In Mr. Ritter's class another student talked about injustices as well. As she meandered in her writing from her topic of Chinese weddings, contrasting them with American weddings, she shared that, "When finding a person to get married to the Chinese cannot marry someone with the same last name even if they are not related. They believe this is wrong" she continued with a passionate discussion of discrimination and peace.

> The people lied, they gave the familys fifteen dollars took there children and used them as slaves. This reminds me as discrimination. Like African–Americans and cacations [caucasians]. Why don't people look on the inside? When Blackes were descriminated we did not look inside for friendship and for many more things. Discrimination is a said [sad] thing just like slavery. The world should have peace but all people should have their own opinion but should not be taken out on other people But people can share there opinion but not disstructivialy [distructively]. Peace should be declared by all countries. That would be nice, then we could invest the weapon money in other things that mean more money.

Some affect by topic included experiences that were more personal. In the following example from an interview with a student in Mrs. Chamber's classroom, the student described her experience with divorce. "I just thought about what I was going to do this weekend. Because my parents just got separated so [pause] probably going to go to my dad's and I have to go to counseling tomorrow night, for court order stuff." Later this girl linked to boring and then continued to talk about school.

The final indicator of A/E was through a conceptual description (e.g., explaining something so that it implied that they were excited or bored) (identified *by description*). Notice in the following example from a student in Mrs. Schneider's classroom that, although there are no explicit affect words, one comes away with a sense of uneasiness."… this is a test. Everybody is too quiet, pencils tapping. It's weird…" Brian, the first grader who was introduced in Chap. 1, also indicated affect. Not so much by using affective words, but by the narrative he shared through the classroom observation about his grandfather and then followed up with in the interview. His description gives you pause to wonder about potential sadness that he might be feeling.

An affective description that had a tactile and visual cue occurred in a student's writing in Mrs. Schneider's classroom. She began her writing by sharing that the Middle Ages "was pretty much a desolate time." The following excerpt begins in her fourth paragraph and is prompted by the act of writing,

> My hand is starting to hurt, I wish this were on the computer instead. Then when I saw my hands drooping I would think "oh no! must not get carpel tunnel!" My dad has that, and he has to wear those braces when he sleeps or types. When he sleeps he has something wrong with his breathing (I used to know what it's called but I forget) where his lungs collapse. Onetime he stopped breathing for two or three minutes while he was still asleep. Now he wheres something on his nose to keep his lungs inflated when he sleeps. He used to have alergies, but he had one shot a week for two years to get rid of them. I have alergies but you can't tell, because I'm taking 5 perscription medicines. Can you believe it **FIVE**. I started with two pills in the morning, two inhalers in the morning, and an eyedrop. At night I take the eyedrop, one pill, and one inhaler personally, I might wanna go with the shots.

The physical act of writing itself, a common practice in classrooms, prompted fear for family members and for herself.

Another example of fear was described by a fifth-grade girl in Mrs. Wilson's classroom. As she began her paper about the bushmaster snake and the Poison Arrow Frog, she moved on to describe a friend's cat who jumped and scared her, then contrasting its nonvenomous bite with that of the snakes she had studied. "This also reminds me of when I was riding my bike home from school with my friend and I ran over what I thought was a piece of rope, but it really was a snake. It jumped up at me and nearly bit me. My friend and I ran away quickly after that."

Although many of the examples of descriptions that seemed emotionally laden, but did not necessarily use affect words, seemed to draw on affective responses that might be construed as negative, there were elements that were positive as well. Note the passion (with one explanation point) in the writing of this student from Mrs. Schneider's classroom. "I am especially interested in the lives of the women.

They were treated terribly and looked on as evil during the Middle Ages. This flares me up. Some people say that I am too feministic in this sense. Too feministic my foot! These women were treated like dirt and people say that I'm overreacting."

Notice the mixed affective components in this sixth-grade boy's writing from Mrs. Wilson's classroom, "We think we have cold winters, poor Belugas. Belugas have beady little eyes, like golf balls. Which reminds me that it's getting warmer and pretty soon I'll be able to golf. Once when I was golfing we saw a fox carrying a rabbit. On the next hole the rabbit was laying on the green."

As may have been clear from a number of the previous examples, many affect/emotion trajectory dimension examples were characterized using a number of these indicators. The following two excerpts are affect/emotion by topic and by punctuation. This link follows a lengthy discussion of individuals in the Middle Ages and how long Eleanor of Aquitaine had lived.

> She died there at age eighty. People usually didn't live to be sixty-five, let along eighty! At the rate I am going, I won't live to be thirteen! I have been sick with a virus, a cough, a cold, and pink eye in the last week!

Another student linked living conditions in the Middle Ages with her own experience using multiple indicators.

> There was also problems such as (during the Middle Ages) fleas and the cold. Even in castles! I used to let my cat sleep on my bed. She had fleas and they jumped off her. When I slept I would get dozens of flea bites. Never again will she sleep in my room.

In Susan's writing example, which followed a thread about medical theories in the Middle Ages, she mentioned that George Washington was bleed (which she had also mentioned in Mrs. Schneider's class), and the town of Williamsburg, A/E by word, topic, and punctuation are included.

> I know someone who not only believes in ghosts, but WANTS to be abducted by aliens. She thinks it would be cool to see them, and she thinks Scream was funny (which kind of was if you think about it). It wouldn't have been if the plot was better and the blood more realistic, but when the killer is dragging the bloody and mutilated body, it was obviously a mannequin. Of course if it was real I sure would not be laughing, but that hardly ever happens. All these movies are about serial killers, but there are hardly any in real life. Movies also make it seem like aliens are bad guys and automatically want to kill us. That is why I like the twilight zone episode where aliens come & there is this huge council (to kill or not kill) and earth decides to blow up the spaceship. But then a guy is walking among the debris and finds a piece of paper that says "The cure for cancer is… ..," and is burned off right there.

8.2.2 Affect as Cue: Semiosis Unfolding in the Classroom

The trajectory dimension, reflecting the prior experience of the learner, indicated affect in a variety of ways. Further, once that affective element from the trajectory was brought up, the affect often colored the flavor of the learner's developing

trajectory. Once the affective cue, the meaning taken or implied with the next topic, was created, it became the lens through which the next topic was interpreted. This occurred frequently in the writing. Consider this example prompted by the word tornado.

> Hello I'm going to talk about the Deserts a little. One thing that I remember is it's snow and rain and other thing like tornato's. When I was little I all way's got afaird if there was one. I still feel that way some time because, I don't what to get hurt some happen to me. Which I remember last year I was in the hopital because I got very sick and I had to have surgy. but I new I would never get hurt or sick again and that was a promise to me to never do or get it again. Well that's all that I could remember aboat it. Thanks for being here and picking us to do this. bye-bye.

The initial trajectory dimension included an affective component. Once that trajectory became the interpretive mechanism, the links that followed sprang from cues that were, themselves, affective. Figure 8.3 captures this process of unlimited semiosis as cues can then prompt additional elements of the learners' trajectory.

For example, the feeling of fear in the classroom will link with prior elements of the learner's trajectory that contain fear. Consider this example from Frieda, a girl in Mrs. Olson's class as she linked from the Vikings currently being studied to the Romans. The affect ("cool") becomes the link to the next topic, Egyptians.

> I like the Vikings tons but who could beat the Romans. Talk about cool. They rule everything. They had everything right till their good ruler died then they had their downfall. Egypt was cool too. I liked how they wrapped their dead up. My great uncle just died it was sad. I can't turn my book to the egypt pgs at school because 3 pages it all muddy. I did not mean to do it. I left my book open and my dog jump with his muddy paws all over it I'm planning to tell Mrs. Olson the last day of school and I will bring $5 to pay for it. I just don't want to be yelled at. I hate that. Egypt is hot but they have nice piramids and status [statues]. The Egypt people had grave takers. That would be mean to take some ones thing and not let them have their peace. I know I would hate it if anyone took anything special to me like my bennie babies, titanic stuff, or radio.

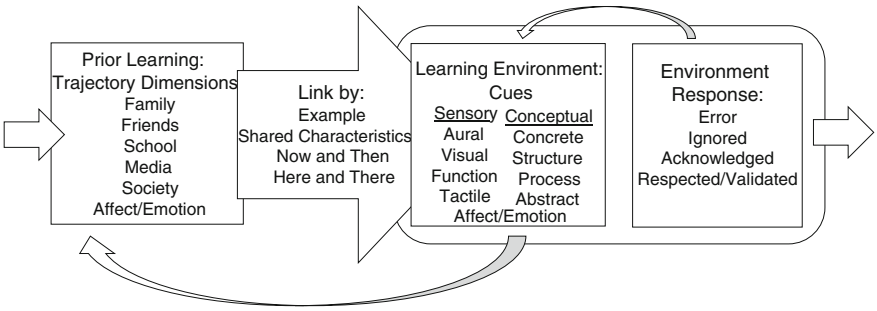

Fig. 8.3 While a trajectory dimension may include an affective/emotional element, as it colors the learners' interpretation of their environment, the cues themselves can carry an affective element, thus linking with further affective elements of the learners' trajectory in a process of unlimited semiosis

She continued writing, weaving together information about the social studies, her dog, school, and eventually her own fears..

This fifth-grade girl in Mrs. Wilson's class had a strong affective thread through her writing, the positive affect linking much of it together.

> … Blue whales are very, very loud-they are the loudest animal in the world, and my baby sister is very loud too. She screams and cries and talks a lot. Thinking about my loud baby sister reminds me of how much I love being with her, and how she laughs. She loves Veggie Tales, and loves to laugh at it, so a blue whale reminds me of Veggie Tales. A girl did a spinner dolphin, which reminds me how much I love to swim, which reminds me of the ocean which reminds me of Topsail Island where I went last year, with my grandparents. I was floating in the ocean with all the other animals. A blue whale lives in the ocean too.… [My aunt] has 2 boys who play basketball with me. They have a hoop. My new house doesn't, although we're going to get one. Being a basketball player would be fun. I would like to be on the Jr. High and high School team. Jr. High would be fun.

Recall the boy in Mr. Jackson's classroom who struggled to write about the content to start the open-ended writing. He began, "I wasn't really hear that much over this chapter. I don't think I will do very good on this test." His analysis of potential success on the test, the affective component of the trajectory dimension, became a cue for the next link. "That reminds me of my first little league game. I was so scared at first, but I actually did pretty good. I hope I do as good on the test as in that game." As he continued to write, it was apparent that he was troubled by the test and it colored what he thought about it,

> I am sorry I couldn't tell you more about social studies. I just wasn't here very much. The reason I wasn't here is because I was in trouble and had to sit in the office during social studies. I really don't know why they made me miss such an important class. That is all I have to write about. Good bye and good luck on your experiment.

Consider Anne's writing, from Mrs. Olson's classroom, as she elaborated her understanding of the conquests in Europe with characteristics of her family with an affective thread. She wove the concept of "annoying" through half of her writing (recall the student's grammar and spelling are left unedited).

> The conquest of the Danes was not really that big of a conquest. First they settled in well they actually raided western and southern Europe
>
> I wonder if they raid southern and western Europe like a rat would raid a trash can or how my oldest brother raid the refridgerator
>
> I sure hope not. Etherland was nicknamed the unready well because he was unready. That reminds me of my brother Scott, one of my 3 brothers is never ready every time we go to a restaurant or even going to church we always wait for Scott it has gotten to the point were every tiem we are waiting for him my brother Rich says "Well what do you know we are waiting for Scott"
>
> But if my brother was a king I think he would be a good kind because he is very smart and very organized. But my brother Rich is the very opposite. He is also every smart. But he never wants to do his homework or anything if he had his way life would just be him sitting on his but just watching TV all day. every day.

I wonder if they meant Ethelred was unready for war or just plain old unready. His wife probably could never go out. 1. Becuase he was king and everybody would bug him. 2. He would never be ready.

That also reminds me that is so mean how movie stars can't even go out because the public will NOT LEAVE THEM ALONE. I wonder why that is. All they have to do is mabe ask later or after they are through eating. It is almost like they have to pay a price fro being good at something or being a good actor. Personally I think that is just stupid. People need their privacy.

To me it looked like th Danes were very annoying. First they raid southern and western Europe and then thy try to take over Paris it is almost like a fly. They just won't leave you alone.

Personally I hate bugs.

I absolutely love cattapillars and butterflys. Well are those really bugs or are they insects.

I whish the French would fight off bees like they did the Danes. But you have to think about it if we had no bees then our flowers would not smell as good or something like that. Bees would be just fine with me just if they did not sting.

See what I mean the Danes tried again and the people of Paris held them off for ten months I think. Yeah I think it was ten months and then the French king paid them off to abandon the attack.

I would do the same thing Because I would not want all those people to die.

I hate war it is like to me that someone is crying and it does not stop for at least 3 years. It is like a part of the world all together has fallen and scrached or even cut his/her knee.

That reminds me. last summer my brother Rich was at a summer camp he was fooling around on the stairs and he stood up on the stairs he lost his balance and fell off (3 stories) and landed on his head. He kind of blacked of and they rushed him to the hospital. He had a broken arm a hurt knee above his eye he had a crack in his scull as black eye and a mild concution. But other than that he was fine. I don't htink he will be sitting on any railings anymore.

Also that summer my brother Scott fell and broke his arm very badly (combound fracture). But he is okay now.

Although much of Anne's narrative seems a rambling of loosely linked experiences, she periodically integrates the course topic in the narrative in an analogical way. Her trajectory was colored with affect, but her thinking was propelled by affective cues that she derived from prior experience, weaving family and society trajectory dimensions in particular.

While some students, once they ended up in a stream of affective cues, were able to move from that affect, or change the direction of it (as the sixth-grade boy did with the beluga whale) others retained the affect to the end of the writing. Consider more of Frieda's writing, as she begins with the Vikings.

The Vikings are the coolest. They remind me of my family. We are always fighting, talking, and sometimes being nice.

The Vikings fighted a lot and took everything.

My dog Milo loves to take stuff off the beds like Teddy bears.

> The Vikings like to travel and I do too. I went to Rome. Their bread was good and pizza.
>
> Vikings used to burn down homes and churches.
>
> There has been a lot of church fires and the time the next door people and us got in a big egg fight it was fun!
>
> The Danes are pretty cool too. I mean they tried to take Paris (I have always wanted to go their). The Danes control the whole country that a lot of land to control to much work I think.
>
> The chapter called the Vikings I wonder what that means. I can see why the Vikings were hungry. I had no breakfast and now I'm so hungry I could eat anything.
>
> I like the Vikings tons but who could beat the Romans. Talk about cool. They rule everything. They had everything right till their good ruler died then they had their downfall.
>
> Egypt was cool too. I liked how they wrapped their dead up.

Frieda's example is interesting because it shows the bits of information that help with her own understanding. She wove information about the Danes in with other topics of her life and notes family dimensions, school friends being the links. While her links in the previous excerpt are all quite positive, likely given her positive view of the topics (Vikings are the coolest), notice the turn that has been taken once she brings up the notion of death (link by topic). From that point forward in her writing, her links have a negative spin to them. She continued, linking that her "great uncle just died it was sad." Her writing picked up at that point, with her example about her Egypt pages from her book that were muddy and her concern about turning in the book at the end of the year. She then returned to the content of Egypt, but was again drawn to a more negative affect as her narrative continued.

> The only thing with teachers is they think they can make you understand and make you like it but they can't.
>
> The only thing that comes from doing homework is a bad night trying to do it. I read one of my grandma's Newsweek and it said homework is a wast of time till highschool. I always knew that. Making kids read a book the teacher picks out is no fun either becaue it not what I want ot read it what they want me to read.
>
> I wish the boys would just shut up over their but I'm not going to say anything I might get in trouble.
>
> Lots of kids in my class mom/dad are divorsed. I hope mine never do.
>
> It's funny what scars kids big people don't know What scars me is being along [alone] or only have a mom or dad. My parents getting a devorce. I sure hope it never happens. I'm a good girl. I've never done anything against the law and never had smoked or done drugs so I hope my mom/dad are happy. The only thing that bad is that I'm overweight. I hope it just a faze and that I will be skinning like my sister. But I don't care now. I think I will stick with histroy. Will learn from it and read from it.

While the extended example does seem like an endless stream of consciousness, showing the role of an ongoing semiosis that is often linked with affective components, what is more important is how, in such a short period of time, this young girl shared so much of her personal experiences and thoughts and how they are

linked, some indirectly, with her own learning. Through this, her writing exemplifies the idea of a life trajectory guiding interpretations in the moment.

Of course these streams of thought could be described by schema activation and the continual use of a particular schema (in this case an affective one), or spreading activation of network models. It does seem very scheme-like, with the student usually assimilating ideas into what they know. It is top-down use of schema, which allows us to make sense of the world, rather than an analysis of the elements of the world. In a sense, it is priming in that the information in the environment becomes a cue that then primes other experiences or information to be recalled. In yet another sense, it is the activation of various networks. Any theory of knowledge construction or learning should be able to account for routine phenomenon. Yet, those models of this phenomenon seem to miss the fluidness of the transitions and how the cue that has meaning will color the future as it leaves residue on the trajectory. Rather than an affective schema as a lens for the situation that then is used to interpret what comes next, what is captured through the notion of a trajectory created through time is that the trajectory itself, or the lived experience, has changed. That lens not only changes the interpretation of the world; it changes the world for that learner. The first characteristic of the rhizome mentioned in Chap. 1 was that it was dynamic, pointing merely to being continually changing. Dynamic systems provides a deeper explanation of that change process.

8.3 The Rhizome as a Dynamic System

Rather than just being a processor or constructor of information, using the rhizome metaphor prompts for the individual as an interconnected part of the environment, notes the mutually-determining relationship between the individual as part of the environment, and also provides an explanation about meaning-making progresses given that relationship. For example, although the affective examples are mostly from writing it is fairly straightforward to see that if a student's trajectory bumps into negative affect of some sort, for example, it changes the world at the moment for the learner. But more importantly, because of unlimited semiosis, it can also change how they move forward. It is the individual's path that has been affected. Different moods can affect the use of different thinking strategies and can also prompt greater creativity. That said, at times the arousal from the emotion can increase to a level that reduces cognitive resources (Newton 2013).

While the rhizome provides a metaphor through which to consider knowledge and learning as something more fluid than a structure and as engagement as an element of an environment, how this process might work is captured quite elegantly in descriptions of dynamic systems models.

Simply stated, a dynamic system is a system that changes in time. Rather than considering a discrete, quantitative perspective, dynamic systems is a qualitative perspective that considers the global features of a system over long periods of time (Norton 1995). Technically, dynamic models are mathematical models, requiring a

change in tools (for example, dynamic systems would draw on differential equations for data analysis to capture what happens across time) for describing cognitive processes. Dynamic systems models stand in contrast to the information processing model with its mind as computer metaphor. Thus, the change in tools also prompts a change in world view. This change in world view may parallel to the change described in Chap. 2, the move from a more objectivist or positivist stance, where an assumption must be that elements remain stable to some degree for some period of time for valid study, to that of a more dynamic view in which elements may change given particular times and contexts. The concept of what a cognitive system is has changed. In a dynamic system, cognitive processes, "unfold in the *real* time of ongoing change in the environment, the body, and the nervous system. The cognitive system does not interact with other aspects of the world by passing messages or commands; rather, it continuously coevolves with them" (van Gelder and Port 1995, p. 3, emphasis in the original). A dynamic system does not create or pass representations to do its work, as was modeled by the computer metaphor and realized through a variety of information transmission models of knowledge construction. Rather, the state of one aspect of a system affects another part in a coupled, dynamic process.

Dynamic systems are self-organizing. This means that they do not come with an a priori organization or path, but develops or organizes itself through its own path and interactions. This view considers the behavior of systems as continuous interactions through time (Greeno 1998). From a dynamic systems perspective, trajectories are paths that a system follows to arrive at a new state (Norton 1995). Thus, if one considers a rhizome a dynamic system, the notion of trajectory as has been described in this book is analogous to the trajectory of the dynamic system. The trajectory, because of the system's fluidness, creates the new state as it progresses. In other words, an individual's trajectory is essentially creating the evolving dynamic system.

While a self-organizing system might then seem to be in flux at all times, there is stability that is built by the system itself. "Some of the self-organizing patterns of action and thought are very stable because of the intrinsically preferred states of the system and the particular situation at hand" (Thelen 1995, p. 77). The trajectory, as the dynamic system unfolds, may appear stable because of consistent environments, for example, or preferences of the individuals. The consistencies represent typical patterns of interactive activity for that system (Greeno 1998). For example, in classrooms, routines become set; the culture shaped. Students know, for example, if it is appropriate to add tangential information (recall Mark's strategies to be heard in Mrs. Chambers' classroom). Individuals, as well, have their "go to" areas or topics. In addition to areas of stability there also exist unstable areas which can be perturbed by small changes, and are thus unstable.

Both stable and unstable areas in the system, called attractors, attract trajectories. Attractors are environmental aspects to which an individual trajectory may seem drawn much in the way that a thing becomes an object and gains meaning, as when a cue exists because of similarities between something in a learning environment and prior knowledge of the learner. Just as an object may not have meaning for

everyone, an attractor is only an attractor given a coupling with a particular trajectory. This is akin to the notion of affordance and effectivity set as noted in situativity theory (Barab et al. 1999; Turvey and Shaw 1995) and the ideas of environment and propensity in the literature on abilities. If initial conditions of the system are close to an attractor, the trajectory will move towards it. In other words, an individual may attend to something in the environment, or interact in a particular way, because of prior knowledge or experience. Thus, the attractor can be a cue captured in the trajectory of the learner—it has meaning for the learner; is an object/sign. For Frieda, that Vikings were the coolest was an attractor and her own trajectory prompted her to move in that direction. Considering Frieda's example, sad affect, primed by the word "death," another attractor that guided her trajectory development, colored with her weavings of school and other experiences. Her new "state" was a space that was laden with sad affect. In contrast, for another student, the same topic may propel the student to a different state, such as fear.

Given that the trajectory of the learner will influence how the system evolves, one might wonder if an individual will always move in the same relative direction (i.e., towards particular attractors), and thus never change. Rather, a cycle occurs in which "changes in the organism lead to changes in the information that is *available*, thereby allowing the organism to experience the environment in a new way. In turn, these new experiences lead to further changes in the organism at both neural and behavioral levels" (Plumert 2008, p. 376). It is the individual with the environment that allows aspects of that environment to be cues in the interactions. As the learner's trajectory interacts in the environment, the environment is changed, which in turn allows for change in the individual; different cues in the environment will then become salient (i.e., have meaning). The learner's trajectory, his or her path creating the rhizome, is both the individual and the environment. What is created is the unique trajectory of that individual with the environment woven at that time, given what is currently salient for that individual.

The description of cues and trajectory-dimensions address what, how, and where the information is from, but why *was* the cue from the environment salient? Plumert (2008), in her study of seven, nine, and eleven year olds, considers categorical bias as an explanation. The saliency comes from a categorical bias that emerges from the system itself. These biases come from the interaction between the person and environment, they are a co-determining system. It is the interaction of components of the system as the systems designs, in a sense, what potential attractors could be. Once the system is stable, it will remain so until something changes that (Greeno 1998). Thus, changes in the individual or changes in the environment can change the course of the trajectory by changing the potential attractors (Plumert 2008). In this way, changes within the system can take place; or as Greeno noted, learning occurs. Thus, learning becomes the traversing of the rhizome by experiences (observable and not), making decisions, settling perturbations, communicating, i.e., seeking an attractor. This attractor, as it is woven into the system, will then be a stable area that may later be the lens from which the individual makes sense of the environment, either the current one or one that is encountered later.

Further, dynamic systems, itself considered a metaphor for cognition by some (Eliasmith 1996), provides a vocabulary within the rhizome metaphor. The rhizome is a dynamic system. A rhizome is (1) *dynamic*, *continually growing in dimension*, has (2) *heterogeneous features* in which there is potential for (3) *infinite connection among those features*, is (4) *not necessarily hierarchically organized*, but is a continuous interconnected system that (5) *cannot be ruptured*, has (6) *no inside or outside,* yet has (7) *multiple entrances* (Deleuze and Guattari 1983; Duffy and Cunningham 1996; Eco 1984; Hess 2008; Schuh and Cunningham 2004). How the rhizome expands, how it may grow, is determined by interactions in a boundless state space.

Consider the learning environments described in this book. They are parts of a continually growing system as students and teachers gain understanding, creating links between information in the classroom and the varied individual experiences that they bring with them. In particular environments students have rich opportunities for infinite, robust connections. The system itself defining to what extent a hierarchical organization may exist. As students and teachers enter and leave particular classrooms, and engage in particular learning experiences, each individual's trajectory will carry with them the residue of that experience, expanding the rhizome as their trajectories continue to weave new paths. Ideally trajectory dimensions gained both in- and out-of-school should be seamless as the individual moves in and out of the school door.

Thus, infinite paths creating the rhizome, essentially spinning the life-long learners' activity space, are spun through a process of unlimited semiosis. While I would argue that learners of any age may have their meaning-making processes operationalized in this way, it is particularly relevant for those learners, as Piaget would describe, transitioning from concrete to more formal operations. Plumert (2008), who included 7-, 9-, and 11-year-old children and adults in her study, suggested that

> important developmental changes are occurring in the cognitive system during late childhood and early adulthood. These developmental changes fundamentally alter the interaction between the cognitive system and the task structure because they lead to differences in the amount and kind of information that is "available" for use. (p. 390)

What is available in the environment (i.e., potential cues) may depend on development—what *can* be perceived and understood. While some students' links may be described as limited, surface, simple, or lower level, they are the lens that the learners currently bring to the learning situation. The goal is to provide an environment to help learners develop the ability to more deeply think about and intentionally identify cues that have potential for deep processing.

While the instructional strategies of teachers such as Mrs. Schneider and Mr. Ritter may seem more constructivist or learner centered, learning theories and their related instructional interventions have long acknowledged using the learners' lens or prior knowledge as a starting point. Plumert echoes this with a nod to Vygotsky's descriptions of scaffolding and the zone of proximal development. Understanding where the child is at, how they are viewing the situation (Wertsch 1985) necessarily

provides us information from where to begin. Given that, scaffolding such as the prompts of Mrs. Schneider's allows students to weave a newly informed trajectory.

The coupling between individual and environment becomes more finely tuned as individuals get older. In this way, while learners make their personal links, they become more adept at linking elements of the environment with what they know, and thus become better able to regulate comments, for example, as well as distinguishing opportunities for useful elaboration. In other words, as unlimited semiosis is the norm and continues, the outcome (i.e., culturally accepted, often collective, and goal directed) of that process becomes better aligned with the goals of the environments. In classrooms, teachers support the process. Recall Ms. Smith and her first grade classroom. The Gap bag link, for example, may not have been shared in an older classroom. That does not mean that it would not have been thought of, but rather than it may not have been overt.

Learners do bring what they have learned out of school with them to school, the residue of what they have encountered in their lives—a wealth of personal experiences that allow them to make sense of the world around them. Throughout this book, This book has documented descriptions of cues in the environment that became embedded as part of students' ongoing trajectories. Lemke (1997) stated that the "trajectories of individuals to some extent always create rare or unique new connections among practices, activities, and communities of practice that are not already typical of those that define the prevailing subject types of a community" (p. 49). It seems likely that individuals with unique experiences follow or develop unique trajectories or paths. Should a trajectory develop that extends beyond the prevailing community, broader synthesis may occur and individuals can connect with new communities, expanding their learning and opportunities.

Learners' understandings of the world are what their sign structures may support them in interpreting (Cunningham 1992); what they bring with them to the classroom will affect how they interpret what they are learning. Within individual classrooms, students will come away with different meanings based on these experiences, accounting for why some students, for example, share links to a vacation, to the trauma of school, and to daily activities with friends. Consider that the semiotic process is unlimited (Eco 1984) and that the new meaning that learners will take away from the classroom is the basis for interpretation of other experiences as their meanings become future signs for understanding. While the nature of the student links are fairly simply classified, they reflect the links themselves. In that way, they are not surprising given the age of the learners and what is likely of importance in their lives. Many students' initial contact with information, particularly if unsupported, will be surface links. Unfortunately, the surface links in the classroom with their prior experiences will likely persist as their trajectories continue outside of the school environment. Thus, it would seem surprising if there *would* be transfer to out of school, as Resnick (1987) noted "the possibility that very little can be transported directly from school to out-of-school use" (p. 15). If students demonstrate surface links with what they bring to school, it is difficult to believe that the meaning they take from school could be more robust.

8.4 Making Meaning by Making Connections

What then can we take away in looking at this small part of the semiotic process? First, it seems critical that this process should be seamless along a learner's trajectory. How learners "think" in school should be the same as how they "think" outside of school. If we hope that students will transfer what they have learned in school to outside of school, then allowing students to seamlessly bring what they know into the classroom, and helping them understand how they may build on that initial interpretation, no matter how limited, seems useful. As Carraher and Schliemann (2002) note, we need to consider how former understandings "are brought into play in new situations" (p. 3).

Consider what problem solving, or inquiry, may be like out of school. We solve problems when there are "surprises" (i.e., perturbation, puzzlement, cognitive dissonance), in other words, unexpected events. In a pragmatic sense, if we are getting around in the world without these surprises, the signs and meaning attached provide a safe prediction of what the new experience is (McCarthy 2000). However, when there are surprises, we often solve those dilemmas abductively, in that we are provided with an experience, and create an hypothesis on the fly to account for the surprising experience. Considering that learners do this spontaneously, inquiry then is reflected as an ongoing process of life. "Regarding semiosis as a system of beliefs and abduction as the primary mode of building new beliefs, places inquiry, in some form or another, squarely back where it belongs, with the capacity of every person" (Cunningham 1992, p. 186).

Students integrate what they know with what they are learning in a semiotic process. These links encompass various degrees of intellectual usefulness; the links may or may not help students more fully expand and understand ideas. Despite the potential for understanding, a semiotic process indicates that the learners will develop their new understanding based on their prior meanings of elements that may or may not be similar. Early research on transfer considered identical elements (Thorndike and Woodworth 1901) and identical structures (Judd 1908). The link for transfer, and these early notions has been revisited in later research on and discussion of transfer (e.g., Bransford and Schwartz 1999; Carraher and Schliemann 2002; Detterman 1993; Greeno et al. 1993; Marton 2006; Underwood 1951) as researchers and instructors have attempted to identify what need be common between a current learning and a transfer situation. The links described here seem more closely to align with Greeno et al.'s (1993) definition of transfer in that the cue captures something similar between the relation a learner has "to one situation and the learner's relation to another situation" (Marton 2006, p. 505)—an invariant interaction (Greeno et al. 1993). Yet, the semiotic process and the uniqueness of individuals' trajectories compels us to consider that the potential for transfer for each individual lies in his or her own meaning-making *process* and what *their* sign structures will support. In other words, how they make meaning of the situation.

Sfard (1998) called to recast the idea of transfer for the participation metaphor in her discussion of acquisition (aligned with traditional) versus participation (aligned

with contemporary) metaphors for learning. "When one refuses to view knowledge as a stand-alone entity and rejects the idea of context as a clearly delineated 'area,' there is simply nothing to be carried over, and there are no definite boundaries to be cross" (p. 9). Yet there seems to be agreement that "something does keep repeating itself as we move from situation to situation and from context to context" (p. 9). She concludes that these participation-focused theories of learning will likely need to include the idea that there is "an acquired, situationally invariant property *of the learner*, which goes together with him or her from one situation to another" (p. 10). As Engle (2006) noted, the intercontextuality always exists between two situations in which an individual participates. This property seems inherent in the semiotic process, unique and defined by each individual based on his or her meaning stemming from prior learning, which then spins a trajectory that will form future experiences.

Realizing this provides a prompt to understand *how* the learners may understand a particular learning experience given their prior experiences that help them interpret the new learning. How does a cue link for a learner and how can the teacher support that? The overarching instructional tasks then become (a) invoking students' personal understanding, (b) helping students understand new information and experiences by evaluating and modifying these understandings, and then (c) modeling and supporting a process that values thinking as an ongoing process of making sense of things given what we know, spanning in- and out-of-school. Students need opportunities to capitalize on the links that they will spontaneously build.

In the research reported here students made a number of types of links including sensory links and conceptual links that included primarily concrete concepts with few that were more abstract. Conceptual links also included relationships such as now-and-then links in which students looked across different periods of time, and here-and-there links in which they linked something in one context that they had encountered in another. Teachers, as well as students, shared these links. Students and teachers also identified links that indicated similar process or structure.

This research agenda described a grounded theory of student knowledge linking, those initial links that students made between what they were learning and what they already knew. It articulated the types of personal prior learning that were woven into a student's trajectory as he or she engaged in the content offered in their learning environments. The environments, orchestrated by and containing the teacher, often provided the cues through which the process began. The links that occurred were of different types and usefulness to the learning processes pulled by particular attractors that, although perhaps hoped for by the teacher, were truly vetted by the student. The environment itself may have fostered or inhibited those links. These may have been contingent on what were considered authority sources in the classroom and who was allowed to identify those, how links were responded to, and how students perceived the appropriateness of sharing links. As the idea of student links has been articulated, a semiotic lens as well as rhizome as a metaphor for learning has been used. I realize that these lenses are merely that—lenses through which to describe a situation that allows certain elements to move to the

forefront. The classroom narratives, student and teacher interview excerpts, and open-ended writing examples could certainly be elaborated in a different way.

Returning to the cliché that began my own trajectory, "*learners have no alternative but to construct their knowledge based upon what they know,*" it appears, at least to me, that it must be true; we just need to consider what this process might look like and not be swayed by what's happening in the learning environment. "Constructing" knowledge is not limited to learning that takes place during instruction that "looks" like it aligns with a constructivist or other contemporary lens. Rather, knowledge construction happens everywhere, not just in classrooms that employ strategies that appear more constructivist or contemporary such as Mr. Ritter's and Mrs. Schneider's. Yet it seems that in the case of Mrs. Olson for example, with the constraints imposed by the questioning format, and with Mrs. Chambers' focus on the test and the information for that test, that students' were not constructing their knowledge, but someone else's. We find explanation of this in another semiotician, Vygotsky. What we know is not a mirror image of the outside world. What we internalize is developed through a process of mediation via environmental affordances, by having the content, rich activities, dialogue, and support needed to making meaning our own.

These experiences, both in and out of school, color students' trajectories and essentially create who they are as learners and as people. The types of trajectory dimensions of the students described in this book, as well as the varied types of cues that propelled a learner in a particular direction to a particular attractor, reflect those vast experiences. Learners will engage in this process whether called unlimited semiosis, meaning making, or any other name. While it might appear that, at times, what they bring is not all that useful for learning, what they bring represents their starting point—where they currently are. If this process would not occur, nothing would make sense to the learner. As with other descriptions of knowledge structures, it is the use of the most salient lens in vivo. Whether a structure or a process, it is their initial meaning making.

While all of these links that the students make may not be created equal in terms of potential for learning gains, they are what they are. They form in interaction with the environment, and while in school, much of that is controlled by the teacher. In the past decades the role of the teacher has been said to move from the sage on the stage to the guide on the side. Teachers cannot pour information into students' heads. Yet, it seems the teachers' role as a facilitator or coach is also limited. The idea of a co-learner or co-creator of a trajectory may come closer to describing the process. Better yet, is the role of the teacher as environment. As such, the teacher's own trajectory may help orchestrate attractor states that draw learners through viable cues that are developed, offered, and accepted.

As I conclude this work I am reminded of my own trajectory as a learner and scholar. My lens has continued to develop as my trajectory developed, woven by the experiences that have quite frankly prompted and allowed the findings to develop as they have. The goal of any learning experience is to provide a positive type of residue that will be woven into an individual's trajectory that will then position them to seek useful future attractors in various environments. Whether that residue is

content "knowledge," positive affect, processes that allow students to be good learners and successful students, or merely building relationships, it is the trajectory, the next lens as the learner moves from school and then back again in later years. Meaning will be made—but of question is the value of that meaning making to improving the learners' trajectory for later encounters. Opportunities to share, valuing of contributions, prompting for links, and then probing offered links to scaffold the learner to increase the depth of the relationship—to help create an attractor is important. These allow for meaning making. My own meaning making, my quest to understand how learners constructed their knowledge based on what they knew illustrated to me this process. My trajectory has been colored by a variety of lenses to try, experiences and opportunities to build connections. The rhizome metaphor provided a means for me to make sense of what these children brought with them to school and how they linked those with what they were learning. The metaphor pointed to a connectivity that allowed formal schooling to make sense. Those learning opportunities do only seem to make sense when considering school experience as an element of the full rhizome, rather than an extant trace.

We seem to focus on how to use what's learned in school outside of school. In other words, transfer of learning is considered a unidirectional process (school to somewhere else). Drawing on the rhizome metaphor, with its dynamic growth of which learners and their environments are a part, and the seamless nature of the rhizome, the learners' trajectory not only moves out of school, but also ventures in. Students do bring all kinds of things with them to school, along with their backpacks and carried lunches. Unpacking that personal backpack, the residue of their life's trajectory that will weave into and create the learning environment, may be a challenge. But at a fundamental level, it cannot be overlooked or ignored. This narrative provides a glimpse of the types and depth of the links that kids may typically bring with them, how these may be overt in classrooms, and how they may be fostered. Given a process of unlimited semiosis, meaning made in school provides a lens to make meaning out of school, which in turn, may work its way into school again in a positive way. And, if that is the case, then that which is learned in school may also become of value outside of school in a seamless way. As students create a trajectory that indicates value of where they have been and why that is of importance as lifelong learners, they will make meaning by making connections.

Appendix
Research Methods

Making Meaning by Making Connections is a synthesis of data and interpretation from a number of studies. Just as the findings of the studies evolved, so did description of the qualitative research traditions that best described each study. The first study was identified as a qualitative study, the second study an instrumental collective case study (Stake 1995), and finally as the remaining studies were completed and data synthesis began, the most appropriate method seemed to be grounded theory (Strauss and Corbin 1998) focusing on the development of a substantive theory within a constructivist framework that described how these late-elementary students linked what they were learning with what they knew. As the final analysis and writing of this monograph progressed, it became clear that I was personally invested in the cases and felt a need to allow those cases to be understood as individual classrooms. In this way, the overall study retains much methodological support as an instrumental study (Stake 1994, 1995) in that my focus was to gain an understanding of student knowledge links, those links that learners made between what they were learning and their personal prior knowledge, and how those may or may not have been apparent overtly in their classrooms. However, while in an instrumental case study the individual cases would be secondary to understanding the phenomenon in question, I wrote this monograph including a variety of narratives from the classroom so that these classrooms could become understood in their own right. Given the time commitment of the students and teachers, I felt it important that they, in a sense, communicate what learning and instruction in their classrooms were like. Finally, as I considered my research over the past decade I drew on the methods of grounded theory to make sense of the data and potentially synthesize the data into a type of story that shares the classrooms, makes statements about this particular aspect of the knowledge construction process, and weaves these together in a way that allows the reader to consider these six late-elementary teachers' classrooms. I have chosen the linking process operationalized by cue and trajectory dimensions as the core story and integrate other categorical data to support that story (Strauss and Corbin 1998). This appendix describes the processes through which this final synthesis was developed, from initial research question through final analysis.

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DOI 10.1007/978-94-024-0993-2

First, each individual study is described in terms of purpose, guiding question, and participants. Then, data collection methods in common across these studies and of importance to address the purpose of the overall study are noted. The analysis process is described noting any deviation from that process for particular studies. The appendix concludes with a brief section on the processes engaged to foster trustworthiness in data collection and analysis for these studies. The data synthesized in this book, as well as the methods for the individual studies have been presented and reported elsewhere as parts of the individual studies.

Students, Teachers, and Classrooms

Mrs. Olson's Sixth-Grade Students and Ms. Smith's First-Grade Students

The purpose of the pilot study that began this research "was to identify students' questions and comments in classrooms that may typically be viewed as off-task or irrelevant for the learning process" (Schuh 2007, p. 173). Prior to the data collection, the question that guided the study was "How can knowledge of these elementary school children who were situated in an existing school environment be described as multidimensional knowledge structures?" (Schuh 1999, p. 4), reflecting an early link to the rhizome metaphor that prompted me to explore the varied idiosyncratic meanings that resulted from student's personal knowledge. With further data analysis and evolution of the guiding question, the question was adapted to "In these two elementary classrooms, what were characteristics of students' idiosyncratic comments, questions, and thoughts that captured a semiotic process of viable learner interpretations of their classroom learning and how could these meanings be construed as inappropriate?" (Schuh 2007, p. 177).

Participants in this study were enrolled in a first- and a sixth-grade class at a parochial elementary school in a small mid-western city, which would later be called "St. Francis School."[1] St. Francis was situated in a small city, with a population around 55,000 and over 100,000 when the surrounding areas were included. The first-grade class, taught by Ms. Smith, had 14 boys and 11 girls, ages 6–7. Of these, 13(50 %) consented to participate in the study (8 boys and 5 girls). Mrs. Olson's sixth-grade class had 9 boys and 15 girls, ages 12 and 13, with 50 % participating in the study (3 boys and 9 girls). St. Francis had about 450 students, with an average of 2 classrooms for each grade level, a low minority rate at about 8 %, and only a 1 % free-reduced hot lunch rate during that year.[2] Prior to data collection, I had visited the classrooms, was introduced to the students, and

[1]Throughout the text, all school, teacher, and student names are pseudonyms. Noteworthy is that I gave St. Francis School its pseudonym prior to the election of Pope Francis.
[2]Citations for sources of school demographics are not included to help foster school anonymity.

interacted with the first-grade children by assisting them with their class work. The first-grade teacher stated that these early encounters with the children identified me as a helper and increased the children's comfort level and willingness to talk in the interviews.

Unfortunately, as in many graduate students' pilot studies, questions that should have been asked were not and depth of data was limited because of that. While demographics of the school noted in the previous paragraph were obtainable from the school website, questions about Mrs. Olson's and Ms. Smith's background remain a mystery. Both teachers had been with the school for a number of years and seemed similar in age to the other teacher participants in the study. I had been placed in contact with them through my academic department chair, indicating that they might be interested in participating in a study.

Mrs. Chambers' Sixth-Grade Students

The data from the next three classrooms, those of Mrs. Chambers, Mr. Jackson, and Mrs. Schneider, were collected for my dissertation. The purpose of that study was described as "Given three sixth-grade classrooms that differ in degree of learner-centeredness as determined by student perceptions, what is the nature and occurrence of learners' links to prior learning? Further, what characteristics of the classroom environment are associated with the learners' use of these links to construct new knowledge?" (Schuh 2003, p. 427). These three classrooms were purposefully selected from a pool of six classrooms based on results of the Learner-Centered Battery (LCB) (McCombs et al. 1997). Mrs. Chambers was chosen as the most teacher-centered classroom in that study.

Meriweather Lewis School, the pseudonym for this newer elementary school in a suburb in a large mid-western city (population of around 1.5 million), included 770 students in grades K-6. School demographics. Twenty-four students participated in the study (13 boys and 11 girls, ages 11–12). Mrs. Chambers was 59 years old and had taught for 15 years in various grades and communities (grade three in the nearby university town, 5 years at a middle school teaching language arts and computers, 7 years at another school teaching sixth grade, and this study was in her third year at Lewis Elementary School).

Mr. Jackson's Sixth-Grade Students

Mr. Jackson's classroom at Carl Ben Eielson Elementary School was chosen for my dissertation as a "middle" level classroom in terms of learner centeredness. The students' LCB scores were nearer the "most preferred score," which indicated a

classroom was viewed as being learner centered (McCombs et al. 1997). My dissertation committee questioned that these scores were nearer this preferred score than the scores of Mrs. Chambers' classroom, given the structure of Mr. Jackson's classroom. This prompted a closer look at the LCB questions and how they may have been interpreted by these students (Schuh 2004a).

The 24 students in Mr. Jackson's classroom were one of three sixth-grade classrooms at Eielson Elementary, which had a school population of 430 students including approximately 15 % 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, which was in the same city. The classroom included 13 boys and 9 girls aged 11–12. Mr. Jackson was 47 years old and had taught for 22 years. He described his teaching experience in his interview, "it's about 22 years of teaching mainly in the sixth grade but I've taught just about everywhere. I've taught three years in the first grade at a smaller school. I have taught fourth grade. Like I said, a lot of years in sixth grade. I've taught high school students at the area vocation school, I've even worked with college age students when I was the education director of Planned Parenthood. So, other than kindergarten and second grade, I think I've taught just about all the grades at one time or another."

Mrs. Schneider's Sixth-Grade Students

The final classroom that participated in my dissertation study was Mrs. Schneider's. Theodore Roosevelt Elementary School, in the same city as St. Francis and Carl Ben Eielson, was located near student housing for the local university; about one-third of the approximately 600 students were from campus housing, a transient population. Roosevelt Elementary had a 32 % reduced/free hot lunch rate—but only three of these students were in Mrs. Schneider's class. There were 19 girls and 7 boys in this classroom, ages 11–12. I had noted in my field notes, "Mrs. Schneider's classroom was a classroom for gifted students. Initially, this was a concern, because of the possibility that the students may have developed better skills at integrating information and more experience on which to draw in particular domains. When I first spoke with Mrs. Schneider about the possibility of her classroom participating in the study, she stated that her students were not different and that there were a variety of students in her classroom. In fact, there were a number of special needs students in the class as well."

Mrs. Schneider's experience in the classroom had a non-traditional start. She initially was a teaching assistant in art history at a university in another state. After moving to various places with her family, when her children started kindergarten she began volunteering in the schools and eventually returned to college to take classes, obtaining a teaching degree as an older student. She had taught five years in

a preschool, later completing her student-teaching in third grade in a neighboring county which had a high poverty rate. She had also taught theatre classes for grades three through twelve, but stated she had only taught in a typical teaching assignment for two-and-a-half years, taking over her current classroom midyear.

Mr. Ritter's Fifth- and Sixth-Grade Students

My study of Mr. Ritter's class was prompted by my wish to replicate my study in a new location. William Clark Elementary School was located on the outskirts of a small Midwestern (population near 60,000) city that housed a university. This class was a combined fifth (N = 12) and sixth (N = 13) grade class in a Basic School (Boyer 1995) with an enrollment of 450 students in grades K-6. The school was relatively new at the time of data collection. Teachers in the school were not all new teachers, but seasoned teachers from around the school district. Mr. Ritter had taught for 15 years, 14 of which has been with fifth- and sixth-grades. His current class included 12 girls and 13 boys, age 10–12.

While the purpose of this study was, as was typical of my studies, seeking instances where I heard students contribute links that indicated what they were learning had linked with something that they knew, as the study progressed, the students use of the computer as they wrote an expository paper about an aspect of Chinese culture become of interest, as often happens in qualitative studies in which results are emergent. The strategies that students used, specifically differences in how students viewed electronic attributes of text presented on the computer as well as constraints imposed in the writing process by use of computers were the focus of initial data analysis (Schuh 2002).

Mrs. Wilson's Fifth- and Sixth-Grade Students

Mrs. Wilson's classes participated in the study for two years as part of a research study on students' writing process, which provided a context for me to look at their knowledge linking. That study was prompted by Mrs. Wilson—she had contacted the College of Education (COE) suggesting a researcher might like to conduct a study in her classroom. She had noted that she thought her students may not read as well when reading information on the computer screen compared to textbooks. The note was sent to the COE e-mail distribution list and I used the opportunity to also gather information for my broader study of how students linked what they were learning with what they knew. Formally, the purpose of the study was to explore the differences in the types of written syntheses that students create depending on the types of resources they use; this focus providing a venue to listen for links that students made in their classroom and as they worked in the media center.

The first year of the study, 54 students (32 boys, 22 girls, 28 grade 5, 26 grade 6) worked on an expository writing project where they researched animals of the rainforest. Two classrooms were involved in the study that year; one was her home room (the morning class) and the other was the class from across the hall (the afternoon class). As Mrs. Wilson's students crossed the hall to go to math class, those students came to Mrs. Wilson's room for social studies. The second year of the project included only Mrs. Wilson's homeroom with 13 fifth-grade and 11 sixth-grade students participating in the study. In this second year, her combined classroom of fifth- and sixth-graders included eight sixth-grade students who had been in the study the previous year.

Mrs. Wilson's classes attended Thomas Jefferson Elementary, a Basic school (Boyer 1995) similar to Clark Elementary, the school in which Mr. Ritter taught. Cultural/ethnic diversity in this K-6 school of 495 students included 66 % white students, the remaining 34 % reflecting the cultural mix of the community's large research university. Free or reduced hot lunch was available to 17 % of the students. Mrs. Wilson had taught at Jefferson when it had opened 10 years previously. In addition to 14 years in fifth-sixth grade classrooms, her 30 years of teaching experience included high school, grade four, and enhanced learning classrooms.

The initial data analysis from the first year of the study addressed the research question regarding use of electronic and print text by students writing expository papers. These results about students' effort and enjoyment while using print or electronic text are reported in Schuh and Farrell (2006). Analysis continues on the overall writing process undertaken in these classes and is not reported in this monograph.

Recruiting and Data Collection

Invitation to Participate

With the exception of Mrs. Wilson, potential teachers for the study were identified through convenience, generally by recommendations from college professors who were familiar with either the teachers or their principals. The recruitment procedure for students was similar for all of the studies. After approval by the university Instructional Review Board from the location where the individual studies were conducted, recruitment information was provided to the teachers, parents, and students. In particular, students carried home to their parents a packet with instructions, two copies of a student assent form, and two copies of a parent consent form. The students were to return a signed assent and consent form to their teacher for participation in the study.

Once a teacher indicated interest, for most of the studies they proposed a full unit of study in which they would allow me in the classroom for observations and

interviews. Units were chosen because they provided a naturally occurring treatment within a classroom (Alton-Lee and Nuthall 1992a). The exception was the classrooms in the pilot study in St. Francis School where a full unit was not observed. In Mrs. Olson's classroom the study occurred during social studies. In Ms. Smith's first-grade classroom a variety of subjects (math, reading, music, and religion) were included. Full units included the Biomes in Mrs. Chambers' classroom, the Roman Empire in Mr. Jackson's classroom, the Middle Ages in Mrs. Schneider's classroom, current events and a China research project in Mr. Ritter's classroom, and expository writing units on rainforest animals (year 1) and sea mammals (year 2) in Mrs. Wilson's classrooms.

Once the study time in the classroom had been scheduled, data collection began. For Mrs. Chambers', Mr. Jackson's, Mrs. Schneider's, and Mr. Ritter's classes, the students initially completed the Learner-Centered Battery (McCombs et al. 1997). As previously noted, this instrument was used to select the first three teachers' classrooms into the study, while Mr. Ritter's classroom completed the instrument to provide a point of comparison with Mrs. Schneider's class in particular.

Data collection methods to gain the qualitative data to address the knowledge linking question needed to be deliberately non-standardized to allow for individual variation among students (Ginsburg 1997). Observation, interviews, and an open-ended writing activity allowed for this variation.

Observation

Each classroom was observed a number of times. Because of the differing units, the observation times varied, but all observations were conducted in the spring of the school year, potentially indicating the instructional routines and types of interactions were well-established. Mrs. Olson's and Ms. Smith's classrooms were observed three times each, while each of the other classrooms was observed across an entire unit of study. Mrs. Chambers' and Mr. Jackson's class were observed during each class period of the unit, given a tight regular schedule. The observations in the other three classrooms were more intermittent given schedule variations and also length of the units. For example, the middle-ages unit in Mrs. Schneider's class spanned seven weeks. Observation times were chosen to span the entire unit in Mrs. Schneider's class, with an intense focus in the middle of the unit, when students were most involved in the learning, rather than performance, phases of the unit. In the first year in Mrs. Wilson's classes the instruction that modeled the writing was often similar for the two sections (her home room and the kids across the hall). Given this, and my own work schedule at the university, I did not attend all of the instructional sessions. Table A.1 includes information about the observations in each of the upper-elementary classrooms used for the analysis is the synthesis.

Table A.1 Demographics of the eight classrooms participating in the various studies

Classroom	Grade	n[a]	Topic studied	Data collection period	Characteristics
Mrs. Chambers	6	24	Science/biomes	10 observations in 2 weeks (average 60 min)	School district 2 State 1
Mr. Jackson	6	24	Social studies/Roman Empire	8 observations in 2½ weeks (average 30 min)	School district 1 State 1
Mrs. Olson	6	24	Social studies/European world history	3 observations in 3 weeks (average 60 min)	Parochial school School district 1 State 1
Mr. Ritter	5–6	26	Writers workshop/Chinese culture	9 observations in 3½ weeks (average 45 min)	Basic school[b] School district 3 State 2
Mrs. Schneider	6	26	Interdisciplinary/middle ages	21 observations in 7 weeks (average 45 min)	School district 1 State 1 Gifted classroom
Mrs. Wilson (year 1 homeroom)	5–6	27	Interdisciplinary/animals of the rainforest	11 observations in 5 weeks (average 50 min)	Basic school[b] School district 3 State 2
Mrs. Wilson (year 1 afternoon class)	5–6	27	Interdisciplinary/animals of the rainforest	13 observation in 5 weeks (average 60 min)	Basic school[b] School district 3 State 2
Mrs. Wilson (year 2)	5–6	24	Interdisciplinary/sea mammals	19 observations in 6 weeks (average 55 min)	Basic school[b] School district 3 State 2

Note [a]Classroom size, not all students participated in each study. [b]Basic school (Boyer 1995)

Observation data collection tools varied as the studies progressed. For example, in St. Francis School I did not use an electronic data collection tool, but merely took notes on a steno pad. In Mrs. Chambers', Mr. Jackson's, and Mrs. Schneider's classrooms observation notes were also taken using a Palm Pilot[3] with attached keyboard. This facilitated the gathering of data immensely, allowing the flow of the discussion to be captured. Although the compact size of this equipment was intriguing to the students and they questioned me about it, once the class session had started the quietness of the keyboard and its portable size allowed for easy movement in the classroom as needed. In Mrs. Wilson's and Mr. Ritter's classrooms I used a laptop computer to capture my observation notes.

In addition to my observation notes, I also used a video recorder in Mrs. Chambers', Mr. Jackson's, Mrs. Schneider's, and Mr. Ritter's classroom. The recording was used to provide me additional information as I typed the narratives

[3]A handheld computing device. The screen size is approximately 2 by 3 in. I used the Palm III Connected Organizer available through 3Com.

Table A.2 Number of words and pages of captured observation data by classroom

Classroom	Observation		Interviews[a]		Writing
	Words	Pages	Words	Pages	Words
Mrs. Chambers	26,101	87	16,507	44	5063
Mr. Jackson	12,379	36	12,765	31	4761
Mrs. Olson	1826	6	5652	11	4486
Mr. Ritter	21,261	50	11,340	36	4100
Mrs. Schneider	35,535	88.5	20,058	41.5	10,303
Mrs. Wilson (year 1 homeroom)	28,718	74.5	26,669[b]	96.5	6602
Mrs. Wilson (year 1 afternoon class)	16,339	40	19,889[b]	76	5267
Mrs. Wilson (year 2)	38,958	93	33,488[b]	98.5	6281
Total	181,117	475	146,368	435	46,863

[a]Number of interview words and pages for teacher: Mrs. Chambers 6444 (11.5 pages); Mr. Jackson 3727 (6.5 pages); Mrs. Schneider 14,346 (21 pages); Mr. Ritter 4005 (8.5 pages), Mrs. Wilson (Year 1) 8868 (25 pages); Mrs. Wilson (Year 2) 13,255 (25 pages). Mrs. Olson was not interviewed

[b]Conversations with students in Mrs. Wilson's classrooms include much explanation about the students' writing process. Therefore, interview numbers are inflated in regard to knowledge linking

and to help foster trustworthiness in data interpretation. However, the single camera with no operator (given that I was taking notes) had limited use as a recording device. Consequently, in Mrs. Wilson's classroom dialogue was captured via a small tape recorder. Because of this, observation data from Mrs. Wilson's classroom is nearly verbatim where it was audible on the recording. Despite this improved fidelity of captured dialogue I continued to take observation notes on the laptop, later (with the help of a research assistant) integrating my observation notes with the verbatim transcript. Table A.2 includes the number of words/pages of captured observation text in these studies. During the observation I focused on indications of learners' experiences, while also trying to capture the flavor of the classroom as evidenced by student activity and classroom interactions. Thus, any narrative excerpts in this monograph should not be treated as verbatim transcripts of the classroom dialog, but indicative of the nature of the interaction and activity, with a shell of conversation that was often further detailed through the student interviews and researcher interpretation.

During the observations in each classroom, I was a passive participant (Spradley 1980) and did not initiate contact with the students, allowing the teacher and classroom to function in their normal routine. Students were, of course, interested in what I was doing, often asking about the equipment I was using, research I was conducting, and about my work at the university. For example, I was observing two boys, students in Mr. Ritter's class, working on their expository paper in the computer lab at Clark school. They had engaged in conversation when I first started watching them. I include my raw notes from my third observation.

> "My turn to type," 070119[4] said. 070116 got up and looked through the video camera as 070119 moved back to the computer. "So, why are you taping this anyways?" 070119 asked. 070116 moved back to the chair next to the computer on which they were typing their paper.
>
> "Why am I taping this?" I repeated. "Because I can't type and get everything down, so I use the videotape to go back and fill in."
>
> "Do you teach classes?" I'm asked and I affirmed this. "Will they see it?"
>
> "Because I teach classes and do research and they are separate," I answered.
>
> "What are you researching us for?"
>
> "Because Mr. 070100 said I could come into your classroom," I answered.
>
> "No, but what's the subject?" 070119 asked.
>
> "The subject is how students learn."
>
> "Oh, OK." 070119 said has he picked up the papers they were using, looked at the camera and said, "We printed these off." 070116 laughed.
>
> 070112 had been listening to our conversation. "How did you decide to try and figure out how students learn?" she asked me.
>
> "Well," I began, "because when I was a teacher there were some students that I couldn't figure out how to help learn and so I decided that I would study that."
>
> "Oh," 070112 dragged out the word. "That makes sense. That makes a lot of sense."

This type of conversation was typical in most of the classes. As time was available and students became comfortable with me, they asked me questions about what I was doing, and occasionally asked me questions pertaining to their work. Generally, I tried to reiterate what I had heard the teacher say, or would refer them to the teacher.

Because of the extended time commitment of the study and also a desire to disrupt the classroom as little as possible, I chose to be the only observer in the classroom. Further, because of the nature of the interviews, I wanted the students to become comfortable with me in their classroom, so that I became part of the "routine." I felt that a second observer would hinder those efforts. The rapport that I had with the students in the interviews may not have occurred if I was one of many visitors in their classroom during the study.

Student Interviews

Following each observation session, students were chosen to be interviewed based on comments and questions that had occurred in the class. This was the case in all

[4]My raw notes included a numbering system for each participant, which was later replaced with a pseudonym.

classrooms except for Mrs. Wilson's were students were more systematically chosen to talk about different aspects of their writing process. They were not asked to elaborate links that had been made in the classroom, and in fact there were few of those links noted in the classroom observation. For this interview section I describe the interview process that focused on student knowledge links.

Ginsburg (1997) stated that if one accepts the constructivist position as a theoretical framework, there is no choice in data gathering method other than a "clinical interview or some method that attempts to capture the distinctive nature of the child's thought" (p. 58). Clinical interviews, which Piaget used in his interviews of children and Vygotsky supported as a means for working within a child's zone of proximal development, are a nontraditional method which can be used to examine aspects of a child's thinking. Although the tasks for the interviews in this study were of a slightly different nature than those that are usually conducted in a clinical interview (having a child solve a problem), characteristics of clinical interviews provided helpful guidelines for the interviews in this study. Central to the clinical interview is the non-standardness and flexibility that must exist during the interview. Although the interview begins with a predetermined open-ended question or problem, the interaction must follow from the child's point of view, the interviewer being flexible enough to develop questions and problems that can help clarify the child's thought processes. Fairness, shown as sensitivity to the individual, putting the child at ease and setting the stage for the interview, providing an explanation of the purpose of the interview, and being conscious about the ratio of actual speech in the interview were also items to consider in the interview (Ginsburg 1997).

Students were selected for a semi-structured interview in two ways. First, if a student said something that appeared to be a link to prior learning during the observation time, that student was selected for an interview. For example, in Mrs. Schneider's classroom during a discussion on medicine in the Middle Ages the student selected for an interview had commented that George Washington had been bled. If no comment was identified during the observation period, a student was either randomly chosen or selected by an ad hoc decision based on the particular classroom circumstances that day. In Mr. Jackson's classroom in particular it was critical to quickly choose a student and ask about his or her willingness to be interviewed because the students passed immediately to their next class. These interviews generally lasted <15 min, were audio taped for later transcription, and were guided by the following protocol.

1. During class you were studying ____, tell me about that.
2. During your lesson you brought up something about ____, what made you think of that?
3. At times when we're in class and learning about something, other things will pop into our heads. They might be about the class, or about another class, or something in school, or be nothing about school at all. I was wondering if anything popped into your head during class.

One variation in this protocol occurred in Mrs. Chambers' classroom. Students appeared to have little recall of the information about their biome, and were better

able to describe what their group had done so far. Asking the student about their group's progress before the first question in the protocol better prepared the student to address the content-related question. Following each question, the interview followed from the child's point of view, allowing them to discuss the topics in any manner that they chose. In Mrs. Wilson's classroom, conversations with students typically occurred at each stage of their writing process (e.g., notes, drafting, final copy). Limited information in those interviews pertained to links.

Table A.2 includes information about the interview including number of words and pages.

Teacher Interview

All teachers, with the exception of Mrs. Olson and Ms. Smith, were interviewed after completion of all of the observations in their classrooms. These interviews provided a means to develop a more complete description of the classroom, clarifying classroom activities and addressing questions about particular students or comments that had occurred in interviews or the classroom. For example, I asked Mrs. Schneider about *Jackaroo*, a book I had not heard of that was mentioned in a class discussion. Information was also gathered about the teacher's background, classroom strategies, and the intended unit objective. The notes to Table A.2 include general information regarding the amount of teacher interview data.

Open-Ended Writing

At the end of unit, each class (with the exception of Ms. Smith's first-grade students), often including the teacher, participated in a writing activity. This open-ended writing activity was based on the unit that the students had just completed. To introduce the activity I reviewed the directions with the students, which was provided as a cover sheet to a number of blank colored legal pad papers (purple, pink, blue, etc.). Students were also provided a new pencil for the activity. In this activity the students were told to begin by writing about the topic that had been the focus of the observation while I visited their classroom. 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 directions provided a framework for my interactions with the students during the activity. I read the directions aloud, elaborated on them as needed to clarify student understanding and alleviate student concerns. To not have allowed this flexibility (i.e., only read the directions verbatim) and not to have tried to understand and clarify the activity for the individual students within each classroom, would have been contrary to the theoretical assumptions on which these studies were based. Although each student was to participate in the same activity, it was necessary to ensure that they understood the activity from their own perspective.

Further, each classroom context provided a background of experiences that framed students' willingness and ability to participate in this type of activity. I also provided a brief example of how students might follow one idea to another. In Mrs. Schneider's classroom this was omitted because the students, in developing their understanding of the activity, provided examples of their own. For example, one girl commented, "This is not a question, but if you say something really dumb, like you're thinking about the blackdeath and you're like, and you're thinking about fleas, and you're thinking, 'Oh, my cat just got a new flea collar.'" Using the directions as a guide (included at the end of this Appendix), the writing activity was explained and questions answered until the students indicated they understood their task by having no further questions. The students were told not to be concerned with spelling, as indicated by the excerpts in this book, but to spend their time getting their thoughts on paper. The directions and student questions were audio recorded in each classroom, with the exception of Mrs. Olson's. This writing activity typically lasted between 30 and 45 min. Surprisingly, students seemed eager to complete this writing activity. Often students would continue writing even after the expected time had passed and they had been asked to stop.

One change was added to the activity in Mrs. Wilson's classroom in the second year. They were provided a more structured format to the writing activity, specifically asking them to think about connections before they began writing. The goal was to foster deeper links in the students; but this was not the case as the analysis for link depth indicated. The updated open-ended writing instructions are included at the end of this appendix.

The students' handwritten pages were typed verbatim into a word processor. In entering their writing I strove for fidelity to the students' renderings, complete with misspellings, errors in grammar, and notes of various types of emphasis that the students used including larger letters, underlining, and varying types of punctuation indicating emphasis (!!!!!).

Researcher Journal

Following each data collection session I took the opportunity to immediately capture my thoughts about the session including questions that I had that I wanted to further explore. The reflections were captured in the tape recorder that I had used for the interviews and were transcribed along with the other data.

Analysis

Given the sequence of studies, data analysis occurred in phases and over time. Collectively, these data analysis processes were responsive to the particular studies as well as providing an evolving sense of the phenomenon being studied

(knowledge construction links) and the issue at hand: how do students link what they are learning with what they know. The question that guided the synthesis was "What is the nature and occurrence of learners' links to prior learning in their classroom, what characteristics of the classroom environment were associated with the learners' opportunity to share those links, and how might those links be valued in the learning process?".

Data analysis began in the pilot study with the data from Mrs. Olson and Mrs. Smith's classrooms. This early analysis was conducted using pencil and paper. In the constant-comparative method (Lincoln and Guba 1985), ideas of themes begin to emerge during data collection. The primary purpose of this first study was to identify the nature of learners' links to prior experience and knowledge that were called forth and/or used in their knowledge construction process. In fact, it was these incidents that were used to identify students who would be interviewed. Given this, analysis began as soon as the first incident was identified in the first observation in Ms. Smith's classroom. As data analysis continued I reviewed the data, noting categories that seemed apparent in the data. These included sounds like, looks like, same word, is-a, same concept, analogy, complex relationship, experience, personal, family, friends, school, society, past/present comparison, abstract ideas, and emotion/affect. Themes, specifically the identification of cues and trajectory dimensions that encompassed the noted coding categories, were identified. In this first analysis, the characteristics of the rhizome (see Chap. 1) conceptually guided the analysis, particularly that heterogeneous, multiple connections exist within one's knowledge, and that these connections extend beyond domain-specific boundaries, adding dimensions. As the analysis progressed, these features were illustrated through the creation of diagrams which were adaptations of a traditional concept map in that they moved beyond the domain content to capture where the students made links to their personal prior knowledge. Early assertions from this analysis included: (1) Trajectories types were largely personal and experiential in nature and stemmed from a small number of simple cues. (2) Trajectory dimensions were heterogeneous thus allowing a child to follow a number of potential paths at a given moment. (3) With age, cues increased in complexity and trajectories increased in variety.

Following data collection at each of the three classrooms, but before the teacher interview, I read all of the data for that particular classroom. Although the primary purpose of this review was to develop the teacher interview, identifying any areas that I felt I needed the teachers' perspective to understand his or her classroom, it also served as a first round of identifying characteristics of interest in each classroom. Through these reviews of the classroom data, the cue and trajectory dimension types were further identified and characteristics of the role of the teacher in the classroom and how those shaped the classroom environment in which the students learned were further highlighted.

The formal analysis began as a second researcher and I independently reviewed a portion of the data. The second researcher involved in the analysis of the project was a doctoral student in Educational Psychology at the same university. She had a masters' degree in counseling and had worked with experiential learning and

therapy contexts. Her research areas included social interaction and meaning making. She sought to study the impact of emotional and social engagement on cognitive processes and her current research was in the area of post-traumatic stress disorder and emotional engagement within natural environments and their impact on moral reasoning. She was paid for her assistance in the analysis process.

After our individual reviews, we compared our perceptions of the classrooms and considered how these could move to broader themes (rather than specific features) that could be used for the formal analysis process that would follow. This process was particularly helpful because it allowed me to move beyond the specific incidents that had been observed, as had been the case in the analysis for the pilot study of Mrs. Olson's and Ms. Smith's classrooms, to seek the underlying themes that would bind the features together into a picture of the classroom. Given our discussion, I reread all of the data from Mrs. Chambers' and Mr. Jackson's classrooms and a portion of the data from Mrs. Schneider's (recall that this classroom contained twice as much data). During the process I identified 56 characteristics of the classrooms that were not discrete incidents, but more broadly defined characteristics supported by a variety of incidents that captured the nature of the classrooms.

However, as this process continued and the categories that emerged from the data were further defined, problems arose. The primary concern was that these categories, although emerging from the data, did not align well with the purpose of this study. Because the data were gathered in classrooms, many themes could have emerged. A few prevalent ones had been "accepted" as of interest, and indeed they were interesting perspectives for gaining understandings of the classrooms. And, as I tried to define the categories in light of the phenomenon of interest, the categories became confusing for the second researcher as well as me. As a result, an analysis structure that was driven by the nature of the guiding question (i.e., the nature and occurrence of knowledge construction links) and the type of study was developed. This, in turn, provided a more direct means to address the guiding question. I discuss this mapping of analysis process to guiding question in the next section.

Analysis of an Instrumental Case Study

In an instrumental case study, the cases are instrumental to understanding the phenomenon. For this instrumental study the phenomenon were those instances in which learners called upon unique prior knowledge and experiences within their current classroom learning. Further, in instrumental case studies the need for categorical data may be greater, given the need to concentrate on the relationships that were set out in the research questions. "The nature of the study, the focus of the research questions, the curiosities of the researcher pretty well determine what analytic strategies should be followed…" (Stake 1995, p. 77). Thus, for this study, the phenomenon of interest needed to be identified first. Then, analysis questions

needed to be asked that led to the understanding of the phenomena. With this goal in mind, the following questions were posed as a framework for analysis.

1. What were instances of the phenomenon of interest? In this study, the phenomenon were called knowledge construction links and were operationalized as instances where the student (or teacher) drew upon or linked prior experience and knowledge into the current classroom dialog. These links varied: some being content related, others being idiosyncratic yet relevant, and still others that appeared seemed irrelevant and off-track. In the students' writing, the links were identified as a change of topic or tangent in the flow of the writing as it progressed. In this process, identification of the links was broadly interpreted, seeking to include instances rather than discard them.
2. What was the immediate context around the link? Did the student preface the link? What happened before the link? What would characterize the learning environment at that moment?
3. What prompted the link? What was the prompt/cue/stimulus where the corner was turned? The pilot study that had included Mrs. Olson and Ms. Smith (Schuh 1998, 1999) had prompted six cues types. These cues captured the beginning of the link. Given the addition of three teachers since the first study (Mrs. Schneider, Mr. Jackson, and Mrs. Chambers), it was fully expected that those six cues would be inadequate and would evolve to reflect the cues found in the larger data set.
4. What was the character of the tangent that was followed? An experience? Who were the other characters involved? Whom did the tangent relate to? Again, the pilot study (Schuh 1998, 1999) provided an initial set of trajectory types to begin this analysis, although it was fully expected that these would also be inadequate and would evolve to reflect the trajectories found in this data set.
5. What happened after the link occurred? Given the previous review of the data set, the following possibilities had already emerged.
    - Were they treated as errors?
    - Were they ignored? (no comment following, conversation continued)
    - Did the teacher acknowledge them?
    - Were they respected as a valid part of the conversation? (perhaps teacher or student asks about it)
    - Was the context and tangent woven together?
6. What was the character of the learning environment? To address this question, for each observation we characterized the learning environment broadly in terms of teacher's role, interaction (discussion strategy/method), and the nature of learning.

These last three features had emerged in the earlier analysis as being interesting ways of considering this group of classrooms. In each classroom, as is typically the case, regardless of the teacher's role during the students' learning process, the teacher designs the classroom environment in terms of activities and resources,

outlining how learning can occur. Thus, the teacher role shaped, as well as indicated, the nature of the environment.

Differences in the interaction in each was largely fostered by how the teacher asked questions, how the students responded, how the teacher then responded, and the open or closedness (divergence or convergence) of the dialog in terms of the topic being learned.

Our own premise was that learning *was* the primary goal of instruction. A characterization of what learning seemed to be, given the activity in which the students and teacher engaged, was the final description gleaned from the data. As the analysis unfolded, we tended to focus on the learning process in a traditional sense (were students asked to recall? synthesize? etc.) and what students were *doing* that perhaps indicated their perception of "learning." This was a more task-oriented focus (e.g., learning as preparing for a presentation, learning as note taking).

These emerging questions aligned with the guiding question that was posed for this second study to explore how students link what they are learning with what they already knew: Given three sixth-grade classrooms that differ in degree of learner-centeredness as determined by student perceptions, what is the nature and occurrence of learners' links to prior experience and knowledge and what characteristics of the classroom environment support or limit the learners' use of these links to construct new knowledge?

Once the analysis process was developed I reviewed all of the data, noting the links the students and teachers had made. Given the amount of data that were gathered for the three classrooms, 40 % of the data was defined as a reasonable minimum amount to be subjected to a second review. Forty percent would allow coverage of all three classrooms at a variety of points within their units.

Proportionate amounts of data from each classroom were purposefully sampled from the entire set of observations. These observations were chosen because they potentially provided a number of examples of students' links and represented the variety of activities that occurred within each classroom. Once an observation was chosen, the accompanying student interview and field notes were also chosen. From this sample, three sub-samples were chosen for various stages of analysis by the second researcher.

The first sub-sample consisted of ten percent of the entire data set. These examples were perhaps the richest in the data set, being chosen because they would challenge our thinking and stretch the categories. The second researcher and I reviewed the data independently and then shared results. Although we were using the cues and trajectory dimensions from the pilot study (Schuh 1998, 1999) as a starting point, adherence to these or even total agreement between us, was not the goal. Rather, attempting to capture a viable description of the phenomenon as well as the context in which it was embedded was our primary purpose. When we had not identified the same cues and trajectory dimensions for a knowledge construction link, we generally overlapped. The process was then to provide justification to one another that additional cues or trajectory dimensions that had been identified

were viable. At times they were, and at other times they were not. We also had different ways of characterizing the teacher, interaction, and nature of learning. Our discussion indicated that, although using different terminology, we often meant the same thing. We acknowledged that our differences in understanding the data emerged from own prior experiences and knowledge. For example, the second researcher, given her background and research interests, was more likely to capture affect/emotion as a characteristic of a trajectory dimension. I was more likely to clarify the differences among the cues that were associated by the concepts in two different settings, a more cognitive aspect. For example, in this writing excerpt by a student in Mrs. Chamber's class,

> I thought that the saltwater biome was the most interesting biome because the titanic sank in it that reminds me last night I watched the movie the titanic. My fav part in the movie is when the guy jumps and hits the propeller,

the second researcher identified this trajectory dimension as having an affect/emotion component whereas I had not picked up the subtle cue that this was an enjoyable activity and also had a favorite part that was salient for reconstruction. I, however, was able to piece together the link more clearly that it was a similar concept that derived from the classroom discussion about the depth of the ocean with the Titanic sitting at the bottom. Given our personal views, our goal was to develop a shared understanding of the data and clarify the categories.

In this first stage of the review process the *same concept cue* from the pilot study was expanded and other cue types were added. In addition, the description of the phenomenon, which had previously been considered to only be those shared by students, was expanded to include teacher models and prompts of knowledge construction links. The categories to capture what happened following a phenomenon were clarified and ordered.

The second sub-sample (20 % of the entire data set) was reviewed independently by each of us using the more clearly defined categories. After independent review we met to discuss our coding. Again, our goal was shared understanding. We found that we generally agreed on the cues and trajectory dimensions that we had individually assigned as well as the characterizations of the classroom environment. Overall, the categories worked well, with few examples of cues or trajectory dimensions falling into an "other" category of unclassified links.

Although I had initially identified the pool of links in the data, some of these had not been noted on the second researcher's copy. In her review of the data, she identified those unmarked incidents, thus supporting the identification of the links themselves within the data. For example, she had coded a writing example that had not been marked. In this, she identified the same link and the same cue and trajectory types that I had assigned.

The results of our shared understandings were coded in software for qualitative analysis (in this case, NUD*IST (non-numeric unstructured data index searching and theorizing), later I would continue to use N6, a more recent version of the

software). In this coding process, rather than coding identified phenomenon together into a broad category (as may typically be done), it was more meaningful to create a separate category for each phenomenon so that all relevant data tied to a student's statement could be cataloged together. For example, multiple instances of a girl's statement about a character in the literature book were all cataloged together as a means to better understand that particular link. While this made the task of coding in in the software more difficult, it did provide a convenient way to easily draw all data related to an instance together. Categories that included open-ended comments such as context, teacher, dialog, and learning, were added directly into the data set in the computer program. Thus, the data set increased to include our memos that emerged as the data were analyzed.

At this point, the second reviewer read and coded the remaining sub-sample (10 % of the total) and I continued to read and code all of the remaining data. This last review was to ensure that while I worked with the rest of the data I did not redefine the categories. I did, however, add one category. Our struggle with the *society* trajectory dimension and the role of media in it (i.e. was media automatically society?) was clarified by adding a trajectory dimension for *media*. During my review, there were a small number (approximately five percent of the total data set) of phenomenon that I had difficulty classifying. The second researcher reviewed these as well. After completion, my results were compared with the 15 % that had been reviewed by the second reviewer. Again, shared understanding was gained on the few items in which there was not total agreement, generally one adding what the other had overlooked.

Following this review of the final sub-sample, the remainder of the data were coded in the qualitative software. A sample of reports generated from the software for each of the categories was printed and the second researcher reviewed these for accuracy in recording our shared understanding. These data reports also included the codes, which were all accurate in her view. Therefore, the process of recording our analysis into the software not only provided a means to facilitate the data analysis process by clarifying the data through repeated engagement with it, but also provided an accurate record of our shared understanding of the data that emerged during analysis.

As Wolcott (2009) noted, analysis takes place through writing. I approached writing the story of each of these classrooms to illuminate what the classrooms were like and occurrence of the links in the classrooms. While the analysis of the open-ended writing activity indicated that generally the students did create links (with a few exceptions), as I developed the story of these classrooms it became clear that in some classrooms this process was not fostered and may actually have been discouraged. Evidence indicated that in the most learner-centered classroom in this study, use of prior experience and knowledge as evidenced through knowledge construction links, was fostered through open and divergent dialog, positive reactions to and acceptance of the students' knowledge construction efforts, modeling of the use of prior experience and knowledge by the teacher, and design of new

opportunities within the classroom environment for the students to gain experiences on which they could draw.

In addition to organizing the data from which I would narrate the findings of the study, our entire analysis process fine-tuned my own lens for identifying, extracting, and categorizing relevant information in the data. As I continued the studies in Mr. Ritter's and Mrs. Wilson's classrooms, the analysis generally proceeded independently. However, as I prepared manuscripts for presentation and publication feedback from reviewers continued to guide my interpretations.

Given the analytical framework that developed in the first two studies and building the dataset through the remaining classrooms there were adequate data to continue to test and refine the categories and themes that had been developed. As noted in the description of participants, the data were analyzed to address emergent and designed questions about students' use of resources and their writing process. The data were analyzed to address that question, but the data were also subjected to the coding process that used the a priori categories developed from the analysis for the five classrooms previously described. The coded data from Mr. Ritter's and Mrs. Wilson's classrooms were entered into N6 (although N-VIVO had been developed in the meantime, I continued to use N6 for this full data set) by a graduate student in Educational Psychology. In this process he was asked to take a critical eye to my analysis and bring to my attention anything that may have been misinterpreted. He took this task to heart, flagging those incidents for my review. Following the addition of these final data sets, the N6 project file contained 700 documents and a variety of codes including cues types, trajectory dimensions, before phenomenon, after phenomenon, teacher's role, learning as, classroom description, method, research bias, and researcher bias, as well as individual nodes for each knowledge construction link.

One additional technique was added to the analysis process in my first year with Mrs. Wilson's class. Given feedback from reviewers that went something like "how do you know that the link you identify, such as same concept, is the link that the student made" I followed up the open-ended writing activity with individual interviews about the student's writing. Prior to those interview sessions I had highlighted each link in the students writing, numbering each link. On another sheet of paper I coded these items, folding the paper over the coding so they would not be viewed until later. In the interview with the student I pointed out each highlighted numbered link noting as a comparison that the individual had made and asking the student why the one thing reminded them of the other. For example, consider this excerpt from 090112.

> Kathy: okay, alright. This was your writing that you did last time I was here. I just had my students write—type it up. And I've highlighted areas where you made comparisons, that things reminded you of other things. OK? and so I just want to know why these reminded you of these things. So I can understand it better.

12: mm-hmm
K: so we can look at the first one. You were talking about your probiscus monkey, right?
12: mm-hmm.
K: and that it had a very long and large nose and how did, why would that remind you of Pinocchio?
12: because when Pinocchio lies his nose grows and so he has a long nose

As these interviews progressed what became apparent to me was that the links were self-explanatory. This was largely shown by students' growing wonder through their facial expressions at how naïve I was to not see the obvious in their writing. Given the time frame of the analysis for this entire monograph, the formal validity test (i.e., my codings of their links) remained sealed until years later. I reviewed the transcripts from the eight interviews that had been completed, comparing the student explanations with my earlier coding. The students' explanations typically reiterated what they had said in their paper, supporting the analysis that had noted typically conceptual and sensory links. At times, additional information was included to help clarify the link while it continued to support the analysis.

Grounded Theory

While the instrumental-case study methodological lens had served the analysis well, it had become apparent that as the remaining cases were added, a grounded theory approach would help facilitate the final analysis of the data. A theory, as described by Strauss and Corbin (1998) "denotes a set of well-developed categories (e.g., themes, concepts) that are systematically interrelated through statements of relationship to form a theoretical framework that explains some relevant social, psychological, educational, nursing, or other phenomenon. The statements of relationship explain who, what, when, where, why, how, and with what consequences an event occurs" (p. 22). A grounded theory is a way of thinking, essentially a methodology. Corbin and Strauss state that in this approach it is the data that are relevant, rather than a particular case. For this study, including the detailed cases to provide the flavor of the classrooms as the context in which the links occurred seemed useful and provided a useful means to introduce the data sets. However, aspects of grounded theory analysis informed the final reporting of the data and fit well with the data analysis.

For example, drawing on the terminology of grounded theory, knowledge linking may be considered the phenomenon, it is the concept under study in the research. The categories defined in open (identify the concept and its properties, and dimensions in the data) and axial (reassembling of the data as subcategories related to categories in terms of properties and dimensions) coding included cue, trajectory

dimension, nature of the learning environment, role of the teacher, etc. Each of these were described through their properties that defined them, and also the dimensions on which they could vary. Further, some of the categories such as cues and trajectory dimensions included a number of subcategories.

As required with the constant comparative method, as new elements were identified, such as the media examples as a trajectory dimension, the entire data set was again reviewed. As the analysis continued, the phenomenon was categorized in terms of actions (in the case of knowledge links, these are various cues, the kinds, their usefulness, and the trajectory dimensions that provided the students' meaning to the link), conditions (the classroom environment in this case, including the activity, the culture including the teacher and view of authority), and the consequence (what happens post link as well as potential value that may or may not stem from particular links). While the coding for process (Strauss and Corbin 1998) seemed limited early in the analysis, it is the process itself that is the focus on the study—what is knowledge linking as a process and how it is then fostered or inhibited in classrooms. Finally, as selective coding was undertaken in the preparation of this monograph, the categories were integrated and refined. Each category group was re-read, summarized, commented on (i.e., memos), and subjected to reorganization. Through this, linkages across elements of categories (sensory cues, types of concept cues, linkage cues such as here-and-there, now-and-then) and linking of categories were integrated to tell a story of student knowledge linking that is informed by the other elements. Post-it notes became particularly useful in this venture. Further, "knowledge construction links" were renamed to be "student knowledge links", with "student knowledge linking" capturing the phenomenon as a process.

Student-identified cues remained the core story for the study. All other elements are used to provide context of what they might be like, when they might occur, the potential value of them and how best to foster useful links, and ultimately how they may be thought of as underlying an ongoing process of unlimited semiosis. As writing (Wolcott 2009) was the final method of analysis in creating the narrative, care was taken to ensure that all classes, regardless of time of participation in the study (early or late) or amount of data, were considered in the various bends in the story. The narrative in progress, itself, pointed to natural connections among the data; those were followed as a means to create a logical and cohesive narrative. As the links of these individual students were integrated to illuminate how students may link what they are learning with what they knew, operationalized as those instances where they moved from the content to something else, particular categories become more useful in the story while others fell away. Various other analyses were undertaken for particular elements of this book. For example, the further elaboration of the affect/emotion cues and also of the open-ended writing occurred as the monograph progressed. Those analyses are included in the chapters in which the findings are described.

Trustworthiness

The studies synthesized in this monograph included various techniques to foster trustworthiness of the data and the interpretation of that data. In general, data were triangulated by data source seeking whether a phenomenon stays the same "at other times, in other spaces, or as persons interact differently" (Stake 1995, p. 112). Data forms included observation, writing, and interview (different interaction), in the different classrooms (different spaces), and gathered across a classroom unit (different times). As is typical, methodological triangulation through observation, interview, writing, and document data provided a variety of means to capture thorough explanations of a particular knowledge construction link, the nature of the classroom, and the phenomenon as a whole. Investigator triangulation was used formally in analysis of the data from Mrs. Chambers, Mr. Jackson's, and Mrs. Schneider's classrooms.

Early in the data collection process for Mrs. Chambers, Mr. Jackson's, and Mrs. Schneider's classrooms, two video-recorded sessions of each classroom were reviewed by another researcher (class observations with student interviews) to ensure that appropriate students were selected for the interviews based on the observation and that students were not led to particular responses during the interview. This check also ensured that the comments that were pursued were generally clear and striking within the context of the observation. Given this positive review, I continued data collection in Mr. Ritter's and Mrs. Wilson's classrooms without this review.

All teachers were given the opportunity to review the observation data gathered in their classrooms in a member check process (Merrian and Tissell 2015). In addition to the observation transcripts, occasionally teachers were asked to clarify particular content or processes that were captured in their classrooms. Feedback from the teachers other than specifically addressing those questions was minimal. When it occurred, the feedback was typically corrections on the writing of the classroom narratives. Students were not provided transcripts of their interviews given their age and the time commitment involved.

As these data were gathered, analyzed, and synthesized I have had many opportunities for presentations, conferences proposals, and papers to be reviewed. The feedback over the years has been incredibly valuable in ascertaining the viability of the interpretations and shaping the findings.

Biases

Although I was a passive participant observer in each of the studies included in this synthesis, I felt quite involved in each classroom. Given the regularity and frequency of my visits in the classrooms, the informal interactions and interviews with the students, and various conversations with the teachers, I had a place within each

classroom. Further, as I engaged in conversations with individuals about my work and used my published articles in my classes, I developed what might be viewed as biases towards each classroom based upon my participation and involvement. As I also taught a qualitative research class during my synthesis process I was constantly reminded to acknowledge my observations and discussion of the classrooms as a potentially bias-building activity. This bias may have materialized in a number of ways. First, I was theoretically biased. My interest was not in traditional classrooms, but more contemporary classrooms. Given this bias, I have attempted to objectively present the happenings in each classroom without that lens and to make it clear in the writing what is interpretation and what is uncontestable data. Second, I developed experiential biases. For example, I was surprised at the use of the word "boring" in Mrs. Chambers' classroom by both the teacher and the students in describing learning activities, and expressed this to my colleagues. Obviously, my sensitivity to hearing this word in the classroom sharpened. However, through interactions with colleagues, I was able to understand these potential biases as aspects of broader themes in my understanding of that classroom. It also increased my awareness of how critical it was to capture as much conversation as possible in the classroom given that the conversation was what the students were exposed to as well. Finally, as I spent more time with particular teachers in the study, the rapport in our relationship became more as colleagues, discussing various issues about schooling. A change in the relationship with the students occurred as well in that as they became comfortable with me. As Ms. Smith noted about my observations in the classroom prior to data collection, the student could see me as a helper. This type of relationship seemed the norm in most of the classrooms. While this openness made data collection easier, I remained cautious, ensuring that these connections were documented and did not influence my overall interpretations.

As I conclude this elaboration of the research methods undertaken in the studies shared in this monograph, I am conscious of how, at least for me, these teachers and students who participated in these studies have taken on a type of life of their own. Although I have tried to remain closely tied to the actual data, the story reported is not about data, but about real people in real classrooms. Ironically, I have a hard time recalling the teachers', much less the students', real names. They are real, and then again, not. And, I acknowledge that my time spent in the classrooms had a vastness beyond what could be reported here. In other words, I have only provided a glimpse. Certainly, given the data set, others may come away with different insights about how these students linked what they were learning with what they knew. And certainly none of these classrooms, teachers, or students have stood still, they are merely a snapshot in time, a mere trace of the rhizome. It was a pleasure to be a thread woven in their trajectories, and a privilege to have them woven into mine.

Writing Activity

1. Write any thoughts or ideas that you have about the animals of the rain forest. You might start by writing what you remember about these animals.
2. You might want include things that the rain forest animal reminds you of. These might be things you've learned in social studies or science, things you've learned in other classes, experiences you've had outside of school, or any thoughts that you have had about anything.
3. There are many ways that you can tie together your thoughts in your writing. Here are some examples of sentences that will help you tie in your thoughts and ideas.

   - This reminds me of _____because _____
     (then write what you know about the new topic)
   - I think this is the same as _____because _____
     (then write what you know about the new topic)
   - This makes me think of _____because _____
     (then write what you know about the new topic)

4. Your new topic might lead you to another topic. Follow your lead, writing what it reminds you about and why it reminded you about it.
5. If you run out of ideas, continue with the rain forest animal and write a little more about what you remember about it.
6. Remember, this isn't like a book report. It's a writing of your thoughts and ideas, starting with the rain forest animal and expanding it with what you know about that topic *and other ideas or experiences* that it reminds you of or that you think that it relates to.
7. Here's the hard part—don't make up a story that's not true. Using the word "I" and "me" will help you do that. Writing about things you've learned and things you've done will be the easiest way.

~ ~

When you are done—answer the following questions.
Number: ____ Age: ____ Gender: boy girl
How much did you use resources for this writing activity?

____ none
____a little
____ a lot

Would you like to be interviewed about this paper? ____ yes ____ no

Writing Activity Thinking About Whales (Used in Mrs. Wilson's Year 2 Class)

Number: ____ Age: ____ Grade: ____ Gender: boy girl
Would you like to be interviewed about this paper? ____ yes ____ no

Directions

1. **Think**: Think about the whale that you've just researched. Think about important, interesting characteristics of your whale, rather than just simple things like what color it is. Maybe it had an interesting personality, habitat, or life cycle.
2. **Compare**: What comparisons could you make between your whale and other things (but not other whales) that you know about? In other words, what other animals, objects, experiences you've had, places you've been, things you're learned in school, or even people share similarities with or have interesting differences from your whale? To help you get ideas, try to think of a simile for your whale, "My whale is like ____". Then, see what else might pop into your head.
3. **List**: List four things that popped into your head while you were thinking about your whale.

   a. _____ b. _____

   c. _____ d. _____

4. **Choose**: Look at the items that you wrote in question three. Choose two of them that you think might be most helpful or interesting in understanding and remembering your whale. Circle the letters of your choices.
5. **Write**: On the attached paper, begin writing about your whale. You might start your paper with something like, "My research was about the ____ (list your whale)." Then, tell something interesting about your whale. As you continue to write, include as many ideas about the two items that you chose in question three to help describe your whale. You might want to make some comparisons by including a sentence something like, "My whale reminds me of _____ because ____" and then see where that will take you.
6. **Then**: After you have finished writing your essay about your whale and your two items, turn in your paper and get the next question from Dr. Schuh.

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K.L. Schuh, *Making Meaning by Making Connections*,
DOI 10.1007/978-94-024-0993-2