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Documentation panels: Evidence of scientific literacy in a primary multi age classroom: Teaching at the edge of magic

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DOCUMENTATION PANELS:
EVIDENCE OF SCIENTIFIC LITERACY IN A PRIMARY MULTIAGE CLASSROOM
—TEACHING AT THE EDGE OF MAGIC—

BY

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Although this is the first page in my dissertation, it is the last page I will write. Once again, I am filled with emotion and gratitude for so many people who have helped me in some way as I made this journey.

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DOCUMENTATION PANELS:
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This project is the result of a question I raised about using documentation panels in my classroom; it is teacher research. Teacher researchers participate in their own inquiries, participating as both teacher and researcher in the study. Teacher research provides practitioners a method for investigating a question or wondering that arises from the classroom. This project aims to explicate the science learning demonstrated by 5, 6, 7, and 8 year old students through the use of student created documentation panels while at the same time providing me with an insightful and critical look at my pedagogy. Within the context of my primary multi age classroom setting I investigate my use of nonfiction texts to teach emergent and early literacy skills, discuss why I encourage classroom discourse among my students, posit the need to establish criteria for completing best quality work, and argue for the inclusion of science in an integrated curriculum.

I analyze the visual and conversational texts of the documentation panels for evidence of science knowledge as noted in the National Science Standards for students in Kindergarten through grade two. I create categories connecting the visual text to the Science Standards including, picture glossaries; life cycles; simples, scale, and analytic

diagrams; various types of maps including bird's eye view and elevations. The categories created to connect the conversational text to the Science Standards include use of content vocabulary, approximations of vocabulary, discussion of scientific concepts and processes, an analysis of student generated kinesis, and examination of the narrative stories some students tell as they talk about science. Linking the documentation panels to the National Science Standards provides evidence of science knowledge in young students in this class.

INTRODUCTION

Prologue: Becoming a Teacher-Researcher

When I began this project, I was focused on looking at the documentation panels my five, six, seven, and eight year old students made about science topics. I kept looking at them but I had a lot of trouble figuring out what data the panels contained. As a practicing teacher, I knew the students liked making them and I enjoyed conversing with each student about his or her panel; and parents expressed interest and surprise upon seeing the panels and reading the transcripts during portfolio share night at school. I realized the year I decided *not* to have my students make panels that *I* looked forward to the process of creating and talking about the panels with my students; both the process and the product were compelling to me. I knew that these documentation panels were intriguing but I had no way to predict they would take me on an investigative journey into my own teaching.

I began with the concrete: I began with the panels themselves and worked toward understanding the theory and practice behind them. In an effort to make the data manageable, I divided the panels into two broad categories; the visual piece and transcripts, which later evolved into what I call the *Visual Text* and the *Conversational Text* in the dissertation. I initially worked with the visual text; it was easier for me to access and understand than reading through scores of transcripts of conversations.

Analyzing the Visual Component

As I analyzed the *Visual Text,* I examined the National Science Standards and discovered that my students really were demonstrating scientific ideas. I now had evidence that these panels were useful tools in understanding what students know about science! I discovered and drew primarily on the works of Professor Edward Tufte, a statistician from Yale, whose life's work has been about the visual display of quantitative information and Steve Moline, a writer, illustrator, and book designer whose work focuses on visual literacy. The examples and explanations I found in Tufte and Moline provided me a lens to see and understand what my students had created on their individual panels. Patterns and aggregates of examples emerged in the visual. I took the collection of elements from the panels and created the categories for the *Visual Text*, which include picture glossaries, life cycles, various diagrams (including scale diagrams), and maps (such as bird's eye views and elevations).

Analyzing the Transcripts

The *Conversational Text* took me down a different path. It was much more difficult than working on the visual text. In retrospect, I think, that was because I hadn't really thought about dialogue and talk in the classroom, so it was new territory. Once again, I turned to the National Science Standards as a framework on which to hang pieces of these conversations. Linking student use of appropriate content vocabulary and definitions, their explanations of scientific concepts and processes, and the connections they made to the standards paralleled my findings in the visual text. It was clear that making the connection between the panels and the science standards provided evidence of science knowledge, a purpose for teaching science in the elementary school, and validated my purpose in using the documentation panels as the product of a science unit.

A Shift in My Thinking

A very important shift in my thinking and in this work occurred while analyzing the transcripts of the conversations I had with students. This work became personal; I was listening to my own voice and hearing the ways I spoke to children. I heard the questions I asked and the statements I made. It was no longer simply about the data, it was personal.

I realized that there is more to any transcript than just linking it to the National Science Standards, as nice as that was. There were times in which I thought to myself that this study would have been neatly tied-up much sooner if I had simply made the connection between the visual and conversational texts and the National Science Standards and left it at that. But, I couldn't do that.

My learning about what these panels hold was in a state of disequilibrium. I had to know more. I needed to investigate gesture because some students used it as part of their explanations. I needed to confirm in my own mind that students who use only artifacts made in class for their panels are not at some disadvantage because they chose not to transmediate their learning into a new form. I wanted to validate my students' use of verbal approximations of science vocabulary. I wanted to recognize the interesting and often magical explanations that some students give for science concepts. I needed to investigate the narratives that some young learners always tell. There is so much more to the panels than my narrow view of science.

Researcher as Autobiographer

While I was analyzing the data revealed in the panels, I began to write what I think of as a parallel track to the visual and conversational texts. This parallel track was more introspective and reflective rather than data driven. Somewhere along the way, I began thinking of myself as a learner, as THE learner in this process called my dissertation. I started to think about why teaching science matters to me: why have I made time for it in a school that until this very school year made little to no mention of science at all. I realized that what I was grappling with was an ethical concern: why do I value science and why do I insist on its inclusion in my classroom?

Using the lens of introspection and reflection made this project easier in some ways because it became personal. It was also much more difficult because it was personal. I began looking at my practice with a critical eye, and that is not easy. I wrote small, autobiographical incidents that happened to me as a child, a student, and as a teacher. Those autobiographical snippets helped me explain or understand situations or reasons for doing what I do.

Teacher as Researcher

As I worked through the parallel processes of analyzing the panels and critically examining my pedagogy, I discovered that the organization of my classroom and the ways in which I establish expectations of my students play a significant role in the success my students have as members of the class.

Perhaps the most important educational discovery I made while doing this work, and the one most likely to make an impact on classroom teaching, is the inclusion and use of nonfiction texts in the primary classroom. Like every primary elementary school teacher, my main objective is to teach my students to read and write. Emergent and early literacy skills dominate my classroom as children practice everything from letter and sound recognition to developing an idea and writing a story for classroom publication. I have made a conscious decision to use nonfiction texts as often as possible as models for literacy acquisition. I use *both* fiction and nonfiction texts to teach emergent and early literacy skills, to model fluent reader behaviors and strategies, to generate discussion and questions, and in the case of nonfiction texts, to disseminate information to my students. While I wrote about the use of nonfiction texts as elemental in my classroom it wasn't until the day before I handed in this dissertation draft that I was aware of the impact nonfiction texts can have on young learners and its connection to scientific literacy. Throughout my teacher education programs and the professional workshops I attended over the years, fiction was always the exemplar for teaching reading and writing skills, particularly at the primary elementary level. Nonfiction texts were used to teach content, or 'the facts.' The realization that *scientific literacy*, as defined by the visual and conversational elements of the documentation panel, *could be more accessible to some young children* than fiction, hit me like a thunderbolt! Although, I tacitly knew that using nonfiction texts to teach emergent and early reading skills and strategies was important (and it worked), the actual realization was, for me, a paradigm shift. I was reminded of one reason why I wanted my students to create documentation panels in the first place; it was my intuitive sense that every student would be successful using the panel as a tool for demonstrating science knowledge.

My Metamorphosis

My greatest challenge, from the beginning of this doctoral program, has always been first, to recognize what I do intuitively or tacitly as a teacher; to understand the implications of those actions, articulate what I have done, reflect on it, and possibly change it for the next time. As a practitioner, there just isn't time for that, as a graduate student, there should be. This dissertation became the manifestation of that challenge. I read a lot about nature and science and science education, which I loved. I grappled with theory that I didn't understand until it made sense. I laughed often and cried a lot throughout this work and I realized that if an idea brought me a smile or a tear, it was important, and needed to be written about and perhaps, included.

One day as I was sitting in the fifth floor reading room of the university library, thinking about this work, I claimed for myself the role of teacher-researcher, a role I had resisted for a very long time. My resistance was the result of someone telling me long ago that I "could not have one foot in the classroom and one foot in doctoral work and do well with either one." For some reason, I had created a dichotomy in my head based on that comment. That significant summer day, I said to myself, 'I am a teacher. I'm a good teacher and this work is research. I *am* a teacher-researcher. Be proud of it.' It was an important moment for me as a teacher, as a graduate student, and as a human being.

Being a teacher-researcher is who I am. For me, teaching is personal. I don't aspire to be anything other than a teacher. I need to be a teacher who makes a difference within the profession and perhaps the work I have started with this dissertation will prove to be my contribution to the field of education.

Science is Creative

> If you cannot place science smack in the middle of the context of your life, how can you ever see yourself as a scientist? If you cannot associate the wonder that the natural world evokes with the excitement of science, how can you dare to ask the silent questions that follow the wondering? (Karen Gallas, 1994, p. 73)

I cannot imagine being anything other than a teacher. Teaching was not my first career choice as an undergraduate in search of a profession; it snuck up behind me and took hold. I always enjoyed being a student and I thought becoming a teacher, in some ways, seemed like a logical next step. Over two decades later, I am glad to have made that decision. The responsibility of being a teacher overwhelms me and fills me with pride, but most of all it challenges me to continue to understand new concepts and ideas and to learn new information.

I teach young children. As a primary school teacher, I am responsible for teaching children how to read and write, add and subtract, and countless other things that have become part of our daily work. My favorite subject to teach in our busy days at school is science. I have always found a way to make time for this important subject even though there has been no science curriculum in the school in which I have been teaching for the past sixteen years. Sometimes I actually teach 'science'—the facts about a topic as we know them. I am most happy, however, when I am discovering something along with my students.

Although the western notion of science is filled with facts, I have found that teaching and learning about science is not only learning the facts, but also the journey to discovering the information that leads to the facts. Scientists make predictions and hypotheses and, more often than not, those postulations do not come out the way they thought they would. But, with each failed prediction comes knowledge and a revised hypothesis. Science in the elementary school is often viewed in a 'textbook knowledge' (Cain, 2002) manner by the teacher and the students. In my experience, young children want to know about the natural world and how things work. Young learners should be actively engaged in observing the things around them and noting what happens.

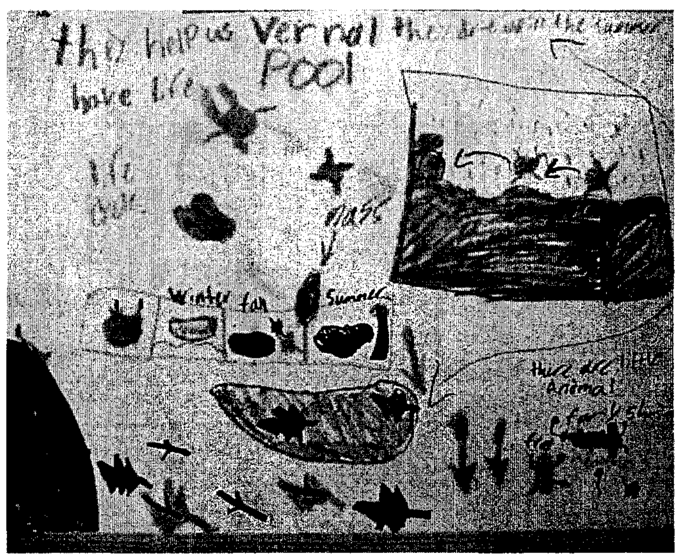
In my classroom, students learn science facts and knowledge based on discovery; in my classroom, science is a messy endeavor.

It has been important for me to think about and consider the reasons why I enjoy science education. I am a member of the science committee at school where my voice is heard and my ideas are valued as I work with like-minded educators, all of us wanting to bring science education to the students. Our work in science is overshadowed by the curricular mandates in reading, writing, and math. Current literature indicates that most primary elementary school teachers focus their attention and energy on teaching the basic and important skills of reading, writing, and math. Both science and social studies are being excluded more frequently at the elementary level (Rivken, 1997; Louv, 2005) due to the current emphasis on passing state mandated assessments that focus on math and literacy. I maintain throughout this dissertation that early literacy must include science. Science literacy is not separate from emergent and early literacy learning. Teaching reading and writing skills using both fiction and nonfiction texts, including science topics, vocabulary, concepts, and processes shifts the focus from always using fiction to the inclusion of nonfiction, a genre overlooked in most elementary schools (Duke, 2000).

My background and beliefs play a role in shaping the expectations for social and interpretive competence in the classroom, of which science learning is an essential part. I define social expectations as those expectations related to the norms and criteria established in the class at the beginning of the school year then revisited and reshaped throughout the course of the year. Interpretive expectations are those expectations relating to the reading or listening to and understanding of expository texts and to the experiences in which students participate about the science topic. The social and interpretive expectations define the manner in which the class operates and the way, as a group of people, we learn. Although it is important for me to distinguish between these expectations for the sake of clarity, the events depicted throughout this dissertation show that the social and interpretive are intertwined; indeed, they rely on each other. Nonfiction texts provide the foundation of my pedagogy, and science education is the cornerstone of my teaching practice.

Student created documentation panels are a tool that provide the data about science knowledge that I use throughout this dissertation. Documenting student learning in this manner is a concept derived from Italian primary schools and will be discussed in detail in Chapter 2. In my classroom, students use the documentation panels as a place to house artifacts that demonstrate science knowledge. The three elements of the documentation panel are the visual, conversation, and the completed panel, which consists of both the visual and conversation and the interplay between them. The creation of documentation panels is discussed in detail in chapter 3 of this dissertation.

As a classroom teacher, when I see a documentation panel for the first time, I take in the overall aesthetics of the piece: the color, style, use of space, and the special nuances that make each piece individual. I am always pleased that no two look the same,



and that once again my students have expressed themselves as individual learners, thinkers, and artists. When I look at the panels, I see complexity: I see the fine motor development in a student who did not know how to write his name in September; I see precision and detail in the bright colorful drawings and diagrams; my eye reads the narrative illustrations and the information embedded in them.

I hear the voices of my students as I review the transcripts of our conversations. I listen for my students to use vocabulary and talk about information specific to our science unit. I listen for the student to explain the main science concepts I taught, often going beyond what I taught. I listen for approximations and partial explanations. Both hold nuggets of facts that are the foundation of student knowledge, which through our conversation the student clarifies and augments her understanding.

While I have tacitly known that documentation panels are a worthwhile project for students to complete and for me to examine, looking at them through the lens of research has provided me with insight into their complexity. For the purposes of this study, I have chosen to divide the visual component from the conversation about the documentation panel. This division allows me the ability to examine, define, and discuss the discrete elements that comprise the panels. It is important to keep in mind that the documentation panel is complete only when viewed in its totality. That totality is the combination of the visual and conversational elements.

Initially, using both the visual elements and the transcripts of the conversations about the panels, I began to sort them into groups based on categories that connect with the National Science Standards (1996) such as, 'life cycles', 'cause and effect', or 'formulating questions.' I employed a recursive-generative process that enabled me to do three things. First, I was able to move between the initial categories to the data on the panels, then to research literature in the fields of art, early childhood education, literacy, and discourse, and finally, to a revision of the categories. The two major categories in this study are visual text and conversational text. There are several subordinate categories for the two major categories. While the categories and supporting student examples may appear mutually exclusive, they are not. Any particular documentation panel represents several categories simultaneously. I have isolated specific examples to illustrate and define the categories I chose to explore. Due to the complex nature of learning and demonstrating that learning, I am certain that many more categories are contained within the range of the data.

This study suggests there are multiple ways individual students can express understanding about the same science topic through the creation of documentation panels.

Biography

My childhood in the West - where geology overwhelms biology, lightly vegetated landscape commands attention, and weather is intense- surely gave me an edge.
Stephen Trimble 1994, p. 19.

I am the product of many generations of people who worked the land and lived closely with nature. I am one generation removed from people who relied on the land and its bounty for survival. Lumberjacks, farmers, cowpunchers, well diggers and the women who gardened and sewed and tended their homes; these are the people who raised me and taught me to be respectful of the earth. My childhood played out in the Rocky Mountains of Colorado, fishing for brook trout, walking lumber roads looking for animal tracks and special rocks, searching irrigation ditches and small creeks for asparagus in the spring and for berries in the fall. With my grandfather, we would bump along for hours in the back of his pickup truck over long-faded dirt roads. When we got to the end of the road, we would eat sandwiches and explore the ghost town he had discovered while scouting his next hunting trip. We would silently watch the deer outside the tent in the early morning and the bats flying around our camp at dusk. I would study the stars with my dad and memorize the shapes of constellations before we turned in for the night. Each trip into the woods would yield a treasure for my collection: a stone, feather, bone, plant, and memories of places and smells so indelible that they remain with me today. Growing up, my sense of wonder and awe with the natural world was nurtured by everyone around me, particularly by the men in my family. Although many of my childhood mentors are gone, my memories of them and the gifts they gave me remain strong. I continue to explore and appreciate the world around me but nowhere as lovingly as in the mountains of my youth.

My brothers, Matthew, an entomologist, Alex, a geologist, and Daniel, a naturalist, continue the traditions of our ancestors. I will join them at any time for any reason: sorting through a net filled with insects, a five-mile hike under the desert sun to see the fossilized remains of creatures that once lived in a prehistoric seabed, fishing in August in a small lake surrounded by snow. It makes me smile and brings joy to my soul to watch their eyes search for something I do not easily see and listen to them talk about the natural world and its endless wonders, all the while teaching me and challenging me to make connections for myself. I will go anywhere with them because I know my spirit will be renewed and my sense of wonder will be restored.

I live in a small city on the east coast now, less than a mile from the Atlantic Ocean. When I first moved to Portsmouth, New Hampshire, most things about my new surroundings were a mystery to me, and many still are. I viewed this change as an opportunity to learn about the unfamiliar aspects of New England nature. Nearly all things and ideas water-related were foreign to me; perhaps that was a determining factor in my choice of science topics to teach. After all, growing up in Colorado in the 1960s and 1970s did not lend itself to most water sports and the most likely creatures one could find there were various kinds of trout and water snails. There is quite often drought and water is revered as a commodity in the west. The amount of available water depends on the previous winter's snowfall and its use is restricted in the summer months. In the west, people talk about water in terms of the threat of forest fires, the water level in reservoirs, and the snowpack on the continental divide. They water the drought-tolerant plants in their gardens with buckets of recycled water from the morning shower. During the driest and worst years of drought, people take care of their trees, watering them before any other plants. I have seen many lawns and gardens die for lack of water, but great care is always taken with trees. The trees are essential because they provide protection from winter snows and wind, and their shade helps cool us off in the heat of the summer.

In New England, there are trees everywhere, and they do not appear to require special attention. Water abounds in New England; lakes, ponds, big rivers and tidal inlets and of course, the mighty ocean. It is even in the air. It shapes people's lives differently than in the west. Here, people go to the beach, to swim, to fish, to play in the sand and along the water's edge, sometimes they go simply to lie there and be baked by the sun. There are in-ground and above ground swimming pools for those people who do not wish to be part of the tourist crowd. Here, the tides influence when people go to the water: paddlers and sailors, fishers and diggers of clams. In my neighborhood, the grass is green and gardens are lush. Indeed, my yard requires little care.

So what is this connection between growing up in Colorado and my work as a teacher in Maine? It is rather simple: water. Many of the science units I have planned for my students have been about water, including the estuarine and vernal pool habitats, both discussed in this work as documentation panels. I need to understand water in a broader context than my previous experience allowed. As a nature enthusiast residing in unfamiliar territory, I have to learn and become familiar with my surroundings. I have to understand how things work.

This study of the science-based documentation panels my students create has been my attempt to understand how things work in my classroom: why science education is important and the ways in which my students demonstrate science knowledge.

The rigor of teacher research is evident in this study. Karen Gallas (1994) states, "teachers tell stories about their classrooms" (Gallas 1994, p. 2) and those stories can often become a point to ponder and sometimes turn into a research question. This dissertation is seasoned with my stories, stories that establish an idea, illustrate a point, and critique my practice. This story begins in a graduate classroom and moves to my elementary classroom where, one day I asked my students to make documentation panels in relation to a science unit. I wondered if my students could do it, how they would do it, and what all of us would learn from the assignment. That wondering became the source of many questions that eventually led me to this articulation of my learning.

This dissertation is my investigation and explication of some of the ways in which young students demonstrate their understandings of the natural world and science learning. I ask my students to 'be scientists' in the classroom, that is, to be observant, generate questions, and discuss hypotheses and findings about the science topics we investigate. Throughout this study, I examine my pedagogy, becoming a scientist of my own practice as I consider the information and insights apparent on the documentation panels created by my students.

This dissertation argues that students represent science knowledge in a variety of visual and conversational ways when science information is presented using practices common in early literacy instruction, including read aloud and classroom discourse. Similarities emerged as I inspected the documentation panels, and I used those similarities as themes to create categories for further investigation. There are two main features of the documentation panels: the *visual text* and the *conversational text,* each with several categories that provide us with insight into the science learning of young students. Using multiple examples of each category, I connect the category to national and local science standards and literacy practices, thus validating the significance of both the visual and conversational texts.

Professor of science education, Robert Yager (2004) states, "Science is not written, but it can be written about…[M]ost written materials offered to students in the course of science instruction are but descriptions of past science exploration." (Yager 2004, p. 95). Documentation panels, as artifacts, *are* descriptions of the past science exploration conducted by students, and the conversations about them disclose developing understanding of scientific reasoning, inquiry, and problem solving. This study reveals that students exemplify science through the visual text and discuss science through the conversational text of the documentation panels.

Outline of Chapters

Chapter 1 establishes my conceptual frame for this work as I discuss national science standards, children's loss of connection with the natural world, my own theoretical influences as a teacher for over twenty years, and results of my own teacher research. The historical context of documentation panels in Italian primary schools and their influence on American education and my teaching is discussed in Chapter 2. In Chapter 3, I focus on the classroom setting and four contributing factors for the successful completion of documentation panels. These four classroom conditions include establishing criteria in art, using expository text as read alouds, encouraging classroom discourse about science, and an integrated curriculum in which science is the critical element. Chapter 3 concludes with the methodology for this study.

In Chapter 4, I introduce and define the *visual text* of the documentation panels. The visual text is created by individual students and includes such strategies as picture glossaries, a variety of diagrams, life cycles, maps, elevations, and gesture. This chapter includes a case study of the documentation panels of one student over a three year period and an examination of three students at different grade levels (K, 1, and 2) all of whom chose to use assigned artifacts only for their panels.

In Chapter 5, I examine the transcripts of my conversations with students about their documentation panels. These *conversational texts* reveal sophisticated understandings of science vocabulary, information, and knowledge as students make connections between personal and school experiences. Chapter 5 concludes with a close examination of two transcripts that are narrative in nature rather than the more typical expository conversation between a student and me.

I propose reasons for science education at the elementary level and implications for further research in Chapter 6. I discuss the use of expository text as an appropriate and accessible genre for children reading at the emergent and early levels and ways in which teachers can use expository texts in their teaching. I explicate the broad differences between traditional models of testing and evaluating science knowledge and the science knowledge explicit on the documentation panel. Inherent in the process of creating, talking about, and examining documentation panels both students and teacher engender a high level of accountability for learning and professional practice.

CHAPTER 1

CONCEPTUAL FRAMEWORK

Habits of mind is the curiosity and creativity that the study of science can spark.
(Judy S. Richardson 2000, p. 7)

My Theoretical Grounding

In this inquiry, I examine the documentation panels my students create for evidence of science learning. I draw from theories in communication and discourse, early childhood education, science education, and literacy to describe and explicate student work. The visual representations on individual documentation panels and the discourse about them reveal sophisticated understanding of science concepts and skills by young students.

In the following section, I will define elements of science teaching and learning for use in this dissertation. I will introduce the National Science Standards and the web metaphor of systems theory.

Science: Standards and Definitions

It is curiosity, the drive to make sense out of something in our surroundings, that causes children to reach out, touch, and wonder and it is curiosity that moves scientists to do the very same thing. –(Joseph Arbruscato, 2000)

I plan and organize activities and discussions about science concepts that allow students to actively construct knowledge. I design and implement some systematic activities that teach procedures that can help inform a students understanding of science inquiry in general.

The term *scientific literacy* is defined by the National Science Education Standards (NSES 1996) as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (National Research Council [NRC], 1996, p. 22, inYager 2004, p. 99). This working definition is quite broad but continues with a subset of a dozen skills the scientifically literate person can do, including: "Ask for, find, or determine answers to questions derived from curiosity about everyday experiences. Describe, explain, and predict natural phenomena., Identify scientific issues underlying national and local decisions" etc. (NRC, 1996, p. 22). Lemke (2004) expands this definition as follows: "Scientific literacy is not just the knowledge of scientific concepts and facts; it is the ability to make meaning conjointly with verbal concepts, mathematical relationships, visual representations, and manual-technical operations." (p. 38). My study links the definitions of the NRC (1996), NSES (1996), Capra (1996), and Lemke (2004) to the work students do on their documentation panels. Students illustrate the specific terms and concepts embedded in the definition of scientific literacy through the documentation panel process.

Elements of scientific reasoning provide the framework for my lessons and over the course of the three years children are in my classroom, my students have many opportunities to practice them. The elements suitable for the students I teach include making observations, using appropriate tools, discovering relationships and patterns, distinguishing between important and unimportant information relevant to the topic, hypothesizing, predicting and confirming, and engaging in simple logic based on that information. The students learn and use vocabulary and processes specific to the unit of study and begin to make connections between what they are learning and what they already know about the natural world. I want my students to be comfortable talking about scientific ideas and to think of themselves as 'scientists' in a broad sense (Doris 1991). One of the difficult issues for science education today is "science as a subject is increasingly ignored in the primary grades (Harlan & Rivken, 2004, p. 30) as teachers and schools focus on math and literacy. Another problem facing today's students is that many children conclude that they are "not good at science" because they were never really involved with the messy surprises of science discoveries. Elementary school teachers are often uncomfortable teaching science because they don't view themselves as authorities on the subject finding "it an intimidating and difficult subject" (Gallas 1995, p. 7). Because teachers are often uncomfortable with science and with the teaching of science, students do not experience it in the classroom. This attitude reflects the authority of the Cartesian model of teaching science.

Science is an active endeavor in my primary elementary classroom consisting of hands-on activities that allow children to explore and investigate materials and ideas. I teach in Maine and use the *State of Maine Learning Results* (MSLR 1997) when planning and creating activities for my students. This document expresses what "students *should* know and *be able to do* at various checkpoints during their education" (p. ii, emphasis in the original) and is the driving force in all statewide education reforms. "Science as a continuous process of inquiry" is based on current nationwide reform efforts in science education (*Science for All Americans, Benchmarks for Scientific Literacy,* 1993, and *National Science Education Standards,* 1996) and this investigative approach meets the needs of young children as learners.

Inquiry is a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories....Students then will learn science in a way that reflects how science actually works. (National Science Education Standards 1996, p. 214)

Direct hands-on experiences that involve the learners in the process-inquiry skills by investigating physical, life, and earth/space science concepts must become the norm if we are to experience sustained reform that enable all our students to become scientifically literate. This is the goal of the reform effort. (Cain 2002, p. 5).

Traditional definitions of science include processes or the general strategies used to collect and evaluate information and a body of knowledge about specific phenomena that explain the universe. Professor Chet Raymo's explication of science expands this definition,

...fundamentally, science is a set of attitudes about the world. It is respect for the evidence of the senses: seeing things as they are and not as we wish them to be. It is conviction that the world is ruled by something more than chance and whim, and a confidence that the human mind can make some sense of nature's complexity (Raymo 2003, p. 109).

The broad objectives stated in *Benchmarks* (1993), *NSES* (1996), and *MSLR* (1997) are about scientific reasoning and processes that are relevant across all specific science units and topics. Processes are the ways in which scientists investigate and communicate about the natural world (MSLR 1997, p. 63). A scientific body of knowledge includes concepts, facts, principles, laws, and theories that are applied to a specific field of study and often generalized across fields. For the purposes of this dissertation, my use of the term "science content" refers to this body of knowledge. My use of the term 'science' reflects Raymo's notion that a definition of science includes attitudes about the world and Capra's theory of systems and the web metaphor.

Learning specific science content is important and can be fun for young children as they explore the natural world, developing attitudes toward nature as well as learning about processes, skills, and facts. Recognizing and learning about patterns (life cycles, seasons) and relationships (predator/prey, cause and effect) as well as the ability to make comparisons based on observation and prior knowledge help establish the foundation for scientific learning. Rooted in these basic scientific processes is the understanding of physics, chemistry, ecology, and biology, which students will encounter throughout their school years.

Dennis Sumara (1996) asserts that we should not think of school as a place where we create readers, but rather as a place where students learn to live lives that include reading. I agree with that idea and invite educators to expand that notion and embrace the ideal that school is a place where students learn to live lives that include an understanding of and respect for the natural world, as well.

Loss of Connection with the Natural World

Lacking direct experience with nature, children begin to associate it with fear and apocalypse, not joy and wonder. (David Sobel in Louv 2005, p.132)

As a teacher in a public school without a prescribed science curriculum, I have made a conscious choice to include science in my teaching; a conscious choice to expose my students to science. My goal as a teacher of young children is to make science exciting and appealing by involving students in the exploration of natural phenomena in interesting and exciting ways. I want to share my curiosity and joy about the natural world with my students. I hope to spark an interest in my students that leads them to feel at home in the world outdoors, with a sense of familiarity with the natural environment and its myriad elements. *Nature* is often defined in a narrow sense as the plants and animals found in the outdoor world (Terborgh, 1999). That is certainly part of it. I think of nature in a much broader sense and define it as the dynamic interconnection between and among plants, animals, and humans. This definition of nature hints at my continuing learning and understanding of environmental and ecological issues and suggests my stance as a science teacher. My students often voice concern about the impact humans have on the natural world and we engage in interesting discussions about pollution, hunting, new construction, and other human influences. Humans are affected by and affect the natural world and my students include this factor in many of our discussions. We are in fact, connected to the earth and the environment. We are part of the web of life that Chief Seattle (c.1850), Capra (1996), Nabhan and Trimble (1994), Terborgh (1999), Raymo (2003) and others talk about with passion. Professor of indigenous studies Gregory Cajete states,

> We are all related. Plants, animals, the earth, and all those forces of Nature that surround us are part of us. Only through understanding those forces can we truly be human, because humans not only live in relationship to the natural world; we are the natural world (p. 80).

While I do not disagree with Cajete's statement, I am mindful that I teach in a public school and the opinions of students and their parents can be contrary to such an extreme position. I am respectful toward differing ways of thinking as my personal stance on nature and science education informs my teaching and can influence the outcome of a discussion, activity, or science unit.

My continued need to learn more about the natural world and to share it with my students is nothing new. Physics and astronomy professor Chet Raymo, outlines the history of this sentiment in America from the Victorian Age to the present. He sums up, "The very constancy of the notion that children should be exposed to nature suggests that…[I]t is always good to know where we've come from, and if there is a single valuable lesson to be learned from nature it is that the universe is all of a piece" (p. 107). Psychiatrist Robert Coles, discusses a young girl he met in a Boston ghetto who articulated a need for a place in nature,

> …a child's earnest effort to find a place, a home of sorts that…would return her to her very humanity as the creature who looks at the world and wonders those utterly existentialist questions: Who are we? And where do we come from? And where are we headed?...all young people ache for nature as a part of their bread and water, their creaturely sustenance (Coles in Nabhan & Trimble, 1994, pp. xxii-xxiii).

Considering the changes in our modern society, I think this ideal is timely and necessary with the proliferation of asphalt, concrete, and building. Parents increasingly restrict their children's outdoor play. Such restrictions center on many reasons: the possibility of an insect bite resulting in illness such as a tick and Lyme's Disease or the latest news report of a child abduction. According to child advocacy writer Richard Louv (2005), these restrictions are based on fear;

> Fear is the most potent force that prevents parents from allowing their children the freedom they themselves enjoyed when they were young. Fear is the emotion that separates a developing child from the full, essential benefits of nature. Fear of traffic, of crime, of stranger-danger – and of nature itself p.123).

Most children do not explore their local environment. In fact, there is little opportunity for such exploration. Children ride the bus to and from school; they no longer walk. Their parents plan and organize extracurricular activities such as dance, soccer, piano lessons, and even play dates. Staying indoors to use the computer or watch a movie or favorite television show is appealing to many of today's youngsters (Louv, 2005). For most of the young children I know, exploring the natural world is limited to short periods spent in their own fenced-in yards. Naturalist Gary Paul Nabhan (2001) writes about this disconnection between children and nature,

> "[t]o counter the historic trend toward the loss of wildness where children play, it is clear that we need to find ways to let children roam beyond the pavement, to gain access to vegetation and earth that allows them to tunnel, climb, or even fall…formal playgrounds are the only outdoors that many children experience anymore…" (Nabhan in Nabhan & Trimble, 1994, p. 9).

Like Nabhan, I worry about the disconnection young children have with the natural world and the impact it may have in the future. Legendary environmentalist Rachel Carson had similar concerns half a century ago. She cared passionately about the subject of how to maintain a sense of wonder in children and adults and she believed the "war was won or lost in childhood" (Carson [1956], 1998, p. 11). She hoped her writings would inspire both children and adults to experience "the sensory and emotional in nature, and knew that if they did, they would have less appetite for those activities that threaten the living world" (Lear in Carson, 1998, p. 11). Carson contends, "[T]he lasting pleasures of contact with the natural world are not reserved for scientists but are available to anyone who will place himself under the influence of earth, sea and sky and their amazing life" (Carson 1998, p. 106). I agree with Carson and believe that having connections to the natural world is an essential piece in the puzzle that makes us human.

I believe that curiosity about the natural world is at the heart of science learning, curiosity leads to questions. Questions seek investigation and may yield answers. Inquisitive minds have sought answers to their questions about the nature of the universe and specifically, the earth for centuries. Physicist Fritjof Capra (1996) discusses systems theory or systems thinking in which the metaphor for knowledge is a web or network rather than one of a building blocks. Capra (1996) contends that no single phenomena in science is more important or fundamental than any other. Instead, everything is interconnected making it impossible to 'know science' in an objective Cartesian sense which is the paradigm built on the certainty of scientific knowledge. There are facts that I can teach my students like *there are eleven pairs of legs on a fairy shrimp* but I cannot teach the fairy shrimp's interdependence on the health of a vernal pool, I can only teach about it. My students can come to understand the web of relations between the fairy shrimp and other creatures in the ecology of the vernal pool and other animals in their specific habitats. Capra (1996) calls this 'approximate knowledge and states it is "...crucial to all of modern science...In the new paradigm it is recognized that all scientific concepts and theories are limited and approximate. Science can never provide any complete and definitive understanding." (Capra, 1996, p.41).

As a learner, I have made the shift from the objective, correct scientific knowledge of the Cartesian model to an understanding of the approximations of systems theory. Most public school teachers and science curricula are rooted in the old paradigm of the Cartesian model because that is what and how we were taught. As a teacher, it is my job to help the next generation of learners to understand and apply systems theory in science classes and perhaps throughout education.

Echoing Capra (1996), one of the aims of the American Association of the Advancement of Science (1993) is to promote a "common core of learning in science...centered on scientific literacy, not on an understanding of each of the separate disciplines" (p. xii). Scientific investigation for young children involves observation, prediction, and experimentation as they learn specific factual knowledge and as they develop approximate knowledge about concepts and processes. Science in my classroom also includes students communicating with each other about their discoveries and questions, as well as about the wonderings and uncertainties they have prior to verbalizing their questions. This reflects the generally accepted view of science within the scientific community (Yager, 2004, p. 95), the work of professional scientists may be more complex than ours, but it is based on the same tenets. Science, then, is the body of knowledge people build when they use a group of processes to make discoveries about the natural world. The term *sciencing* is found in recent literature (Cain, 2000; Arbruscato, 2000; Bredekamp & Rosengrant, 1995) about the teaching and learning of science at the elementary school level and is used to "convey the child's active involvement in learning about science…sciencing is a 'hands-on, brains-on' undertaking" (Kilmer & Hoffman 1995, p. 44).

Cycle of Learning in Science

The learning cycle procedure for teaching originated in the early 1960s by physicist Robert Karplus in response to his teaching of science to second and third graders (Marek & Cavallo, 1997). This cyclical approach to teaching has been adapted and adopted by teachers and researcher in the field of literacy (Short, Harste, & Burke, 1996), oral language development (Cambourne, 1988), and early childhood education (Bredekamp & Rosengrant, 1992). The program Karplus developed for elementary educators was "designed to be consistent with the discipline of science-that is, to match the investigative steps that scientists have used throughout history in the formulation of new inventions and theories" (Marek & Cavallo, 1997, p. 14). Karplus identified three phases for teaching and learning, 'preliminary exploration,' 'invention,' and 'discovery.' Science education programs have adopted and adapted this learning cycle, renaming the phases to reflect each program. Every learning cycle is comprised of repeating processes that lead to the construction of knowledge (Lind, 2000). The learning cycle is used as a teaching strategy as well as a procedure for developing curriculum.

The Bredekamp and Rosegrant (1992) adaptation of the learning cycle for early childhood education includes four phases; awareness, exploration, inquiry, and utilization and aligns with my use and understanding of the learning cycle. The first phase, *awareness* is one in which the teacher creates the environment, introduces new objects, events, and people, and responds with enthusiasm to student's interests and questions. During this phase in the teaching of a science unit, I highlight books about the topic and display them prominently. I say things to rouse student interest in the topic, such as, 'On Monday we will be visiting the vernal pool,' 'Don't forget to take home your mail today. There's a letter to your parents about going in to the woods,' and 'I can't wait to get out to the vernal pool, how about you?' I have learned that this phase provides a segue into the new unit.

During *exploration*, the second phase, the students are active as they explore materials, observe, make discoveries and construct their own understanding (Bredkamp & Rosegrant, 1992). I make relevant materials for exploration available to my students so they will be prepared to use them constructively during a lesson. For example, the science center contains a variety of magnifiers for children to use as they enjoy examining objects closely. When the time comes for the students to use a hand lens to observe and record those observations of a small water creature from the vernal pool, the students know how to correctly and confidently use the tool. Because exploration is critical to science discovery, I ask many open-ended questions causing students to imagine, wonder, and hypothesize. I want them to begin to figure out what they can about the materials and unit. I want them to begin to construct their own understanding of the use of scientific tools and ideas. There are few right answers during this exploration phase and I allow for a lot of constructive error. That is, learning *about* the tools, and learning to use them appropriately takes time and repeated practice. Learning how to make connections and construct knowledge takes time and repeated practice, too.

In phase three, *inquiry*, students investigate, examine, generalize, and make connections to prior learning (Bredkamp & Rosegrant, 1992). This is the phase in which I develop activities that guide and focus attention on the topic. I ask focused questions that will lead to students making connections between the new and the known. Students complete assignments, ask questions, and answer questions, both my questions and theirs, about the topic. These structured learning experiences are designed to teach students scientific facts like, *Atlantic salmon are an endangered species* or *salamanders are amphibians*. These lessons and activities are designed to teach scientific vocabulary, such as, *amphibian* or *embryo* and concepts, like *camouflage* and *endangered species*. This is the phase in which a great deal of information is in the room; it can be in the form of activities, projects, reading, writing, and speaking. Information permeates the room and questions abound. All this physical and cognitive activity leads us to the fourth phase in the learning cycle, *utilization*.

In this phase, students *utilize* their learning in different ways; they represent learning in various ways and apply that learning to new situations (Bredkamp & Rosegrant, 1992). I provide for real world application when I can and present meaningful situations in which students can use learning. This may be a research report presented to peers, parents, or another class about what was learned. In the case of the documentation panel, students apply their learning in creating and discussing the panels.

The learning cycle is not hierarchical. Learners move through the phases in the cycle as learning about a science concept develops. As a teacher of young children, I am mindful of making available to my students experiences that provide for awareness and exploration. Awareness and exploration are strands in the web of understanding that provide an anchor for more learning and complex restructuring of ideas in the inquiry and utilization phases. The basic tenet in Karplus' learning cycle model and the one I subscribe to is that "science is a quest for knowledge" (Einstein in Lind, 2000, p. 9). Knowledge about science does not develop sequentially. The process for learning science is cyclical in nature and multifaceted. Unlike a spider's web, the web of connections and understanding we create as we learn is broad and deep, making connections in any and every direction.

It has been my good fortune *not* to have a prescribed science curriculum. This allowed me the freedom to develop units and topics based on the collective interests of our classroom community (and my desire to explore and understand more about water) and to develop activities and learning situations based on the cyclical nature of learning. Curriculum guides, handed to teachers as an official document that must be followed, relegate and regulate the teaching and learning process to one of following the manual rather than the dynamic process it can become. Dewey (1956) argued that the development of curriculum could not occur without the knowledge of and involvement of students. Sumara (1996) states that curriculum is "a set of complex relations" that cannot be predetermined, sequenced, and generalized to meet the needs of students in differing learning populations. Like Sumara and others, I know that teaching is about being immersed in the cultural milieu of the classroom and has little to do with strictly following curriculum guides. He continues, "For me, curriculum was a *path laid while walking*" (p. 39, emphasis in original), a metaphor that helps me understand the differences between following the manual and using it as a touchstone. For me, science curriculum is one part a multi-dimensional weaving in which I am attaching the threads.

Theoretical Influences

My training and education to become a teacher occurred in the late 1970s and early 1980s. During this time, I was introduced to developmental theories but it was not until much later as a practitioner, that they began to make sense to me. There is no single theory that adequately encompasses my teaching or my students as learners in the classroom. Instead, several educational theorists and theories have influenced my understanding of learning as well as my pedagogy and its impact on student learning.

In the following sections, I will briefly discuss these early influences followed by a discussion of more recent influences that have helped me better understand my pedagogy and my interest in documentation panels.

John Dewey

Reading John Dewey's (1859-1952) work was difficult for me and I did not understand much of what I read as a pre-service teacher. I was influenced however, by his tenet that students should be given opportunities to think for themselves and engage in real-world, practical learning. Years later, revisiting Dewey's ideas made more sense to me. Dewey (1938) believed, as do I, that, an educative experience is based on the children's interests and grows out of their existing knowledge and experience, supports the development of new skills, and adds to the understanding of their world. Furthermore, he considered curriculum to be the material gathered, used, and constructed by students and teachers during instruction and inquiry rather than the typical body of material gathered beforehand and used in instruction (Dworkin, 1959). This is an important distinction between what I am expected to teach my students and how I would like to teach my students. On a daily basis, I must cover mandated pre-established curricula in literacy and math. However, there is no mandated science curriculum in my school. This enables me to treat the science curriculum in a Deweyan manner, creating it with my students as we learn together, engaging students in activities that are educative. The documentation panel reflects this organic curriculum and enables students to express their knowledge through investigation and construction of the panel.

Maria Montessori

The greatest sign of success for a teacher is to be able to say, "The children are now working as if I did not exist." (Maria Montessori)

Many of the revolutionary ideas of Maria Montessori (1870-1952) have influenced the way in which early childhood educators think about early childhood education today, and indeed, have become common practices. Montessori's work also "contributed to the ever-evolving practice of the Reggio [Emilia] approach" (Cadwell 1997, p. 4). She posited the creation of rich, child-centered school environments to augment impoverished home conditions. She developed the idea that children need to work with real tools and equipment which should be smaller to fit the child (Montessori 1949/1995). Montessori stressed that materials and supplies be within reach of children in order to facilitate children becoming responsible for their own learning. Teaching children the organization for the materials and supplies is essential in maintaining order, facilitating learning, and fostering independence (Montessori 1949/1995). She believed that young children learn best through sensory experiences. Consequently, she believed it was the responsibility of the teacher to provide students with varied sights, smells, sound, and textures to stimulate learning. Montessori believed that in order to teach, one needs to know all they can about their students. She believed that careful observation of students would lead the teacher to determine what children were interested in and needed to learn and that knowledge would facilitate the creation of curriculum. Montessori posited the idea that young children can and do learn independently of peers or teachers and they should be provided long uninterrupted periods of time to engage in serious, self-directed work. She also posited the concept of "sensitive periods" or critical periods in which children are particularly interested in and able to master certain tasks (Montessori 1949/1995, p. 96). The idea of an optimal time for children to learn specific things seemed to be an important piece of the teaching puzzle for me. It was always in the back of my mind. Although I disagree with Montessori's (1949) theory of genetically programmed blocks of time for learning and mastering certain tasks including locomotor skills and language acquisition, I am intrigued with the notion that periods of time or windows of optimal opportunity exist in which young children are sensitive to ideas and experiences that can shape their learning.

I can trace many of my pedagogical ideas and beliefs back to Montessori's influential work with young children. Establishing an inviting and rich classroom environment, careful observation of students, and helping students move toward independence as learners and individuals are among my strongest pedagogical practices and beliefs. Developing science curricula based on student interests and taking advantage of nature or 'the outdoor classroom' and the sensory experiences it can provide gives my students other perspectives for learning. Students may use those experiences and perspectives in the creation of or conversation about their documentation panels.

Jean Piaget

Piaget's stage theory of development was very influential during my formative years as a teacher. In his early work, Jean Piaget (1896-1980), a Swiss epistemologist, believed that children's intellectual growth is based in part on physical development and that intellectual or cognitive development passed through established stages. Piaget believed that all children pass through the same stages in the same order when developing their thinking skills (Crain, 2000). This stage theory promoted a 'building blocks' mentality about learning and teaching for me. This theory assumes, or perhaps it was my working understanding of the theory, that, once a child has passed through a stage, she is done with it and has moved on to the next as a learner. "Unfortunately, this...phase of Piaget's work has become crystallized in the minds of most Americans as *the* theory" (Gallagher & Wansart, 1991, p. 32, emphasis in the original), which leads me to believe that I was not alone in my limited understanding of Piaget's work.

As I began teaching, I assumed that my young students fell into Piaget's preoperational and concrete operational stages of development. In many instances, this was true. However, I realized over several time as a practitioner, when a student had no prior experience with a particular tool or manipulative or idea, he automatically 'went back' to the sensorimotor stage (Piaget in Crain, 2000) in which he needed to create a sensory experience. These students needed to explore the new manipulative and make discoveries about it before they would be able to use it in the fashion I wanted them to. I began to understand the importance of 'playing with,' exploring, and using materials before expecting students to use a particular material in an assignment. I began to understand that children are active participants in their learning. This practical knowledge led me to question that learning occurs in the invariant sequence Piaget posits. I began to think about learning as cyclical and recursive in nature rather than what I had understood about Piaget's stage theory.

Years later, as a graduate student I discovered that there was far more to Piaget's work than his early developmental stage theory. I was pleased to discover that Piaget emphasized that young learners are mentally and physically active and that "knowledge growth is described by Piaget in terms of the dynamic processes of assimilation, accommodation, and equilibration, and the construction and internalizations of action schemas" (Phillips, 1995, p. 9).

According to Piaget, assimilation is the process in which a student takes an experience or piece of information and puts it into her existing knowledge structure. Accommodation occurs when it is necessary for a learner to reconfigure her existing knowledge in order to assimilate the new information. Equilibration then, is the balance between accommodation and assimilation. When equilibration has been established, a student's "understanding usually moves to a higher plane, a higher level of insight. It often becomes more abstract as well" (Byrnes, 2001, pp. 16-17). Piaget (1952) "wrote that the mind's tendency to be adaptive is embodied in the form of equilibration" (Byrnes, 2001, p. 20). In Piaget's theory, equilibrium is dynamic, always in the state of reconstructing or newly constructing understanding. This theory of equilibrium or balance naturally points toward self-regulation or what Piaget called auto-regulation (1952).

According to Piaget, children will progress as thinkers and learners when they have prior experiences that can serve as the foundation for future ideas, new experiences that contradict their current understandings, and alternative ideas that can use to achieve balance.

Lev Vygotsky

The first time I encountered Vygotsky's work I was in graduate school and I realized what had been missing from my theoretical foundation was the element of social learning that occurred in my classroom.

Lev Vygotsky (1978) believed that not only is the person active in his or her learning, but that the social and cultural systems in place along with their historical context contribute to the learning process. These elements cannot be separated from each other. Children construct meaning through a variety of experiences that work together in the formation of new learning. I take into consideration the social elements of the classroom and what role they play in the learning process. This reflects Vygotsky's work in which both the learner and the environment are active. Because I value and respect Vygotsky's tenet that people are products of their social and cultural worlds, I believe that the social and cultural context of the classroom influences learning and informs teaching in specific ways.

One of the most influential aspects of Vygotsky's learning theory is the zone of proximal development. The zone of proximal development is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). I think of the zone of proximal development as a window of opportunity that when taken, yields changes in learning.

Scaffolding. Scaffolding is the temporary support and gradual withdrawal of that support that teachers create to help children extend current skills and knowledge to a higher level of competence. This metaphor was not originally used by Vygotsky, "[s]ome of Vygotsky's followers have used the notion of scaffolding to describe how teachers and more capable peers lend a hand to students to help them advance to the next level of performance" (Byrnes, 2001, p. 36). The term scaffold and the scaffolding metaphor have become useful tools in understanding Vygotsky's zone of proximal development. Structured learning tasks provide students with clues and directives that guide the learner in a learning task (Dixon-Kraus, 1996). "Scaffolding does not mean simplifying the task during the learning event. Instead the task remains constant while the teacher provides varying degrees of support according to how well the children are doing on the task" (Dorn & Soffo,s 2001, p. 8). My observations and prior knowledge about each student provide the foundation for individual scaffolding events in my classroom.

Discourse between students and the teacher and among students can act as a scaffold for learning. The structured discussions of the *Reciprocal Teaching* method that include the comprehension monitoring strategies of questioning, clarifying, summarizing, and predicting provide teachers with a format for scaffolding reading comprehension for members of a group (Cazden, 2001). In his discussion of teacher scaffolding during discourse, Searle (1995) cautions teachers to "honor the original intentions" (p. 186) of the student. He asks, "Whose intentions are being honored?" (p. 187) as he cites examples of student experiences that were molded into what the teacher believe to be relevant.

Due to the age range and ability levels of the students in my multi age class, it is critical that I differentiate instruction and provide support for all students in all curricular areas, regardless of their places on the continua of learning. Most of the scaffolding takes place throughout the learning phase and activities in the science unit. In relation to documentation panels, scaffolded learning is implicit in the final panel; that it to say, what a student learned about the topic is evident on the panel. However, during our conversations about the panels, scaffolding *during the conversation* often takes place. The examples from the transcriptions of some of these conversations in Chapter 5 demonstrate the teacher (me) providing verbal support or verbal scaffolds for students.

<u>Independence in Learning</u>. Independent learning and self-regulation is embedded and implicit in both Vygotsky's (1978) zone of proximal development and Piaget's (1952) concept of equilibration as being a critical factor for learning.

Definitions of self-regulation vary and are grounded in different theoretical constructs in which "most [early theories] assume that very young children cannot self-regulate during learning in any formal way. Although both cognitive constructivists and Vygotskians assume that most children develop a capacity to self-regulate during the elementary school years" (Zimmerman & Schunk, 1989, p. 5). Bodrova and Leong (1996) argue that "self-regulation begins to emerge in first and second grade students as they begin to make the transition from being regulated by adults to being self-regulated" (p. 78). With student input, I establish classroom situations and tasks that assist young children as they learn, helping them to become independent learners. My use of the term 'independent learner' does not mean that a student is isolated or engaged in asocial learning, but rather, it is a form of socially responsible learning in which students are aware of themselves, others, and the task, acting within the context of the group or class to complete work and interact positively with others.

One of my main goals as a teacher is to develop students with the ability to guide and monitor their own learning for different purposes using a variety of tools. I want students to be able to use the knowledge they have acquired during assisted or scaffolded activities in independent situations. I want my students to learn *how* to learn and be *aware* of their learning. I know that not every student will achieve these goals by the time they leave my classroom. Some will. Everyone else will be moving along the continuum of learning toward those goals.

Creating a documentation panel is for each child an independent task based on myriad interactions with other students, with me, and with relevant objects. According to Paris and Byrnes (1989) "self-regulated learning [includes] identifying a goal, making a plan, integrating information, and evaluating the outcome" (p. 172). Although *I* assign the task of creating the documentation panel, each student must understand the task and identify the purpose; demonstrating what he knows about the topic. The student then makes a plan, integrates all the information learned, and evaluates the final visual product, thus creating the documentation panel.

According to Vygotsky (1978), self-regulation is one of the components of higher order thinking as is the use of symbols or signs, including language, to mediate the cognitive activity. The theory of transmediation (Siegel, 1995) helps explain how sign systems can mediate learning.

Transmediation. Between completing my studies as a graduate student and enrolling as a doctoral student, I discovered the concept of transmediation. Simply stated, transmediation is "the translation of content from one sign system into another" (Suhor in Siegel, 1995, p. 11). Transmediation draws on Charles Peirce's (1839-1914) work with semiotic theory that deals with signs and symbols. Peirce suggests that understanding the meaning of signs does not mean substituting one idea or sign for another but rather, it involves an expansion of meaning that is mediated (Siegel, 1995).

Transmediation involves taking what you know in one sign system and "recasting" it or expressing it in another (Berghoff, Egawa, Harste, & Hoonan, 2000; Whitin, 2005). Different types of sign systems include language, math drama, art of all kinds, and music among others and each carries its own unique and nonredundant potential (Whitin, 2005). Visual symbols and other sign systems convey meaning through "the whole, through relations with the total structure" (Langer in Whitin, 2005, p.367) rather than through the discourse structure of language (Siegel, 1995; Whitin, 2005). These sign systems help people make sense of experience. Creating a visual representation is a generative process in which learners must invent the connections between ideas and across two sign systems or modes of representation; making connections and expressions in other sign systems is transmediational.

Berghoff et. al. (2000) discuss the use of *sketch to stretch*, a literacy activity that involves reading and then sketching or drawing a response, as an act of transmediation. Students read a passage silently then draw an interpretation and finally, explain their drawings to a peer or group. Moving between the written word, artwork, and language 'recasts' knowledge into other sign systems and mediates understanding. In her study of seventh grade students' use of interpretive sketches in response to literature, Whitin (2005) discovered "What stood out during data analysis was the talk that surrounded these visuals. It was regularly through conversations that the students (and their teacher) assumed fresh perspectives on the literature, expanded and revised their interpretations, and revisited the written text with new insights" (p. 370).

The act of transmediation encourages critical thinking because each sign system is unique and offers a particular perspective of the world whereby there are generally no direct equivalencies (Berghoff, et al., 2000). "The process of translating meanings from one sign system (such as language) into another (such as pictorial representation)… promote[s] the kind of thinking that goes beyond the display of received meanings to the invention of new connections and meanings" (Siegel, 1995, p. 4). Creating a visual representation of science learning generates thought because there is no one to one correspondence between the documentation panel and the science learning referent (Whitin, 2005).

The symbolic representation of thinking in the creation of the documentation panel is transmediational. Students recast sensory experiences, classroom assignments, class discussions, information acquired through read alouds, and their own life experiences as they create their panels. "Learners must invent a connection between the two sign systems as it does not exist a priori" (Siegel, 1995, p. 2), that connection results in mediated meaning. When the student talks to me about her panel, another act of transmediation occurs. Using language (talk) to explicate the visual representations extends the visual and the students thinking about it. If, as Siegel suggests, "language nearly always accompanies meanings constructed through alternative modes" (p. 12) then one must agree with Vygotsky's premise that language is the single most powerful sign system and the 'tool of tools' (Vygotsky, 1978).

Many theorists and researchers argue that transmediation is at the core of literacy (Siegel, 1995; Short, et. Al, 1996; Whitin, 2005). I argue that transmediation is also at the core of science learning and can be observed and discovered through the examination of documentation panels.

Teacher Research

"Teachers themselves must know what it means to be engaged in a particular practice before they can teach it...being able to engage learners in disciplined study demands a well developed sense of what is involved in such engagements." (Davis, Sumara, and Luce-Kapler 2000, p.94)

I am a teacher. I work with elementary aged students. I have developed as a teacher over the course of time. Twenty-one years in the classroom and working in public schools has had an effect on me, or rather, many effects. I have attended more professional workshops and seminars than I can remember. Some of them gave me ideas to try with my students, generally activities or management tips. Others gave me insight into professional issues and the politics of education. Many were a waste of my time. When I enrolled in graduate courses, I was, for the first time, encouraged to talk about the complex structure of the elementary classroom and my role in it. I learned about theories that support and explain the multifaceted aspects of school and I began to question what I was doing and why. I was challenged by professors and colleagues to consider my own pedagogy and philosophical beliefs. My questions, uncertainty, and disequilibrium caused my to realize that teaching is not something to master. I came to realize and understand that teaching is not a routine task. It is an intellectual pursuit which assumes dynamic change over time (Dewey, 1933). This study is grounded in the tradition of teacher research.

I am a teacher struggling to make sense of my teaching. This dissertation is an inquiry into my pedagogy and into the practice of student created documentation panels. As the title suggests, this research contains my reflections and understandings about science education and science learning in my elementary classroom. And it is more than that. This work is about me as a teacher: the decisions I make, the community I establish, and the interactions I have with my young learners. This inquiry as a teacher researcher forces me to reflect on the experiences that surround documentation panels in order to understand their purpose, to understand my teaching and to make informed decisions about my practice.

Professor Paula Salvio of the University of New Hampshire introduced me to the concept of documentation panels several years ago. I was particularly interested in her discussion of dynamic assessment and the possibility that active involvement by both student and teacher in the assessment process can result in a more accurate picture of a student's understanding and knowledge. One of the class assignments was to create a documentation panel as a teacher about my learning throughout the course. The process of creating the panel was stimulating and creative and provided me with an informative space to demonstrate my knowledge. This process was compelling, so I asked my five, six, seven, and eight-year old students to follow a similar process in the classroom to see what would happen. My curiosity and interest in asking my students to create documentation panels at the end of a unit of study was based on my 'teacher's intuition' or tacit knowledge (Schon, 1983) that the making of these panels would be an educative experience for students. My exploration of teaching and learning has shifted my consciousness about teacher research to the foreground and has legitimized my questions about education. As a teacher, I want my students to be successful in the school environment. As a learner, I want to understand how my decisions and choices affect their learning. Examining my pedagogy requires me to ask and seek understanding about questions that are meaningful to me about what happens in my classroom. These "real questions" (Brady & Jacobs, 1994) are based on my experiences as a human being, as a learner, and as a teacher. My simplistic question about documentation panels has generated countless questions for me. This inquiry started as a quest for meaning of the extraordinary and varied ways that children can express learning of science concepts; my understanding of theory and learning coupled with the examination of these panels has made for a fascinating adventure into learning and teaching.

Teaching as Tacit Action

As a teacher with many years of classroom experience, I employ both tacit and reflective action when I teach. According to professor of education Donald Schon (1983), we bring our tacit or everyday know-how to situations; we know how to carry out particular actions spontaneously, and we do not have to think about them. In my case, these tacit actions are the result of hundreds or thousands of decisions made over time, culminating in a body of tacit knowledge. I carry my tacit knowledge about working and dealing with young children with me and employ that knowledge continuously throughout my teaching day.

Although I treat my five to eight year old students as human beings first and foremost, that is to say I do not condescend and treat them like "little kids" I know tacitly that people of their age have particular needs that must be recognized and nurtured. I encourage students with smiles, goofy faces, and high-fives. I give and receive hugs. I wipe tears and noses. I attend to skinned knees and hurt feelings. I treat my students with respect. I am aware of learning some of these actions in the classroom. Others I probably learned simply by being the oldest of six children. Regardless of how or when I learned about the nuances of working with young children, I am now unaware of doing them: my actions are spontaneous. They have become part of my tacit knowledge. Schon (1983) calls this "knowing-in-action, the characteristic mode of ordinary practical knowledge" (p. 54).

Of course, not everything I do in the classroom stems from tacit knowledge. A great deal of what I do requires thought, planning, action, and reflection. Well-planned lessons often require adjustments or changes, sometimes in midstream, in order to make learning more accessible or more challenging for students. Schon (1983) calls this "reflecting-in-action" (p. 54) and claims that this process often happens in the middle of a performance. Although Schon discusses the reflecting of athletes and musicians as "having a feel for" or "finding the groove" in their respective disciplines, I believe teaching calls for reflection-in-action, as well. I reflect on my teaching: *on* my own actions including the plans I make and lessons I teach. I am also reflective *in* action, to any adjustments that need to be made for individual students.

> When teaching goes on in face-to-face interactions with students, the opportunity for artistry expands enormously. No one can ever prescribe successfully all the twists and turns to be taken as the classroom teacher uses judgment, sudden insight, sensitivity, and agility to promote learning (Gage 1978).

My reflection-in-action is a key element in the success my students have as learners in the classroom and in their discussions of their documentation panels. My analysis of student transcripts in Chapters 4 and 5 illuminates this reflection-in-action as part of my tacit knowledge of young students. Making adjustments during conversations with individual students in relation to their documentation panels has become tacit in my practice. In fact, my interest in having my students create documentation panels was in the beginning, a tacit notion that I put into action.

I allow my students, with guidance, to determine the course of our science inquiries based on their questions and interests. The criteria Dewey (1938) sets forth for educative experiences influences my attempts to plan a purposeful science curriculum based on knowing my students, understanding the social nature of learning, developing new skills, helping children to better understand their world, and prepare them to live more fully. Creating science curricula in response to my students strikes me as being one of the most professionally responsible things I do.

CHAPTER 2

HISTORICAL CONTEXT OF DOCUMENTATION PANELS

Documentation is the visible trace of the process that children and teachers engage in during their investigations together. (Fraser and Gestwicki 2002, p.129)

This inquiry considers the completed documentation panels created once each school year for the past few years by the five, six, seven, and eight-year-old students in my class. The panels are an assigned project based on individual student learning following a science unit. These documentation panels are based on those made by the teachers in Reggio Emilia, Italy. While there are some common elements between the two types of panels, the creation and purpose of them differ significantly.

Today, there are many excellent early childhood programs throughout Italy; however, the Emilia Romagna area including the northern city of Reggio Emilia remains noteworthy. Community support for families with young children is a traditional stance in Reggio Emilia and one that expands the Italian cultural view that children are the collective responsibility of the state. The local school committee, or *La Consulta*, comprised of citizen membership, significantly influences local government policy (New 1993). Parents are important members of the school community, "expected to participate in discussions about school policy, child development concerns, and curriculum planning and evaluation" (New, 1993 p. 2). Reggio Emilia is an affluent community, committing twelve per cent of the town budget to providing childcare to children six years and under.

Today, nearly half of the city's young children attend one of the twenty-two preprimary schools or fourteen infant-toddler centers, all municipally sponsored (New, 1993).

History

Documentation panels have a long historical tradition founded in the primary schools in Reggio Emilia, Italy (Edwards, Gandini & Forman 1996, Cadwell 2003). Preprimary schools serving children three to six years old existed in northern Italy, including the Reggio Emilia area, as early as 1820, and later, Foebel's Kindergarten model became influential after 1867 (Edwards, Gandini & Foreman, 1996). By the early 1900s, municipal funding supported these institutions and a national law established a training school for teachers of young children (Edwards, Gandini, & Foreman, 1996). Educational initiatives following World War II gave rise to the parent-run schools that evolved into the Reggio Emilia preschools of today (Cadwell, 2003). "The experience of the schools in Reggio is rooted in the reality of that particular city" (Fraser & Gestwicki 2002, p. 7) as the people of that community joined together using bricks from the bombed-out houses and money from the sale of army trucks and a tank to build a school for their children in one of the first acts of healing at the end of the war in 1945. This act was revolutionary:

> ...[That] the idea of building a school would even occur to ordinary people, women, laborers, workers, farmers...that these same people, with no money, no technical assistance, authorization or committees, no school inspectors or party leaders, were working side by side, brick by brick to construct the building... turned logic and prejudice, the old rules of pedagogy and of culture upside down. It set everything back to square one, and opened up completely new horizons. (Malaguzzi in Fraser & Gestwicki 2002, p. 7).

I am impressed with the courage required to perform this act and, particularly, the hope it inspired in the people of Reggio Emilia following the end of World War II.

The School

The role of the physical environment is crucial to Reggio's early childhood program and is often referred to as 'the third teacher' (see Edwards et al. 1993; New 1993; Cadwell 1997, 2003; Fu, et al. 2002; Fraser et al., 2002 for detailed discriptions). Careful attention is paid to creating a welcoming atmosphere filled with student work in the form of documentation. Documentation can take any form and communicates the "careful consideration and attention given to the presentation of the thinking of the children and the adults who work with them" (Cadwell 1997, p. 6). The school environment reflects both the ancient and modern architectural and artistic beauty of the city, and art becomes "a natural vehicle in educational approaches for helping children explore and solve problems" (Edwards & Springate 1995, p. 1). Another element of the environment is the organization of materials and supplies, often "arranged to draw attention to their aesthetic features" (New 1993, p. 3). This attention to detail in the form of the arts encourages children to explore and express their understanding through one of many symbolic languages, including drawing, dramatic play, writing, and sculpture. These symbolic expressions are known as 'the hundred languages' of children (Edwards et al. 1993).

Each school housing the early childhood programs in Reggio Emilia is staffed with two teachers per classroom and one *atelierista*, a teacher trained specifically in the arts who works with teachers in developing curriculum and documentation. Curriculum is continuously developed in response to the spontaneous questions and explorations of the children: "teacher autonomy is evident in the absence of teacher manuals, curriculum guides, or achievement tests…[and teachers] place a high value on their ability to improvise and respond to children's predisposition to enjoy the unexpected" (New 1993, p. 4). Teachers share responsibilities in the classroom so that one can attend to instruction while the other observes, take notes, and records conversations among students. These anecdotal notes are shared and discussed with other teachers, the *atelierista,* and parents, as they plan curriculum. Teachers from different schools often work together to explore ways of expanding the spontaneous activities of children. Curriculum planning and implementation is open-ended and includes long-term projects based on child initiated and teacher directed activities. Teachers facilitate children's work and encourage revision of artwork and ideas, allowing students to repeat activities and modify work as a means for children to understanding better the topic and for teachers to understand better children's learning. (New 1993; Fraser & Gestwicki, 2002; Fu, Stremmel, & Hill 2002).

Four distinguishing features of the schools in Reggio Emilia include the *atelier* (studio or workshop) and *atelierista* (a curriculum specialist with art training and a member of the teaching team), the involvement and participation of the community, and the commitment to research, experimentation, communication, and documentation (Cadwell 1997). In Reggio Emilia, documentation focuses intensively on children's experiences, thoughts and ideas in the course of their work.

Documentation

> Documentation does not refer just to creating a final report or collecting documents that help to remember or evaluate learning activities. Documentation is a vital part of the...complex web of hypothesis, observations, predictions, interpretations, planning, and explorations... There is a sense that it is an open and living system, a basic daily action of communication...completely integrated into the everyday work of the classroom (Fraser & Gestwicki, 2002, p. 129).

Documentation is ongoing and done by teachers and the *atelierista*. Teachers may gather and use student artifacts along with their observations, queries, and journal entries in the creation of the documentation. Giudici, Rinaldi, and Krechevsky (2001) list five features essential to the practice of documentation in the Reggio schools. Documentation involves a specific question that guides the process, often with an epistemological focus. Students may learn about the culture of the area by repeated visits to a local vineyard over the course of several months. Through their active involvement and interactions with farmers, the students learn how grapes grow and how to make wine. The epistemological focus is on teaching students about their immediate surroundings and their cultural heritage through experience. Documentation involves collectively analyzing, interpreting and evaluating individual and group observations. The teachers in Reggio Emilia collaborate as they continuously develop and modify the curriculum to meet the needs and interests of their students. Interpretation of data is strengthened by the multiple perspectives of several educators. Documentation in Reggio Emilia also makes use of multiple languages or the different ways of representing and expressing thinking in various media and symbol systems. This is based on the notion that children have a hundred languages in addition to spoken and written words, in which they can express themselves. Attention to many languages expressed with a variety of materials and media is considered essential, making it possible for children to fully represent their ideas and develop their thinking. Documentation makes learning visible, not private. It becomes public when it is shared with children, parents, and teachers. Finally, documentation is not only retrospective, it is also prospective, it shapes the design of future contexts for learning. Documentation takes on many forms including panels, and can be created in many media "depending on the topic and age of children, [it] may range from a simple photograph with an explanation and, perhaps, an example of a child's work, to a series of panels that illustrate the process followed in a lengthy project" (Fraser & Gestwicki 2002, p. 133).

Teachers document and display children's work with great care and attention. Any of the following may be included in the documentation: samples of child work at different stages of completion; comments written by the teacher, other adults working in the school and parents; transcripts of student conversations, comments, and explanations about the activity, transcriptions of tape recordings, observational records, and photographs. These teacher-created documentations are on public display in the classrooms and hallways of the school (Katz & Chard 1996).

Theoretical Influences

The cornerstone of the Reggio Emilia philosophy is the strong, competent, rich image of the child. Many theoretical perspectives work together to create the educational philosophy of the Reggio approach, including the works of Piaget, Vygotsky, and Dewey. According to the philosophical leader of the the Reggio approach, Loris Malaguzzi, "Here all theorists are put together in an unusual way…[by] combining pragmatic philosophy, new psychological knowledge, and –on the teaching side- mastery of content with inquiring, creative experiences for children" (Fraser & Gestwicki 2002, p. 9).

The work of American pragmatist John Dewey (1859-1952) influenced the philosophy of the schools in Reggio Emilia through his ideas of a child-centered curriculum in which teachers planned their program based on children's interests and, at the same time, were responsible for the inclusion of traditional subject matter in school experiences. Dewey believed that if teachers gave children the freedom to construct knowledge from their own investigations, they would develop the inner motivation to learn. Dewey's work was the beginning of the project approach to education for many early childhood programs, including Reggio (Fraser & Gestwicki 2002).

The educators in Reggio Emilia agree with Jean Piaget's (1896-1980) image of the active, self-motivated child. They questioned his early work about progression through the four developmental stages and disagreed with Piaget's notion of the egocentric child who constructs knowledge in isolation from the social group and without the support of adults. However, Piaget's process of learning within the developmental stages is integral to the Reggio philosophy (Edwards, Gandini & Foreman 1996). The three-part process of assimilation, accommodation, and equilibration creates a dynamic spiral of learning that occurs throughout development and is experienced differently as children become more experienced (Crain, 2000). Piaget's work emphasizes the importance of sensory experiences and concrete learning activities for young children.

Lev Vygotsky's (1896-1934) work influenced the philosophy of Reggio through his inclusion of the social context in learning (Edwards, Gandini, & Foreman 1996). Vygotsky posits that children actively construct knowledge and learning is advanced when children are able to interact with others who can and do assist and support them in the learning process. Vygotsky identified language as central to intellectual development because through the use of language the higher mental functions of focused attention, deliberate memory, and symbolic thought are transmitted. Vygotsky's 'zone of proximal development' is another critical element in the teaching in the Reggio schools. The Reggio approach emphasizes strong values placed on relationships as essential aspects in the construction of learning. Vygotsky's zone of proximal development is integral to the social constructivist nature of the schools in Reggio Emilia.

Transferring the Reggio Emilia Approach to the United States

"I think that it's a mistake to take any school approach and assume, like a flower, that you can take it from one soil and put it into another one. That never works. This doesn't mean at all that Americans can't learn a tremendous amount from it, but we have to reinvent it." (Howard Gardner in Fraser and Gestwicki 2002, p. 6)

The Reggio model has been employed in some American schools (Moran 1998, New 1992, Cadwell 2003, Fraser & Gestwicki 2002). The schools and teachers who have adopted the Reggio approach in the United States have generally been half-day and full-day childcare and preschool programs [North Carolina, St. Louis, Seattle] working with children younger than public school age. Reggio practices and philosophy have taken root in some university children's centers [University of Vermont, University of Massachusetts at Amhearst], lab schools [Virginia Tech], and teacher education programs [University of Vermont] (Fraser & Gestwicki 2002). For many years, the schools in Reggio Emilia, Italy have been visited and observed by practitioners and researchers in the field of education. The results have yielded many research articles, chapters, and books, including works by individual teachers and researchers (Cadwell 1997, 2003; Fraser & Gestwicki 2002; Helm, Beneke & Steinheimer 1998; New, 1991) describing their experiences while visiting and observing the teaching and learning conditions present in the Reggio Emilia schools. Some of these teacher researchers have implemented elements of the Reggio approach in schools in the United States and subsequently written about those experiences (see Cadwell 1997, 2003; Fraser & Gestwicki, 2002).

Another notable study was conducted by Project Zero, an educational research group at Harvard Graduate School of Education and the Reggio Emilia research team, Reggio Children. This joint effort focused on

> multiple intelligences, new forms of assessment, [and] education for understanding...the extensive documentation of student learning that is integral to the 'Reggio project' constitutes an exciting form of assessment, whose potential needs to be demonstrated to the rest of the world (Gardner in Guidici, Rinaldi,& Krechevsky, 2001, p. 27).

As these educational researchers worked to understand and articulate the unique elements of the 'Reggio approach' and render them visible for other teachers, they discovered some important distinctions. First, in contrast to theoretical claims or conceptual analysis "what is special about Reggio has grown out of promising practices that have been worked out over the years" (Guidici et al. 2001, p. 338). Another distinction is that learning and documentation in Reggio relies on visual and graphic representation of learning rather than on the heavily favored linguistic approach in American schools.

The most difficult distinction to articulate is one of conceptualizing the complexity of the Reggio approach.

> Reggio educators are more comfortable approaching their own creation in a holistic spirit. They stress the interconnection-indeed the inseparability -of teaching, learning, documentation, assessment, individual and group learning, and many other terms and practices, and they are equivalently suspicious of efforts to distinguish (they would probably say, too sharply) among these various elements (Guidici, et al. 2001, p. 338).

This holistic approach to understanding contrasts sharply from the typical notion of making breaking an idea into parts, each with its own definition and interpretation. Howard Gardner suggests, "Like many other smoothly operative but deeply introspective entities, Reggio is well guarded and not readily accessible to outsiders." (Gardner in Guidici, et al, 2001, p. 339). Since being introduced to the Reggio approach many years ago, I realize that it is my need to make connections and make sense of learning and teaching that causes me to return to the elements of the Reggio approach as I refine my pedagogy. There remain inarticulate yet alluring questions

Using Parts of the Reggio Approach in My Classroom

My research points to fundamental differences between the documentation panels from Reggio Emilia, Italy, and Wells, Maine. Those differences are twofold: *who* creates the panels and *how* they are used as an educative tool. In the primary schools in Reggio Emilia there is no established curriculum. In Reggio Emilia, the teachers examine the work the students complete and use it as the basis for the documentation panel, which in turn informs their pedagogy and assists them in developing and extending the curriculum. Documentation becomes a means for teachers to share the educational experiences of children with their parents and the community (Edwards, Gandini, & Forman 1996; Cadwell, 2003).

In my classroom, my students create individual documentation panels based on a unit of study in the science curriculum; the panel acts as a tool to assist the student rather than the teacher as she expresses what she has learned about the topic. My students may use any original artwork or completed artifacts from class study on the panel; this represents student choice rather than teacher choice. This difference is significant in terms of the documentation panel.

CHAPTER 3

STUDENT CREATED DOCUMENTATION PANELS

My desire to meet the varied needs of my students caused me to consider documentation panels as a tool to use in the classroom. Documentation panels would provide students with a way to demonstrate their learning and for me to examine my beliefs about young students as science learners.

The students in my primary Multi Age classroom are five, six, seven, and eight years old; many of them are not yet able to read and others are at an emergent or early reading level, so using a textbook to learn about science is inappropriate and ineffective. I employ the literacy instruction practices of read aloud and oral language development with the whole class and small groups. I read aloud relevant informational texts and we discuss them; this provides the students a way to utilize expository texts as a tool for gaining information. The talk surrounding each book is extremely important, as well; it allows the students an opportunity to ask questions, comment on observations, and make connections between the information presented in the book and what they already know. I design learning activities to maximize student discovery and assist them in making connections between and among ideas.

Making Documentation Panels

Throughout the course of the science unit, the students save all of their work pertaining to the unit in a collection folder. The science unit is interdisciplinary and the type of work students complete during the unit is varied and may include student writing such as drawings, poetry, lists of facts or questions, stories and expository pieces; various forms of artwork or photo representations of large or three-dimensional pieces; math activities often include measurement and numeracy skills. Artifacts focused on reading may include a literature response, summary of expository or narrative texts, questions generated from the reading or specific skill work based on either a book read aloud by me or by the student. In short, between the students and me, we collect and save everything. I make a conscious choice to integrate subject matter from across the curriculum; it helps students make connections and develop their understanding of the natural world. It is also easier to teach connected lessons than pigeonholing curricula into specifically designated times of the day. Quite honestly, if I taught each discipline in isolation there would not be enough time in the day for science. Furthermore, Nel Noddings, points to the dilemma of creating meaning.

> We rob study of its richness when we insist on rigid boundaries between subject matters, and the traditional disciplinary organization makes learning fragmentary and –I dare say – boring and unnecessarily separated from the central issues of life…The attempt to confine all topics to their proper disciplines works against the kind of understanding human beings long for – understanding with meaning for their personal lives (Noddings 1993, p. 8).

At the end of the unit, I give each student their collection of work generated during the study and ask them to create a documentation panel about their learning. Each student uses large poster board as the foundation for the panel, sometimes taping two or three pieces together, creating a larger space. My directions for completing this task are open ended: I ask each student to look through his or her collection and, using the poster board and any artifacts he or she wishes, represent or show learning. They may choose or not choose any artifact; it is up to the individual student to evaluate his collection and decide what best represents his understanding of the science concept. Some students choose to use only already completed artifacts, those worked on during the course of the unit, in their documentation panels (see 'use of assigned artifacts only' section, in Chapter 4) . Many students choose to incorporate completed artifacts with new drawings made specifically for the documentation panel, while others choose to use none of their artifacts and instead generate completely new pieces for the panel. The visual elements of documentation panels or the *Visual Text* is discussed in detail in Chapter 4.

Following the completion of the documentation panels, I meet with each student and have a conversation about his or her particular panel. This meeting provides the student with the opportunity to articulate what she learned in relation to the topic. Each student and I agree to a time to meet and talk about his panel. We may meet at recess or during writing or reading workshop. This 'appointment' sends the message to my all of my students that when a student is talking with me about his panel, we are engaged in serious work that requires our full attention. In the midst of an active classroom environment, sitting and conversing with one student at a time is gift to both of us. We get comfortable and we use the documentation panel as the focus for our conversation.

> [The] conversation should be in a one-to-one situation...when both child and adult are engaged in a shared activity, the chances are maximized that they will be attending to the same objects and events and interpreting the situation in similar ways. This means they will each have the best chance of correctly interpreting what the other says and so of being able collaboratively to build up a shared structure of meaning about the topic that is the focus of their intersubjective attention (Wells, 1987, pp. 44-45).

These conversations are tape recorded so that I will have an accurate record of our discussions. The tapes capture the language of students as they discuss their pieces and respond to the questions I ask. The average length of a conversation is sixteen minutes. As we sit together, I invite the student to begin speaking with an open-ended statement such as, "Please tell me about your documentation panel." Throughout the conversation, I ask a variety of questions ranging from prompters such as, "Why did you choose this?" or "Tell me about this piece" to questions specific to each panel and to each student based on the understanding I have about the individual's participation in class, as well as our history with each other. These questions appear simplistic but they are not. Rather, these open-ended questions and prompts allow me to create a space for specific and detailed dialogue to occur. The elements of the *Conversational Text* are discussed in detail in Chapter 5.

After the conversations are completed, I transcribe the tapes. The transcription is attached to the actual documentation panel, becoming a permanent record of our conversation. Sometimes, to help with clarity for the reader, the transcript is cut apart and the text is positioned next to specific artifacts. The dialogue between the student and me is now represented in written form. I ask each student to "read" and verify the transcribed conversation and agree to the placement on the panel. In asking my students to attempt to verify the dialogue, I am acting from a respectful stance. I want each student to know that it is important to me that I get their words right. It is also an attempt at face validity with young children.

Like the teachers in Reggio Emilia, I think of this documentation as communication:

> Careful consideration and attention is given to the presentation of the thinking of the children and the adults who work with them. Teachers' commentary on the purposes of the study and the children's learning process, transcriptions of children's verbal language (i.e.; words and dialogue), photographs of their activity, and representations of their thinking in many media are composed in carefully designed panels…to present the process of learning in the schools. The documentation serves many purposes. It makes parents aware of their children's experiences. It allows teachers to better understand children, to evaluate their work, and to exchange with other educators. Documentation also shows children that their work is valued (Gandini in Cadwell, 2002, p. 5).

Unlike the teachers in Reggio Emilia, within the school where I teach, I am solitary in my effort to implement the use of documentation in this fashion. I know of no other teacher, anywhere, doing this particular documentation. The curriculum in public schools is established and must conform to learning results and standards. The current state of public education in America emphasizes assessment, evaluation, and accountability; the curricular mandates in the school in which I teach are shifting in response allowing less time for inquiry and discovery based learning.

Classroom Setting

The Community

My classroom is in the only elementary school in Wells, Maine. Wells Elementary School houses approximately 530 students in Kindergarten through grade four. Wells is a predominately white, middle class town. Many businesses and restaurants in town continue to rely heavily on the summer tourist trade, and some close down in the winter months. In the sixteen years I have worked there, I have observed changes in the community. During the first couple of years I taught in Wells, there was a small population of people who followed seasonal work. Many children would begin the school year in Wells, leave in mid October, going with their parents whose employment opportunities were greater in warmer climates, and then return to Wells in May to complete the school year, generally in the same class they started in September. This itinerant lifestyle rarely occurs now and the population of the town is steadily growing. Wells now boasts a multiplex movie theatre, two grocery stores, newly constructed businesses, and the train stops each day, increasing access to Boston and Portland and provides access for others to Wells.

There are many "No Hunting" signs posted in many areas of Wells where locals hunted wild turkeys, deer, and moose not too many years ago. Sixteen years ago, young boys in my class would talk with excitement about learning to shoot. They would talk about 'someday' when they would be old enough to join their fathers and older brothers on a hunting trip. I recall a shift several years ago during our morning meetings at school from students talking about going hunting to wearing bright orange clothing when they went out to play in their backyards: hunters had been spotted walking in the woods behind the property lines of the new housing development that abutted their hunting grounds. Animals and hunters moved further away from town, although moose remain prevalent and there is still an occasional bear sighting. My students no longer talk about going hunting. Fewer parents fish commercially or farm. Fewer parents work at the Portsmouth Naval Shipyard. Nearly all of my students' parents work. Wells, Maine continues to transform from a rural, tourist dependent town to one from which people commute to other cities for work, such as Portland, Maine, Portsmouth, New Hampshire, and even Boston, Massachusetts.

<u>The School</u>

The makeup of my class is a microcosm of the total school population. There are three primary (Kindergarten, first, and second grades) multi age classes and two intermediate (third and fourth grades) classes. The school offers two 'looping' classes (first / second and third / fourth grades) and three 'traditional' classes at each grade level, first through fourth grade. There are five half-day Kindergarten classes. Primary multi age classes have been an option for parents and children for the past eleven years and the addition of the intermediate classes two years later was in response to parents requesting their children continue their elementary education within the same philosophical parameters. Class sizes in the primary multi age program average twenty-one students; other Kindergarten, first, and second grade classes in the school often have fewer students. Most parents who have made the decision to place one child in the multi age program are satisfied with the experience and opt to place their younger children in multi age, as well. Through parental choice, siblings and cousins can be in the same class and, if not, share the extended experiences of being multi age students. Teachers and families get to know each other well. I have had the unique opportunity to teach all the children of some families and worked with those families for as long as nine years. The multi age program creates a 'family' oriented community among children, among parents and teachers, and among the five multi age teachers and the students in their classrooms.

Classroom Setup or Organizing the Physical Space

I am in the unique position of sharing two classroom spaces with my colleague and teaching partner, Mary Beth Clason, also a primary Multi Age teacher. Mary Beth has an incredible sense of functional classroom design, paying attention to traffic flow, quiet work areas, space for large projects, and the overall aesthetics of a room. We work together each summer arranging the physical space so that it is both inviting and functional. The room setup is differently every year. In Reggio, classroom space is carefully planned, "reflecting the beliefs and values that have evolved in the schools over the last 50 years" (Fraser and Gestwicki 2002, p. 101). Our classrooms reflect our beliefs about early childhood education and present a respectful, stimulating environment for our students. We respect and value children as competent and active learners. As do teachers in Reggio Emilia, we place importance on the classroom environment, organizing the space and materials so that they offer students many choices for exploration and learning.

Several years ago, when faced with moving to very small classrooms, Mary Beth and I pooled all of our resources and divided them according to curricula areas. We created a reading and writing room and a math/science/theme room, which we share, spending half of our teaching and learning time with our students in each room. Although we know and interact with the students in both classes, we do not teach each other's students. Each fall we work out our schedules for sharing the rooms throughout the year and loosely plan our big units of study together. Our reading/writing room houses both of our very large fiction libraries; mine is alphabetical by author's last name, and hers by title. All of our big books, anthologies, multiple copies for guided reading, and listening center are located here as well. Everything students need for writing workshop is in this room including their personal journals, story folders, story maps and other book projects, as well as writing tools like alphabet strips and cards, sound cards, a wide variety of markers, pencils, colored pencils, and date stamps for dating their writing. The lamps on the tables provide students with calming ambient light rather than using the fluorescent lights overhead. The sofa, child-sized recliner and beanbags provide comfortable places for reading. The tone of this room is quiet concentration as young children learn about literacy and practice the skills and strategies of reading and writing.

The math/science/theme room, located next door, is home to my nonfiction library, sorted by categories, at last count, over 500 books. There are many periodicals, as well; the *ZooBooks*, *Ranger Rick,* and *Your Big Backyard* magazines are right next to the *National Geographics*. I use many of these books and periodicals as read alouds or as discussion starters with my students. I have made a conscious effort to purchase expository texts written for elementary aged children so they have access to information. I teach my students how to use this library: how the books are labeled and arranged by topic and how to replace the books they use. We discuss categories or places where the topic they are looking for can be found. For example, if a student is interested in humpback whales, the obvious place for most young students to look would be under *H*, but nothing about humpbacks would be there. She could look under *W* for whale, or under *A* for animals, or under *O* for ocean, all likely locations. She learns that her search would prove most fruitful in the *W* and *O* sections of the library. It is a critical element for school learning to understand how libraries are organized and "children need guided practice in using the system and the books as well as explanations of how to do so" (Wray and Lewis 1992).

The books in the nonfiction collection are shelved according to topic, allowing the students and me easy access to topical and related ideas. However, all of the books about our topic of study or theme are gathered and displayed separately throughout the unit of study. These books are on shelves that expose the front cover, an invitation for students to explore them (Routman, 1991). My students seem to love big books and those related to our topic are always being read or examined by students during silent reading time, particularly following a class read-aloud of the book.

The math / science / theme room is filled with math manipulatives such as pattern blocks, attribute blocks, dice, dominoes, cards, shape templates, coins, clocks, and rulers. There are science artifacts such as antlers, dead insects, animal bones, fossils, magnifying glasses, and protective eyewear. In one corner of the room, the large L-shaped teacher's desk has been converted into the art table for student use: the drawers are filled with glue, clay, pipe cleaners, watercolors, colorful yarns, and construction paper fills the file drawer perfectly. The shelving behind the art table is organized with shoeboxes and containers filled with miscellaneous art treasures such as glitter, sequins, beads, fabric, ribbons, egg cartons, and craft sticks. There is a different feeling when students are working in this room: it is a very busy place. There can be as many as ten different groups or centers going on simultaneously in this room. There is a lot of movement; students are in charge of getting supplies and can often be seen seeking out a book, photograph, or peer when they make connections in their learning. There is a lot of productive noise because students talk with each other as they actively engage in the project and in their learning. Using different rooms for different curricular purposes, in our case math and science or literacy, helps students focus on the tasks. The organization of the supplies and materials in our two classrooms reflects the richness of the Reggio Emilia school environment (Edwards, Gandini & Forman 1996; Cadwell, 1997, 2003; Fraser & Gestwicki, 2000; Fu, Stremmel, & Hill, 2002).

Establishing Our Learning Community

My main objective as a teacher is to establish and maintain caring relationships among my students and between my students and me. For the past several years, we have had only two rules in our classroom: *Be Kind* and *Do Your Best. Do Your Best* deals with the academic scope of school life; the implication is to work hard and produce high quality work. *Be Kind* addresses the social and emotional needs of the people in the class and implies an ethic of care (Noddings, 1992). During the very important first days of school in September, we engage in many discussions as we attempt to define the rules. Along with discussion and some debate, students role play different scenarios to determine the criteria that defines our rules, making critical decisions that will affect our classroom community for the year. Criteria are established when everyone in the class agrees to it; everyone understands what it means and is able and willing to do it (Gregory, Cameron, & Davies 1997).

Over time, I have established behaviors and routines that are unique to my teaching. Students work in various types of groups throughout the day and across the school year: I employ the idea of flexible groupings in which students work with all of their peers at different times rather than only with those of like ability. I continuously move around the room as students work on assigned tasks, monitoring their work and listening in on conversations, sometimes joining in. As a result of my eavesdropping, I learn important information about my students and their worlds to which I would not have access if I did not set up conditions for talk to occur. I know what movies they watched last night, what time they went to bed, what was or wasn't for breakfast. I hear about family events like vacations and family issues like divorce, moving, and new babies, often before the parents tell me.

I engage my students in whole group instruction once each day around our science topic and often later in the day for a mini lesson in writing. The bulk of the day is spent working in small groups of various size, from individuals working (a group of one) independently to two, three, four people working together. I establish 'group leaders' to help with management and organizational issues. These students are generally the older, seasoned veterans of the class whose job it is to assist the members of their group and keep things going. They come to me if there is a situation that requires my attention. Group leaders eliminate countless interruptions for my attention when I am engaged in small group instruction throughout the day. There are situations in which I need and want to hear from every student, when eliciting information for our K-W-L chart (Ogle, 1986) for example. Sometimes there is not time to hear from everyone, so I ask my students to 'turn and talk' to their neighbor. In this way, everyone has the opportunity to speak and be heard by another, even if it is not me. ☺ I ask many questions, explicit to inferential, and I allow ample wait time for individuals to formulate their thoughts and respond. I welcome questions from students, and I encourage students to respond to them because I know that each question and its response can germinate, leading to more questions. Questions are the foundation of the inquiring mind.

Modeling and Demonstration

As a teacher, I help establish conditions for success for my students and then gradually hand over responsibility for learning to my students while guiding and providing them with models (Harvey, 1998) and demonstrations (Short, Harste, & Burke, 1996). The distinctions between modeling and demonstration are essential to an inquiry based classroom. Modeling assumes that students imitate what was shown to them. Imitation requires little thought beyond following the steps and recreating the model although, for some young learners, imitation is the first step in understanding. Demonstration, however, assumes that students are actively conscious about the choices they make and attend to from what was shown to them (Short, et al., 1996). When I demonstrate an activity or project for my students, I talk about certain procedures that may have to be followed, but more often than not, I use open-ended language, such as: "you might want to…" or "you may choose to…." or "who has an idea about…?" This provides students with the underlying notion that there is not a single correct completed piece. Demonstration encourages a degree of autonomy and independence for students as it causes me to limit my involvement and influence over the final product. Of greater importance, during demonstrations I ask my students for their ideas and challenge them to interpret what I am doing and how it connects to our larger study. My students know I want to see and hear *their* ideas! This collaborative talk provides students with ideas and information that connects to and generates thought. Demonstrations go a step further. They provide multiple opportunities to learn based on the variations of demonstrations available to students. Students who are engaged in various science activities, such as reading a book, listening to a book, reflecting on personal experiences, investigating a scientific concept, and discussing ideas, participate in different opportunities to learn. Those opportunities can become part of the student's repertoire and used to demonstrate her learning. Not every student will learn the same thing. Classrooms in which demonstrations are a method of teaching allow students active participation in their learning by creating their own demonstrations of knowledge. Demonstration is an invitation for learners to use their understanding and experience as they construct knowledge.

In the case of the documentation panel, students are assigned the task of demonstrating to me their understanding of a science unit. Unlike other assignments, I do not demonstrate the creation of a documentation panel for my students. Over the course of the school year, and for most students, over the course of two or three years, my students have observed and participated in myriad demonstrations of learning. Students create documentation panels late in the school year so they have had many experiences establishing criteria and working toward meeting them as well as invitations to draw on their experiences in the classroom. The goal is to produce a documentation panel in which the student plans, monitors, evaluates and chooses how she will reveal her understanding of the science concept. This is a demonstration of independent learning or self-regulated learning (Zimmerman, 1989; Meyer, 1993) based on previous engagement with shared activities, read-alouds, and conversations as a member of the class.

The classroom climate is based on my belief that everyone in the class is both a learner and a teacher: everyone has strengths that can be shared with others just as everyone has the capacity to learn new skills and information, and while many of them are similar, they differ in some way for everyone. Karen Ernst (1994) states, "Educational researchers have emphasized the importance of collaboration, that all participants see themselves as members of a learning community. This perspective has value for both teachers and students." (p.26). The classroom climate encourages conversation; the members of the class expect and value talk as a means to learning (Vygotsky). Conversations between and among my students and me are commonplace. These conversations include questioning and reflection on experience both in and out of the classroom (Brady & Jacobs,1994).

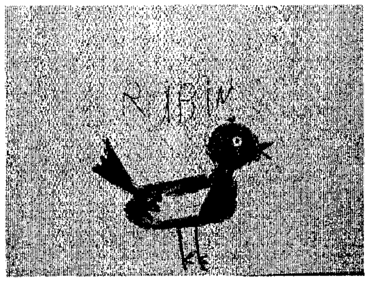
Four Classroom Conditions for Successful Documentation Panels

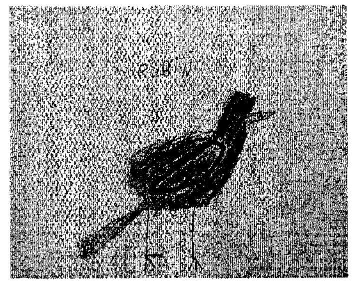
In the following section, I will explicate four classroom conditions that are necessary for the successful completion of documentation panels. These conditions involve establishing criteria in art, using expository texts as read alouds, encouraging classroom discourse, and integrated curricula.

Establishing Criteria in Art. Managing the classroom remains a collaborative effort as my students and I work together to establish criteria for completing work that supports learning. Setting criteria implies a level of excellence for work while demonstrating what that exemplar looks like (Gregory, Cameron, & Davies, 1997). This process implies a work ethic for students based on collaborative input that focuses positively on the effort and work students do every day. In other words, we are all working along a positive continuum toward achieving the goal. In my classroom, there are many different sets of criteria ranging from walking in the hall to reading workshop behavior to completing independent research projects. Working together, students and teacher develop, define, and establish each set of criteria. Establishing criteria plays an important role in the completion of the documentation panel. Working with criteria throughout the school year and across subjects causes students to analyze their panels and make decisions about what elements to include as well as the aesthetic quality of the finished piece.

We develop criteria as a way to meet standards. Standards are an expression of what all students should know and be able to do. Standards may be set at the local, state, or federal level and often without clearly demonstrating what the standard looks like. Grade level specific standards assume that all students begin and end in the same place, at the same time, and proceed to learn in the same way. Learning, however, is not sequential. Students learn at different rates and in different ways. Many state mandated standards assume a two to three year range for learning and demonstration of the standards. The standards that guide my teaching in the Maine State Learning Results are grouped pre-K through grade two, a perfect match for my primary multi age classroom. This three-year span acknowledges the developmental range of young children in any classroom. Standards can guide teaching and learning when "accompanied by a range of samples that show what development might look like over time...Knowing what the range of evidence of learning looks like at different developmental points makes the destination more clear" (Davies, 2000, p. 26). In my classroom, setting criteria to meet standards begins with a class discussion.

At the beginning of the school year, we talk about and define quality work. We use a four step process for establishing criteria: brainstorm ideas, discuss ideas using examples, agree to the criteria and make a chart, and post the chart to be used as a reference. The first area in which we establish criteria is art, specifically drawing. The theme for this activity is connected to our first unit of study.

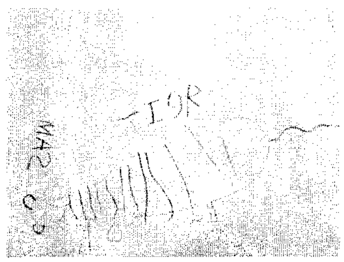
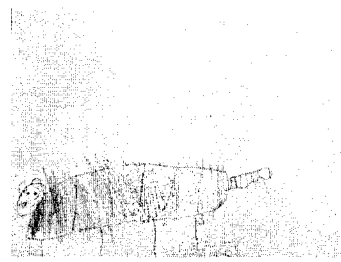
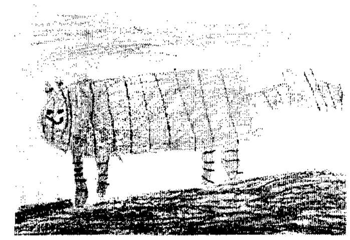




Generally, animals can be linked to our unit. Everyone, including me, chooses an animal that he is interested in learning about and then creates a drawing of that animal. The next day, I hang up my drawing and ask students to give me suggestions for improving it. I write down every suggestion for improvement, generating an ongoing list of ideas on chart paper. Then each person examines his own drawing and makes a decision to add at least one detail that will improve the overall quality of the drawing. It could be adding claws or spots or using realistic colors. We refer to our list of ideas, add new suggestions, and tally our use of old ideas. Afterward, each student in turn shows both of his drawings to the group and once again makes a decision about another element that will improve the piece. These drawings are the foundation of our class generated collection of samples describing the range of development for our criteria (Davies, 2000) for artwork. At this time, the student may ask for suggestions from the class or make the decision on her own. New ideas are added to the list. The students make another rendering of their animals. Some people choose to make a fourth picture, working to improve their piece. Finally, the students transform their drawings into large paintings that accompanied their research about the animal. These beautiful and colorful paintings hang in the hallway all year as an example of the range of abilities inherent in a classroom of young children. The koala made by five-year old Cameron looks quite different from that of seven-year old Chris, but both boys participated in the process of improving their work and were satisfied, as was I, that they had done their best. The list of suggestions for improvement becomes the foundation for a class discussion about quality drawing and, as a class, we negotiate and agree to the list of criteria that everyone will work toward throughout the year. The criteria are posted in the room; they are used, revisited, and revised by the class throughout the year. In the case of the animal paintings in the hall, they became a kind of visual criteria for students: it became commonplace for someone to refer to a painting for ideas about form or color for their latest artwork. The paintings also became a touchstone for developing art ability, as students would evaluate their original work against something new and were able to see changes in their ability over time.

This exercise in establishing criteria for creating quality work establishes an essential piece in the puzzle of our classroom community. Criteria are the standards by which something can and will be judged. Determining those standards as a class ensures that students have a voice in what the final piece will look like, and they know the level of acceptable performance because they agreed to it. They have a target to aim for as they work. When students have a voice in negotiating criteria, "they are much more likely to understand what is expected of them, 'buy in,' and then accomplish the task successfully" (Gregory, Cameron, & Davies, 1997, p. 7). I introduce the concept of criteria with something all of my students understand and has meaning for them: their own work. Researchers in the field suggest establishing criteria with students before they begin the assigned work (Gregory, et al. 1997; Davies, 2000; Davies, Cameron, Politano, & Gregory, 1992). This can be an abstract or difficult process for children unfamiliar with critically examining their own work. However, older students with many classroom experiences can rely on their prior knowledge to assist them and others as they develop criteria prior to beginning their work. One third of my student population is comprised of five-year old people, or Kindergarteners, who have had little to no experience in a formal classroom setting. I agree with the statement that, "students need to know enough about a learning experience to be able to develop criteria, so it is important to use familiar classroom experiences" (Gregory et al., p. 18). Therefore, it is important for my young students to work through the process of setting criteria *as* we do the work. This allows students the opportunity to use the real artifacts recently created as specific examples for the basis of our discussions about quality work. Establishing criteria takes considerable time and invites students to spend their time working on an assignment rather than handing it to me and waiting for me to evaluate and assign it a grade. Working on one piece over time is a form of what Sumara (1996) calls "dwelling." Working with the same piece, thinking about it, examining it, and re-working it gives students some clear messages: *Work is important. Doing my best is important. It does not have to be perfect the first time. My teacher will give me time to practice my work in order to do the best I can.*

Working with criteria includes the reflective practice of giving specific, detailed, descriptive feedback in relation to the set criteria. My response to a student's work is based on the criteria. I can state the criteria met *"You used realistic colors for your tiger"* and offer suggestions for meeting others, *"Does this tiger have all of its body parts?"* This feedback enables students to focus on improvement and move along the continuum toward meeting the goal. Students are empowered to create goals and work toward meeting them. Students assume responsibility for their actions and their work. For students this is movement toward becoming what Vygotsky (1978) calls a self-regulated learner working within the framework of the established criteria.

Establishing criteria for artwork in September gives students the opportunity to work with it throughout the year before asked to create documentation panels. The artwork on documentation panels meets or exceeds the criteria for best quality as determined by my class each year.

Establishing Criteria in Graphic Languages. A graphic language can take the shape of many forms of expression, such as, painting, sculpture, dance, movement, music, and writing. When young students use what are called graphic languages to record their ideas (Short, Harste & Burke, 1996; Katz, 1993) or what the teachers in Reggio Emilia call *the hundred languages of children* (Cadwell, 1997, 2003; Edwards, Gandini, & Foreman, 1993) the demonstration of their understanding becomes a rich and complex expression of understanding. Gallas (1994) contends that a separation of the arts from life often occurs when children enter school and "for most children, that separation represents a loss in expressive opportunities at a time of maximum learning potential when they most need to expand, rather than limit, their communication strategies" (p. 115). Artwork (Ernst, 1994; Hubbard 1989) and visual information such as graphs, charts, diagrams, and labels (Moline, 1995; Tufte, 1997) are accepted and valued in my classroom as legitimate forms of expression. As a result, these types of genre are also present in documentation panels. The artwork used on a panel is symbolic communication of the student's learning; there is often a synthesis of ideas encapsulated in the drawing. Dyson's experiences and observations as a researcher of young children and their writing have led her to conclude that their "spontaneous texts are often composed of multiple media, including drawing, talking, and writing." (Dyson, 1986, p. 380). When students create documentation panels, they are using language, artwork, and artifacts in a combination unique to each individual.

Expository Text as Read Aloud. As an undergraduate in elementary education, I was introduced to *The Read-Aloud Handbook* by Jim Trelease (1979/2001). At the time, it was on the *New York Times* best-seller list and a topic for discussion in my education classes. I recall thinking at the time that Trelease didn't need to sell me on the importance of reading aloud to children and what he was writing about just made sense. After all, I was the oldest of six children and had experienced reading to my younger siblings as long as I could remember. I paid attention to punctuation and detail in the story and used them to my advantage as a reader. I would practice different character voices and use them to make the story more exciting and to keep the attention of my younger audience. Reading aloud to my brothers and sister made me a better reader. I grew up being a book-reading performer and I continue to use the skills I practiced and learned on the living room sofa in my classroom today. I enjoy reading aloud to my class; they are among my favorite times of day.

The term 'read-aloud' describes the phenomenon of an adult reading a book to a child or group of children (Trelease, 2001) and is a common practice around the world between parents and their children (Smith & Elley, 1994; Campbell, 2001), although some studies indicate a low occurrence of storybook reading among families (Teale, 1984). There is evidence that supports the importance of read-aloud to very young children. Reading aloud stories provides the basis for children to learn about language and literacy (Teale, 1984; Smith & Elley. 1994; Campbell, 2001). Butler and Clay (1995) argue that children who grow up in families where reading is practiced regularly come to understand that reading is part of the "natural course of every-day life…[and] are developing a solid basis that will give them a great advantage when they start school" (p. 8). Teale (1984) argues that being read to is "a basic means by which children come to understand the functions and structures of written language" (p. 110). Heath (1980) informs us that children who arrive at school with vast book reading and read-aloud experiences from home are already socialized into the school-preferred approach to teaching literacy and are often viewed as 'more successful' than children without those experiences (Heath, 1980). Teale (1984) cites evidence that being read to at an early age figured prominently in the histories of many children who became literate prior to formal schooling. Children entering school without the regular experience of read-aloud at home "benefit from having frequent and regular story readings in the classroom" (Campbell, 2001, p. 6).

Read-aloud is frequently practiced in school among early primary teachers but gradually reduced in frequency by third or fourth grade and ultimately ceases to exist in most junior high and high school classrooms (Duchein & Mealey, 1993; Hynds, 1997; Richardson, 2000). The benefits of read-aloud are included in textbooks for pre-service teachers (Cunningham & Allington, 1999; Temple & Gillett, 1996) including booklists of appropriate titles, how to select books for reading aloud and tips on practicing before reading to students. Read-aloud as a topic is included as a chapter or section in almost every book about reading instruction geared for the elementary teacher and has long been viewed as an important element of every literacy program (Holdaway, 1989; Hornsby, Sukarna, & Parry, 1986; Cambourne, 1988; Routman, 1991; Chambers, 1993; Clay, 1998; Burns, 1999; Campbell, 2001; Duke & Bennett-Armistead, 2003).

There are some practical benefits to reading aloud in the classroom; these benefits have been studied and are included in the current canon of reading research. There has been much written about the value of read-aloud as a way to engender reading enjoyment in students, both as listeners and as readers (Cambourne, 1988; Hornsby, et al., 1986). Reading aloud "helps children acquire essential prerequisites for learning to read" (Hornsby et al., 1986), these prerequisites can be demonstrated as reading strategies during read-aloud. They include voice print match with letters and words and how print functions (Strickland & Morrow, 1989; Clay, 1998), the value of using picture clues, prediction, context clues, the idea that reading is about making meaning, and the "modeling of expressive, enthusiastic reading" (Richardson, 2000). Heath (1982, 1983) argues that as a result of read-aloud experiences, children learn how to talk about the meaning in books: they are able to provide descriptions, explanations and affective commentary of the text.

There has been evidence of gains in vocabulary, particularly when the teacher explained or somehow illustrated the meaning of target words (Smith & Elley, 1984) and higher literacy and reading test scores (Campbell, 2001; Morrow, 1992) in classrooms that included read-aloud as a regular practice. While read-aloud is practiced more in the early primary grades, there is evidence that older students, including those in middle and high school, benefit from being read to by their teachers (Richardson, 2000). Richardson (2000) reports that many adolescents lack critical reading skills and engage in little reading for pleasure. Read-aloud in high school content area classes such as science, can engage students in the concepts that make up the content, clarify vocabulary, and provide a foundation for understanding prior to completing assignments.

One of the most important reasons for reading aloud to children is that we can share literature that extends their thinking (Hornsby, et al., 1986). In the case of young students, the concepts and ideas they are able to discuss and understand are more complex than their reading ability, so, read-aloud time provides opportunities for children to learn without having to struggle with reading comprehension. This underscores the adage: through grade two, children are learning to read and after that, they are reading to learn (Hynds, 1997). Reading aloud expository texts provides my students and me a way to practice early literacy skills while we explore complex science topics and concepts. An example of a typical read aloud session in my classroom offers students both literacy skills and science content.

> Charlene: This book is titled *Bug or Insect* by Anne Rockwell. Who can make a prediction about this book?
> Students: It's about bugs.
> About all kinds of bugs.
> It's gonna teach us about insects.
> Charlene: The title says *OR, Bug OR Insect.* What do you think that means?
> Students: Maybe its saying 'bugs *are* insects' like they're the same...
> ...or maybe it's gonna say they are different, cuz it says *or*.
> Bugs and insects are the same thing!
> Yeah, insect means bug.
> Charlene: Let's find out!

Introducing the book I will be reading aloud and asking for predictions about it activates student thinking and establishes connections to their past experience and knowledge base.

Later during this read aloud session, a discovery is made.

Charlene: This book just told us the differences between a bug and an insect! What are they? Let's write them down.
Students: They have six legs...
...and three body parts.
And their head is a triangle shape...
...they have antennaes on their heads!
It said their mouth is shaped like a beak...
...Like a bird beak, that's funny!
Charlene: Does every bug have a mouth shaped like a beak?
Students: Yes.
Charlene: Does an insect have a mouth shaped like a beak?
Students: No.
Charlene: Does every bug have a triangle shaped head?
Students: Yes.
Charlene: What about insect heads?
Students: Not triangles...
...any shape, like oval, round...

During this exchange, students used the emergent literacy strategies of prediction, listening comprehension, and because we wrote a list of characteristics, students also used letter sound knowledge and spelling strategies. Teaching, modeling, and demonstrating early and emergent reading strategies can occur while reading aloud expository texts as well as when reading fiction. In my classroom, read-aloud encourages discussion and application of content material as I encourage my students to think, ask questions and apply the ideas and concepts learned in our group discussions. During this brief exchange, my students were engaged in early literacy activities while learning facts about bugs and insects.

The many examples of the benefits of read-aloud cited above "lead us naturally towards a Vygotskian approach to children's development in reading" (Smith & Elley 1994, p. 5). The use of expository texts as read-alouds in my classroom act as the stimulus for learning information and concepts. This too, is reflective of Vygotsky's zone of proximal development or the window between the current level of achievement by a child and the level which can be achieved with assistance from an adult or more capable peer. It also reflects Rogoff's (1990) ideas about apprenticeship in thinking and guided participation. Apprenticeship in thinking, according to Rogoff (1990), involves active participation in learning by children as they interact with more skilled members of their society. Guided participation is essential to apprenticeship in thinking and involves collaboration between children and their more capable peers or adults. Guided participation builds bridges between a child's present understanding and skills and new understanding and skills as well as shifting a child's participation in and responsibilities in activities (Rogoff 1990).

The term 'read-aloud' is defined and used in this study to describe the activity in which as the teacher, I read aloud to students for the purpose of disseminating and discussing information, generating and answering questions, as well as for enjoyment.

Expository Texts. Historically, fiction has predominated as the genre of choice in elementary schools, particularly in the early primary grades and specifically in the area of read aloud, and these stories engage children in the meaning-making process that educators have come to recognize and accept as the foundation of literacy (Holdaway, 1979; Doiron, 1994; Smith & Elley, 1994). Davinroy and Hiebert (1994) posed the question, *Why teach expository text?* to teams of third grade teachers from schools in the Denver area as part of a study in the use of classroom-based assessments in reading and mathematics. Student use of and teacher expectations for the use of expository text had been limited to an animal research paper each spring. The teachers in this study "referred to expository text as 'new,' something about which they 'hadn't really given much thought' and indicated that expository text experiences and instruction of strategies had not been a focus of their reading programs" (Davinroy & Hiebert, 1994, p.63).

In a recent study of twenty first grade classrooms in the Boston area, Duke (2000) showed that students do not have access to much reading material beyond fictional stories in the classroom. She observed little informational text on classroom walls and few nonfiction books in the class libraries. Duke (2000) found that the amount of informational text children could expect to encounter ranged from none at all to an average of 3.6 minutes per day spent with expository texts during writing activities. This amount of time does not offer students sufficient exposure to expository texts for instructional purposes, nor would it encourage students to explore nonfiction on their own. Duke's findings corroborate earlier studies (Wray & Lewis, 1992; Dioron, 1994; Davinroy & Hiebert, 1994; Hynds, 1997; Howe, Grierson & Richmond, 1997) about the primacy of narrative text and the lack of expository text at the primary elementary level.

Student access to expository texts and learning about the unique characteristics of them play important roles in the teaching and learning of science concepts (Oyler & Barry, 1996; Harvey, 1998; Duthie, 1996). Reading expository text is different from reading a story or novel: the purpose and formats vary. Students need to learn how to "manage the organizational patterns of expository material" (Burns, 1999, p. 208) in order to be successful readers of it. Expository texts use visuals not found in fictional stories such as charts, maps, graphs, and diagrams and these visual or graphic elements can often be studied independently of the text. Expository text does not have to be read in sequence, but instead can be read in nonsequential segments (Moline 1995).

To date, all of the references I have read about expository text and reading refer to the student learning how to read those texts based on the premise that they have already learned to read; none focused on the teacher reading aloud expository texts and demonstrating how to do it. As a teacher, it is my job to point out the organizational features of the expository text I am reading aloud and engage my students in discussion about how the text is organized (Temple & Gillett, 1996) as well as the content we are learning. One of my pedagogical tenets is that those children interested in information and the natural world can use expository texts to learn to read. The world of narrative and fiction is not the only route to learning to read.

Due to their beginning, emergent, or early reading abilities, my young students access information through nonfiction books and texts such as *Time for Kids* and *Weekly Reader* during our daily reading workshop time in which students participate in guided reading, explicit instruction, and independent or self-selected reading. They also have access to nonfiction books read aloud in class by me and by more able classmates rather than actually reading these texts themselves (Dioron, 1994; Yopp &Yopp, 2000). The use of nonfiction trade books as read alouds and the student discussions that follow read aloud is a place where students engage in dramatic discourse including inquiry, dialogue and conversation in response to observations about the information read aloud (Moss, 1995; Yopp & Yopp, 2000).

The availability of interesting nonfiction read alouds helps make the teaching and learning of science concepts and other content interesting and inviting for me and for my students. Nonfiction texts can capitalize on the curiosity and interests of young children and can play an important role in motivating children to read (Duke, 2000; Duthie, 1996;

Moss, 1995; Harvey, 1998; Oyler & Barry, 1996). "Nonfiction trade books have both content and visual appeal: they provide current, in-depth information on a huge variety of specific topics that textbooks cannot offer" (Burns, 1999; p. 211). For the purposes of this inquiry, informational texts are defined as texts having one of more of the following features: (a) factual content; (b) technical or specific vocabulary; (c) detailed illustrations or photography specific to the content; (d) compare/contrast, problem/solution, cause/effect, or like text structure; (e) lists of attributes; and (f) graphic elements such as maps, diagrams, tables, cut-away and bird's eye views (Moline, 1995; Tufte, 1997; Burns, 1999; Duke, 2000; Newkirk, 1989). I will use the terms informational text, expository text, and nonfiction interchangeably throughout this work.

It is important to note that many children's books are narrative-informational, that is, information or facts are presented in a narrative story structure. An example of this type of informational text would be many of the picture books by Gail Gibbons, Lois Elhert, and the *Magic School Bus* books by Joanna Cole. Learning through embedded information in a narrative format is as old as the recitation of parables through which information has long been conveyed (Leal, 1994). Research indicates that reading aloud informational storybooks may offer some benefits for students as they makes connections with scientific learning. Leal's research has shown "when discussing an informational storybook, first-, third-, and fifth-grade students tend to (a) stay on topic longer, (b) use speculation twice as often, (c) rely on peer information more frequently, and (d) more frequently discuss related extra-textual topics than with an information book or storybook" (Leal, 1994, p.138). Leal concludes that students may learn more science information through the reading aloud of informational storybooks than reading aloud science textbooks, "greater retention of scientific information with the informational storybook indicate[s] that [they] can be a useful tool in science education to help students to become scientific thinkers and readers" (p.142)

After selecting a book related to our science topic, I read it aloud to my class as they sit on the floor at our class meeting spot. I generally do not read nonfiction books straight through. Instead, I stop at critical points and ask questions or wonder aloud about the information I am reading. I am demonstrating an important reading strategy aloud: how to check for understanding. I am also inviting students to become active participants in the reading. The read aloud time becomes interactive as my students interrupt the reading to ask questions and make comments. Reading aloud informational texts stimulates student discussion that involves new science information. They point out observations about illustrations, photographs, and artwork presented in the book. They make connections between familiar texts and the new one I am presenting. They make predictions based on their knowledge and the newly presented information. My students make connections between their prior knowledge about our science topic, if any, and the new information they are learning. Grounded in broad science themes, the links students make may be general in nature, such as making an observation or comment about the predator / prey relationship or as specific as stating 'Orcas eat penguins.'

Content specific vocabulary is introduced, defined, clarified, and discussed during the read aloud time. Kilmer and Hofman (1995) suggest that children become familiar with scientific terminology but "teachers should not require memorization or rigid adherence to scientific terms or procedures; rather, teachers should introduce these as labels and methods to be used appropriately in the investigative process" (Kilmer &

Hoffman, 1995, p. 45). It has been my experience that young students enjoy learning and using scientific terminology. Because I believe in using appropriate terms and labels with children, not using simplified language except as a means to clarify and define, we talk about 'using the scientific words' for things. Not long ago, we generated a long list of possible names for our new class fish until a student asked, "What's the scientific name for fish?" as he handed me my college biology text, an often used reference. I looked it up and the decision was unanimous and immediate: its name is Ichthys.

The essential nature of talk in the primary classroom allows for and encourages discussion, questioning, and clarification of information during the read aloud session and is viewed as "constructing their own knowledge" (Oyler & Barry, 1996, p. 325) both as individuals and as a group. I encourage my students to be active participants in my reading of expository texts. This approach to reading aloud creates a whole-class approach to scaffolding by using the ideas and contributions of students to create meaningful dialogues within our classroom based community of inquiry (Many, 2002).

Comprehension. I consider comprehension to be an active process in which a reader interacts with a text to produce meaning. Comprehension is not simply the ability to answer questions about a text; it is about making connections between the text and prior knowledge or experience. Comprehension is about understanding and knowledge. Understanding science concepts in my primary classroom is based on the comprehension of texts read aloud by me. My students are not required to read the science text and make meaning from it. Of course, a student can and is encouraged to read science information at the appropriate instructional or independent level however, the foundation of our science topics is based on me reading information aloud and engaging students in conversation and discussion about the text.

Rosenblatt (1978/1994) posits an active relationship between reader and text. The meaning does not lie solely in the text; "the finding of meanings involves both the author's text and what the reader brings to it" (Rosenblatt, 1994, p. 14). For Rosenblatt, comprehension and meaning are actively constructed by the reader as she brings relevant ideas, beliefs, and feelings to the reading. Rosenblatt's transactional theory is based on the earlier works of Dewey and Bentley (in Rosenblatt, 1994). For Dewey and Bentley, transaction is "composed of irreconcilable separates" (Rosenblatt, 1994, p. 17). In other words, "transaction…[is] an ongoing process in which the elements or factors are…aspects of a total situation, each conditioned by and conditioning the other" (p. 17). Rosenblatt separates aesthetic reading, or reading for pleasure from efferent reading used to acquire new information. This division between aesthetic and efferent reading is used by Rosenblatt to discuss theory however, she reminds us that it is a fine line that separates them: "It is more accurate to think of a continuum, a series of gradations between the nonaesthetic and the aesthetic extremes" (p. 35).

Taking Rosenblatt's theory of transactional reading and juxtaposing it on to the read-aloud process provides me with a framework for reading expository texts with my students. While Rosenblatt focuses on the reader and the text, I introduce a third element: the teacher as the <u>conduit</u> for reading the text and the student as participatory listener. In this case, my students are too young and inexperienced to do the actual reading. Their cognitive ability, however, can handle complex ideas and concepts.

"Discussion brings together listening, speaking, and thinking skills as participants engage in exchanging ideas, responding, and reacting to text as well as to the ideas of others." (Gambrell 1996, p.26)

Encouraging Classroom Discourse. Establishing criteria in my classroom begins with talk, discussions about the quality of work students will do and why. Establishing a culture in which my students generate questions, make comments and connections during the read aloud sessions values talk. Because I work with young children, talk is the natural and easiest mode of communication available to everyone in the room. Our classroom environment encourages talk and oral language development. Students discuss, listen to and exchange ideas throughout the day: when we are at the meeting spot during our whole group sessions and when working in small groups. At any given moment, in fact, my young students can be heard talking to themselves, problem solving the spelling of a word or organizing the supplies they need to do their work, they might be 'talking the story' they are writing (Dyson, 1988). On any given day, I can hear several students humming or singing quietly as they work. Encouraging and accepting student discourse about science is an important element in science learning, as Yager (2004) points out, science needs to be discussed between people in order to gain new insights and understandings. This is true for the documentation panel, as well. Classroom discourse in its various forms is an essential element for the successful completion of documentation panels as it provides students with an enriched base of knowledge.

Many young children enter school with eager anticipation; the teacher's actions and words toward the individual child as well as the larger group influence and determine each student's concept and definition of school and the role oral language plays in their learning during the school day. The extent to which oral language is valued in the classroom is a crucial factor in its use as a tool for learning. Oral language or talk is accepted and expected at certain grade levels, generally primary elementary, and by particular kinds of teachers who value the role talk can play for their students. Too often, those of us who are literate forget how important it is for those who are becoming literate to use spoken language as they learn and make connections between what they know and the new information being learned. In his discussion of primary oral cultures Walter Ong (1982) states "we – readers of books….are so literate that it is very difficult for us to conceive of an oral universe of communication or thought except as a variant of a literate universe" (p. 2). In light of this statement, it is no wonder that many educators and programs often neglect to continue the development of oral language as a subject in school, assuming that students know how to talk (Dudley-Marling & Searle, 1991) and neglecting to emphasize the use of oral language as a mediating tool for understanding.

Talk in classrooms has changed over time and classrooms that encourage talk have not always been the norm. Success as a teacher was once measured by the quietness of the class. The teacher's voice was predominant as she dispensed information, often as a lecture, or asked questions of the class. Lecture or recitation still dominates the field of science instruction, despite the emergence of new teaching styles (Atkin & Black, 2003). Students were, and too frequently continue to be, passive recipients of knowledge rather than active participants in learning (Barnes, 1976; Atkin & Black, 2003).

As a student, I remember silence. The classrooms I grew up in were generally quiet places where the teacher did most of the talking and the students were expected to sit at their individual desks and work quietly. I recall the first day of fourth grade when I got in trouble for whispering "thank you" to the girl behind me after she said she liked my long hair. My punishment was to write the multiplication problems for six until my paper was completely filled: sixteen columns, front and back. I remember being silent for the rest of the year. I also remember lively conversations with my family at the dinner table every night, even through my undergraduate years. When my dad asked what we learned at school, my five siblings and I would vie for the attention of the table as we began to tell the stories of our day. Everyone had the opportunity to speak and quite often the table would be cleared, the dishes done, and we would still be gathered in the kitchen, talking. No topic was off limits: the definition of unfamiliar words for the next spelling test, facts about a foreign country, the difficulties of algebra, dissecting frogs, plate techtonics, and current events like the Viet Nam war and the importance of establishing a recognized day for the Earth and Martin Luther King, Jr. I realize now these conversations helped me make connections between school and life and between the world and me. The questions we asked of each other stimulated our thinking and made us want to learn more. We were eager learners, learning from each other and articulating what we learned each day helped us clarify our own thoughts.

When I became a teacher, I do not recall making the decision to allow my students to talk, to spend their learning time talking, but I could not imagine a group of young learners who had to be quiet as the rule. It happened as a natural matter of course. I encourage my students to speak as much as possible, using that genre as the basis for our learning. Children learn to talk as a natural part of their development, according to Brian Cambourne (1988) it is a "stunning intellectual achievement" (p. 30). Oral language development is initially motivated by the young child's need to communicate: to understand and be understood. As the child matures, language becomes more refined and is used to satisfy simple social needs such as gaining control of objects, people, and knowledge in their environments. Later, language is used as the foundation for learning and inquiry. Oral language in the classroom establishes a foundation for cognitive learning, thinking, and experimentation before students are able to independently read about these ideas in books. Science content and vocabulary become part of everyday classroom talk helping students to make connections, formulate questions, and deepen their understanding of a concept. My classroom environment enables children to use language as often as possible in a variety of situations. Success in speaking and listening provides a sound basis for reading and writing. Understanding of written language will enhance speaking and listening. Speaking and listening are vital components of a language arts program along with the more frequently considered literacy skills of reading and writing (Barnes, 1992; Smith, 2001; Cambourne, 1989).

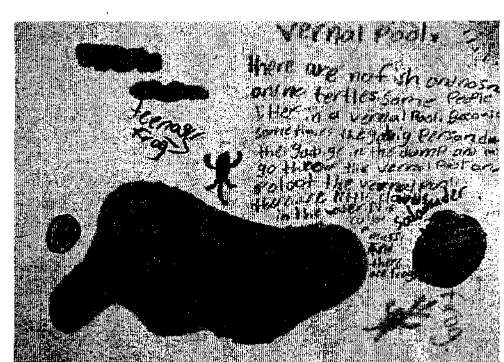
Speaking and listening are essential to the learning process and cannot be developed in isolation. They develop in the context of community. Oral language provides a background and a springboard for developing language skills across the curriculum. Students in my class have opportunities to express their opinions, ideas, and feelings in a respectful environment. I want my students to view oral language as a vital and integral part of learning. Encouraging talk provides students with the knowledge that their ideas are respected and important to our community.

I organize experiences that activate thinking and motivate my students to verbalize their thoughts throughout the school year, allowing them myriad opportunities to practice and refine talk. Our classroom establishment motivates students to interact with each other and use oral language for a variety of meaningful purposes. Students routinely share ideas and experiences, problem solve together, and work on common projects. We talk a great deal in our classroom, sometimes for academic purposes and other times, we communicate as friends, sharing some news or a laugh.

As students talk about their documentation panels, they are using language to express, reshape, and clarify their thoughts and understanding of the topic. They demonstrate knowledge by talking to other students while making their panels and then to me about their completed panels. Discussion involves interaction by small or large groups to reach a deeper understanding of the topic. Language clarifies thinking, adds to new knowledge, and aids in the expression of ideas and opinions.

Oral Language and Science. Using the following example from a documentation panel I would like to explore and elaborate on the role oral language plays in my primary elementary classroom as students learn about some of the broad concepts of science. Our new elementary school abuts a fenced in wooded vernal pool area. It was obvious to me that my students and I should explore our new surroundings and become familiar with the area. Christina, a second grader, and Sam, a Kindergartener, were sitting near each other as they made their vernal pool panels and briefly discussed the litter that they picked up near the vernal pool on a recent visit. As part of Christina's vernal pool panel, she wrote the following:

> *There are no fish and no snakes and no tertles. Some people litter in a vernal pool. Sometimes the garbige person dumps the garbige in the dump and it might go threw to the vernal pool and poloot the vernal pool.*



Dyson (1983) asserts that children's talk provides both meaning and, for some, the systematic means for getting that meaning on paper. Talking acts as a mediational tool, providing students with a foundation for the use of the written word, a more abstract symbol system. Christina and Sam's conversation was based on the social act of having the shared experience of exploring the area around the vernal pool together and finding some trash. Students rarely include spontaneous writing of more than a few words or brief sentence on their panels. In this case, Christina did. As a class, we had a brief conversation about pollution following our initial visit to the vernal pool and decided we would take trash bags with us the next time we explored the area. Christina explained that she wrote about pollution "because it is important to know about but I didn't want to put pollution in my picture." During our conversation, I asked about her concerns around pollution:

Charlene: What you wrote about pollution interests me a lot. Would you talk more about pollution so I understand it better?

Christina: It's like, if there's a road right next to the vernal pool or maybe a house is there and if someone takes out the trash and puts it on the side of the road and maybe the wind might blow it into the vernal pool.

Charlene: Why is that a problem?

Christina: Because it could kill the animals in there, because it could hit them and they couldn't swim around.

Charlene: Are you saying that if garbage landed on an animal in the vernal pool, it would kill it?

Christina: Yes. Or if it was really smelly garbage, that would do it.

Charlene: The smell could kill them?

Christina: Yes. And another thing is, if the garbage goes in another place that's connected to the vernal pool, it could rot and then go into the vernal pool and kill the animals or make them sick, like poisoning them.

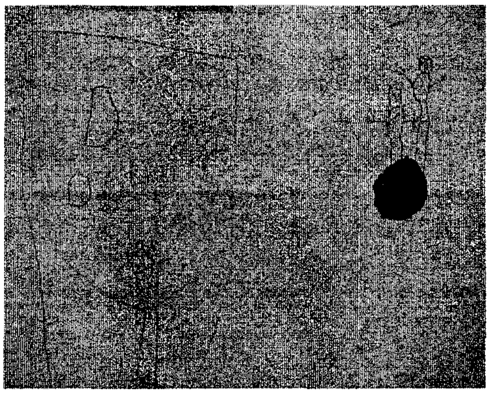
Charlene: So, are you telling me that garbage could pollute or contaminate the water in a vernal pool and perhaps kill some of the animals?

Christina: That's exactly right! That's why people need to be careful about their garbage and where they put it.

Christina discusses several possible origins for pollution in the vernal pool going beyond what she had written on the panel. Acknowledging her written statement and asking for more information about it opened up the topic of pollution and allowed Christina to include other ways pollution can be harmful to the vernal pool environment and its inhabitants. Christina did all of the talking, I only asked clarifying questions based on what she had said. Implicit in my questions is my interest in and respect for her ideas and my vocal intonation invites her to say more. According to Martin Nystrand (1997), by incorporating Christina's responses into my questions, I not only validate her ideas, I have created a discourse in which the meaning is negotiated and determined by both of us.

Sam, a five year old student, did not write words about litter on his panel. Instead, his simple black line drawing includes a small rectangular shape near the edge of the pool. In our conversation, Sam briefly mentioned it: "I found a bag in the water there. A BJ bag."

I asked if he had picked it up. "Yep. So I could throw it away". However briefly noted, finding and throwing away the plastic bag had been an important act for Sam during his visit to the vernal pool. He mentioned it in our class discussion and was one of the organizers of the trash pickup during our second trip.



According to Dyson (1989) representational language during (social) conversation and the drawing process is an "information-rich symbolic medium" (p. 157) for young writers, and at this point in the writing process most story elaborations remain in the student's talk rather than in the artwork or written text. When Sam and Christina recalled these events and talked about their experiences, they were using representational language, which is a means of analyzing and organizing their ideas. Sam's organization was the creation of a representational drawing of the shopping bag while Christina chose to briefly write about 'garbige.'

Christina and Sam explored the vernal pool as partners. While they made their individual documentation panels, they talked, but it was not random or casual conversation. It was specific to their visit to the vernal pool and to the context of making their panels, creating the context for joint decision-making and the expansion of their individual understandings. Christina and Sam are appropriating their learning in a social context which will in turn become internalized and allow them to move from social talk to self talk or intrasubjectivity (Vygotsky, 1978), a cognitive act.

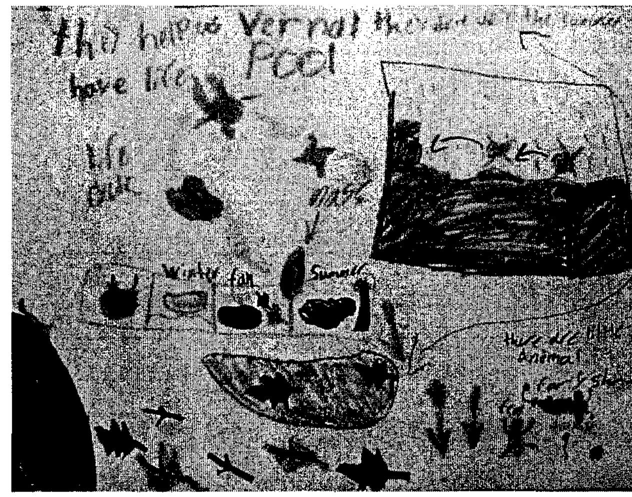
Young children use spoken language continually as they explore their world; they talk to themselves, each other, and use language to direct their activities. In the case of the vernal pool panels, talking about what they had done while exploring the area around the vernal pool is the first level of abstraction according to Vygotsky (1978). The fieldtrip itself consists of physical perceptions and the sensations of sight, sound, touch, smell, and taste, which inform children about the world. Talking about those sensations is the first level of abstraction from the actual event; drawing and writing about it follow.

Language is, according to Vygotsky (1978), the primary cultural tool used by humans to mediate their activities. The use of language is instrumental in restructuring the mind and in forming higher-level thought processes. Vygotsky continues by positing that the ability to compose written text grows out of gesture, speech, dramatic play, and drawing. According to Vygotsky (1978), language is a social construct; it is flexible, evolving, generative, and defined by negotiating meaning. Language learning is acquired as children interact with family and friends; over time, language becomes an important tool for understanding concepts and solving problems. Children learn through interactions with objects and other people as in these vernal pool pollution examples, students share common experiences and are able to engage in conversations that are meaningful to them. They can mediate their conversation by listening to voice intonation, reading visual clues present in body language and in each other's facial expressions. The immediacy of talk allows us to negotiate meaning (Nystrand, 1997; Dyson, 1989; Gallas, 1994, 1995; Wells, 1986) and come to a common understanding.

There has been much written about young children linking speech to early forms of writing (Graves, 1983; Cambourne, 1988). The pictures on Christina's documentation panel could be considered a prewriting activity or means of organizing her thoughts as Graves (1983) suggests in his study of first grade writers. He writes, "for many children drawing was a major step in the prewriting phase....as he [a student] drew he would talk, often making appropriate sound effects to go along with the figure being drawn at the moment" (Graves, 1983, p. 231). This artwork represents another level of abstraction in which the picture is a symbolic tool or sign that stands for an idea or concept; Vygotsky (1978) states, "...we see that drawing is graphic speech that arises on the basis of verbal speech. The schemes that distinguish children's first drawings are reminiscent in this sense of verbal concepts that communicate only the essential features of objects" (p. 112). He goes on to say that these "written signs [vernal pool pictures] are entirely first-order symbols...directly denoting objects or actions, the child has yet to reach second-order symbolism, which involves the creation of written signs for the spoken symbols of words" (p. 115).

Ann Haas Dyson (1986) uses the term, *symbol-weaving* to describe the relationship between the drawing, talking, and emerging literacy of young learners. Symbol-weaving implies the use of more than one symbol system and does not rely on conventional written text only, the often expected and accepted tool for demonstrating knowledge in the classroom. *Symbol-weaving* reflects the constant shifting between drawing and talking that young students do; for them, their work is neither the talk nor the drawing. It is the sum of both. As symbol-weavers, my students use all of the forms of expression they know as they create documentation panels; drawings, assigned artifacts, the spontaneous and creative talk of children working, and the negotiated discourse of their conversations with me. Through the process of creating and completing documentation panels I am asking for and accepting a product that is a woven representation of different symbol systems, including drawings and talk.

Internalization is what Vygotsky claims to be an essential element in the formation of higher mental functions. What first appears as the social behaviors of talking and drawing later becomes an internal psychological process of drawing symbolic signs and understanding the conceptual category 'vernal pool'. Christina and Sam actively constructed their drawings and used that symbolic tool in the complex structure of their individual documentation panels. Both students use first-order symbols or pictures to express their knowledge of the vernal pool including the litter they found. In subsequent conversations with me, the students reveal more detail about the vernal pool supporting and elaborating on their artwork. Christina's inclusion of written text shows her confidence as a writer, as well as her ability to restructure what she knows in the formation of higher-level thought processes indicative of the written word. The illustrations that go with the sentence "they dry up in summer," for example, depict first a brown, dried pond covered with leaf litter beneath a series of four drawings illustrating what the vernal pool looks like throughout the seasons. The cyclical concept of time and repetition of natural events are scientific concepts (Benchmarks for Scientific Literacy, 1993).



Christina's illustrations provide more information than the actual written text, and Sam's panel contains no written text at all. Without the accompanying conversational text these panels could both be considered examples of pictorial imbalance (Newkirk, 1989), a common occurrence among my young writers in writing workshop situations. When Christina's and Sam's visual work is considered in the context of science content documentation panels, the visual texts are multilayered and complex. The elements of a documentation panel cannot be separated from each other and understood completely; the interrelationship that exists between the visual text and conversational text on the documentation panel engenders the essence of the meaning. The visual text and conversational text are complementary.

"Thinking skills as process may be the most important area a scientist develops, because the skills influence the way a scientist proceeds with a study." (Richardson, 2000, p.7)

Science: The Critical Element in an Integrated Curriculum. In the following section, I will explain how the science topic is integrated with other curricular areas in my classroom. An integrated curriculum reflects an interdisciplinary approach to teaching and learning that is "grounded in social constructivist views of the learning process" with the emphases on "...encouraging students to construct meaning from a variety of sources [including] their use of small group and collaborative structures" (Many, 2002).

Research in learning and teaching science suggests that people learn about the world in three main ways (Arbruscato, 2000; Carin & Bass, 2001; Cain, 2002; Atkin & Black, 2003): discovered knowledge, acquired knowledge, and constructed knowledge. Discovered knowledge is a result of personal experiences and observations about the world. Acquired knowledge is transmitted from one person to another, as in the case of a teacher presenting information or facts. "Acquired knowledge provides children with a variety of terms and categories for representing and expressing their discovered knowledge" (Carin & Bass, 2001, p. 75). Constructed knowledge occurs when discovered and acquired knowledge are transformed by the learner in meaningful ways.

Interdisciplinary units or integrated curricula involve students in interpreting information and "constructing an understanding of a topic through inquiry" (Many, 2002, p. 380). During a unit of study, students will construct knowledge using their personal experiences in and out of class, the information I told them (acquired knowledge), and their discoveries during planned activities and read-aloud time.

Science topics are integrated throughout most of the day in my classroom. Using a variety of nonfiction books as read alouds helps me establish the foundation for our science units. The emphasis on nonfiction books allows me to introduce and define vocabulary and concepts that will be important for understanding our topic. I also read aloud fictional books that are related to the topic; these books often relate science information through a narrative story line. For example, many picture books by authors such as Gail Gibbons, Lois Ehlert, and David McCauley and the photo essay books of Bruce McMillan and Tana Hoban contain science information and concepts woven through them. Reading aloud to my students is a critical element in integrating science in my classroom.

Once the science topic is determined, such as the estuary, vernal pool, or hatching chicken eggs, that theme becomes the foundation for nearly everything we do. It cuts across curriculum lines and permeates the classroom. Using Ogle's (1986) K-W-L chart, the class brainstorms facts and questions for our study. The questions are organized into categories and become the basis for my planning. Every day, students participate in activities and complete projects in which they are discovering something about the topic. It may be recording an observation, investigating unfamiliar objects, experimenting with science equipment, classifying objects, sequencing events, recording data, or interpreting events and phenomena.

As I teach the mandated math and reading programs, I am mindful of how I can tie them to our science topic. Although the sequential nature of learning mathematics and the limitations of the program I am required to teach often prohibit me from placing science into a math lesson, it does not stop me from putting math into a science lesson.

Students may learn about linear measurement during a specific math lesson and need to complete a workbook page but during our unit on dinosaurs, we measure the length of Apatosaurus (in the hallway), the teeth of Tyrannosaurus Rex, and the chicken bones uncovered during our in-class paleontological dig-site. This is real world application of a specific math skill for young learners. Measuring dinosaurs has a duel purpose: practicing the skill of working with measuring tools (rulers, tape measures, meter sticks) in both the English and metric systems and developing an understanding of the concept of size relative to themselves. Measurement and size are essential skills and concepts in the science curriculum (Benchmarks for Scientific Literacy, 1993, p. 209).

Reading and writing are much easier to integrate into science than math at the primary level. Students read books about or related to the topic; we may do literature circles, have a book discussion, or just read for the fun of it. When we are learning about dinosaurs, I make sure students read the dinosaur stories in the prescribed anthologies and connect them to our study rather than reading the dinosaur stories at a different time of year simply because they are next in the book. Students often incorporate elements of our science unit into their daily writing during writing workshop. A student may choose to write a list of facts or one fact and illustrate it; another may use the topic as a springboard into a fictional narrative that in the end has little to do with the topic.

My goal as a teacher is to integrate as much of the student day as possible with science units. I introduce, teach, and have students practice using science related tools. Throughout the school year, I invite my students to explore myriad materials and assign projects and activities that allow for various ways of completion. By the time my students complete their documentation panels late each school year, they have had innumerable opportunities to represent their learning. I am interested in the choices my students make when they represent knowledge on their documentation panel.

Methodology

Teacher Research

I have inadvertently been conducting teacher research in my primary Multi Age classroom for years. This research has evolved out of wonderings about things that have naturally occurred in the classroom. I believe that teacher research should evolve out of what is already happening in the classroom. It should be in response to a question posed by either the teacher or a student, or both. The best questions arise from uncertainty or from the dissonance between what we know and that uncertainty. The questions are based on what is going on in the classroom and these questions guide the research. "The process of asking questions and describing data is compatible with the normal demands of teaching… [T] he research described will involve teachers in doing what they have to do anyway-paying careful attention to what is going on in their classrooms" (Odell in Goswami & Stillman, 1987, p. 129). This 'paying attention' invites me, as teacher researcher, to discuss what insights I discover, what works within the context of the classroom and what doesn't work, and why. Incidents that some might consider failure are actually just a different learning. The learning that results from that incongruity, from that "failure," becomes the spawning grounds for the recognition and emergence of more questions. Odell states that "research is never finished…..we see new questions that need to be answered; as we answer those questions we see other questions that didn't exist until we had answered the previous ones. Exploration leads to still further exploration, discovery to still further discovery" (Odell in Goswami & Stillman, 1987, p. 129).

As a teacher of young children, I sometimes find myself in conflict between the mandates of school curriculum and state standards and what I believe to be effective and developmentally appropriate practice. I understand that learning to read and write are not only important but essential in order to be successful within the school setting; however, I also recognize the importance of expressive art forms such as movement, drama, painting, drawing and other forms of artwork, as well as oral language in the development of one's understanding. Often, creative expression in young children is viewed singularly as play rather than as an act of learning (Edwards, Gandini, & Forman, 1993). Play provides students with a space to practice, learn, and understand concepts that they will use or build on throughout their lives.

I constantly monitor my students and the lessons I teach in an attempt to modify what is going on in order to maximize learning for both our students and for myself. Teacher research can be anything from a simple wondering (Bissex, 1987) about a student, a lesson, or an approach to teaching, such as 'I wonder why she does that before she writes?' to asking and attempting to answer a broad question, such as: 'If everyone did that before writing, would that change their writing in some way and do I actually want to find out?' Teacher research has become a legitimate strand within educational research. I have noticed in recent years more articles written by teacher researchers in professional journals and in edited collections than twenty years ago, at the onset of my career.

Having recently read scores of articles and texts, I now have a better understanding of what constitutes good teacher research and an interesting presentation of findings (Bissex, 1987; Odell, 1987; Cochran-Smith & Lytle, 1993). As a result of reading and understanding this type of research, I am proud to label this study "teacher research". I am immersed in my classroom setting, working with young learners every day. The physical context for this dissertation is my classroom. Every situation in my classroom adds a fiber to the ever-evolving teacher that I am and will become in the future. My use of the term 'teacher researcher' in this application encompasses classroom inquiry and scholarship as an organic action based on the interactions among students and between students and the teacher. Over time, my students have made me a better teacher. Their actions, questions and responses to my teaching make me think about my intentions as an educator as I continue to refine my craft.

The rigor of teacher research is reflected in this study (Bissex, 1987; Odell, 1987; Cochran-Smith & Lytle, 1993; Ray, 1993; Gallas, 1995). I learned throughout the course of this project that the questions I have about my practice and about my students started out as being meaningful and important to me. When I began talking about my work on this dissertation about science and science education, my work began to impact other educators; pre-service teachers, colleagues, and administrators in the school district. Conducting research as a practicing teacher has kept me grounded in the realities of the classroom. It has made me more aware of and accountable for my actions and decisions. Becoming a teacher researcher has strengthened my voice in the face of adversity and as an agent of change in the school.

Case Study

This work represents a collective case study in which as the researcher, I will "study a number of cases jointly in order to inquire into the phenomenon …or general condition" (Stake in Denzin & Lincoln, 1998, p. 89) of student created documentation panels about a science topic. “Individual cases in the collection may or may not be known in advance to manifest the common characteristic…They are chosen because it is believed that understanding them will lead to better understanding, perhaps better theorizing, about a still larger collection of cases.” (Stake in Denzin & Lincoln, 1998, p. 89).

Using Cresswell’s (1998) four features of case study, I began to sort and analyze the collection of student generated documentation panels. The case for this study is one hundred fourteen (114) completed documentation panels. It is a “bounded system” (Cresswell, 1998), that is, bounded by the ages of my students (five, six, seven, and eight years) and the classroom setting over a period of time; specifically, four to six week science units. Earlier in this chapter, the context for creating documentation panels as well as the classroom setting has been described in detail, situating the case for the reader. Multiple sources of information were used to provide a detailed, in-depth picture of the documentation panels, including student artwork, transcriptions of conversations, and completed panels.

In the following section, I will discuss the panels in terms of data. This includes the category system I developed for examining the panels for evidence of science learning.

Data Collection

Completed documentation panels are the primary data resource for this study. I examined completed documentation panels made by my Kindergarten, first, and second grade students. I reviewed the audio taped conversations between each student and me about the completed panels as well as examining the transcripts from those conversations.

My class consists of five, six, seven, and eight year old children. The children enter the class at the age of five years as Kindergarten students and stay with me for three years until the end of their second grade year. I have been collecting documentation panels for the past five years from students and their parents who have been willing to allow me to keep them for the purpose of studying them and learning from the works of young children.

Participants

Sixty-six former and present students in my Primary Multi Age classroom, Wells Elementary School, Wells, Maine. These students range from five to eight years of age and represent students of one to three years in my classroom. As noted earlier in this chapter, my classroom is a microcosm of the entire public school in which I teach; therefore, the range of abilities in my classroom is wide. Over the years these documentation panels were collected, six students were identified with Special Needs and currently receive or received support through the Special Education program while in my class and one student was later identified as 'gifted.' Many students received Title I reading support services and some received tutoring in math. All of my students

Number of Panels

I have a pool of 114 documentation panels from which to draw for use in this dissertation. I have permission from all 66 students and their parents to use the panels in my dissertation work. The condition of some of the earlier panels had deteriorated; the adhesives of glue and tape had failed causing artifacts to fall off and the color of some markers had faded appreciably. I decided not to examine these panels for this study.

I examined individual panels for patterns in artwork and conversations, collecting examples of conceptual change in the understanding of science concepts.

I am in the unique position of working with students for the first three years of their public school lives and can examine the panels in a longitudinal fashion. There are complete sets of three years of documentation panels from fourteen students, K-1-2.

Analysis

Analysis of the data represented in the documentation panels was ongoing and reflective throughout this study. This reflective practice emphasizes the production of meaning as a commitment to "pondering impressions, deliberating recollections and records" (Stake in Denzin & Lincoln, 1998, p. 99) in this case, the documentation panels and transcripts. As I examined the panels, listened to tape recordings, and read through transcripts of conversations with students about their panels, questions emerged and evolved that prompted me to examine particular aspects of the panels. It quickly became clear to me that there are two main elements to the documentation panel: the visual element and the transcripts. I examined these two elements separately, looking for patterns and similarities among the panels. These patterns and similarities became the primary categories I used to sort the data. In the following section I will explicate the categories and in Chapters 4 and 5 will define, illustrate, and discuss in detail each category.

I began with an investigation of the visual elements of the documentation panels. I photographed all documentation panels in order to have easier access to them as the originals are quite large and cumbersome. I sorted these photographs while examining artwork and conversations as separate elements of the panels, identifying any patterns that emerged. In many instances, the data revealed categorical aggregations (Tufte, 1997; Cresswell, 1998) or multiple examples of an idea. The following examples emerged in student artwork as indicators of science learning as indicated in the National Science Education Standards (1993) and Maine State Learning Results (1997) as important elements of becoming scientifically literate:

-picture glossary

-life cycles

-simple, scale and analytic diagrams

-maps and elevations

-gesture as explanation

-class assigned artifacts

I termed the visual elements of the documentation panels *The Visual Text* and the categories that comprise it will be further explored and explicated in Chapter 4.

I examined the transcribed conversations for each panel, again, looking for possible patterns evidenced by 'markers', indicated in the National Science Education Standards (1993) and Maine State Learning Results (1997). The categories that emerged during *The Conversational Text* are

-vocabulary and definitions

approximation

-science concepts and processes explained by students

-making connections

personal connections

school connections

recall class experiences

"I never knew..."

student generated questions

magic

-narrative: science as the familiar

Reliability

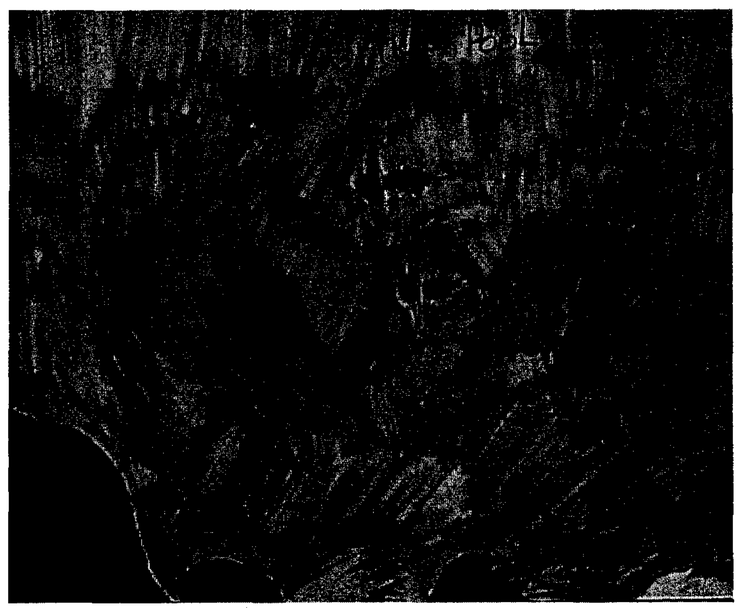
I engaged four colleagues to examine twenty randomly selected documentation panels using the above mentioned indicators and definitions. The purpose was to determine if (1) the definitions were clear and (2) how other teachers would categorize the artwork on the panels and the dialogue in the transcripts. This exercise, called 'check-coding' by Miles and Huberman (1994) acts to clarify definitions; "[D]efinitions become sharper when two researchers code the same data set and discuss their initial difficulties. A disagreement shows that a definition has to be expanded or otherwise amended" (p. 64). In every case, my colleagues matched with 100% accuracy, the visual examples and definitions with my own coding. Therefore, the definitions provided for the visual text were clear and the visual science indicators can be determined to be reliable. My original definitions for the indicators in the conversational text required discussion for clarity and substance with my colleagues. This prompted me to refine and clarify the definitions for use in this dissertation.

In Chapters 4 and 5, I will examine the two divisions of completed documentation panels: the visual text and the conversational text. These two major elements are both sources of information. While each panel is an amalgam of indicators, I will often isolate one indicator for examination and discussion in terms of science learning. In some cases, I will use several examples of one indicator (categorical aggregate), demonstrating a range of possibility. The array of examples found in the documentation panels indicate a wide variety of ways in which young students demonstrate science learning.

CHAPTER 4

THE VISUAL TEXT

To envision information is to work at the intersection of image, word, number, art.
-Edward Tufte



Developing and using established criteria for quality drawings is an important element of my classroom curriculum. Student generated sketches, drawings, and paintings permeate all areas of the curriculum, becoming visual texts that reflect individual learning and thinking. Many sketches and drawings become part of documentation panels.

The visual elements of documentation panels are comprised of various types of diagrams and pictures that the students produce. Students use simple diagrams, analytic diagrams, process diagrams, and maps to convey information about the scientific facts and processes they have learned or have amended from their prior knowledge. The information provided in visual texts, such as diagrams and maps, is "accessible to all readers" (Moline, 1995, p. 1) regardless of their reading or writing ability. Visual-spatial intelligence, one of Howard Gardner's multiple intelligences, encourages the use of pictorial representation in the classroom, "By supporting written or spoken language with charts, diagrams, or photographs, learning can be facilitated and retention reinforced for many students" (Campbell, Campbell, & Dickinson, 1999, p. 100). Documentation panels allow communication to occur in visual form, through the artwork of the visual text as well as in spoken form through the conversational dialogue between the student and others.

The elements of visual texts can be complex and used to present information in textbooks, newspapers, periodicals, catalogues, advertisements, and television. Moline argues that visual literacy is a life skill that people need "to get by in our everyday lives" (Moline, 1995, p. 3). Visual texts are part of our everyday lives from reading road signs to choosing consumer goods to checking on the weather forecast. Professor and statistician Edward Tufte (2001), claims, "charts, diagrams, graphs, tables, guides, instructions, directories, and maps comprise an enormous accumulation of material. Once described… as 'cognitive art', it embodies tens of trillions of images created and multiplied the world over every year" (p. 9). Children are exposed to these myriad images and include many of them in their own repertoire as they express what they know. The nature of science learning and the developmental ability of young children merge in hands-on activities and classroom discourse. Visualizing information and synthesizing data and concepts into visual metaphors is the confluence of the multi-layered text of the documentation panel.

> …[V]isual texts are not simple texts. Reading and writing visual texts is not merely a transitional phase which is later discarded in favour of reading and writing words; visual text elements can be highly complex and are used extensively at all levels of learning...Visual texts are therefore not an academically "soft option" to verbal (words-only) texts, since they can be equally demanding to produce. (Moline 1995, p. 2)

Students transform their observations and classroom learning activities into the visual and verbal texts of the documentation panel. The activity of creating a visual representation, or the visual text, on a panel gives students an opportunity for learning and a way to express ideas. Transformation plays a major role in knowledge construction and acquisition. Combining verbal and visual information on the documentation panel provides students with an alternative means to express knowledge and understanding. The documentation panel becomes an integrated text grounded in the teaching and learning of science.

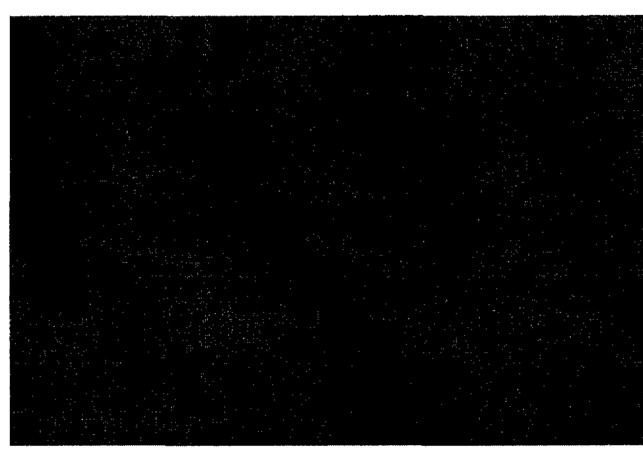
Students often choose to use diagrams on documentation panels to explain their learning. Diagrams make generalizations that explain or define a common representation of a group. Diagramming an idea or concept is a widely accepted method in scientific research, in that scientists create visual representations of their hypotheses, experiments, and outcomes (Yager 2004, NRC 1996, AAAS 1993).

In the following section, I will define and show examples of diagrams students have included on their documentation panels and how they demonstrate national or local science standards.

Picture Glossary

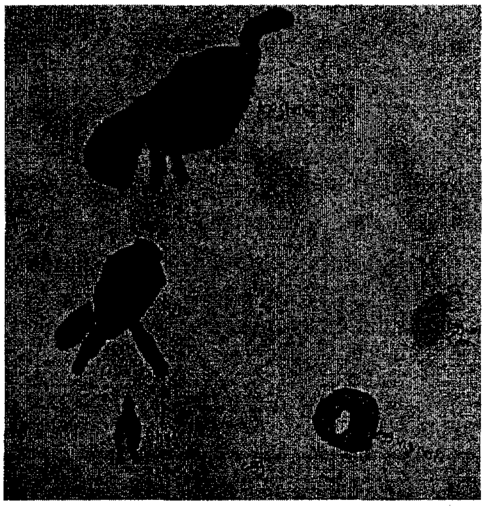
A picture glossary "helps the reader to identify, differentiate, or define items within a group or parts of a whole" (Moline, 1995, p. 19). Young students begin with the illustration and add word labels to various parts of the illustration. As Moline points out "the labels name parts of the picture, while the picture helps to define the labels" (p. 21). The illustrations define concepts and subjects visually and the accompanying word labels act as definitions and demonstrate science knowledge in the form of vocabulary.

During our unit about the endangered Atlantic Salmon, Brody, a nine year old child with autism, focused on learning about the different stages of salmon life as they relate to human development. His documentation panel is a picture glossary of four stages (rather than seven) of salmon life that parallel his understanding of human growth and development. Learning about the development of salmon paralleled his educational plan to name and label stages in human development, such as baby, child, teenager, and adult. Brody understood the idea that fry are 'little fish like little kids,' specifically making the connection to his younger sister. We analogized the parr stage to Brody, or a 'big kid'. He connected the adult stage to his parents. The most difficult stage for Brody to understand was the egg. His assistant and I correlated it with a pregnant woman but it did not make sense to him until he saw a photograph of his own mother, pregnant. Brody would say, "Baby egg in mama's belly. Little fish, Brendle [his sister].



Big fish, Brody. Big, big fish, dada, mama." Brody worked on comparative age and size during this unit and with word cards was able to match specific salmon vocabulary to the appropriate stage. The illustrations on his documentation panel are clear, depict four stages and indicate some relative size. Brody's illustrations do not follow a sequential pattern indicating a life cycle. However, we observed him as he worked and he drew them in the correct sequence from egg to adult. Brody's labels name the pictures and the pictures help to define the labels creating a simple and accurate picture glossary (Moline 1995).

Amy, a first grader, also created a picture glossary specific to our unit about chicken eggs. Her glossary includes, 'egg with a dot, egg in a nest, egg, chick, hen, rooster.' Her inclusion of 'egg with a dot' and 'egg in a nest' is similar to Brody's use of 'big fish' and 'little fish.' Both Brody and Amy have included these details because of their significance to our studies. The developing chicken eggs including 'egg with a dot' and the live alevin or 'little fish' were in our classroom far longer than the succeeding stages of either animal.



Amy's picture glossary includes the gender names of adult chickens; hen and rooster, as well as the juvenile names; egg and chick. When asked what was important about her panel, she replied, "The rooster and the hen can mate and have babies. Then there's an egg with a dot in it, it's a red dot."

Charlene: Then what?
Amy: It grows in the egg. The egg is in the nest. The chick is getting bigger.

Charlene: Then what?

Amy: Then it pecks out and hatches into a chick. It could be a rooster or a hen but no matter what, it's a baby.

Charlene: Then what?

Amy: It grows up to be a rooster or a hen then they have babies and it starts all over again.

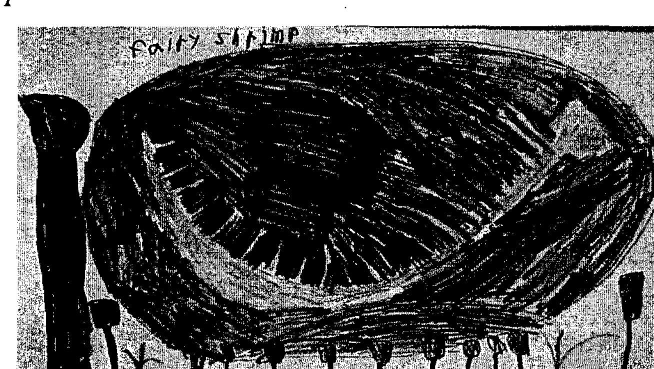
Amy's picture glossary reflects her understanding that the process of procreation requires both a male and female. She created a colorful rooster and a brown hen on her panel. This is a visual representation of a class discussion following the reading aloud of a book about birds. This book stated that male birds are generally more colorful than females of the same species for the purposes of attracting a mate (male) and camouflage while nesting (female). Identifying gender and using correct gender and name labels is a subset of the life sciences standards in the Maine State Learning Results (1994). These standards include identifying similarities and differences between and describing characteristics of living things. Amy and Brody described some characteristics of chickens and salmon through their drawings and in their conversations with me.

Diagrams

Simple Diagrams

Some of the diagrams my students create for their documentation panels focus on one element of the science unit. These simple diagrams have a drawing accompanied by a single label or title, stating what the picture is.

Christopher's simple diagram makes prominent the single inhabitant of the vernal pool that fascinated Christopher and



many other students: the fairy shrimp. The panel includes a tree and some cattails along the bottom edge of the picture but the fairy shrimp is the focus. Initially, Christopher talked about his knowledge of fairy shrimp; their color, size, and number of legs and then went on to tell me many facts about the vernal pool. At the end of our conversation, I asked, "Why did you choose to make your panel mostly about fairy shrimp?" His reply, "Because I wanted to do one whole thing and do a good job concentrating on it." Christopher's fairy shrimp panel is labeled and focused on one inhabitant of the vernal pool. During our conversation, it was apparent that his knowledge of the vernal pool was broader and encompassed more than a limited discussion of fairy shrimp.

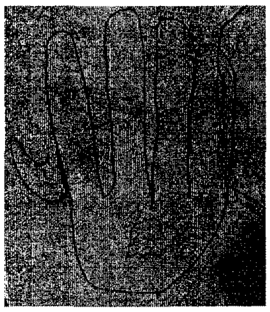
One of the standards outlined by the National Science Education Standards (2002) and National Research Council (1996) for elementary school science curriculum is "Students will describe, explain and predict natural phenomena" (Yager, 1996, p. 99). These simple diagrams act as one type of descriptor of a natural phenomenon. While the labeled artwork of a simple diagram gives the student and teacher a response to that question, in Christopher's case, *what do you know about vernal pools?,* it is the conversation about the diagram that reveals what a student knows about the topic.

Scale Diagrams

A scale diagram relates the relative size of an object in relation to the student's experience (Moline, 1995) and aids the explanation and description of natural phenomena. Over the years and across science units, students have included 'actual size' drawings of small objects, including salmon eggs, the red spot on a fertile chicken egg, mosquito larva, fairy shrimp, and tadpoles. Some of these diminutive drawings are labeled "actual size" or "real size" and those not labeled, are pointed out by the student during our conversation about the panel. Because students are given opportunities to explore and observe local habitats such as the estuary or vernal pool as well as providing then with real animals such as salmon and chicken eggs in the classroom for observation, students often choose to draw and label elements of their panels 'actual size'. While these illustrations may not be *the* actual size of the object, they are an estimate or approximation of the size. They are also an indicator of a students understanding of relative size, an important element in physical science whereby students learn about the structure of matter including physical property of size (MSLR, 1994; NSES, 1996; NSTA, 2002).

Gabrielle, a first grader, created two scale diagrams in the same drawing. She was amazed at the large size of the skunk cabbage leaves she saw on our fieldtrip to the estuary and drew a leaf in comparison to her hand. The tiny black dot on her hand represents a tick. The tick is so small that she chose to enlarge and label it in a separate drawing, above the picture of her hand holding the leaf. Gabrielle used her hand as the scale of measurement in her illustration.

Harold also used a hand to relate the relative size of a Caddis Fly larva found at the vernal pool. He said, "In my sketch, this is a Caddis Fly and that's Mrs. Oakes holding it." I asked him, "So, that's a Caddis fly larva. What did "they look like to you?" "They looked like pinecones, little baby pinecones." Harold's verbal description of the size of the larva adds meaning to his sketch. The verbal and visual combine to relate approximate relative size of the caddis fly larva he observed.



Scale diagrams enable students to imagine either very small, even microscopic or large objects by placing them in a familiar context. Scale diagrams often contain a standard unit of measurement such as the linear measurement of inches, meters, or miles and this works well provided the object is reduced or enlarged accurately in relation to the conventional unit of measurement used (Tufte, 1997). Conventional units of measurement are abstract for young children and do not provide them with a clear understanding of size or distance. Harold used someone else's hand for scale in his sketch while Gabrielle's hand provides her with the constant measure for both the tiny tick and the large leaf. The size of the objects discussed by Gabrielle and Harold make sense to them because they used a hand for the scale in these examples.

Analytic Diagrams

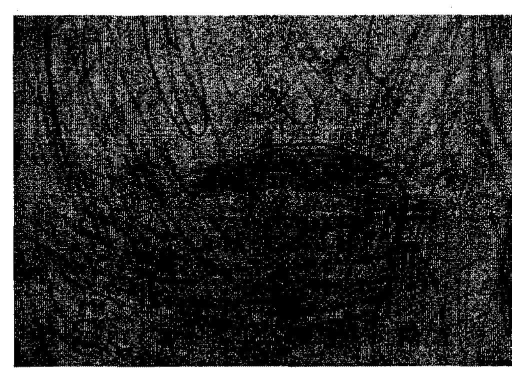
Analytic diagrams show the inside of a subject in order to understand how something works or reveals something that is not outwardly obvious. These are typically cutaway diagrams or cross sections often found in books about animal and plant biology or in technical manuals (Moline, 1995).

In Reece's diagram of the egg incubator, he has drawn and labeled the incubator, light, and eggs. He explained: "The incubator keeps the eggs warm, as warm as if the hen is sitting on them. It's plugged in and the light and the motor keep the inside warm. The eggs are sitting in little cup holder things that hold them and moves them around. When they start pecking out, you might see a beak or egg tooth."

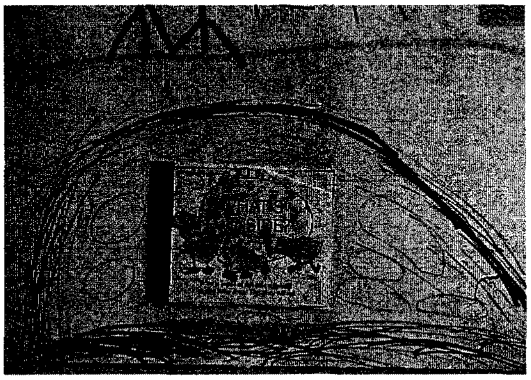
Reece's description of the incubator and how it works is simple but clear and accurate. He has touched on the science concepts of heat energy and motion. He had taken the first steps toward explicating the impact of technology on modern life, a standard developed to understand the implications of science and technology (AAAS, 1993; MSLR, 1994).

Another type of analytic diagram is the cutaway diagram, which often reveals a natural setting such as an animal nest or burrow, using a glass or imaginary wall to view what is going on. During our study of Atlantic salmon, we had a one hundred gallon cold-water tank filled with river rocks and stones, constantly moving water, and approximately one thousand salmon eggs.

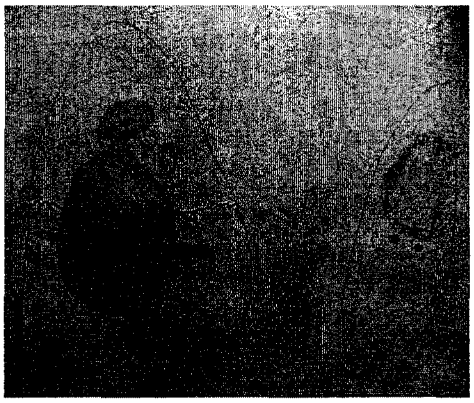
The tank was housed in the third-fourth Multi Age classroom next door but my students had access to it whenever they wanted to observe or check on the latest developments. The students could clearly see eggs lying along the bottom of the tank, between and on top of rocks. Elizabeth observed the salmon eggs at the bottom of the tank and drew what she saw, a group of nearly colorless spherical eggs. Elizabeth, a kindergartener, used her knowledge of mothers and offspring to place the adult female above the eggs, and said in our conversation, "Right here, the salmon is laying eggs." Later in our conversation she said, "I think all the alevins in our tank are related, they all have the same mom." This drawing illustrates Elizabeth's notion that the salmon eggs were laid by one female and are therefore, related. Elizabeth's conclusion is based on her practical experience with puppies and kittens but it is one of the fundamental principles in heredity or life sciences (AAAS, 1993).



Stephanie incorporated a class made artifact into her cutaway diagram of a chicken nest. She drew eggs that are nestled in the brown straw and hay that make up the nest. The book, *What's Inside?* was the product of a small group activity during our study of chicken eggs. *What's Inside?* reveals the developing chick embryo inside the shell over the course of its twenty-one day incubation period. As the students made the book, we read the information on each page, looked at the changes in the embryo over time, and discussed how the chicks in our classroom might be developing as the book indicated. Stephanie's decision to use the book as part of her panel makes sense because it is filled with information. Her decision to place it within the drawn nest that is part of the large life cycle enables her to reference the stages of development without drawing each one on her panel.



Unlike Stephanie, several students chose to illustrate the stages of chicken embryo development. Jordan, a second grader with special needs, drew two pictures on his panel both depicting a cut away view of the inside of the chicken egg. The first (left) depicts a fully developed chick suspended within the shell by the chalazae. The chalazae are in fact, attached to the yolk, not the chick, suspending it and the earliest stages of the embryo within the albumen, or egg white. He said of the chalazae,

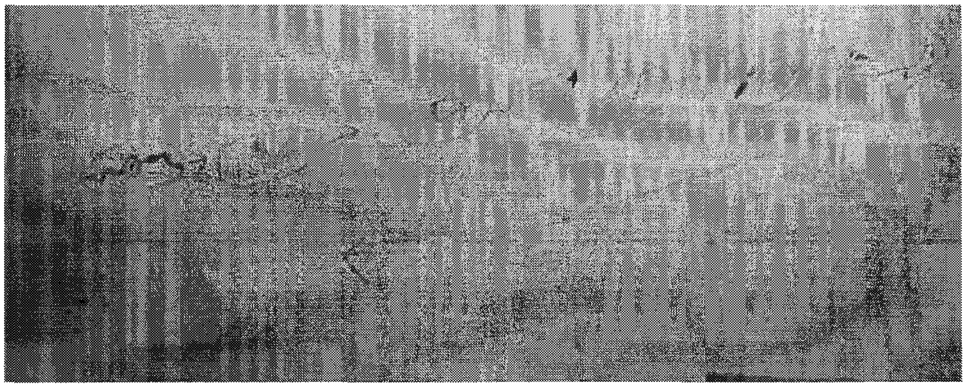


Jordan: It's the thing that comes from the shell that holds the chick inside.
Charlene: What are the things inside the shell?

Jordan: The shell is on the outside.
Charlene: Right, and what's inside?
Jordan: The baby chick.

Jordan understands the concept of the chick developing inside the shell, and said, "The egg is pregnant." Jordan described his panel, "This is about a chick that is waiting to be born, to be hatched, because I made a picture of it. The chicks are breathing. If the chicks don't peck out it means they died. The next thing is pecking out." There is an arrow between the two drawings indicating change from the earlier stage to his second drawing that shows the chick in profile, beginning to peck out of the shell. His illustration depicts the chalazae, which he correctly understood to be a suspension system, although he placed it at the incorrect stage of development, by the time the chick is fully developed, the chalazae has disappeared. This illustration also includes the air space at the narrow end of the egg, Jordan made reference to it when he said "the chicks are breathing" but he did not name or label it. It is evident as a component of the developing egg in his drawing. It was difficult for Jordan to understand and visualize the changes of development of the embryo inside the shell. He understood eggs to be made up of yolk, white, and shell. He understood the fully developed chick pecking out. Jordan knew what is inside an egg and he witnessed a chick hatching. He clearly understood these two extremes of the developmental continuum for chicks because he experienced them. That experience became the focus for his documentation panel and our conversation.

Michael also drew many of the stages of the developing embryo on his panel. His diagram shows cut away views of six stages of development inside the egg with the chick breaking through the shell in the final stage. The arrows indicate the process of change from one stage to the next. Michael's descriptions of the developing chick are chick breaking through the shell in the final stage. The arrows indicate the process of change from one stage to the next. Michael's descriptions of the developing chick are insightful. Beginning with the far left upper picture, he said, "The chick starts out to be a little circle with a red dot. Some of the veins are showing". His description of the following three pictures is accurate, "Then the chick is a bean shape inside the egg and it keeps growing and growing. It starts like a bean and then the second one shows a bean



shape with an eye. There was a beak and some legs." In class, we talked about the importance of rotating the eggs in the incubator daily so the chicks develop uniformly and so they don't stick to the inside of the shell which can cause birth defects. Michael intentionally shifts the position of the developing chick between the fourth and fifth drawings and said, "When they are small they are on their back in the shell and when they get kind of big they are on their belly…I know babies flip around before they are born." Michael's parents are both nurses and throughout the three years he was in my class he would often refer to his parents' knowledge of medicine and what he learned from them. Michael's statement reflects a basic understanding of the need for the chick to shift positions within the shell and was as he claimed, influenced by his background knowledge.

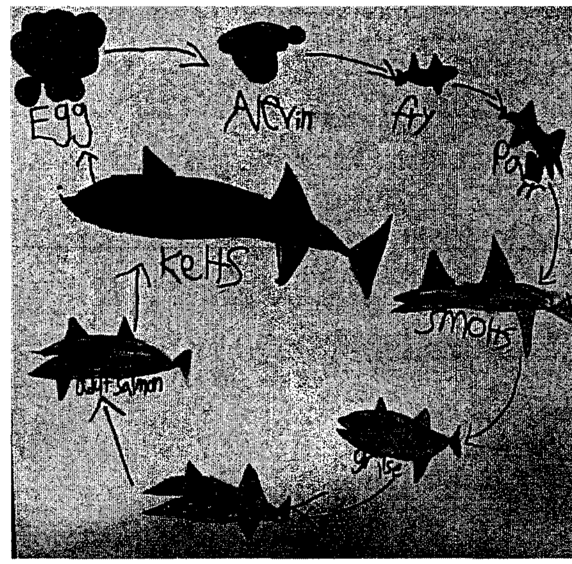
Each of the six drawings Michael produced show developmental changes within an egg. The red dot with veins becomes a bean shape. The bean shape develops an eye final cut away diagram, the chick fills the shell space and is fully developed. Then it pecks out, head first, leaving bits of shell on the ground.

Life Cycles

Life cycles are one kind of process diagram. Life cycles included on documentation panels are cyclical flow diagrams (Moline 1995) that describe a renewable or continuous process. The natural process of procreation is a topic in life sciences and is part of science curricula in the primary elementary grades, often dealing with the life cycle of the Monarch butterfly in the autumn or chicks in the spring. ‘Life cycles of organisms’ is a national content standard requiring the understanding of characteristics and life cycles of organisms and their environments” (NSES, 1995, p. 127). The fundamental concepts and principles that underlie this standard include birth, growth, reproduction and death of plants and animals, the details of which vary between organisms; specific and distinct characteristics of various plants and animals; and how different plants and animals interact with the environment (NSES p.129). The pattern of life cycles is one of the basic scientific processes students will encounter throughout school and throughout life.

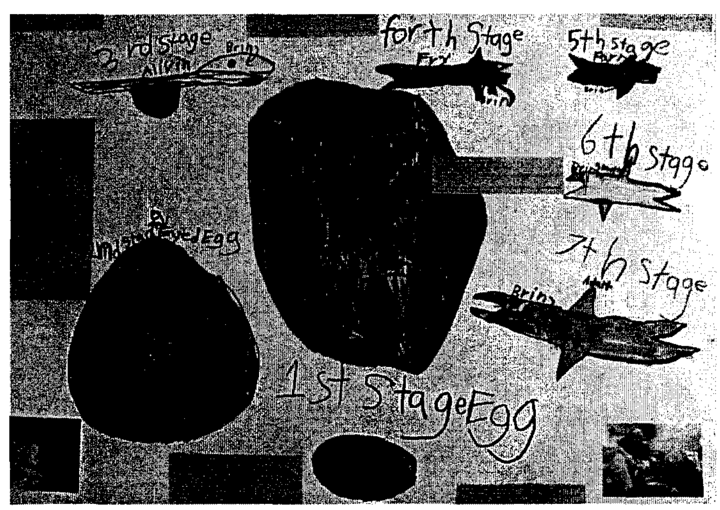
Nikita’s salmon life cycle recomposes the information she learned from class discussions and reading throughout the unit of study as well as our class fieldtrip. The arrows clearly indicate directionality from one stage of development to the next. She has included labels that name each particular stage of salmon development. The artwork indicates some important information, as well. Salmon eggs are deposited one at a time and can often be found together or near each other at the bottom of a streambed. The eggs were in groups in the tank in the classroom although they are not found in mass.

Alevin have remnants of the yolk sac on their bellies, which is clear in Nikita's picture. The yolk sac provides the salmon with nourishment at this stage of life. She drew the fry smaller than the later parr stage and Atlantic salmon turn a silver-blue color at the smolt stage. Nikita's conversation about the elements on her panel included information about color as camouflage for protection from predators,



including dragonfly nymphs "dragonflies are bigger than the salmon at one stage and so they can eat them." Nikita continues with an explanation of the silver colored smolts, "They get silver to camouflage, they go into different water, the ocean, and they have to change color to camouflage and the inside of their bodies change so they can breathe ocean water and not die." The arrows indicate an ongoing or repetitive cycle as there is no break between the life stages.

Like Nikita, James chose to illustrate the life cycle of the Atlantic salmon on his documentation panel. James wrote ordinal numbers for each stage along with the stage name, "1st stage egg". The shifts in development in a life cycle are typically indicated by arrows between and connecting the stages. James' choice to ordinals reflects his interest in and knowledge of math. Alongside the numerical sequencing of the stages, James labeled each stage with its specific name. His artwork is carefully crafted including the use of accurate color and detail. The visual clarity and detail in James' panel indicates his understanding of the life cycle of the salmon and changes within that life cycle. The brain and heart are clearly visible at the alevin stage, due to the transparent nature of the salmon's skin. James drew the brain and heart in his rendering of the alevin. He labeled them and drew an arrow from the word label to the organ. When the skin darkens, they are no longer visible, however, James was intrigue with this and drew and labeled the brain on every stage of his life cycle, including a theory about the eyed egg stage. When asked about it, James said, "I thought I was missing something and then I realized, like, where's its brain? So, I labeled the brain, because if they didn't have a brain… they couldn't go back to their river." James theorized about the eyed egg stage of development, "The egg grows bigger and then the body and two eyes start to appear. If you look really closely, I think you can see two eyes, some veins, the brain, and maybe a bit of the yolk sac."



Including the brain in every stage of development of the salmon was essential to James' understanding of salmon life. He explained, "They have to smell their way back home. The river is fresh water but the ocean is salt water so they can't live forever or lay their eggs in salt water 'cuz their eggs will just die. Their bodies change so they can go to the ocean and then they change back again to the river when they are adults. So when they are an eyed egg and an alevin they get really good at smelling so they can remember. They get that smell in their brains so they know where their river is."

He discussed camouflage on the salmon fry as being "stripes...brown and black and greenish. The green is so they can blend into the weeds in the river.... and the parr are darker and have spots because they hide down at the bottom with the rocks and pebbles." He continues to talk about his understanding of the salmon life cycle with me.

James: They [the smolts] look silvery because they are getting ready to go out in the ocean. They just stay there for three or four years and then they turn into adults than they get ready to come back.

Charlene: To come back where?

James: To come back to the redd, that's what they call their nest, then they're gonna lay more eggs and the life cycle will start all over again. Females lay about 8,000 eggs, they lay a lot of eggs! But, not all of them survive, out of all of them only about two survive.

Charlene: Right. What happens to the rest of them?

James: They die or they get eaten by other animals.

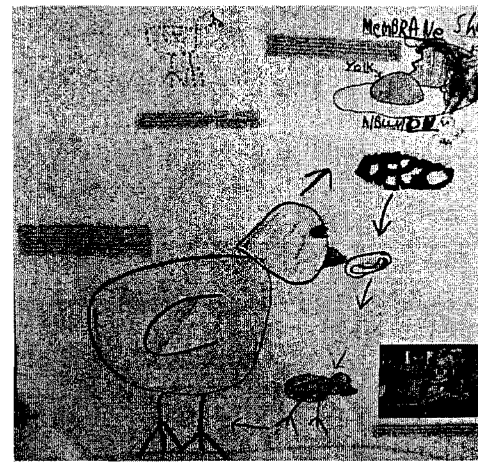
Charlene: Excellent! Tell me about the difference between living in the river and living in the ocean for a salmon.

James: They have to smell their way back home. The river is fresh water and the ocean is salt water so they can't live forever or lay their eggs in salt water 'cuz the eggs would just die. Their body changes so they can go back and forth between the river and the ocean.

James' panel and transcript shows clear evidence that he understands the scientific concepts of camouflage, life cycle, instinct, and anadromous. He uses specific vocabulary accurately. His words and artwork merge forming a more complete picture of the complexity of his knowledge and understanding.

The labels in both James and Nikita's life cycles support the information in their drawings with a minimum of written words however, their conversations contained rich, detailed information about Atlantic salmon.

Stephanie used a combination of drawings and artifacts made in class to create the life cycle of a chicken. The brown nest of eggs includes a diagram of the parts of an egg, which she completed as a class assignment. She said about including it on the panel, "This paper shows the inside of the eggs so you know what's inside...the different parts inside." The arrows indicate the continuous cycle of development in the life of a chicken.



Stephanie said, "Well, it's about the life cycle of a baby chick and all the arrows show us it's a life cycle. Because the arrows tell us what comes before the other thing. The hen lays the eggs which the chick grows inside and it cracks the egg open for one whole day and then it turns into a hen or maybe a rooster. Then it does it all over again. That's a life cycle."

Maps

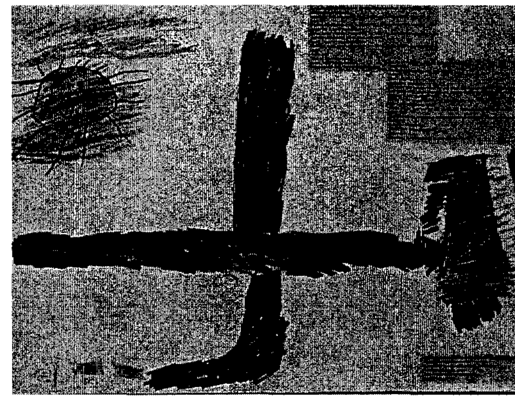
We often think of maps as an expression of landforms and geography. A map also places information in its special context and allows us to locate a subject in relation to ourselves (Moline 1995), as such, maps can be used across areas of study. In the world of science, maps are used in every field of study including astronomy to map constellations and the universe, biology to map the human brain or butterfly migration, and ecology to map endangered habitats or the range of a grizzly bear (AAAS, 2001, p. 137). My students have made maps on documentation panels that pertain to the estuary and vernal pool. Both are geographic landform and lend themselves to the creation of maps. Maps show spatial connections, define territories, and show change over time. Some of the maps included on documentation panels show a specific place using a type of bird's-eye view.

Young children often draw from the perspective of overhead, "...they seem able to understand, and to render, how things look from a bird's-eye view" (Hubbard, 1989, p. 82). Most people think of a bird's-eye view as a picture of an area from the perspective of directly overhead. Bird's-eye view also includes the view from overhead at an angle as well as a side view of the same area (Moline, 1999). This type of view is called a side view or an elevation.

When Emilie and I looked at her panel about vernal pools, I said, "It looks like a bird's-eye view. Do you know what that is?"

Emilie responded, "It means like, if I was a bird flying over and I looked down, that's what it would look like. And that's what this bird (pointing) is doing!" The bird she is referring to is in the extreme upper left corner near the tree. The tree goes out of the picture creating depth in this bird's-eye perspective. The vernal pool and surrounding grassy area is clearly delineated. Emilie clearly understands and made use of a bird's-eye view to map the vernal pool and some of its inhabitants.

As a kindergartener, Austin studied estuaries. His documentation panel shows the road, driveway, and parking lot at Wells National Estuarine Reserve, from the perspective of overhead, complete with the school buses that transported us, labeled with numbers. Austin's map includes the boardwalk to the scenic overlook. The grass of the estuary

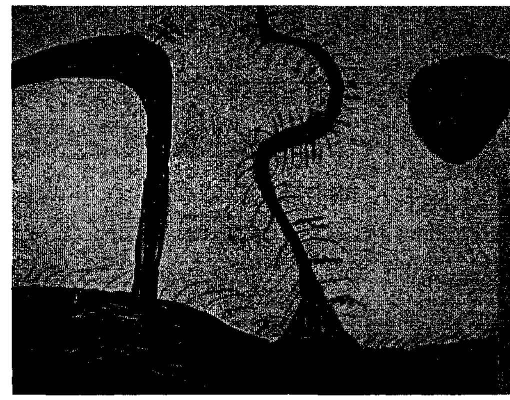


and the ocean is visible at the far right edge of the panel, just beyond the lookout platform. Austin was interested in cars, trucks, and heavy equipment at the time. I was fascinated that he remembered the bus numbers! He said, "This is the lookout and the wavy grass and the ocean and the place for the buses. We went on bus eight and bus one. This is one of the bus drivers." I think Austin enjoyed being at the estuary, however, his personal interest was the bus trip, the road, and the parking lot all of which are the main focus of his panel; the estuary is represented minimally. Our

conversation revealed Austin's understanding of the basic elements of an estuary.

Gabrielle's map of the estuary is a straightforward bird's-eye view of the geography of the area. She has clearly delineated the major parts of the estuary; river, muddy marsh with marsh grass, beach, and ocean. She included "These little pools of water where deers and racoons can drink and ducks can live." When I asked her what was important about the estuary, Gabrielle replied, "It's a kind of habitat. Fish live in the river and they can also live in the ocean. Deer, raccoons, foxes live in the grassy area were they can hide from predators."

Allie, a second grader, included more visual detail in her map of the estuary. The river flowing to the ocean and the estuary where the river meets the sea was the focus of the science unit. In Allie's panel the river and ocean converge as indicated by the dark blue triangular waves intersecting the lighter blue river. She has included the beach and marsh



grass along with a pond in the upper right corner. Allie also included a trail that she walked on when we visited Wells Reserve. Her trail is marked with a signpost indicating the direction to the beach and the direction back toward the visitor's center. The signpost and boardwalk are recollections of her experience and indicates an awareness of beginning map awareness as well as human impact on this environment.

Amanda's estuary map shows the river meeting the ocean. She included the marsh grass and noted that along the outer perimeter it is dead, indicated by the yellow and brown lines. She wrote, 'the grass is important to the estuary. Do not pick estuary grass.' Then she proceeded to explain how the roots of the marsh grass keeps the mud and earth in place "The job of estuary grass is to hold the mud

and not let go" and a likely scenario if the grass were removed from the estuary. "The mud would go into the middle of the water and be sort of blacking it and the water would eventually overflow and be like a beaver dam causing the water to form another pond." Amanda chose to place a deer in the grasslands and fish in the ocean. This indicates her understanding of the estuary as a habitat for animals and their place in that habitat.

Stephanie's estuary map differs significantly from those mentioned earlier. The blue river leads to the ocean. The wavy lines indicate both the river moving downstream and the action of the waves in the ocean. I did not ask about the muddy marsh area but Stephanie volunteered when pointing it out, "which I don't have to color because it's almost the same color as the paper." She placed artifacts made in class that represent the different areas along the way creating the context for the map. She began with a discussion of predators and the food chain.

Stephanie: There's grass there so animals can hide from predators.

Charlene: Can you give me an example of an animal that might hide there?

Stephanie: A heron might be hiding in the grass because there might be a very mean animal there that eats herons.

Charlene: What kind of animal might eat a heron?

Stephanie: Wolves from the uplands, weasels.

Charlene: Those are definitely predators.

Stephanie: It's kind of a food chain.

Charlene: Can you explain 'food chain'?

Stephanie: Herons eat shrimp, fish, and crabs. Seals eat squid, crabs, eels, and fish- they eat four things, which I had to make an extra box on here because there were only three. And clams eat plankton.

Stephanie correctly placed the heron in the grassy marsh, the clam in the muddy marsh, and the seal in the ocean. With words she describes specific food chains and refers to the map in which she has demonstrated the specific living areas of the animals in the larger habitat of the estuary.

Side Views or Elevations

Like a bird's eye view, a side view or elevation is an interpretation of the world from another perspective, specifically, from the side. Sometimes children can make observations from this perspective, looking at the interior of a room from the door for example or watching fish in an aquarium.

Elizabeth provides an underwater view of the vernal pool, which can be classified as a side view or elevation. She includes many of the animals that live there and the depth levels they occupy. The salamanders are at the bottom of the pool among the leaf litter, "to hide from predators" she said. The fairy shrimp are swimming at a mid-depth range and the tadpoles and frog egg masses occupy the upper level of the water where, Elizabeth reports, "you can see them floating on top". Tadpoles tend to bask in the shallows near the bank. The fairy shrimp we saw and were able to catch were in the deeper section toward the center of the pool. While the depth of a vernal pool varies depending on season and amount of snow and spring rains, Elizabeth's map provides an accurate picture of life zones, early in the spring at the highest water stage of a vernal pool. Elizabeth's documentation panel depicts two levels of habitat. First, it illustrates the vernal pool as a general habitat for plants and animals. The second and more complex plane shows various animals occupying a niche within the pool.

Austin's side view or elevation of the ocean and the life cycle of salmon shows complexity of thought. At the upper level or top of this documentation panel is the water, the underside of a boat is evident with the oar hanging into the water. The squiggly lines from the rays of the sun depict heat "going to the ocean." The mid-range of the ocean contains the focus of our study, the life cycle of the salmon along with some floating seaweed. The ocean floor is complete with rocks, sand or dirt, a crab walking along, and seaweed anchored to the bottom. Austin lives on the beach and has a unique perspective and understanding of the line where the water and land meet. He talks about his discoveries in tide pools and what washes up after a storm. Austin chose to include some of his prior experience and knowledge on his panel along with the life cycle of the salmon.

Like Elizabeth, Austin has created a global kind of water habitat and increased the complexity by placing animals and plants in specific zones.

Kinesics and Gestures

Kinesis, defined by anthropologist Birdwhistell (1918-1994) is the "systematic study of how human beings communicate through body movement and 'gesture.' [It is] also the systematic study of the visually sensible aspects of nonverbal interpersonal communication" (Noth, 1990, p. 393). Many students use gestures when they speak to help create meaning. These are often hand gestures and sometimes include more or all of the student's body. Hand gestures are one of the most common forms of marker (Harper, Wiens, & Matarazzo, 1978, p. 124). An idea or concept can be demonstrated kinesthetically, acting as a wordless explanation or as an emphasis to the verbal explanation. Verbal and nonverbal communication are integral and inseparable parts of the total communication system.

During our conversation about frogs in the vernal pool, Adrienne said, "their tongues go out" as she placed her finger near her mouth and flicked it outward demonstrating how a frog uses its tongue to catch insects.

Harold and Emilie used identical hand movements to help them describe the locomotion of fairy shrimp.

Harold: …we brought back a fairy shrimp
and they are my favorite animal in the vernal pool 'cuz they move their legs like….it's weird…..they kinda go like (moves his hands rapidly back and forth in staccato waves right in front of his chest)…It's weird.

Charlene: You just moved your hands to show how the fairy shrimp move their legs. They do swim in an interesting way, don't they?

Harold: Yeah, they're like, upside down.

Charlene: Right, they are lying on their backs and they just swim around.

Harold: I thought these (indicating the legs with more staccato waving of his hands) were just tentacles to help them swim and this was their belly and this was their head (pointing to *his* belly and head) and they just go like this (more hand movement).

Charlene: So you thought the legs were tentacles?

Harold: Yeah. To help them swim...then I figured out they were really their legs...but they do help them swim.

Emilie used the same hand movement in her description.

Charlene: What do you know about fairy shrimp?

Emilie: That they don't really walk but they float on their backs in the water. Their legs go like this (short staccato waves with her hands).

Charlene: I like the way you are moving your hands to show how their legs move. That really is the way their legs work, isn't it? They have a lot of legs.

Emilie: Twenty-two.

Actual fairy shrimp

The context in which certain body movements occur is crucial as they can not be understood in isolation. Because I saw the fairy shrimp propelling themselves through the water, the staccato hand movements of Harold and Emilie are easily recognized and understood in the context of our conversations.

When telling me what she observed in the alevin stage of salmon development, Brianna pointed to her back to indicate the word she was trying to find.

Brianna: Sometimes you can see its heart beating.

Charlene: Really? What else did you see?

Brianna: I can't think what it's called...(touched her back)...vertebrae?

Charlene: You could see its vertebrae, its backbone?

Brianna: Yes. Because fish have backbones.

This simple gesture provided Brianna with a physical indicator to accompany the question in her voice about using the term 'vertebrae'. It also confirmed for me that she was indeed talking about observing the salmon's vertebrae.

As we talked about the changes to the vernal pool throughout the year, Savanah moved her hands upward while rotating her wrists about 45 degrees in both directions and said, "It's so hot that the water just melts away in the air or it goes down into the ground."

Charlene: It could be absorbed into the ground. But you were doing this movement with your hands. What is that?
Savanah: It's going up to the sky.
Charlene: Do you remember that word…?
Savanah: (hesitantly) Evaporating…
Charlene: Evaporating, evaporation, right! You got it!

When Savanah used her hands to convey an idea about 'water melting away in the air' I knew she was thinking about the process of evaporation. Because I invited her to think about the word and remember it, she was able to.

During conversations about incubating and hatching chicken eggs, six-year old Christina relied on her ability to demonstrate her understanding of information through kinesthetic means:

Charlene: How does the chick it in there with all the other things inside the egg?
Christina: Well, the egg is hard and it kinda holds it until it can't hold it no longer (the fingertips of both hands are touching and she is shaking her hands to emphasize the egg being full).When it covers up the inside of the whole shell, like (demonstrates being very small with her body curled up in a ball) then it starts to peck out "peck, peck, peck" and he starts to get out.

Later in our conversation, I ask:

Charlene: Do you know how chickens eat?
Christina: Yeah, they do this (opens and closes her mouth while moving her head forward and back).

As she was explaining how to balance an egg using various materials such as cubes and counters, Christina's use of her body made clear her understanding: she knows how a pan balance works as well as the concept of balanced, which she calls 'equal'. This conversation accurately reflects the answers on her math paper

Christina: We weighed an egg and seen how many of those can weigh equal. This is what they weighed...Pretend I'm the weigher (extends both arms to the side, in the fashion of a pan balance) and I put twelve cubes in here (indicates one hand) and one egg in here (the other hand) they would be equal (extends her arms indicating balance).

Interested in the way she was using her arms to demonstrate 'equal' I asked Christina some questions based on the answers on her math paper.

Charlene: What would be heavier, nine crayons or the egg?
Christina: The egg. Because the egg would weigh more (lowering one hand, indictating greater weight) and the crayons wouldn't (raises her other hand) because it's not the right number.
Charlene: What if you had six scissors and the egg?
Christina: The scissors would weigh more, like this (again, Christina indicates imbalance with her hands. She raises her 'egg hand' and lowers the 'scissors' hand.)

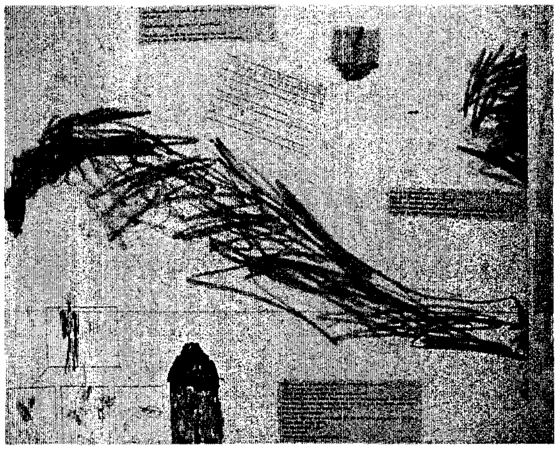
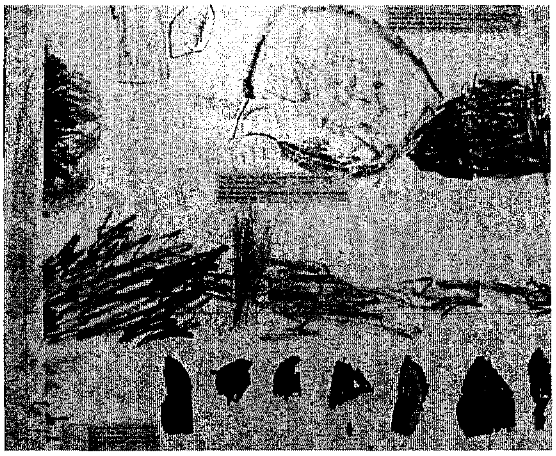
Christina understands the concept of the comparative terms more / less. She uses the word 'more' in her explanation. The term 'less' is implied through the use of her arms acting as a pan balance and as the inverse of her use of the word 'more'. Illustrators are speech-related gestures serving to illustrate what is being said verbally. They have an iconic function of reference, that is, they represent an image or serve to represent something as in a movement. The semantic relation between language and illustrators can be one of emphasis, repetition, substitution, complementation, or contradiction.

Alex: A Look at One Student

The following case study offers a glimpse of the cognitive changes one student demonstrated through successive documentation panels created over a three-year period. Examining the panels of one student enables the teacher to document academic growth in science as well as other curricular areas, including reading and writing. Developmental issues such as fine motor control, changes in artistic expression such as perspective and the development or progression toward organization skills are evident.

Alex was a student in my class for the first three years of his public school experience. He was born in Russia, taken to an orphanage within days of his birth and spent his preverbal years in that situation. Alex was adopted and came to live in Wells, Maine after his second birthday. Although English was not his first language, it didn't take long for him to become a master of conversation and quickly forget his native language. Alex often relies on humor and his ability to negotiate verbally when faced with a difficult situation at school. Using the documentation panel as a mediational tool, Alex is able to construct and represent what he knows about various science topics.

During his kindergarten year, Alex made a panel based on our unit about the estuary. He used a combination of class made artifacts and spontaneously generated artwork depicting the estuarine habitat that we explored on a class fieldtrip. The river and a pond are central to the panel and created with large controlled strokes. Alex used more than one color of blue to depict the water. The waves where the ocean and river meet are bold and face back toward the river; Alex states, "This is the waves and that says 'the river meets the sea'," indicating a piece of lined paper with invented spelling in his handwriting.

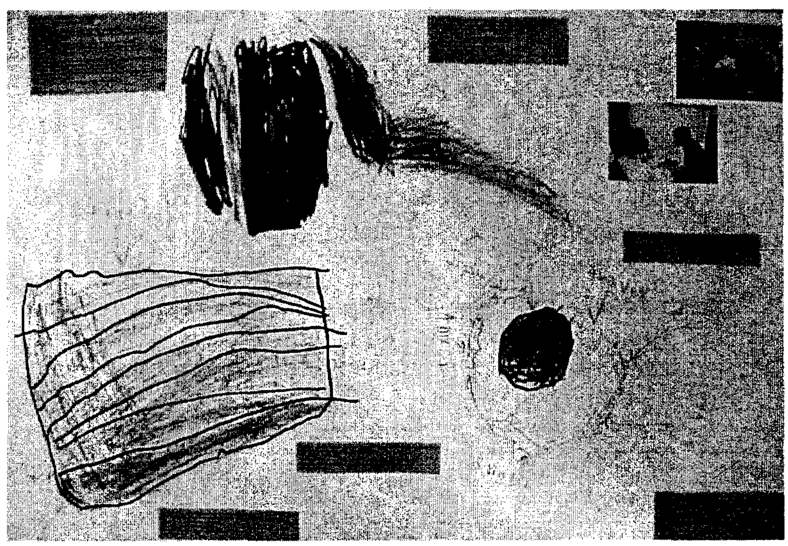
 

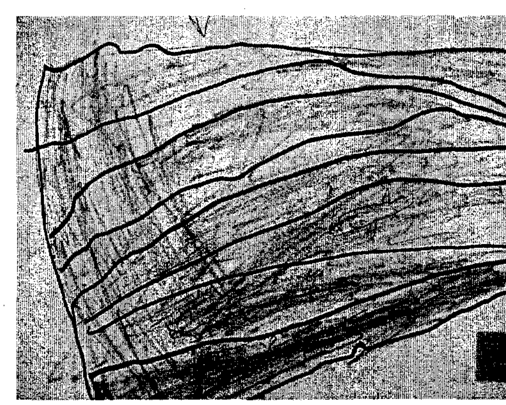
Alex took care with the drawing and coloring of the ten houses around the perimeter of the panel. His initial response in talking with me about his panel was a quick overview:

> *Alex:* This is the woods because it has some logs in it and rocks like there is. These are some houses like we saw and these are all the animals that we can see there. This is woods and the orange is a big house that we saw. I have made some houses right here but when you look over there, it's a house, it's right side up. This is waves and that says "the river meets the sea." This is the mucky marsh that splits the water in twos.

Over the course of our conversation about his panel, Alex states one of the defining characteristics of the estuary environment: *an estuary is where the river meets the sea.* This is one of the important facts I want all of my students to learn. The unique concept of *estuary* is relevant to our study because a large portion of the east side of the town of Wells borders the Wells Estuarine Research Reserve. Alex's illustrations on the panel clearly indicate most of the elements of an estuary: river, ocean (with waves), pond, marsh, and the forest, an element unique to the Wells estuary. He mentions all of those elements plus he talks about the beach, as well. One of his class made artifacts depicts the basic food web of a heron; they eat crabs, fish, and shrimp. Alex has a global understanding of the estuarine habitat and some of the animals that live there.

A year later, as a first grader, Alex's panel documents what he knows about Atlantic salmon. Like his estuary panel, this panel also depicts important elements from a class fieldtrip to the Saco River Fish Hatchery. There are three large expository pictures on the panel: a fish trap, a dam, and the life cycle of the salmon. Alex did not include any class made artifacts from activities or assignments on this panel.





The fish trap shows a black grate over blue water. If you look closely, Alex has drawn four fish swimming in the water. He has written a label: *trap* with an arrow pointing to his drawing.

Alex: This is the trap that we saw that had all the water in it that we walked over.
Charlene: Oh, is this the sidewalk thing…
Alex: …yeah, that we walked over.
Charlene: Oh wow! It's kind of like a bird's eye view.
Alex: Yep!

The dam is two solid looking brown rectangles on either side of the water with a waterfall pouring over the side. Alex was able to observe the dam and river at the hatchery while on our fieldtrip. Alex labeled this picture *Dam* and has two arrows pointing to the brown areas indicating the dam itself and clearly separating the dam from the water in it. The lessons I taught about salmon included some information about dammed rivers and the problems encountered by migrating salmon. The following excerpt from Alex's panel reveals his firsthand observations and understanding of the situation.

Alex: And this is the waterfall that we saw.

Charlene: Can you explain this whole dam and waterfall thing? What's going on?

Alex: It's where the salmon couldn't really go through so they would have to take a path to go all the way to here (pointing to the trap). They have to get sort of trapped and that leads them through the....

Charlene: ...umm hmm, right. It leads them through this trap that you are showing here. So what do the people do?

Alex: They trap them and then they let them go up here so they get actually around the dam instead of going through because they can't go through.

Charlene: How do they get around it?

Alex: They have this sort of little path with corners and they go through it. They go here and then up there (pointing).

Charlene: So, the fish can swim through this other pathway?

Alex: Yep! ...they built this red motor thing [the power generator] so fish couldn't go which didn't help them.

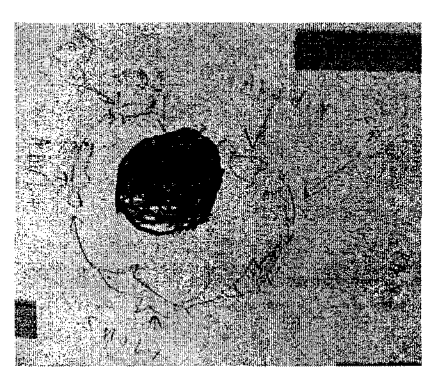
Charlene: It didn't help the fish, why not?

Alex: Because it was where they put the dam.

Charlene: Right, and the dam blocked the river so...

Alex: ...so they couldn't lay their...they couldn't sponsor.

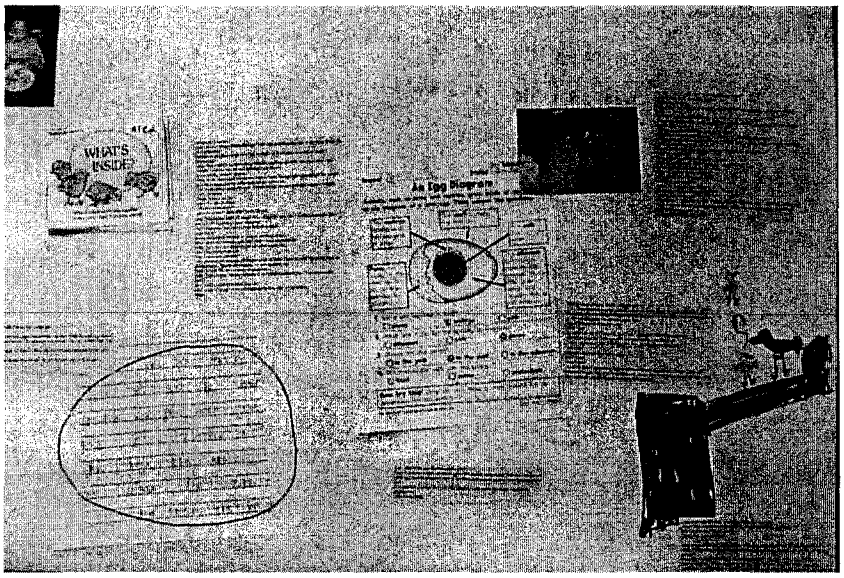
Charlene: Right, they couldn't spawn. Exactly!



The graphic Alex created of the salmon life cycle is set up in a circle beginning with the egg, ending with the two forms of adult salmon, adult and kelt, implying spawning or "sponsoring". Alex labeled each of the seven stages connecting the labels with the appropriate illustration with an arrow. Labeling pictures is a common practice in my classroom, as they are in many primary classrooms (Newkirk, 1989). There are smaller arrows between each stage establishing the direction and cyclical structure of the illustration. These arrows can be interpreted to mean "changes into" or "grows into." Alex includes some significant details within the drawings including the shape of the alevin with the large stomach sac, and the camouflaging spots at the parr stage. The egg however, is the most detailed and largest component of the life cycle. It is orange with an eye spot on it. When I asked him about this egg picture he said, "The egg is the first stage that I knew about. It's also the most important one because if there isn't any eggs there can't be any more salmon."

Alex is able to clearly articulate through his artwork and discourse information about Atlantic salmon, their environment, life cycle, and about human interventions with this endangered species.

The following year, my class studied chicken eggs and chicks. Alex's second grade documentation panel looks quite different from earlier panels. He used five main elements: three class assignments, one small illustration made specifically for the panel, and two statements of fact written across the top. The first fact about candling the egg is a statement based on his experience as an active learner in the class. The second fact is his recall of a statement I made during class.



Alex: On the top I wrote two facts. *'If you look on a powerful light you might see a red dot'. 'There are many different kinds of hens'.*

Charlene: Explain to me about the powerful light.

Alex: In the other room there's an old movie projector that you use to see inside the egg. So, it's pretty powerful.

Charlene: What does the red dot mean?

Alex: The red dot means that there is going to be a chick hatching inside.

Charlene: When we looked through with the powerful light, that's called 'candling the egg'. Did you get to see anything inside the egg?

Alex: I looked two times and I saw some veins and that kind of stuff.

Charlene: Yeah? Anything else?

Alex: I didn't really see the red dot, though.

Charlene: Okay, but you could see the veins...?

Alex: Yes. And I saw it move.

Charlene: Wait! You saw it move?

Alex: Yes, I saw it move twice.

Charlene: Wow! You sure are lucky! Here it says, "There are many different kinds of hens." What does that mean?

Alex: It means that when I was going to draw a hen, you said there are speckled hens, black hens, brown hens....

Rather than using one word labels like he did as a first grader, Alex wrote sentences on this documentation panel. There is also a shift from original drawings made on the panel to the inclusion of pre-made class artifacts as the support for his knowledge about chicks and eggs.

Alex included an egg diagram paper from a class activity. It labels the various parts of an egg and defines the purpose for each. He labeled it with a complete sentence rather than the one-word labels on the earlier estuary panel. He wrote, "This is a paper about eggs." He also included a story he had written in class and labeled it, "This is a story about a egg." Underneath the book *What's Inside?,* he wrote, "This is a book about chicks." His labels have become titles, reflecting the notion that he has to write complete sentences, a skill on which he had worked diligently all year in his Title I reading class.

Spelling words and writing stories or information had always been challenging for Alex. As a rule, he didn't like to write during writing or literacy time and avoided it as much as possible. Alex was a succinct writer. Unlike his verbal expostulations, he wrote short sentences containing little or no elaboration. However, in the panel he included a story he had written indicating his willingness to write as well as his increased understanding and ease with the written word.

Alex: Here is a story that I wrote that I really like.

Charlene: Would you read it?

Alex: "One day there were two eggs. One hatched. One died while the other egg hatched in a classroom. A chick hatched. The classroom was amazed. They got to hold them. They loved it."

Charlene: That's a really nice story. It's almost like a true story for what happened in our class!

Alex: Yes. Yeah, I like it.

With each successive year, Alex had more to say about the topic we were studying. The length of his kindergarten transcript about the estuary is one page; he had one and one half pages worth to say about salmon. As a second grader, the transcript of Alex's chicken egg panel is two and one half pages long. Reading and writing had always been challenging for him and as a fourth grader, he was diagnosed with an ocular tracking deficiency, a result of the time he spent in the orphanage during a vital developmental period. Given the opportunity to draw and talk about what he knew about each science topic allowed Alex to be successful as a learner and to demonstrate his knowledge about them, something that would have been quite difficult for him to do if given a multiple choice test or essay assignment.

Assigned Artifacts Only

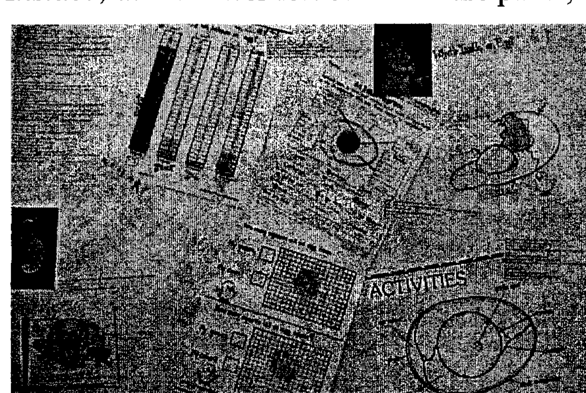
Throughout a science unit, I assign my students a wide variety of activities and experiences that will enhance their understanding of facts, processes, or concepts. Some units, including our study about chicken eggs, involve a greater number of activities that students make and collect, while other units have many experiential activities, such as our work with Atlantic Salmon and the vernal pool. Each student reviews all the artifacts he made at the end of the unit, prior to making the documentation panel. As discussed earlier, some students look at their work and choose a few artifacts to include in their panels. Others choose to create a documentation panel comprised entirely of artifacts already completed in class as assignments. The visual elements of these panels are predictable in that the student has already worked with the material or artifact. I find it interesting to see which artifacts are included and which ones are not. This is unpredictable and student reasons for their choices range from "I don't know,' 'I liked it,' 'I did a good job on it,' to 'I learned something.'

Occasionally, the student will begin our conversation by talking about one artifact and will repeat the directions or tell me how he made it. Other students do a quick overview of the artifacts on the panel, often pointing to specific artifacts: 'This is a story.' 'This is a paper that says what's inside.' 'This is when I counted.' This overview grounds me and the student in his work but does not give me any information about science learning for the student. An overview or repeating directions signals me to prompt him to talk about what he learned from the activity or why it is important to include on the panel.

In the following section, I will examine the chick panels of three students, all of which are comprised of assigned artifacts only. The artifacts represent both the specific learning that occurred during class while doing the assignment and the scaffolded learning that connects those discrete assignments creating a context or web of understanding. I will examine the visual and conversational texts of Zach, a Kindergartener, Doug, a first grader, and John, a second grader, all of whom created documentation panels using only class assigned artifacts.

Learning about the life cycles of animals is one of the fundamental concepts included in the National Science Education Standards (1993, 2001, 2002). Discovering how a chick develops inside a shell brushes the surface of thinking about animals at the cellular level (MSLR, 1997), an important biological concept for older students.

Visually, Zach's the placement of artifacts on his panel appears random. It looks as though he simply took some assignments and haphazardly glued them down. Our conversation revealed that Zach learned a great deal about chicks and eggs. Initially, Zach chose to talk about the book, *What's Inside?,* at the lower left corner of the panel, because "it shows how chicks grow in an egg."



Charlene: What can you tell me about how chicks grow in an egg?

Zach: First they are a round circle thing. It starts as a circle. The dot here, it shows that a chick's gonna grow.

Charlene: Okay, so that red spot shows that a chick is going to grow. I got it. Then the next page shows that a chick is growing! Tell me about that.

Zach: Well the blood veins are coming out, connecting into the chick and the chick is starting to grow.

Charlene: You said the blood veins are connecting into the chick, what else are they connected to?

Zach: The egg…the yolk. And then the chick gets bigger.

Charlene: So the chick is getting bigger, what's happening to the yolk?

Zach: It's getting smaller.

Charlene: How come?

Zach: Because the chick is eating it for food.

Later in our conversation Zach said, "Most of the veins are in it already and the yolk is just about gone. So it's kinda like, too big for the egg, so it hatches."

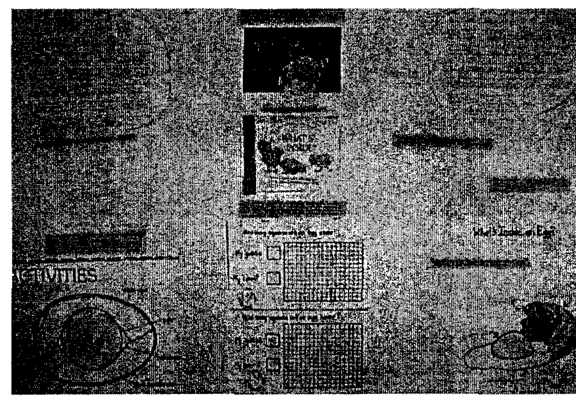
Charlene: You said most of the veins are in *it*. What are the veins in?

Zach: The chick

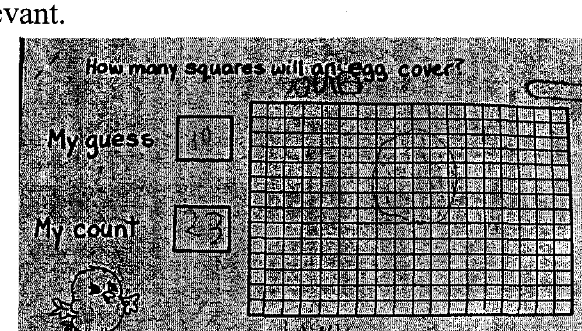
Zach was the only student to discuss the veins as a connection between the yolk and the developing chick. Most students talked about the chick 'eating' the yolk inside the shell as it is developing but Zach recalled the veins being a critical element as they "connected *into* the chick."

The students completed a math activity in which they traced around various egg stencils onto centimeter grid paper. They were to estimate the number of squares the egg covered and then count to arrive at the correct number. The objectives are to explore area and to discover that different kinds of birds lay eggs of differing size. Zach included this activity on his panel and briefly talked about it. He said, "This told me how many squares it took to do a heron egg or an owl egg. It told me how many squares it took to…." He paused, uncertain about elaborating on his answer. I asked, "What did you learn from doing this project with different sizes of eggs?" He replied, "I don't know." Clearly for Zach and some other students, this was a counting activity. He may have understood that eggs can be various sizes but he was unable to verbalize a connection between the idea and counting the squares.

Some students, like Doug, are reserved and quiet throughout the school day, focusing on their work and learning. Visually, Doug's panel reflects a certain symmetrical balance. He placed his questions and information written on egg-shaped paper at either upper corner, two diagrams or the inside of an egg are at the bottom. Down the center, Doug chose to place the photo of him holding a chick, the book *What's Inside?*, and the math activity about area. Being a man of few words, our dialogue was brief and to the point. Doug talked about each of the artifacts he included and made reference to those he did not include, "These are all the stuff that I mostly learned about chicks. Some of the stuff was math so I didn't put it on." He used and defined content specific vocabulary when talking about the two diagrams. His writing on egg-shaped paper reveals some of his questions and facts that he has learned. For example he wrote, *How do chicks get out of ther eggs? Chicks can die in ther eggs. Is ther a poaisinous kind of chick? A chick lives in a brooder house. I like chicks. Chicks have sharp feet. Ducks have webbed feet. Chicks are wet when they come out of ther eggs.* The questions and sentences are not organized which is typical of a first grader, but they are all on topic and relevant.



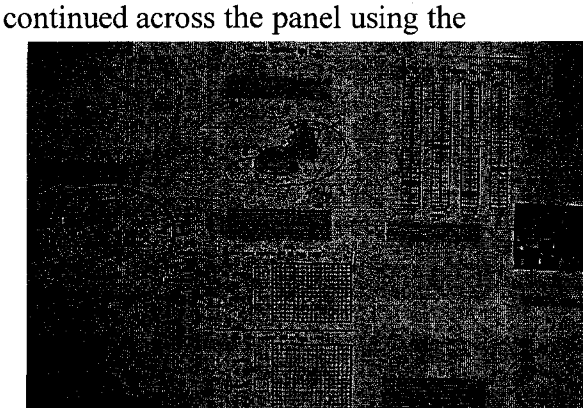
Twenty-one days is a long time for a class of young children to wait for chicks to hatch, so there is a lot of time to think and wonder about the



process. Doug's question, *How do chicks get out of ther eggs?* is focused on the end result and his curiosity about how hatching actually happens. He was able to observe a chick hatching but the mystery surrounding the event remained with him. Doug's question about whether or not poisonous chicks exist is an interesting one and directly linked to our reading and class discussions about reptiles and reptile eggs; some reptiles are poisonous.

When he talked of the math activity about the area different kinds of bird eggs cover, he said, "I counted the squares for the inside of some eggs. I guessed first and then counted….All of them are different sizes. That's so they don't get mixed up, like, if you had a hawk and an eagle egg in the same nest, they wouldn't get mixed up." He understands that all of the bird eggs are different sizes and cover different area in this activity. His reasoning about why the eggs are different sizes is interesting; "so they won't get mixed up."

John, a second grader, expresses his knowledge of chicks and eggs with ease. The artifacts he chose to include are lined up creating an orderly or 'neat looking' documentation panel. The transcript of our conversation reveals that he talked about each artifact starting at the upper left corner and continued across the panel using the directionality of a reader. Unlike Doug and Zach, during our conversation, John points out the lessons that helped him learn something. For example, he said, "This diagram is about an egg and I think it really helped me learn all the parts, so I put it on" and "This is another diagram that



helped me, too." When discussing the math activity about area, John said, "This is a packet that shows different eggs, pictures of eggs. This activity helped me learn that eggs are different sizes, so I learned how big some eggs are by counting the number of squares for each one." This is a clear statement about both the math activity (area) and the concept that different birds lay different sized eggs. This assignment demonstrates one way in which I integrate curricula; for many of my young students, like Zach, it is clearly a counting activity. For my older students they are able to understand it is a math lesson utilizing the fact that different birds lay eggs of differing size. Doug understood how the lesson connected math and bird eggs. John clearly understood that bird eggs are different sizes and said so. Knowing how to calculate and measure area in square centimeters, yards, acres, or miles is used in the study of ecology and organisms. Calculating the size of a ponderosa pine and the number of pine beetles that inhabit it or knowing the range of a wolf and determining how many a state park can successfully accommodate have implications for continued study in ecology and biodiversity. Although the relevance of this activity was interpreted in different ways by these students, it helped create a connection between a math skill (counting and determining area) and a science concept (the similarities and differences between subspecies).

Students can be successful in the creation of documentation panels using only artifacts generated in class as assignments. The artifacts act as touchstones for students, activating memory and generating conversation.

CHAPTER 5

THE CONVERSATIONAL TEXT

To most truly teach, one must converse; to truly converse is to teach.
(Tharp & Gallimore 1988, p. 111)

I use the words 'conversation' and 'talk' throughout this dissertation as I attempt to explicate what occurs between my students and me as we discuss their documentation panels. Both terms imply an informal spoken exchange and are inadequate and nonspecific to the actual event. Yet, as I say to my students, "Let's talk about your panel" or "Let's have a conversation" but what I mean is; "I am so interested in what you have to say that I need to engage you in a dialogue about it." For me, engaging in dialogue with my students individually is an extension of our class and group discussions. Because throughout the day we engage in conversation, discussion, and dialogue, I know my students as human beings and as learners. We are comfortable with each other as a result of doing the hard work of learning together. Nel Noddings (1992) defines dialogue as more than just talk or conversation.

> Dialogue is open-ended; that is, in a genuine dialogue, neither party knows at the onset what the outcome or decision will be...Dialogue is a common search for understanding, empathy, or appreciation. It can be playful or serious, logical or imaginative, goal or process oriented, but it is always a genuine quest for something undetermined at the beginning. (Noddings 1992, p. 23)

The dialogues around documentation panels are grounded in a science topic and therefore determine the subject of the dialogue. How and what a student chooses to talk about within that topic is up to him. These dialogues are an open-ended invitation from me to my students to explore their individual understanding and knowledge.

Examination of my part in these dialogues reveals that I respond to my students with questions and comments that are specific to the individual. I do not set out with a battery of established questions that I must ask and that students must answer. Open-ended questions generate divergent responses. The questions I ask may probe for understanding, elicit predictions, reflect on feelings, or serve as a catalyst for discovery (Harlan and Rivken 2004). I am interested in what my students have to say. I am interested in how they make connections that help them think and understand science. According to Martin Nystrand (1997), when

> [T]eachers validate particular students' ideas by incorporating their responses into subsequent questions…[it is called] 'uptake'. In the give-and-take of such talk, students' responses and not just teacher questions shape the course of talk. The discourse in these classrooms is therefore less predictable and repeatable because it is 'negotiated' and jointly determined…by both teachers and students as teachers pick up on, elaborate, and question what students say (pp .6- 7).

I do not want my students to parrot back memorized facts. I want them to think, interpret, make connections and generate new understandings of everything, not just science. Then I want them to talk about it with me. These dialogues

> engage students because they validate the importance of students' contributions to learning and instruction. The purpose of such instruction is not so much the *transmission of information* as the *interpretation and collaborative co-construction* of understandings. In this kind of classroom talk, teachers take their students seriously (Nystrand, 1997, p. 7).

Tharp and Gallimore (1988) refer to this kind of teacher – student talk as 'instructional conversation.' Although they argue that the

> task of schooling can be seen as one of creating and supporting instructional conversations...It is through instructional conversations that babies learn to speak, children to read, teachers to teach, researchers to discover, and all to become literate (p. 111),

Tharp and Gallimore (1988) and Nystrand (1997) conclude that this type of conversation occurs rarely in today's schools. As a teacher it is essential that I check on student learning throughout the school day and across curricular areas. In the case of the documentation panel, I am able to ask a student to clarify a statement or provide me with more information during our conversation. I check for the understanding of vocabulary words, science concepts and processes. At other times, I ask for clarification about the artwork itself, as I may not readily recognize what the drawing represents. This kind of questioning or asking for clarification to meet the needs of the curriculum is less a dialogue and takes on more of an instructional conversation tone.

In a 1995 study on teacher talk and comprehension Troy Mariage determined that teachers who spend time during dialogue to scaffold student responses, encourage risk-taking, and transfer control to the students were found to be more effective in allowing students to make connections and generate meaning (Mariage 1995, p. 214). Mariage calls this "high-gain" teacher talk. These high-gain teachers engaged students in dialogue that allowed a wide range of responses in the construction of meaning. In this study, meaning was co-constructed, "with the teacher serving as coach, model, and apprentice...in conversations in which the teacher [was] not assumed to know the single correct answer..." (p. 217).

Classroom discourse is comprised of a wide range of genres and in the course of any given period of time, the type of discourse changes. Those changes are fluctuations in the range of discourse, selecting and using the genre that best suits the moment. Once I have determined what the student knows about specific vocabulary or essential points of information we can discuss the topic in a more interpretive way, resulting in dialogue. Understanding what a student knows determines the kind of scaffolds or assistance I provide. "Scaffolded instruction underscores both the role of the teacher and the role of the student as coparticipants in negotiating meaning and in informing the nature of the instructional conversations" (Many, 2002, p. 379). These dialogues or conversational texts about the documentation panel consist of negotiated meaning based on science learning. Dialogue is central to negotiated meaning and it is essential to cognitive development (Vygotsky 1978). According to Many (2002),

> conversations in which students are engaged and are coparticipants... exemplify the importance of nonevaluative collaboration...a form of shared responsibility, where participants work together to achieve new learning, in contrast to discourse in traditional classroom contexts where teachers focus primarily on evaluating previous learning (p. 379).

In examination of the transcripts, I considered my conversational engagement with individual students. The types of questions I ask and the kind of or amount of support I provide for students as they talk to me about their understanding of the topic may reflect guided participation and apprenticeship (Rogoff, 1990), higher level thinking skills (Bloom 1956) and evidence of higher mental functioning (Vygotsky, 1978). To what extent am I challenging a student to say more? Do I 'lead' a student to an answer or allow her to formulate her own?

With every documentation panel, I ask my student to tell me about his work. I initially acknowledge the artwork, the size, or the complexity of the panel aloud and then invite him to talk with me about it. I am interested in my students' thoughts and understandings of the science topic; I want to know as much as I can about what he knows. This dialogue provides my student with an opportunity to explain what he knows about the topic and it allows me to check for understanding of specific points or facts that I want my students to know. It also allows me a glimpse into the remarkable workings of young minds.

I find it interesting that I can rarely guess what the student will begin talking about or where they will start in relation to the artwork on the panel. As our dialogue develops, I ask for explanations, for more details about specific comments made by the student. As with all conversations, many nonverbal cues exist in the plane of conversation that enrich it and allow for the creation of meaning between the speaker and the listener. Facial expressions, vocal inflection, gesture, and hesitancy occur frequently in the conversations I engage in with students about their panels. While I tape record our spoken words, I cannot easily record or in many cases, years later, recall specific nonverbal cues. My understanding of a student's comments is based not only on what she says but also on the nonverbal cues that occur during our conversation. Often, I ask the same questions of many students about content or defining vocabulary to fulfill the underlying demands of science learning. My knowledge of the activities, lessons, and discussions the class has had about the topic as well as my observations of the student's participation and interests leads me to ask certain questions of each individual. Recorded and transcribed conversations create a unique record of science learning for every individual in my class.

When I examine all of the transcripts from my students, I am able to see a more complete picture of my teaching. The concepts and facts I emphasized and the processes I explained are evident because I can see them in the visual text of the panel or they occur repeatedly in our conversations. However, it is student response that continues to make documentation panels compelling for me. Nystrand (1997)states, "Ultimately the effectiveness of instructional discourse is a matter of the quality of teacher-student interactions and the extent to which students are assigned challenging and serious epistemic roles requiring them to think, interpret, and generate new understandings". (Nystrand 1997 p.7). The panels act as a mediational tool for student learning. Documentation panels are evidence that students transform classroom experiences into learning.

Vocabulary and Definitions

"Well, frog mass means eggs only some people just say frog eggs. But, the scientific word is egg mass." *Sarah, age 7*

Science lessons require specific vocabulary that consists of words that are used and have application to a particular scientific idea or concept. This technical vocabulary needs to be taught so that students understand the meaning and importance of the words and their relation to the concept. I use the vocabulary of science with my students whenever I can. When a student tells me he got a new puppy, I first ask its name, and then I ask, "Is it male or female?" rather than, "Is it a boy or girl?" When a student talks about a television program in which she saw lions hunting and killing a gazelle, I ask about her interest in it and then I ask, "Do you remember the scientific name for a hunting, meat-eating animal?" Using appropriate gender terms or asking students to recall specific words and definitions reinforces the idea that science vocabulary has value in places other than the science lesson or assignment. When my students are initially learning science vocabulary words I support that learning by using similar words interchangeably. For example, I might use the words *embryo* and *developing chick* or *cranium* and *skull* interchangeably. This provides the students with a familiar word as they learn the more scientific term.

Current research in the teaching of reading finds that understanding and use of vocabulary is connected to reading comprehension. "Substantial knowledge of vocabulary provides many benefits to the speaker, listener, reader, and writer. It is the single most powerful predictor of how well a reader understands text" (Burns, 1999, p. 184). Young students at the emergent and early stages of reading may not be able to read science specific vocabulary words in text however, it is my contention that they can learn those words through listening to books read aloud and through class discussions about the science unit under investigation. By participating in class science activities and conversing with others about their questions (hypotheses) and discoveries (findings or results) young students are able to correctly use science vocabulary to talk about their learning.

Documentation panels support the knowledge and use of content vocabulary by young students. Students can create representational drawings of science vocabulary and they can use that vocabulary to describe the drawings as well as their understanding of the concept or process. During our conversations, I listen for a student to use content specific vocabulary as she identifies and explains what she has learned.

Students often use specific vocabulary words accurately as they talk about the information on their panels. For example, Nikita, a second grader, discusses Atlantic salmon. She uses vocabulary specific to the salmon and other more general science content words.

Nikita: [Eggs] are orange and they have the baby salmon inside and the alevin have yolk sacks that give them food and that's the stage after eggs. And fry, they get bigger and they get fins. And parr, they get even bigger and they get camouflaged.

Charlene: What's the camouflage for?

Nikita: So predators won't eat them. And they get bigger fins and smolt get bigger and they get a different color.

Charlene: What would be a predator for a salmon?

Nikita: Some humans who might want to get them out of the water to eat them.

Charlene: What predators might be in the river?

Nikita: Dragonflies. That's all I know. Because dragonflies are bigger than the salmon at one stage and so they can eat them.

Salmon specific words include *alevin*, *parr*, and *smolt* and are necessary for Nikita to discuss the life cycle in detail. *Predator* and *camouflage* are both science content words, and can be used in many different science contexts. Nikita understands the concepts of predator / prey and camouflage because we talked about these basic biological concepts with other animals in other habitats during the three years she has been in my room. During our conversation, Nikita generalized her understanding of the predator / prey relationship and its relevance to young salmon.

I asked Marc, a second grader, "What happens to tadpoles?"

Marc: Sometimes it would be eaten by, like, a salamander and stuff.

Charlene: So, a tadpole could be prey for another animal. What else could happen to a tadpole?

Marc: Or, it could just start evolving into a frog.

He continued by explaining that as frogs grow, they develop back legs, front legs, and their tail disappears. His use of the word 'evolving' indicates an understanding of the growth and change that occurs and gives that process more importance that if he had simply said, 'grows' or 'turns into a frog.'

During our dialogue about his vernal pool panel, I asked Christopher if he remembered what 'obligate species' means. He replied, "No... Wait! Frogs and salamanders."

Charlene: Right…what part of their lives do they spend in the vernal pool?

Christopher: When they are swimming, eating…They always have to stay in there when like, a frog is a tadpole.

Charlene: When they are babies?

Christopher: And they lay their eggs there. That's really what makes them obligates. They have to come back to the vernal pool to lay their eggs.

Christopher explained 'obligate species' to me with a bit of support, however, he came to the conclusion on his own.

Zoë's explanation of the inside of a chicken egg is full of specific vocabulary. She also states the purpose of the various parts of the developing egg.

Zoë: It's important to know what the egg looks like before the chicken starts developing and when it is developing, too.

Charlene: Can you talk about that?

Zoë: Because there's a red spot. But if it was a farmer's egg it would be a white spot, that means the chick wouldn't be developing inside. But if it's a red spot that means the chick would be developing inside. And the yolk is food for the chick. And the chalazae holds it to the shell so it doesn't bonk around. And the albumen is like a pillow. The shell, of course, is the protection. The air space is where it breathes from and the membrane, I don't exactly know what that means but it covers the inside of the shell.

Charlene: Exactly. It covers the inside of the shell and helps keep the shell together. It also helps when the air goes in and out of the air holes.

Zoë: Because sometimes when I'm eating my breakfast egg, I try to crack the egg but the membrane stops me.

Zoë used accurate vocabulary and definitions as she discussed the parts of an egg. She named 'membrane' and understood at least one of its functions after my explanation. Her understanding of 'membrane' is tied to her own experience.

Approximation

"Freedom to approximate is an essential ingredient of all successful learning."
(Cambourne, 1989, p. 70)

Unlike Nikita, not every student uses vocabulary words accurately during our conversations. I accept the approximations of vocabulary students make during our conversations about their panels. Teacher-researcher Brian Cambourne (1989) discusses the importance of approximations toddlers make as they learn to talk and later as they learn to write words. Children who are free to take risks and make approximations are engaged in "the natural cycle of learning" rather than "the restrictions of getting it right" (Cambourne, 1989, p. 70).

The discourse in our classroom is respectful and as such, the use of approximation is understood to be a step along the path to more complex understanding. Our conversation about the content on the documentation panels demonstrates that accepting and supporting approximations yields sophisticated ideas. Alex provides an example as he explains information about Atlantic salmon.

> Alex: Because it was where they put the dam.
> Charlene: Right, and the dam blocked the river, so…
> Alex: So they couldn't lay their….they couldn't sponsor.
> Charlene: Right, they couldn't spawn. Exactly!

Alex started to say, "they couldn't lay their eggs." But, he recalled that there is a specific word that encompasses the concept of 'lay their eggs.' He used the word 'sponsor' rather than 'spawn'. I accepted that approximation, validated his idea and used the correct term in my comment to him.

Marc, a first grader, talked about the inside of a chicken egg and was able to name and define all the parts except one.

> Charlene: Do you remember what these little ropes are called?
> Marc: Oh, the chalazeas? I forgot to say that. Are they like veins?
> Charlene: Nope, they are not veins. They are like little ropes that hold the yolk in the middle…
> Marc: Oh yeah! So the chick doesn't hit the shell and get hurt!

In this case, Marc knew the vocabulary word *chalazae* but could not recall their function. As I began to define it for him, he recalled the purpose of the chalazae and finished my sentence.

During our conversation about vernal pools I asked Emma, a Kindergarten student, "What did you see there that was interesting to you?"

Emma: I forget what it was called, but Cameron's mom found it.
Charlene: Was it an animal?
Emma: It was an egg thing.
Charlene: Oh, an egg mass?
Emma: It was that green cloud thing. Yes. I don't know if it was frog eggs or mosquito larvae.
Charlene: Well, if it was a green cloud floating on the water it was frog eggs.
Emma: That's what I knew!

Emma remembered and was intrigued by the 'green cloud' floating in the water but could not recall the name for it. "It was an egg thing" is an approximation of the term 'egg mass. She defines the 'egg thing' or egg mass as being "that green cloud thing," a different approximation. She knows it was eggs and she hypothesizes about their origin, frog or mosquito. Then happily confirms that she knew all along that they were frog eggs!

Danielle talks about Atlantic salmon throughout the early stages of their lives easily. As she began to discuss the later smolt stage, she benefited from the use of approximation.

Danielle: It's [the salmon] starting to be silvery.
Charlene: Why?
Danielle: So it can camouflage in the ocean.
Charlene: What else happens to a smolt? You said the outside of their body changes color…
Danielle: …and so does the inside! They are growing more and they have more muscles.
Charlene: That's true and also because of where they are headed.
Danielle: To the ocean.
Charlene: Do you remember that word, 'anadromous'? Can you talk about that?
Danielle: It means changing from…the fresh water…their bodies have to change so they can go into salty water.
Charlene: Right!

In this example, Danielle's knowledge of the salmon smolt is general until she hears the word 'anadromous' and that sparks her memory of the significance of that particular stage of development.

Accepting the science vocabulary approximations of young students at school is an extension of the every day acceptance of word approximations of infants and toddlers by parents and caregivers "Without the opportunity to approximate, the whole, smooth-running learning cycle is stopped and progress and / or refinement becomes impossible" (Cambourne, 1989, p. 69). Recognizing and accepting approximations in the primary classroom supports young learners as they develop connections between their experience and newly acquired information. Sometimes the verbal approximations of scientific vocabulary by my young learners just make me smile!

Science Concepts and Processes Explained by Students

For the purposes of this study, I have defined the terms *concept* and *process* as follows. A concept is a general notion or idea. In the case of science learning, a concept is an idea that can be generalized and used in different situations. Concepts are akin to facts, laws, and principles. A concept can help to explain a scientific or natural process. A process describes some kind of systematic change that generally takes place over time. Scientists use processes to "investigate and communicate about the natural world" (MSLR 1997, p. 63). Some examples of science concepts and processes described by students follows.

Concepts

Camouflage is a vital component in the *predator/prey relationship* and a concept that intrigues young students. They understand the need for animals to camouflage and that in turn, helps them understand habitats and adaptation.

Camouflage

Chris: Fairy shrimp live in vernal pools and might camouflage their eggs.
Charlene: If they were going to camouflage their eggs, where would they do it?
Chris: Maybe under the *same color* rock.

Cassidy: Leaf litter is dead leaves at the bottom of the vernal pool. *Animals sometimes eat it* and lay their eggs in it and to camouflage. They climb under it to camouflage.

Zoë: A smolt turns silvery so it's camouflaged I the ocean. And a parr is brown with dots so it can be camouflaged in the stream.

Danielle: The parr have a straight line of dots on their back to camouflage themselves.

James: They have stripes so they can camouflage...it's brown and black and green. The green is so *it can blend* into the seaweed in the water.

Alyssa: I *couldn't see* it (the salmon) because it was camouflaged, then my mom picked me up and I could see it.

Austin: He has stripes for *blending* in, for camouflage.

Haley: They (salmon) *change colors* because they are growing up and for camouflage.

Predator/prey

Harold: Like when there are *predators* around them, they *can hide* easily.
Sarah: Fairy shrimp have *predators* like salamanders and frogs.
Nikita: Dragonflies can be predators for salmon. Dragonflies are bigger than the salmon at one stage and so they can eat them.

Stephanie told me about some of the animals that are prey for carnivores in the estuary. She used the term 'food chain' and I wanted to check her understanding of that concept.

Charlene: Why is it important to know about food chains?

Stephanie: Well, a clam might eat some plankton and a seagull might eat a clam, that's a connection. But, what would eat a seagull? A weasel if they go in the uplands. So the animals are sort of connected to each other by being eaten...People are on top of the food chain.

Charlene: Yes, we are.

Stephanie: Actually, lions are because if people go visit the jungle and there are no fences along the trail, lions might come up on the trail and try to eat a person if they are walking on the trail. So, then (chuckle) lions are on the top of the food chain!

Endangered

Zoë: Endangered means there's only a few of them left. I hope mine (the salmon fry she released) survive.

Nikita: Salmon are endangered because people are littering and the litter can get in the water and make them sick or maybe kill them.

James: They are trying not to make them (salmon) an endangered species…they are trying to get them over the dams and they're trying to convince people not to build dams.

Alex: Endangered means there used to be a lot of them and now there's not that much.

Learning about these concepts provides a foundation for young learners in the areas of life sciences including knowledge about organisms, environments and habitats, behavior, adaptation, and biodiversity (NSES 1996).

<u>Processes</u>

Savanah included more information about the vernal pool and an understanding of an important natural phenomenon when I asked her to recall a small group project about the water cycle during our conversation.

Charlene: How do vernal pools get made?

Savanah: Well, they need a lot of rain. It comes down and makes puddles. Also, the snow when it melts and they all mix up together and it makes a big pond.

Charlene: How long does a vernal pool stay there?

Savanah: I think until fall because it might dry up in the fall.

Charlene: What would cause it to dry up?

Savanah: Well, the kind of warm air….and….

Charlene: Do you remember about the water cycle group?

Savanah:…the heat. Heat on the water causes it to evaporate.

Charlene: Right! And, then it goes…

Savanah:…up in the air and then it rains!

Charlene: Right! That's the cycle we talked about!

Savanah: The water cycle, just going around and around and around!

Savanah understands the processes of evaporation and the water cycle and their place in the local habitat we call the vernal pool.

In the following example, Brendle explicated the growth process inside a chicken egg, saying during our conversation, "This is how I learned that it all connects together."

Brendle: At first there's a little red spot. It tells if it's growing or not. If it is, it's called an embryo chick. The embryo chick is getting bigger and the yolk is getting smaller because it's eating it. The embryo chick gets air from outside the egg, it goes into the tiny, tiny holes in the eggshell. They are soooo tiny you can't even see them. Air is tiny, too, so it fits. Then on day 16 the chick is getting really big. It's almost there. On day 19 the chick has like, only an inch to go to fill up the shell. On day 21 or maybe day 20 it starts pecking, pecking, pecking on the shell until finally it hatches out. When the cute baby chick comes out it is really tired and wet.

Charlene: Wow! That was a very detailed explanation!

Brendle understands what happens inside an egg as the 'embryo chick' develops. She uses limited vocabulary but uses it appropriately. She describes the microscopic air holes of the shell and hints that air is made up of even smaller elements. She marks the passage of time and growth changes.

Understanding processes implies understanding the passage of time and the changes that occur over time. Understanding and documenting time and change is an essential element in scientific experiments and procedures. Geological dating deals with minute changes over vast expanses of time. Biological dating generally deals with life cycles and life spans and the changes occur during well-defined periods of time. Ecological dating often occurs with seasonal changes.

Making Connections

"Can I say something not on my poster?"

Elizabeth, age 8

A friend and colleague once said to me, "To connect is to know." I have always thought that to be true and wise. The documentation panel implies thinking, understanding, and making connections about science. Connecting prior knowledge and experience to the documentation panel deepens understanding. Research about the importance of learners making connections between content areas such as science and literacy to develop comprehension and enhance understanding is well-known (Ogle, 1986; Gandini, 1993; Oyler & Barry, 1996; Harvey, 1998; Harvey & Goudvis, 2000). Educational literature (Doris, 1991; Harvey, 1998; Berghoff et.al., 2000; Crain, 2000; Lind, 2000) suggests teachers find and utilize ways to help students make connections between their prior knowledge and new information in order to more completely understand that new information.

Several layers of connection exist within the documentation panel. At first, students create the panel as they recall what they know about the topic. These initial connections are made as the student reviews his folder of artifacts made in class. The second level develops as the student makes choices about what to include and what to discard as he creates the panel. The process of creating the panel is about connecting prior knowledge and classroom experiences and generating a visual representation. The student makes connections between books read aloud or independently, completed assignments, group discussions, experiential projects and activities. All of these connections create a web of understanding about the topic that radiates outward in all directions, ultimately allowing for new connections. In Vygotskian (1978) terms, this knowledge has become more accurate and general, shifting the zone of proximal development, which makes more complex ideas available for learning. The visual text in combination with the dialogue results in one artifact, the documentation panel, which represents connected understanding by each individual in the class.

The following are examples of students making connections during our dialogues. These connections represent a variety of thoughts, no two the same illustrating that learning is indeed a unique and individual experience. The connections illustrated below are part of the Conversational Text and not visually represented on the panels. These connections may be the result of transmediation as students create the bridges between what is represented visually on the panel in combination with their experiences and the need to talk about or explain it to me (Siegel, 1995). This multi layered learning situation is generative and results in greater or more detailed learning.

The students in our Kindergarten through fourth grade multi age team wrote new lyrics to the song, *We're Jammin'* by Bob Marley. This song, *We're Salmon,* included facts about the life and perils facing Atlantic salmon. The music helped more than one student learn information and Danielle, a second grader, referred to it during our conversation.

Danielle: In our song we sing, 'we're dying' because of the pollution and dams.

Charlene: Explain that to me, it sounds important.

Danielle: I think they are talking about people polluting where they live. And we sing 'temperature's dropping, icebergs are melting' I think that means the water is changing, it's getting colder but it has to be exactly the same amount of degrees for salmon.

Charlene: Does the song say anything about being endangered?

Danielle: No, but it says, 'we really want to live, we have so much to give, you'll miss us when we're gone'.

In the middle of Kindergartener Adrienne's discussion of the life cycle of a frog, she included a connection that echoes what parents have told their kids about growing and eating healthy food. I know I heard it at a young age.

Adrienne: He's turning into a frog.

Charlene: So, talk to me, how do tadpoles turn into frogs? What happens?

Adrienne: Well, when they're sleeping I think they grow and stuff because they are getting healthier.

Charlene: How are they getting healthy?

Adrienne: Well, maybe getting something to eat or getting good exercise or swimming.

This was specific connection for Adrienne to make because she was experiencing significant health problems at the time. She needed to get a lot of sleep and to exercise everyday. Underlying everything we did at school with Adrienne was aimed at helping her gain strength and health and learning to take care of herself.

Sam, also a Kindergartener, was describing a drawing on his vernal pool panel,

> Sam: Me and Isabelle are standing on the little island. There was a lot, a lot of pink ribbons. Every where we looked, there was a pink ribbon.
> Charlene: What were the pink ribbons tied to?
> Sam: Trees. But there was none on the ground.
> Charlene: Do you know why they were there?
> Sam: No.
> Charlene: No? A mystery, huh?
> Sam: I *think* I know. It was somebody's property. Sometimes people put ribbons on trees to mark their property.

Outside of school, Sam learned that people can mark trees to indicate property lines and used that information to figure out the mystery of the pink ribbons.

Reece made an interesting mathematical connection. Talking about the estuary he said, "Somewhere at the estuary I read a sign that said the marsh mud was 15 feet deep at that place. That's as tall as the dinosaur I researched, Iguanodon! That's pretty deep!"

Elizabeth was always pondering things and she asked some very interesting and insightful questions during the three years she was in my class. We studied salmon when she was in Kindergarten.

> Charlene: How do they figure out where to lay their eggs?
> Elizabeth: They might remember something from when they were little.
> Charlene: What is that?
> Elizabeth: The smell of the river. But, I don't know how our salmon are going to figure out how to go home because they were here at elementary school!
> Charlene: You know Elizabeth, that is a really good question! Our tour guide was talking about that and he said they would be okay. They won't come back to Wells Elementary School because they have to stay in the river where we let them go…
> Elizabeth: I know. I know they can't get out of the river and walk here!

Charlene: Right! But they are going to stay in that river for two or three years before they go to the ocean so they're going to get the smell of the river from being there for two or three years. So, they will go back to that very same river…

Elizabeth: Maybe even the very same spot where we let them go?

Charlene: Very close to there. Does that make sense?

Elizabeth: Ummhmm.

Two years later, as a second grader, Elizabeth studied vernal pools. During our conversation, I asked her about obligate species and she made a connection to her earlier work with salmon.

Charlene: Do you remember that certain animals in the vernal pool are obligate animals, they are obligate species. They are obligated to come back to the vernal pool every year…

Elizabeth: Oh Yeah! Like salmon!

Charlene: Right! Can you talk to me about that obligation to come back every year?

Elizabeth: Well, I guess it's like if there was a little tadpole and it grew up and married and the next year it would come back and lay its eggs in the same vernal pool.

Charlene: Okay! So how does that make you think of salmon?

Elizabeth: Because I remember when I was in kindergarten, we learned a lot about salmon and we let some go in the river. And they always go back to where they were born. And I was wondering then, "What? How are they going to come back to where they were laid?" because they were laid at our school!

Elizabeth made a very specific connection between science units years apart.

<u>Recall Class Experiences</u>

Sometimes a student, like Elizabeth, recalls experiences that happened long ago and uses them to scaffold learning. Generally, I help this along as I attempt to provide just enough support for the student "to proceed with a new task or skill and experience sophisticated problem solving in interpersonal situations" (Many, 2002, p. 379). Because the panels my students create and the conversations about them are based on a science unit, there are times when I may ask a student to recall a particular lesson or experience during the study. This is an attempt to provide a connection between that experience and about what the student is talking. Verbal or dialogic scaffolding is one type of support.

Scaffolding may be supplied by the classroom environment and activities that support learning (Palinscar in Many, 2002). Building connections with students or helping to scaffold learning produces a different kind of response from the student. The connected response is nearly always more accurate or more complex than an unsupported response.

Students also make connections to classroom experiences. These connections help the student make observations, hypothesize, and justify an answer. Referring to books read aloud is a common connection for students to make. As we talked about frogs in the vernal pool, I asked Adrienne what frogs eat. She said, "I think they eat water beetles because remember we read that book and it showed it."

Films are also a source for connections. The explanation that goes accompanies the visual element provides students with information they may never see or know about through first-hand experience.

Chris: I saw this on the film we watched. There is this little frog and the water is up to here and another frog. And she digs a hole and lays her eggs there and then when they're about to hatch and it rains, the water level goes up and then the tadpoles can swim out.

"I never knew..."

I am always interested in the science units we explore because I know I will learn something new about the science but more than that, I know I will learn something about my students. Each one of my students will tell me what they think is important or interesting. My favorite question during our conversations is some form of the following; 'did anything surprise you while we were studying this?' Sometimes a student will respond with 'no, nothing surprised me' or 'I didn't learn anything new.' But those students who respond positively make me smile as they talk.

Gabrielle: "I always thought estuaries had a lot, a lot of grass and now I know they do. It's for camouflaging animals so they don't get eaten."

Charlene: Was there anything particularly interesting that you learned while we were studying the estuary?

Gabrielle: I didn't know about a fish called a mumichug.

Charlene: So that was new, anything else?

Gabrielle: I didn't know that at my beach there was an estuary. All I knew was that there was a ocean there and a river there and then there's this strange grassy area with all these pools and stuff around in it. I didn't exactly think that was really an estuary, but it was!

Discovering that she lives near an estuary was obviously important to Gabrielle. The ability to name the elements in her environment and learning about the details of this habitat and its significance for local wildlife and water systems may influence some of Gabrielle's future decisions as she continues to live nearby.

Amanda said of the estuary: "I didn't really know there was such a thing as so many animals there! I didn't really know that so many animals could live in one place. That was really interesting."

Elizabeth was always interested in our studies that included animals. She made an interesting connection between our science study about chicken eggs and home during our dialogue.

Elizabeth: Well, I don't really think about chickens that much but I never knew that chickens couldn't swim. Can I say something not on my poster? And I know that some eggs don't even have red spots because we need some eggs to eat. And sometimes farmers don't realize 'cuz they can't see through the eggs that a red spot's there so sometimes red spots come on eggs that go to the grocery store. But still it won't turn into a chick. I've never seen that happen before until the other day when we were making the muffins.

Charlene: And there was a red spot on the egg?

Elizabeth: Yes! For the banana muffins.

Charlene: So you were surprised by that?

Elizabeth: Yeah ☺

Charlene: What did you guys do?

Elizabeth: Wel, we couldn't do anything 'cuz then we realized 'it can't be a chick now.'

Charlene: That's for sure, 'cuz its out of the shell! You just made it into banana bread. That's what I would do! Plus, if it's been in the refrigerator it can't be a chick either, because they need to stay warm, don't they?

Elizabeth: Umm hmm.

Charlene: So, no matter what, anytime you get an egg from the grocery store…

Elizabeth: You never know! (smiles)

"Can I say something not on my poster?" shifts her thinking to include an idea that she did not illustrate. Elizabeth's surprise to discover that an egg with a red spot on it was in her refrigerator was evident in her voice as she spoke. I was pleased that she was not upset about it but rather matter-of-fact, "it can't be a chick now,"

During our unit about chicks, John began to understand that an enclosed space is a constant variable. Charlene: What was the most interesting thing he learned?

John: I think it was how a chick grows inside an egg. The yolk first starts out bigger than the chick but then the chick grows and it shrinks while the chick gets bigger. I always thought the chick just grew and the yolk stayed the same.

Charlene: Why do you think it has to change?

John: Because the chick is growing inside and if the yolk stayed the same size there wouldn't be enough room for both of them to fit. It makes sense that the yolk gets smaller because it's the chick's food and it gets eaten up."

This is a demonstration of conservation. Piaget's (1969) theory of conservation includes conservation of volume, although his demonstrations involve understanding that volume is constant in different shaped or sized containers. John applied conservation of volume to the developing chick and size of the yolk inside the shell.

When a student says, "I never knew…" or "I learned…," this represents a shift in their understanding about their own learning. With external support in the classroom and multiple experiences and opportunities for discussion, some students are able to recognize and talk about their learning in terms of what they did not know before. Generally, this involves a learning event that has personal meaning to the student, such as Gabrielle's estuary or Elizabeth's muffins. Recognition of learning represents higher mental functioning (Vygotsky 1978) and use of deliberate memory (Bodrova & Leong (1996).

Student Generated Questions

As students make connections during our dialogue, they often think of questions about the topic. The act of talking about their artwork reshapes learning and results in new ideas. Students generate questions throughout our science investigations, and so do I. Some students ask questions during our dialogues and I attempt to answer them but many times I do not know 'the answer.' The questions asked during our dialogue may be a result of revisiting the documentation panel and talking about the visual text. Revisiting the panel may result in reshaping the student's knowledge. The reshaping of an experience into artwork and reshaping the artwork into verbal language is transmediation (Siegel 1995). Erin told me about the need for salamanders and frog to return to the vernal pool to lay their eggs and she then asked, "Do they always have to come back to the same vernal pool or could they go to a different one to lay their eggs?"

Zach asked, "How can a chick just start from that dot?"

Alex: I have a question for you. You know when you said we would hold the eggs in I think ten days after they hatch, was that because you just wanted too or was there a certain reason?
Charlene: Once they hatched? Well because I didn't want to hold them when they were too, too little because they are very fragile. I didn't want them to get scared or injured. I thought waiting until they were two days old was a good idea.

Zoë questioned the existence of double yolked eggs during our dialogue about chickens and eggs.

Zoë: I was thinking, it's sort of a question and sort of an answer. If there was an egg, let's pretend that little place has an egg, and two chickens were inside it...
Charlene: In the same egg?
Zoë: Yeah, 'cuz you know how sometimes it's double yolked?
Charlene: Oh, yeah!

Zoë: Well, they would be twins. But if they started pecking out, they would probably be okay, but if they like, started pecking out both, would they come out faster then the others? Because there would be two peckers.

Charlene: Maybe…

Zoë: Maybe they would both come out one end…?

Charlene: Maybe…

Zoë: Because you know they start pecking around and then they come out.

Charlene: I don't know. I think that's a really interesting question, Zoë. I don't know the answer to that.

Zoë: It would be funny, like, to take an eggshell with that end off and that end off because two chicks were trying to get out.

Charlene: They would come out of two different ends? That would be pretty interesting.

Zoë: But that egg would have to be pretty big or the chicks would be pretty small.

Charlene: Why?

Zoë: Because if it wasn't, the chicks are usually pretty big and I would think that two of those chicks wouldn't be able to even fit in the egg, they're so big.

Zoë' hypothesized how two chicks would be able to get out of the egg and went on to conclude that a typical egg would not hold two chicks.

Generating questions in essential to inquiry based learning. Most student generated questions occur throughout the teaching and learning of the unit and are added to the list of questions on our K-W-L chart (Ogle 1968). Others occur during the conversation about a panel and I answer those that I can. Still other questions, like Zoë's double-yolk question are, quite honestly, fascinating and left unanswered.

Magic

Sometimes students cannot explain a concept in scientific terms. It could be a result of mis-learning the information earlier, or making an assumption about the way things work. John Merrow (2005) states that "as children, we make all sorts of 'common sense' assumptions about the ways the world works, which is a loose definition of science…all too often we never unlearn these" (p. 1). Sometimes a student presents their understanding of a scientific concept as magical.

We hatched chicken eggs when Sarah was a kindergarten student. Sarah was and continues to be an outspoken and deeply sensitive person. Our conversation about hatching eggs took an interesting turn while she was talking about birds protecting their eggs.

Sarah: Albatrosses are sometimes mean to protect their eggs because they have to protect their eggs.

Charlene: Why would a mother bird want to protect her eggs?

Sarah: Because without eggs there wouldn't be very many life forces in birds.

Charlene: Life forces?

Sarah: Yes. If a bird dies that means that the life force is up. The blood stream would go down to zero and there would be no more birds. Once all of the birds in the world die, which would be really, really bad, because you learn music from birds.

Charlene: That would be really bad.

At this point in our conversation, I was quite interested in Sarah's concept of 'life force' and wanted to know more about it. I asked and Sarah's response was one of complete indignation, like, *you're the teacher why don't you get it*?

Charlene: I'm not sure I completely understand. Can you explain 'life force' to me? What does that mean?

Sarah: Life force means that if every bird dies that means that it's the end of too many songs because birds bring so many songs to people and to the world. No life force means you have to record them over and over again to have.

At the time, I accepted Sarah's explanation and proceeded with the conversation. Years later, I really want to know more and wish I had asked more questions in order to better understand what she was conveying. Sarah's definition of 'life force' is nearly an explanation of 'extinct'. Her concern is not about the birds so much as it is about their songs and the void that would be created in the absence of birdsongs. That would be sad.

As a first grader, Sarah compared the metamorphosis of frogs and butterflies as she talked about her vernal pool panel.

Sarah: Tadpoles are sort of like butterflies.

Charlene: Tell me about that. How are tadpoles like butterflies?

Sarah: Well, they start out as eggs and then they become a tadpole and somehow they just…somehow they grow legs and the next day their tail might grow tinier just like butterflies when they are a chrysalis, they get older, their chrysalis grows older and older as they grow bigger and bigger. Then it turns into a frog just like a butterfly! It's just magic!

How frogs and butterflies actually change remains a mystery to her, but clearly, Sarah is making a reasonable parallel between the metamorphoses of these two creatures. As she learns about butterflies and frogs in the future Sarah will be able to talk about the life cycle of each with greater detail. For the purposes of science, I hope she understands the process. As a sensitive human being, I hope she always thinks the lives of butterflies and frogs involve just a little bit of magic.

Narrative: Science as the Familiar

Narratives are a universal meaning-making strategy. (Cazden 2001, p. 19)

Some students create a visual story on their documentation panels and then tell me about it during our conversation. These students are without exception, my youngest students, my Kindergarten buddies. On a superficial level, the following documentation panels made by Jake and Emilie demonstrate little evidence of science learning but rather, are the accompanying artwork to some good stories. Initially in this study, I overlooked the fact that my young students are very good storytellers while I focused my attention on the demonstration of *science knowledge*.

As discussed earlier, reading aloud informational storybooks helps students build understanding of science concepts (Leal 1994). Teacher researcher Karen Gallas states

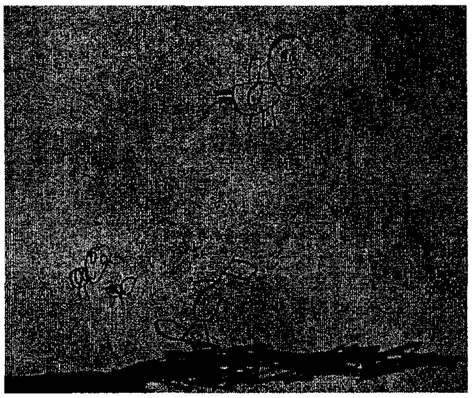
> When narrative is used as a way to reexperience a reality or to redescribe a learning event, the text, whether it be poem, story, picture, or song, is not the actual event but rather a story about that event. All stories allow us to cast a different light on the event itself; all allow child and teacher to reenvision the process of learning and teaching in a way that defies standardization and objective description of what has been learned (p .xvii).

Students describing documentation panels in an informational story narrative reflects the use of that genre as read-aloud. Narratives expand life experience and give it meaning "beyond the circumstances of the event itself" (Gallas 1994, p. xiv) allowing children to invent a world in which information and fantasy coexist. This narrative structure of science information exists in the following examples.

The following documentation panel stories place the chicks we studied at the center of the narrative. The personification of the chicks stimulates the imaginations of Jake and Emilie as they each tell a story interlaced with science facts. Their stories are quite different, demonstrating that "there is no one way of transforming experience into a story" (Cazden, 2001, p. 19). Personification of animals is a common element in picture storybooks and something with which young children are familiar. Personification is a sophisticated concept that "provides an excellent introduction to figurative language and lends itself to analysis and performance" (Norton, 1989, p. 43). The documentation panels created by Jake and Emilie are wordless texts, consisting of drawings only. "The wordless text forces children to observe the detailed illustrations and to produce their own text that includes the personified [chicks] responding to setting, conflict, plot development, characterization, and point of view" (Norton, 1989, p. 45).

Jake's Story

Jake, a Kindergarten student, used two colors in his drawing, this was important because he generally used a single color when he worked. He drew three red chickens, one flying above a blue ground line that he later describes as being water.



Charlene: Good morning, Jake. This is a great documentation panel. Would you please tell me about it? What do you know about chickens and eggs?

Jake: Chickens can fly when they grow up.

Charlene: Is that what this one is doing?

Jake: Yeah.

Charlene: How can I tell that he is flying?

Jake: Because his wing is moving up and down.

Charlene: Okay! Absolutely! What else do you know about chickens and eggs?

Jake: That some chickens go under water.

Charlene: Do you know of any chickens that go under water?

Jake: No.

Charlene: No. So, what makes you think they can go under water?

Jake: They can't.

Charlene: They can't. You're right. They really can't go under water. They would drown because they don't know how to swim. Can you think of a bird that knows how to swim?

Jake: A duck!

Charlene: Yes! Ducks are very good swimmers! Tell me more about this picture. What is this blue part?

When I ask Jake to "tell me more about this picture," I have acknowledged on some level that he is telling me a story. Asking a student to talk about what is going on in their picture is one of my typical queries during writing workshop conferences. At this point, our conversation about science has taken a turn toward literacy. Jake continues:

Jake: It's water. It's for the boat.

Charlene: Oh! This is a boat! What's happening on the boat?

Jake: Someone is sailing to go to Washington.

Charlene: Ooo! That's interesting! Why are they going to Washington?

Jake: Because they never been there so they want to see what it looks like.

Charlene: Hmm. Okay. Is this the person right here? (pointing to picture).

Jake: Yeah!
Charlene: That's a nice sailboat. What are these chickens doing?
Jake: They are trying to catch up to their baby.
Charlene: So the one that's flying is the baby chicken? Who are these other chickens?
Jake: That's the mommy (pointing) and the daddy.
Charlene: Oh! So it's like a family of chickens. I see. What are they going to do when they meet up with each other?
Jake: These two live with that chicken.
Charlene: They all live together?
Jake: They are trying to catch up because he flew before them.
Charlene: He went too fast?
Jake: That's why I put those lines right there so he can zoom by (moves his hand quickly in front of both of us).
Charlene: So those lines are showing that he's zooming by? (Jake nods) Okay. It shows he is flying much faster than his mom and dad, right?
Jake: Yep!

Jake's story is at first about the drawing of the water and boat sailing to Washington. He went on to talk about the family of chickens. His story about the baby chicken, mom and dad may reflect his own life as an active only child. He moves at one speed at school, fast, and the baby chick in his story is 'zooming by." At this point in our conversation, I make the shift from his story back to science with the following question,

Charlene: What was the most interesting thing you learned about chicks?
Jake: That chickens grow fast.
Charlene: You didn't know that?
Jake: Nope!
Charlene: Did you get to hold a chick?
Jake: Yes.
Charlene: How did it feel to hold a chick?
Jake: Nice and soft.
Charlene: Yeah...which one did you get to hold?
Jake: The black one....I'm done now.

I essentially stopped Jake from continuing his story because I had a singular purpose for our conversation. Jake answered my 'science' questions and knowing that we had differing purposes, he quickly stated that he was finished talking with me about his panel. In retrospect, I realize that Jake had more to tell me. In this case, I made Jake restructure his experience to fit my needs, which were about my conception of science knowledge. He was not able to complete his story because I was focused on science not on his story.

Emilie's Story

Emilie, also a kindergarten student, talked about her beautiful 'mother' chicken. I had to ask many questions and draw out of Emilie the story she drew and wanted to talk about. Interspersed throughout our lengthy conversation are many facts about chickens and other birds. Despite asking Emilie to talk about her panel with me many times, she agreed only after all of the other students finished. She was reluctant to talk at all, she stated her discomfort with the tape recorder saying, "I don't think I can concentrate with that on!" I asked if she would be more comfortable and able to concentrate if the tape recorder was behind us and she said, "Okay, I'll try it that way." Once we got underway, she was reluctant to talk about her personified bird. This reluctance may have stemmed from the expectation that the panel and conversation would be about our chicken egg unit and Emilie's visual text was fictionalized. Once our conversation began, Emilie spoke for quite a long time about a variety of bird related information and personal connections as well as the narrative about her personified bird. I notice now that I began this conversation as I would a typical writing conference rather than asking Emilie to tell me what she learned about chicks and eggs. Knowing that Emilie had participated in writing conferences with me all year, I decided to approach the documentation panel in the same way.

Charlene: Emilie, thank you for doing this. Em, tell me what you drew on here, it is beautiful!
Emilie: It's a bird. (long pause)
Charlene: It looks like this bird has wings…and feet with sharp toes…
Em: No. It doesn't have sharp toes.
Charlene: No? What is that? Is it just a regular toed bird?

Em: Umm hmm. (long pause)

Charlene: Okay, what are these little heads at the bottom?

Em: Those are the chicks.

Charlene: Okay, wait a second! These are the chicks, so, is this the mother?

Em: Umm hmm. And that egg didn't hatch when its brothers and sister did.

Charlene: Wow! So, you know what I just heard you say? I heard you say "brothers and sister." How many brothers?

Charlene: Two and there's two sisters but that one didn't hatch.

Charlene: Okay. Can you tell me about these baby birds? What are they up too?

Em: The mother's gonna give them a worm.

Charlene: Is that what's in her mouth right here? A worm?

Em: Umm hmm, and in her feet, too.

Charlene: Oh, my gosh! I didn't notice that!

Em: Because there's three chicks and that one (pointing) doesn't have no mouth.

Charlene: So it can't eat anything...

Em: No.

Charlene: So three chicks and three worms. Now, this mother bird looks like she's got some interesting things on her. What's that around her neck?

Em: A necklace.

Charlene: And what's on her beak? What's that red stuff?

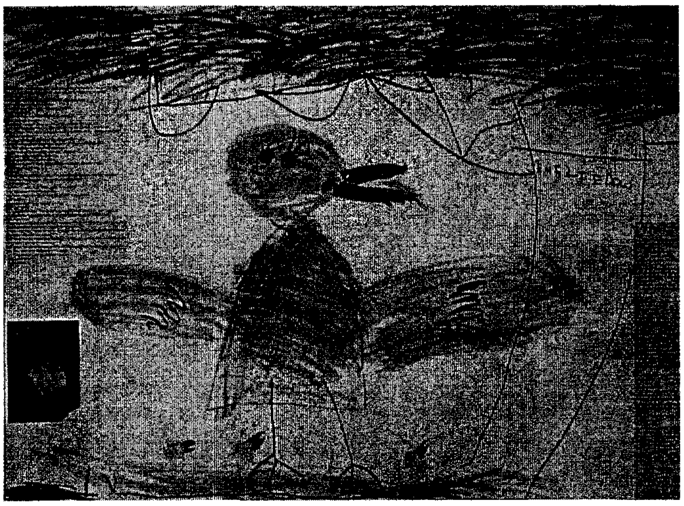
Em: That's just a funny kind of bird.

Charlene: Oh, so it just has that on its beak all the time? It's just red?

Em: (smiles)

Charlene: I thought it might be lipstick, but it's not?

Em: Yes, it is! ☺



Charlene: It is lipstick! I knew it! 'Cuz I know how much you like lipstick! So, how come you decided to put lipstick and a necklace and wait! What's this? Is this a dress?

Em: Umm hmm!

Charlene: How come you decided to put a dress, and a necklace, and lipstick on your mother bird?

Em: Because that's just how I draw birds sometimes.

Charlene: She looks beautiful! She's a beautiful mother bird! What are these black things on her wings?

Em: Those are the feathers. Umm, that are kind of, you know sometimes how there's shadows on the wings? That's how I draw them.

Charlene: Oh! Okay. Now did you see something like this on the baby chicks in our classroom, when their feathers started to grow on their wings?

Em: Umhmm.

Charlene: Yes! So, did that give you the idea for doing that?
Em: Yep!
Charlene: Very smart!

The initial part of our conversation centered on Emilie's beautiful personified mother bird and her babies. Listening to her voice on the tape, I hear her annoyed tone change to a more playful tone and the long pauses early on give way to a fluid verbal exchange with me. I focus on her artwork as I broach the subject of chicks in our classroom.

Later in the conversation, Emilie connected her drawing on a personal level when she talked about her house and yard.

Charlene: This looks like a big tree, Emilie. Is it a big tree, with your name on it?
Em: Umm Hmmm. I decided to draw that for two branches holding the leaves up and that's the sun going through it.
Charlene: How beautiful! Is this a branch, right here? Or is this the ground with the nest on it?
Em: This is the branch that holds the golden nest up
Charlene: The golden nest that had four eggs.
Em: Umm hmm.
Charlene: Three have hatched. Is this one gonna hatch?
Em: It will hatch on Monday.
Charlene: On Monday, excellent! Now, what's this down here? (pointing)
Em: That's my house, below it. (lower left corner)
Charlene: Oh, my gosh! That's your house?
Em: 'Cuz we have a fireplace, too.
Charlene: So, this is the chimney with smoke coming out of it? And this is really far above your house, isn't it?
Em: Um hmm, because I got a really big tree that looks like a plump big egg and it grows it's leaves and there's a whole bunch of leaves even on the top it goes like as big as this whole school!
Charlene: Oh, my gosh! So, when you did this picture, you were thinking about a tree in your yard.
Em: Yes.

When I asked Emilie to talk about what she may have learned from our science study, I included birds and chicks in my questions as a segue between her artwork and our science unit. She began by talking about what she learned and already knew about birds. I continued with questions specific to our unit of study, pushing her to talk in a more 'scientific' manner, perhaps use specific vocabulary or refer to concepts we had covered. Emilie continued to tell me about her knowledge about the broader category of birds in the way she was most comfortable.

Charlene: Emilie, it looks like you know a lot about chickens and birds.

Em: Yep! I sure do!

Charlene: Was there anything that you learned about chickens and birds from our classroom?

Em: Yep. I know that some can't see very good and some can. Like owls can 'cuz they have big eyes.

Charlene: Big round eyes. What else did you learn? Did you learn about hatching eggs?

Em: Umm hmm. I learned about ostrich eggs 'cuz they're big. They're like that big (shows with hands).

Charlene: Umm hmm, they are huge. What else?

Em: I learned that they don't have any feathers, first, when they're born. When they grow up, like two, they start doing those downy feathers...

Charlene: Are those the ones we got to see, those downy feathers?

Em: Umm hmm. Then, when they are fully grown, like this one (pointing to mother bird's wings), they get real feathers.

Emilie's use of figurative language "the golden nest" and "a plump big egg", denote her enjoyment of art and poetry. She has thus far in our conversation talked about nests, eggs, food, feathers and feather development, a tree as habitat and made a connection to her own house. Emilie clearly knows a great deal about birds. She continued to talk about what she already knew, making connections to birds.

Charlene: Keep telling me, what else did you learn?

Em: I learned that some fish live by the sea and one time I saw a bird trying to get a clam out-that gooey stuff-yuch! One time my dad had to scrap it out so I could get that shell cuz there was, I think, a tidal wave that went all the way to the beach. And it flew and almost dropped it on my head. It was like that far from me (indicates distance with hands).

Charlene: You said that birds sometimes eat clams. What other kinds of things might birds eat?

Em: Some eat meat.

Charlene: Do you remember what kinds of birds eat meat?

Em: Crows are really smart, I learned on TV.

Charlene: Crows are really smart. Did you read that book Six Crows?

Em: No, but I saw it on *Stanley and the great big book of everything*- He learned that crows are really smart and when the eagle looked back it grabbed it really fast in it's beak and then flew!

Emilie has made a connection with Stanley, a character on television. Stanley learns about crows and passes that knowledge on to Emilie. His knowledge becomes her knowledge. I recognized the science in Emilie's story and created a bridge between it and science learning when I asked "What other kinds of things might birds eat?" We had discussed raptors in class and I expected Emilie to answer my question with 'hawk' or 'eagle'. Here Emilie pushed me to make a connection within my knowledge of birds; I was not prepared for "crows" to be her response, but quickly deduced that because they are scavengers, they do eat meat. Once again, I attempt to move our conversation in the direction of classroom experience and knowledge and Emilie confers the ability to talk on the chicks and then connects it to her own experience.

Charlene: Did you get to hold a baby chick?

Em: Umm hmm.

Charlene: What did you think?

Em: Well, I thought that they felt really soft.

Charlene: Was there anything about chickens and eggs that surprised you?

Em: Well, what surprised me was they were talking; they were peeping.

Charlene: How did that sound to you?

Em: Sounded kinda squeaky.

Charlene: It did, didn't it? It is kinda squeaky.

Em: One time I heard my cat go "squeak! squeak!" that's why we named him Squeaker. Then he got ran over. And so did Rollo and we had to send George away 'cuz he was pooping all over the place. And he was dirty, he was a dirty kitten. He was like a tiger.

Charlene: Oh, my gosh! Em, what else can you tell me about chickens and eggs or birds and eggs?

Em: I don't know of anything.

Emilie's narrative is complex. She made connections between our unit of study and her life experiences at the beach, at home, watching television, and listening to books read aloud. Due to our conversation, I was able to discover a great deal of what Emilie knows about chickens and the broader topic of birds, although, I'm certain she knows a much more. Emilie created a story to accompany the illustration on her documentation panel and placed it in the context of her life. The tree in her yard housed the golden nest with four eggs and the beautiful mother bird. She went on to create stories that answered my questions by containing information based on a wide variety of learning situations.

I was looking for proof that Emilie had learned some important concepts about hatching eggs. Emilie had participated in every activity and project about chicken eggs; so, she knew that I already knew what was important. Emilie did not have the patience or perhaps saw no value in reiterating what had been said or done, once was enough for her. As difficult as it was to work with at times, one of the things I admired and respected about Emilie was the fact that she made nearly every assignment about *her own learning*; she focused less on pleasing me than on pleasing herself. Emilie innately knew that in order to learn something, she had to make it her own in whatever way she could.

As I review her documentation panel three years after she created it, I realize that Emilie went beyond what I was asking for; she created a story embedded with scientific facts. Emilie's *Conversational Text* is laden with facts. This literacy event is all about science, it is science presented in a different way. Emilie presented science in a familiar genre, that of picture information books. "Children make tangible connections among the many subjects they study in school and, in a larger sense, relate their deep and very personal experiences of the world to the process of their education" (Gallas, 1994, p. 89).

The value of narrative is that it goes beyond a single correct answer or approach. Narrative can help a student make connections between personal experiences and science content. Narrative can provide a space for science to take root.

CHAPTER 6

TEACHER RESEARCH: AN INVITATION INTO THE UNKNOWN

Every mystery solved brings us to the threshold of a greater one. –Rachel Carson

Once again, I find myself writing parallel tracks as I think about the implications of this study. I have included a review of the study that focuses on the outcomes of my work with documentation panels and science literacy. This discussion includes theory explained by theorists and my interpretation and understanding of those theories as they relate to this study.

I have also attempted to explicate what I learned about my pedagogy and how I think learning occurs. My own theory of learning is an integrative model based on myriad factors that are present in my classroom. This section moves between my findings in this study as evidence of learning and my own ideas about how learning happens.

Review of the Study

This dissertation begins with definitions of scientific literacy and my claim that through the documentation panel, students demonstrate science knowledge and scientific literacy. I posit that science learning in my classroom is an essential component of all learning as the science curriculum is integrated throughout the day and across curricular areas. I examined 114 student created documentation panels made over the course of several years as an entry-point for understanding science learning of young students. Close inspection reveals the *Conversational* and *Visual Texts* of student created documentation panels demonstrate myriad ways in which young learners talk about and display their learning about the natural world and of science facts, concepts, and processes.

My commitment to science education and my own appreciation and concern for the natural world play a large role in my classroom and consequently, are elemental to this study. Teachers influence their students every day. I want to encourage my students to interact with and enjoy nature. I want to create a place where students learn to live lives that include an understanding of and respect for the natural world. I want my students to be comfortable with science; the vocabulary, facts, concepts, and relationships that science creates with other disciplines. I believe that my classroom atmosphere based on concepts of life sciences and the curriculum my students and I develop to meet their needs and answer their questions about science reflects John Dewey's definition of educative experience. Creating documentation panels is a piece of that experience.

My understanding of some of the influential works by Dewey (1902/1956; 1938/1997), Montessori (1949/1995), and Reggio Emilia (New 1990, 1992; Edwards, et. al.1993; Cadwell, 1997, 2003; Guidici, et. al. 2001; Fraser & Gestwicki, 2002; Fu, et. al. 2002), has confirmed for me my own philosophical beliefs about the abilities of young children to understand complex ideas and the myriad ways in which they can express that understanding. My pedagogy has been influenced by Piaget's (1952/1963) stage theory and his later work based on the process of assimilation, accommodation, and equilibration (see Phillips 1995). Piaget's notion of equilibration applies to me as a teacher as I question what and how I teach and work with my students. The dynamic nature of constructing and reconstructing knowledge has made me a more receptive and insightful teacher.

Vygotsky's zone of proximal development applies to me, as well. At times, my more knowledgeable peers help me learn or give me the support I need to try something new. While talking with my students about their panels, *they* are the more knowledgeable peer, assisting my understanding of their individual work. In other situations, I provide the higher level of expertise to assist someone through their zone of proximal development. Vygotsky's (1978) theory about the essential nature of social constructivism in learning explicates the foundation for and validates the structure of my classroom.

Consideration of this work reveals the rich complexities of the *Visual Text* contained within the documentation panel. Students regularly use pictorial representations when explaining science knowledge. Their use of a variety of diagrams, maps, life cycles, and written labels is evidence of higher order thinking skills (Bloom 1956) and higher mental functioning (Vygotsky 1975).

Examination of the *Conversational Text* reveals sophisticated reasoning as students use specific vocabulary, ask questions, recall experiences, and make connections about their understanding of the science topic. The transcripts of the student – teacher dialogues about individual panels demonstrate a particular kind of instructional conversation (Tharp & Gallimore 1988) that employs the use of 'uptake' (Nystrand, 1997) or 'high-gain' teacher talk (Maraige, 1995) in which the outcome of the conversation is the construction of meaning for both the student and teacher. In the case of the documentation panels, the construction of meaning around science through these instructional conversations provides me greater insight and certainty about my students' understanding. My students are able to demonstrate science knowledge without taking a traditional test. My students who are not yet able to read a science text demonstrate scientific literacy using the documentation panel as a meditational tool.

The social and interpretive expectations in my classroom are based on the four conditions I establish with my students around setting criteria, using expository text as read aloud, encouraging classroom discourse, and creating an integrated curriculum. The successful completion of documentation panels is rooted in these expectations.

<u>Webs of Understanding: My Theory of Learning</u>

Over the course of my tenure as a teacher, I have assimilated educational theories and practices into what has become my own pedagogy. I cannot claim to be the disciple of any one educational theory, but rather, my pedagogy is the amalgam of many and will no doubt, continue to evolve.

First, and foremost, my classroom must be a safe and respectful place for children to practice the work of learning. It must also be inviting and friendly. I have worked diligently to establish such a classroom atmosphere. It is a place where people of all ages are learners and teachers; I believe we all have something we can share and learn from each other. I invite parents to volunteer or just stop by and say 'hello.' My classroom is an open place—it is open to parents, siblings of students, former students, other teachers, administration, everyone is welcome. My classroom extends beyond the boundaries of its walls to other places within the school, outside the school, the woods and vernal pool. My relationship with my students and their parents extends to my home as we call each other on the phone, send e-mail, and write letters and cards regularly. Parents and students quickly discover that I am interested in every individual, and phone or write when good things happen for their children in class. Establishing a positive relationship makes it much easier to discuss and solve any difficult issues that may arise.

The manifestation of our two classroom rules, *Be Kind* and *Do Your Best* is evident as students work together in a respectful yet challenging manner as they make connections, modify understanding, and *make their work and their learning their own.* I respect my students and treat them as individuals; we work toward mutual respect among everyone. I help my students move along the continuum of respect as they practice talking and solving problems in different situations. For example, students discover that it is okay to question what I say and disagree with me or with a task I have assigned. I will not accept complaints or disagreeable behavior from a student but I will accept a conversation and a reasonable argument against my idea or an assignment. A well argued point (remember, they are five, six, seven, and eight years old) will often result in the looking up of facts or a modification of assignment. I try to validate and understand the ideas and questions my students have and provide them with a safe place to voice whatever is on their minds. The practice of *respect* is one of the basic tenets of my pedagogy and influences my classroom environment and structure.

My classroom is a busy place. There can be as many as eight different activities going on at the same time: students are working in groups of three or four around the room, at tables, on the floor, out in the hall. Students are talking *about* their work *while* they work; asking each other and themselves questions, making and discussing discoveries, and completing the assigned work. Some visitors unfamiliar with the organization of the room have said it looks and sounds chaotic. There is no chaos in my classroom. It is a highly organized and structured environment in which learning, real learning is central.

The underlying organization of the assigned work is an integrated curriculum and my purpose is to make both explicit and implicit for students many of the connections that exist within a topic, allowing them to *make their work and their learning their own.* My students participate in activities that are multidisciplinary and designed to meet the needs of different kinds of learners. Every activity is connected to another in some way. These multiple connections contribute to the wealth of experiences each student has over the school year. Each experience helps prepare students for subsequent experiences.

I think of the myriad experiences and activities in my classroom as interconnected spider webs radiating in every direction. To some, it would look like a tangled mess. To me, it is the best metaphor I can think of to begin to explicate the hundreds of learning situations that occur everyday in the classroom. Imagine, each of my students has a personal web of understanding, so do I. So does every other person who may be in the room. In any given moment or situation some of these webs will intersect, or touch each other in some way. The point at which different webs of understanding bump up against each other is significant because that is where the construction of new knowledge lies. Through working together, my students help each other learn. Their own ideas and learning are challenged every time their webs of understanding touch, causing each individual to question what they know and connect a newly formed strand to their web of understanding.

This interconnected radiating web metaphor is one I will continue to think about as I work toward better articulating the integrative model of learning that exists in my classroom.

When I first started teaching, I taught Kindergarten students in an impoverished area in Colorado. My main objective was to make my students fall in love with school, so they would want to be in school. My best friend, Terry Bradley, taught first grade students in the same school. One day, I asked her how she taught children to read; I was (and still am) curious about such a huge responsibility. Terry hesitated for only a moment and then answered, "I teach them all the skills and strategies I can. I let them practice using what I taught. But, in the end, it's magic. It just happens."

After twenty some years of teaching and nearly as many as a graduate student, I still believe there is an element of the unknown, an element of magic that occurs when my students learn. Some things I am certain about as I establish my classroom each fall. One such certainty is that my job is multifaceted and contains equal portions of teaching content and supporting the social and emotional growth of young children.

My main objective as a primary elementary school teacher is to provide a safe and respectful classroom environment where no idea is off limits. A place where children have high expectations of their work and themselves based on established criteria. Where talk is valued and encouraged. Where I establish learning activities and situations that are explicitly or implicitly connected in an integrated curriculum, where students and adults work together to make discoveries about and understand the topics we are studying. On the surface, it sounds simple. It has taken my professional lifetime, however, to understand what I do and develop language to begin to articulate it.

In the end, as I think about what Terry told me, I realize that I do exactly what she said. I teach my students every skill and strategy I can for every content area, including science—vocabulary, facts, and processes. I also teach my students skills and strategies for their success as learners including fine motor skills and problem solving strategies. I am aware of different learning styles and create activities and situations for each. I provide countless opportunities for everyone to practice what they are learning. Practice occurs in different ways, generally, my students work in groups of two, three, or four. Within those groups, the flexibility in which students work is evident as they make cognitive moves between each other and the work they are doing, almost always talking throughout the activity. These cognitive moves are those webs of understanding that each student possesses. Practice provides my students with peers at their level of independence as well as above and below that level. This means that every member of a group is, at some point learning side by side with another, or may take on the role of a 'more able peer' assisting another within their zone of proximal development, or they may be the ones being assisted. In some activities, students coordinate their efforts to solve a problem or create one jointly constructed piece of work. In every instance, my students are involved in an activity that changes them in some way—their knowledge or understanding shifts, an increase in fine motor development or level of confidence—and prepares them for involvement in subsequent activities. Quite often, these changes are small and may go unnoticed by the student. Sometimes the change is enormous and visible and the student is so excited, finding a way to share that new learning with the group and the class. Shared excitement, joint problem solving, and constructed products are the visible and tangible representations of the internal regeneration and expansion of each persons connecting web of understanding. It is within these invisible webs that the magic of learning is located.

My own web of understanding is now connected to planes of knowledge, theory, and pedagogy I didn't know existed before beginning this work. Each of my students has contributed to my expanding knowledge, as have my professional peers, and the ideas, questions, and theories from many brilliant minds contained in the books lining the wall of my office. My students do not work and learn in isolation and neither do I. The support and interactions I have had with many people has resulted in the present structure of my web of understanding about this project and my pedagogy.

Attempting to understand how learning happens became one of the questions I wrestled with throughout this study. One of my requirements as the classroom teacher conducting this study was the demonstration and explication of the pragmatic use of documentation panels in the primary classroom where developing literacy is the central focus.

Literacy and Scientific Literacy

Teaching young children to read and write is the goal of primary elementary classrooms nationwide. This dissertation shows that the use of expository science texts can motivate young students to practice and learn emergent and early literacy skills. Fiction and expository texts play different roles in the classroom. Historically, primary classrooms use fiction to teach emergent and early reading skills. I argue throughout this study that expository text *can and should be used* alongside fiction for the teaching of those early literacy skills, particularly when tied to the study of a science unit.

Science-based texts can be used during read aloud time and the skills introduced and taught are the same as when using a book of fiction. Students will hear the teacher reading aloud, learn about print directionality, make and confirm predictions and learn about expository format features. Teachers can ask students to demonstrate knowledge of the alphabet—letters and sounds, letter formation, and words—word chunks, rhyming words, antonyms, and synonyms. Teachers can introduce and help define vocabulary words and science concepts.

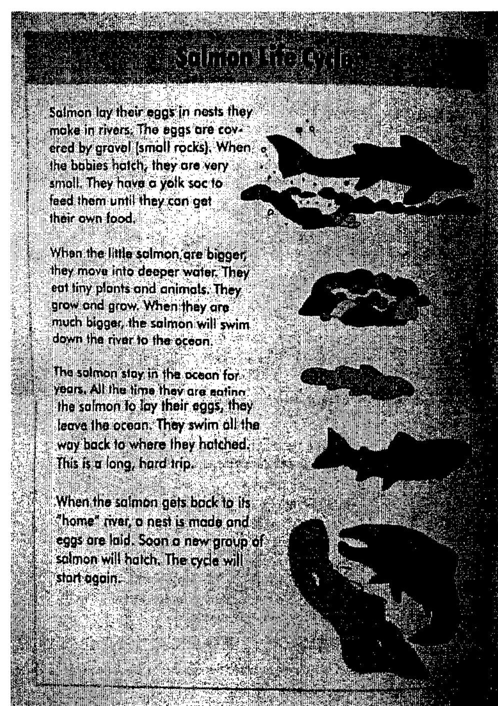
Scientific literacy includes more than the elements of reading and writing. It includes the visual components that require the use and understanding of graphs, charts, various diagrams, maps, and cycles. Another vital component to scientific literacy is the ability to talk about and question scientific concepts and processes. Because scientific literacy encompasses a range of expressive modes beyond the written word, I argue that it is more accessible to young learners than the constraints of emergent reading and writing skills. Examples of the scientific literacy of several students with learning disabilities and some very young emergent readers are included in this dissertation.

Accountability

There is tremendous concern, nationwide that students are not 'learning'; there is concern that teachers and schools are failing in their job to educate young people (Danielson, 2002). Insisting that young students pass a standardized test, that is, a multiple-choice, machine-scored test, as a means to evaluate individual knowledge and classroom performance falls short of really understanding what a student knows. Yet, that is too often the measure. Standardized tests measure quantifiable information; the number of questions the student answered correctly in relation to the number of questions incorrect. Questions on a standardized test are limiting; they evaluate and emphasize limited understanding and lower level thinking skills (Danielson, 2002). They privilege a particular learning style and student (Campbell, Campbell and Dickinson 1999). Standardized tests have their place in education and can indicate the extent to which a particular school is evaluated against a wider population.

> Despite their strengths, [standardized assessments] can measure only a relatively small percentage of desired learning, and they are notoriously ill-suited to measuring higher-order skills, such as writing fluently and expressively, formulating and testing hypotheses, recognizing patterns, evaluating information, designing experiments, and solving complex problems. If a school allows its success to be defined by state-mandated standardized assessments, it will necessarily limit the range of student experience in school. Consequently, standardized measures of achievement should be only one among many ways for educators to gauge their instructional success. (Danielson, 2002, p. 7)

Accountability for teaching and learning can occur and be documented in ways other than written or computerized test situations. Consider the life cycle of the Atlantic salmon presented in a second / third grade science workbook (Evan-Moor, 1995). The explanation is simplified. It shows the cycle in linear sequence rather than a cycle. The vocabulary used in the text does not include the names of the stages of development nor how many stages salmon pass through in their lives. It does not mention some important and unique features of the salmon such as the change from fresh to salt water, how they find their 'home river', nor the fact they are an endangered species. The illustrations imply some unique


Salmon Life Cycle

Salmon lay their eggs in nests they make in rivers. The eggs are covered by gravel (small rocks). When the babies hatch, they are very small. They have a yolk sac to feed them until they can get their own food.

When the little salmon are bigger, they move into deeper water. They eat tiny plants and animals. They grow and grow. When they are much bigger, the salmon will swim down the river to the ocean.

The salmon stay in the ocean for years. All the time they are eating
the salmon to lay their eggs, they leave the ocean. They swim all the way back to where they hatched. This is a long, hard trip.

When the salmon gets back to its "home" river, a nest is made and eggs are laid. Soon a new group of salmon will hatch. The cycle will start again.

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features but the text does not make the explicit. Compare this to the salmon life cycles illustrated and discussed in Chapter 4 by my students on their documentation panels. My students reveal a sophisticated level of understanding about many of the facets of salmon life, much more than what this simple text offers the reader. Examination of the *Conversational Text* on the salmon panels reveals sophisticated reasoning as students use specific vocabulary, ask questions, recall experiences, and make connections about their understanding of the science topic.

Because my students use expository texts on a daily basis either on their own or as participants in read aloud, they are very knowledgeable about science concepts. They are able to demonstrate that knowledge in various ways, all evidence of the elements of scientific literacy. One way every student in my class demonstrates science knowledge is through the use of documentation panels. Documentation panels constitute more complete and accurate evidence of student learning than an essay or multiple-choice test because individual students demonstrate learning through their art and dialogue.

Student created documentation panels, examined by the teacher demonstrate accountability for the teaching and learning of science.

Demonstrating Knowledge beyond the Documentation Panel

Transmediation, by definition presupposes that there is no one way of transforming an experience. Meaning-making strategies are varied and individual and therefore, there is no one way to demonstrate knowledge or learning. This study begins to elucidate the variety of choices young children use on the documentation panel to show their understanding of science concepts and facts. While the documentation panel invites students to use artifacts, drawings and artwork, written texts, and conversation to explain what they know, it is limiting. The documentation panel provides an open space for the synthesis of experiences, information, and creative thought and is therefore, a transmediational tool. It is obvious that the panels reflect and demonstrate student learning. However, this transmediation is confined and constrained by the flat nature of the panel. Multiple intelligence theory (Gardner 1983), work with multi-genre pieces (Romano 1995), and the current push for differentiated instruction (Tomilson, 2003) argue that students can and should be encouraged to demonstrate learning and knowledge through a wide variety of transmediational acts such as painting, sculpture, drama, dance, music, and mathematics. Providing opportunities for students to express science knowledge through other avenues could prove to be advantageous for students as well as an interesting study of science learning.

The Future, Connected to My Past

As I near the end of my doctoral studies and the end of writing this dissertation, I am looking forward to the adventures of a new school year, reconnecting with many familiar young buddies, now in first and second grade. The new faces in my classroom will not be the five-year old Kindergarten people that I always look forward to working with; instead, they will be the first and second graders from a different multi age classroom.

Each of my students will complete local assessments every month of the school year in reading, writing, and math along with the handful of assessments in social studies and science. Each student must 'make standard', in other words, achieve a particular score or an alternative assessment will be given to students who fail. My second graders will participate in the school-wide achievement tests in the fall and spring and their scores will be reviewed and calculated into the formula on which state funding is based. These standardized tests and many of the local assessments have little relevance to the curriculum. There is much about the politics of education with which I disagree and I will do what I can to change what I can. Examining science learning through documentation panels is a step toward change at the local level.

As I think about the new school year, I know my students will complete the mandated assessments. I know I will teach the prescribed math and literacy curricula. I know our science topics will be *insects* and hatching the eggs of *chickens* and *Atlantic Salmon.* I can predict what my class will be interested in, but I do not know how these units of study will unfold and develop. That is what makes teaching science compelling for me: the element of surprise. I cannot wait to build the science curriculum around the questions and knowledge my students will bring to our discussions. I cannot wait to see and talk about the documentation panels my students create to demonstrate their knowledge about one of these topics.

As a classroom teacher for over twenty years, my practice has been informed both positively and negatively by a wide variety of influences. Perhaps the single most powerful advice I received came from my mentor as a first year teacher. Anne Bramhall had been a kindergarten teacher her entire career and was, at that time, nearing retirement. She took me under her wing and guided me through the unparalleled adventure of teaching kindergarten. She told me to remember what five-year old people can do and that they already know a lot. She said, "Never underestimate them and never treat them poorly." I remember her words clearly and have always tried to live up to the standard she set. The work my students do with science learning and documentation panels and ultimately, my work on this dissertation, is an extension of my underlying promise as a teacher to never underestimate the ability of my students.

This study caused me to consider my values, beliefs, and the theories of learning and teaching that have influenced my practice. With the critical examination of my pedagogy, I realize that I will never have all the answers. I have become a teacher-researcher and with the help of my young students, I will continue to ask questions and make discoveries about teaching and learning.

For me, teaching is a journey that I will spend the rest of my life exploring.

REFERENCES

American Association for the Advancement of Science. (1993). *Benchmarks for scientific literacy: Project 2061.* New York: Oxford University Press.

American Association for the Advancement of Science. (2001). *Atlas of science literacy.* Washington, DC: National Science Teachers Association.

Arbruscato, J. (2000). *Teaching children science: A discovery approach.* Needham Heights, MA: Allyn and Bacon/Pearson Education Company.

Atkin, J. M., & Black, P. (2003). *Inside science education reform: A history of curricular and policy change.* New York: Teachers College Press.

Barnes, D. (1992/1976). *From communication to curriculum.* Portsmouth, NH: Boynton/Cook-Heineman.

Berghoff, B., Egawa, K., Harste, J., & Hoonan, B. (2000). *Beyond reading and writing: Inquiry, curriculum, and multiple ways of knowing.* Urbana, IL: National Council of Teachers of English.

Bissex, G. (1987). What is a teacher-researcher? In G. Bissex. and R. Bullock (Eds.), *Seeing for ourselves: Case-study research by teachers of writing.* Portsmouth, NH: Heinemann.

Bloom, B. S., Englehart, M. B., Furst, E. J., Hill, W.H., & Krathwohl, O. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: The cognitive domain.* New York: Longman.

Bodrova, E., & Leong, D. J. (1996). *Tools of the mind: The Vygotskian approach to early childhood education.* Upper Saddle River, NJ: Prentice Hall.

Brady, S., & Jacobs, S. (1994). *Mindful of others: Teaching children to teach.* Portsmouth, NH: Heinemann.

Bredekamp, S., & Rosengrant, T. (1992). *Reaching potentials: Appropriate curriculum and assessment for young children.* Washington, DC: National Association for the Education of Young Children.

Burns, B. (1999). *How to teach balanced reading and writing.* Arlington Heights, IL: Skylight Training and Publishing.

Butler, D., & Clay, M. (1979/1995). *Reading begins at home: Preparing children for reading before they go to school.* Portsmouth, NH: Heinemann.

Byrnes, J. P. (2001). *Cognitive development and learning in instructional contexts.* Boston: Allyn and Bacon.

Cadwell, L. B. (1997). *Bringing Reggio Emilia home.* New York: Teachers College Press.

Cadwell, L. B. (2003). *Bringing learning to life.* New York: Teachers College Press.

Cain, S. E. (2002). *Sciencing.* Upper Saddle River, NJ. Merrill Prentice Hall.

Cajete, G. (1994). *Look to the mountain: An ecology of indigenous education.* Durango, CO: Kivaki Press.

Cambourne, B. (1988). *The whole story: Natural learning and the acquisition of literacy in the classroom.* Auckland, NZ: Ashton Scholastic Limited.

Campbell, R. (2001). *Read-alouds with young children.* Newark DE: International Reading Association.

Campbell, L., Campbell, B., & Dickinson, D. (1999). *Teaching and learning through multiple intelligences.* Needham Heights, MA: Allyn & Bacon.

Capra, F. (1996). *The web of life.* New York: Anchor Books.

Carin, A. A., & Bass, J. E. (2001). *Teaching science as inquiry.* Upper Saddle River, NJ: Merrill Prentice Hall, Inc.

Carson, R. (1956/1998). *The sense of wonder.* New York: HarperCollins Publishers, Inc.

Cazden, C. B. (2001). *Classroom discourse: The language of teaching and learning.* Portsmouth NH: Heinemann.

Chambers, A. (1993). *Tell me: Children, reading, and talk.* Newtown, NSW: Primary English Teaching Association.

Clarke, J. H. (1990). *Patterns of thinking: Integrating learning skills in content teaching.* Boston, MA. Allyn and Bacon.

Clay, M. (1998). *By different paths to common outcomes.* York, ME: Stenhouse.

Cochran-Smith, M., & Lytle, S. (1993). Teacher research: A way of knowing. In M. Cochran-Smith & S. Lytle (Eds.), *Inside/outside: Teacher research and knowledge* (pp. 41-62). New York: Teachers College Press.

Cohen, M. J. (1988). *How nature works: Regenerating kinship with planet Earth.* Walpole, NH: Stillpoint Publishing.

Crain, W. (2000). *Theories of development: Concepts and applications.* Upper Saddle River, NJ: Prentice Hall.

Cresswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks: Sage Publications, Inc.

Cunningham, P., & Allington, R. (1999). *Classrooms that work: They can all read and write.* New York: Addison Wesley Longman.

Danielson, C. (2002). *Enhancing student achievement: A framework for school improvement.* Alexandria, VA: Association for Supervision and Curriculum Development.

Davies, A. (2000). *Making classroom assessment work.* Merville, British Columbia: Classroom Connections International, Inc.

Davies, A., Cameron, C., Politano, C., & Gregory, K. (1992). *Together is better: Collaborative assessment, evaluation, and reporting.* Winnipeg, Manitoba: Peguis.

Davinroy, K. H., & Hiebert, E. H. (1994). An examination of teachers' thinking about assessment of expository text. *NRC Yearbook.* Chicago: National Reading Conference.

Davis, B., Sumara, D., & Luce-Kapler, R. (2000). *Engaging minds: Learning and teaching in a complex world.* Mahwah, NJ: Lawrence Erlbaum Associates.

Dewey, J. (1902). *The child and the curriculum.* Chicago: University of Chicago Press.

Dewey, J. (1938). *Experience and education.* New York: Touchstone.

Dixon-Kraus, L. (1996). *Vygotsky in the classroom: Mediated literacy instruction and assessment.* White Plains, NY: Longman Publishers.

Doiron, R. (1994). Using nonfiction in a read aloud program: Letting the facts speak for themselves. *Reading Teacher*, 47 (8) 616-624.

Doris, E. (1991). *Doing what scientists do: Children learn to investigate their world.* Portsmouth NH: Heinemann.

Dorn, L., & Soffos, C. (2001). *Shaping literate minds: developing self-regulated learners*. Portland, ME: Stenhouse.

Duchein, M., & Mealey, D. (1993) Remembrance of books past...long past: Glimpses into aliteracy. *Reading Research and Instruction*, 33 (1) 13-28.

Dudley-Marling, C., & Searle, D. (1995). *Who owns learning? Questions of autonomy, choice, and control.* Portsmouth NH: Heinemann.

Duke, N. (2000). 3.6 minutes per day: The scarcity of informational texts in first grade. *Reading Research Quarterly*, 35 (2) 202-224.

Duke, N. K., & Bennett-Armistead, V. S. (2003). *Reading and writing informational text in the primary grades: Research-based practices.* New York: Scholastic.

Duthie, C. (1996) *True stories.* York, ME: Stenhouse.

Dworkin, M. S. (1959/1967). *Dewey on education.* New York: Teachers College Press.

Dyson, A. H. (1983). The role of oral language in early writing processes. *Research in the Teaching of English*, 17 (1), 1-30.

Dyson, A. H. (1986). Transitions and tensions: Interrelationships between the drawing, talking, and dictating of young children. *Research in the Teaching of English*, 20 (4), 379-409.

Dyson, A. H. (1988). Negotiating between multiple worlds: the space/time dimensions of young children's composing. *Research in the Teaching of English,* 22 (4), 355-390.

Edwards, C., Gandini, L., & Forman, G. (Eds.) (1993). *The hundred languages of children: the Reggio Emilia approach to early childhood education.* Norwood, NJ: Ablex Publishing Corporation.

Edwards, C., & Springate, K. (1995). Encouraging creativity in early childhood classrooms. ERIC/EECE Archive: EDO-PS-95-14.

Ernst, K. (1994). *Picturing learning: artists and writers in the classroom.* Portsmouth, NH: Heinemann.

Fraser, S., & Gestwicki, C. (2002). *Authentic childhood: Exploring Reggio Emilia in the classroom.* Albany, NY: Delmar Thompson Learning, Inc.

Friedman, T. L. (2005). *The world is flat.* New York: Farrar, Straus, and Giroux.

Fu, V. R., Stremmel, A. J., & Hill, L. T. (2002). *Teaching and learning: Collaborative exploration of the Reggio Emilia approach.* Upper Saddle River, NJ: Pearson Education, Inc.

Gage, N. (1978). *The scientific basis of the art of teaching.* New York: Teachers College Press.

Gallagher, J. M., & Wansart, W. L. (1991). An assimiliative base model of strategy-knowledge interactions. *Remedial and Special Education*, 12 (3), pp. 31-42.

Gallas, K. (1994) *The languages of learning*. New York: Teachers College Press.

Gallas, K. (1995) *Talking their way into science.* New York: Teachers College Press.

Gambrell, L. B. (1996). What research reveals about discussion in L. B. Gambrell & J. F. Almasi (Eds.) *Lively discussions*! (p. 25-38). Newark, DE: International Reading Association.

Gandini, L. (1993). Educational and caring spaces. In C. Edwards, L. Gandini, & G. Forman (Eds.), *The hundred languages of children* (pp.135-150). Norwood, NJ: Ablex Publishing Corporation.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. NY: Basic Books.

Ginsburg, H., & Opper, S. (1969). *Piaget's theory of intellectual development.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Giudici, C., Rinaldi, C., & Krechevsky, M. (2001). *Making learning visible: Children as individual and group learners.* Cambridge, MA: Project Zero, Harvard Graduate School of Education.

Goldberg, M. (2001). *Arts and learning: An integrated approach to teaching and learning in multicultural and multilingual settings*. NY: Addison Wesley Longman.

Graves D. (1983). *Writing: Teachers and children at work.* Portsmouth NH: Heinemann.

Graves, D. (1975). An examination of the writing processes of seven year old children. *Research in the Teaching of English.* 9 (3), 227-241.

Gregory, K., Cameron, C., & Davies, A. (1997). *Setting and using criteria.* Merville, BC, Canada: Connections Publishing.

Harlan, J. D, & Rivken, M. S. (2004). *Science experiences for the early childhood years: An integrated approach.* Upper Saddle River NJ: Pearson Education.

Harper, R., Wiens, A., & Matarazzo, J. (1978). *Nonverbal communication: The state of the art.* NY: John Wiley & Sons.

Harste, J., Woodward, V., & Burke, C. (1984). *Language stories & literacy lessons.* Portsmouth, NH: Heinemann.

Harvey, S. (1998). *Nonfiction matters*. York, ME: Stenhouse.

Harvey, S., & Goudvis, A. (2000). *Strategies that work: Tecahing comprehension to enhance understanding.* York, ME: Stenhouse Publishers.

Hawkins, F. P. (1974). *The logic of action: Young children at work.* New York: Pantheon Books.

Heath, S. B. (1982). What no bedtime story means: Narrative skills at home and school. Cambridge University Press.

Heath, S. B. (1983). A lot of talk about nothing. *Language Arts* 60 (8), pp. 70-87.

Hein, G. E., & Price, S. (1994). *Active assessment for active science*. Portsmouth, NH: Heinemann.

Helm, J. H., Beneke, S., & Steinheimer, K. (1998). *Windows on learning: Documenting young children's work.* NY: Teachers College Press.

Heerwagen, J., & Orians, G. (2002). The ecological world of children. In P. H. Kahn, Jr. & S. R. Kellert, (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations.* Cambridge, MA: The MIT Press.

Hodder, I. (1998). The interpretation of documents and material culture. In Denzin, N. K. & Lincoln, Y. S. (Eds.). *Collecting and interpreting qualitative materials* (pp. 110-129). Thousand Oaks, CA: Sage Publications.

Hornsby, D., Sukarna, D., & Parry, J. (1986). *Read on: A conference approach to reading.* Portsmouth NH: Heinemann.

Howe, M. E., Grierson, S. T., & Richmond, M. G. (1997). A comparison of teachers' knowledge and use of content reading strategies in the primary grades, *Reading Research and Instruction,* 36, 305-324.

Hubbard, R. (1989). *Authors of pictures, draughtsmen of words*. Portsmouth, NH: Heinemann.

Hynds, S. (1997). *On the brink: Negotiating literature and life with adolescents.* NY: Teachers College Press.

Kahn, P. Jr. (1999). *The human relationship with nature: Development and culture.* Cambridge, MA: The MIT Press.

Katz, L. (1993). What can we learn from Reggio Emilia? In C. Edwards, L. Gandini, & G. Forman (Eds.), *The hundred languages of children* (pp. 19-40). Norwood, NJ: Ablex Publishing Corporation.

Katz, L., & Chard, S. (1996). *The contribution of documentation to the quality of early childhood education.* ERIC/EECE Archive: EPO-PS-96-2.

Kellert, S. R. (2002). Experiencing nature: Affective, cognitive, and evaluative development in children in P. H. Kahn, Jr. & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations.* Cambridge, MA: The MIT Press.

Kilmer, S., & Hofman, H. (1995). Transforming science curriculum in S. Bredekamp & T. Rosengrant (Eds.), *Reaching potentials: Transforming early childhood curriculum and assessment, Volume 2* (pp. 43-63).Washington DC: National Association for the Education of Young Children.

Leal, D. (1994). A comparison of third-grade children's listening comprehension of scientific information using an information book and an informational storybook in (Eds). Flood, J., *1994 National Reading Conference Yearbook.* Chicago, IL: National Reading Conference.

Lemke, J. L. (2004). The literacies of science. In E. W. Saul (Ed.) *Crossing borders in literacy and science instruction: Perspectives on theory and practice.* Newark, DE: International Reading Association.

Lewis, C. (2001). *Literary practices as social acts: Power, status and cultural norms in the classroom.* Mahwah, NJ: Lawrence Erlbaum Associates.

Lind, K. K. (2000). *Exploring science in early childhood education.* Albany, NY: Delmar Thompson Learning.

Louv, R. (2005). *Last child in the woods: Saving our children from nature deficit disorder.* Chapel Hill, NC: Algonquin Books

Maine Department of Education (1997). *State of Maine learning results*. Augusta, ME.

Marek, E. A., & Cavallo, A. M. L. (1997). *The learning cycle: Elementary school science and beyond.* Portsmouth, NH: Heinemann.

Many, J. (2002). An exhibition and analysis of verbal tapestries: Understanding how scaffolding is woven into the fabric of instructional conversations. *Reading Research Quarterly* 37 (4), 376-407.

Maxwell, J. A. (1996). *Qualitative research design: An interactive approach.* Thousand Oaks, CA: SAGE Publications, Inc.

Maraige, T. (1995). Why students learn: The nature of teacher talk during reading. *Learning Disability Quarterly* 18 (summer), 214-232.

Merrow, J. (2005). Unlearning bad science. Retrieved April 6, 2005 from http://www.edweek.org/ew//articles/2005/02/23/24merrow.h24.

Meyer, D. K. (1993). What is scaffolded instruction? Definitions, distinguishing features, and misnomers. In D. J. Leu & C. K. Kinzer (Eds.) *Examing central issues in literacy research, theory, and practice.* Chicago: The National Reading Conference.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis.* Thousand Oaks: SAGE Publications.

Moline, S. (1995). *I see what you mean. Children at work with visual information.* York, ME: Stenhouse.

Montessori, M. (1949/1995). *The absorbent mind.* New York: Henry Holt and Company.

Moore, J. E. and Evans, M. (1995). *The science series: Fish and other water animals.* Cleveland, OH: Evan-Moor, Corp.

Morrow, (1992).

Moss, B. (1995). Using children's nonfiction tradebooks as read alouds. *Language Arts,* 72, February.

Nabhan, G. P., & Trimble, S. (1994). *The geography of childhood: Why children need wild places*. Boston, MA: Beacon Press.

National Research Council (NRC) (1996). *National science education standards (NSES).* Washington, DC: National Academy Press.

National Reading Council (NRC) (2001). *Eager to learn: Educating our preschoolers.* Washington, DC: National Academy Press.

National Science Teachers Association (NSTA). (2002). Science/technology/society: Providing appropriate science for all. In *NSTA Handbook 2002-2003* (pp. 226-228). Arlington, VA: Author.

New, R. S. (1990). Excellent early education: A city in Italy has it. *Young Children*, 45, 4-10.

New, R. S. (1992). The integrated early childhood curriculum: New interpretations based on research and practice. In C. Seefeldt (Ed.), *The early childhood curriculum: A review of current research* (pp. 286-322). NY: Teachers College Press.

New, R. S. (1992, July). *Teacher as reflective practitioner: New ways of thinking...thinking of new ways to inform and improve pedagogical practice.* (Available from New Hampshire State Department of Education).

New, R. S. (1993). *Reggio Emilia: Some lessons for U. S. Educators.* ERIC/EECE Archive: EDO-PS-93-3.

Newkirk, T. (1987). The non-narrative writing of young children. *Research in the Teaching of English*, 21 (2), 121-144.

Newkirk, T. (1989). *More than stories: The range of children's writing*. Portsmouth, NH: Heinemann.

Noddings, N. (1992). *The challenge to care in schools: An alternative approach to education.* New York: Teachers College Press.

Norton, D. (1989). Personification in children's literature: identifying, analyzing, and performing. In P. Phelan (Ed.), *Talking to learn: Classroom practices in teaching English*. Urbana, IL: National Council of Teachers of English.

Noth, W. (1990). *Handbook of semiotics.*

Nystrand, M. (1997). *Opening dialogue: Understanding the dynamics of language and learning in the English classroom.* NY: Teachers College Press.

Odell, L. (1987). Planning classroom research. In D. Goswami & P. Stillman (Eds.), *Reclaiming the classroom: Teacher research as an agency for change.* Portsmouth, NH: Boynton/Cook Heinemann.

Ogle, D. (1986). The K-W-L: A teaching model that develops active reading of expository text. *The Reading Teacher,* 39, 564-570.

Ong, W. J. (1982). *Orality and literacy: The technologizing of the world.* London: Routledge.

Oyler, C., & Barry, A. (1996). Intertextual connections in read-alouds of information books. *Language Arts*, 73, September.

Paris, S. G., & Byrnes, J. P. (1989). The constructivist approach to self-regulation and learning in the classroom in B. J. Zimmerman & D. H. Schunk (Eds.) *Self-regulated learning and academic achievement: Theory, practice and research.* New York: Springer-Verlag.

Peirce, C. S. (1985). Logic as semiotic: The theory of signs. In R.E. Innis (Ed.), *Semiotics: An introductory anthology* (pp. 1-23). Bloomington: Indiana University Press.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, 24, (7), pp. 5-12.

Piaget, J. (1952/1963). *The origins of intelligence in children*. Reprint, New York: Norton.

Raban, B. (2001). Talking to think, learn, and teach. In P. G. Smith (Ed.) *Talking classrooms: shaping children's learning through oral language instruction.* Newark, DE: International Reading Association.

Ray, R. E. (1993). *The practice of theory: Teacher research in composition*. Urbana, Illinois: National Council of Teachers of English.

Raymo, C. (2003). *The path: A one-mile walk through the universe*. NY: Walker and Company.

Reid, D. K., & Leamon, M. (1996). The cognitive curriculum. In D. K. Reid, W. P. Hresko, & H. L. Swanson (Eds.), *Cognitive approaches to learning disabilities*.

Richardson, J. (2000). *Read it aloud! Using literature in the secondary content classroom.* Newark, DE: International Reading Association.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York: Oxford University Press.

Romano, T. (1995). *Writing with passion*. Portsmouth, NH: Boynton/Cook.

Rosenblatt, L. M. (1978/1994). *The reader, the text, the poem: The transactional theory of the literary work.* Carbondale IL: Southern Illinois University Press.

Routman, R. (1991). *Invitations: Changing as teachers and learners K-12.* Portsmouth NH: Heinemann Educational Books.

Schon, D. (1983). *The reflective practitioner: How professionals think in action*. NY: Basic Books.

Short, K., Harste, J., & Burke, C. (1996). *Creating classrooms for authors and inquirers.* Portsmouth, NH: Heinemann.

Siegel, M. (1995). More than words: The generative power of transmediation for learning. *Canadian Journal of Education,* 20 (4), 455-475.

Smith, P. G. (2001). Shaping our worlds: The role of oral language in children's learning. In P. G. Smith (Ed.) *Talking classrooms: Shaping children's learning through oral language instruction*. Newark, DE: International Reading Association.

Smith, J., & Elley, W. (1994). *Learning to read in New Zealand.* Katonah, NY: Richard C. Owen, Publishers.

Sowers, S. (1988). Reflect, expand, select: Three responses in the writing conference. In T. Newkirk & N. Atwell (Eds.), *Understanding writing: ways of observing, learning, and teaching.* Portsmouth, NH: Heinemann.

Stake, R.E. (1998). Case studies. In N. Denzin & Y. Lincoln (Eds.), *Strategies of qualitative inquiry* (pp. 86-109).Thousand Oakes, CA: SAGE Publications.

Stewart, J., & Zediker, K. (2000). Dialogue as tensional, ethical practice. *Southern Communication Journal,* 65, 2 & 3, 224-239.

Strickland, D., & Morrow, L. (1989). Interactive experiences with storybook reading. *The Reading Teacher,* 42, 322-323.

Sumara, D. (1996). *Private readings in public: Schooling the literary imagination.* NY: Peter Lang.

Teale, W. (1984). Reading to young children: Its significance for literacy development. In H. Goelman, A. Oberg, & F. Smith (Eds.) *Awakening to literacy.* Portsmouth NH: Heinemann Publishers.

Teale, W. (1986). Home background and young children's literacy development. In W.H. Teale & E. Sulzby (Eds.), *Emergent literacy: Writing and reading*. Norwood, NJ: Ablex.

Temple, C., & Gillett, J. (1996). *Language and literacy: A lively approach*. NY: Harper Collins College Publishers.

Terborgh, J. (1999). *Requiem for nature*. Washington, DC: Island Press.

Tharp, R., & Gallimore, R. (1988). *Rousing minds to life: Teaching, learning, and schooling in social context.* Cambridge: Cambridge University Press.

Tomilson, C. A. (2003). *Fulfilling the promise of the differentiated classroom.* Alexandria, VA: Association for Supervision and Curriculum Development.

Trelease, J. (1979/2001). *The read-aloud handbook.* NY: Penguin Putnam.

Tufte, E. R. (1997). *Visual explanations: Images and quantities, evidence and narrative.* Cheshire, CT: Graphics Press.

Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wells, G. (1986). *The meaning makers: Children learning language and using language to learn.* Portsmouth, NH: Heinemann.

Wertsch, J., Del Rio, P., & Alvarez, A. (1995). *Sociocultural studies of mind.* NY: Cambridge University Press.

Whitin, P. (2005). The interplay of text, talk, and visual representation in expanding literary interpretation. *Research in the Teaching of English*, 39, 4, 365-397.

Wray, D., & Lewis, M. (1992). Primary children's use of information books. *Reading,* November 1992, pp. 19-24.

Yager, R. E., (2004). Science is not written, but it can be written about. In E. W. Saul (Ed.) *Crossing borders in literacy and science instruction: Perspectives on theory and practice.* Newark, DE: International Reading Association.

Yopp, R. H., & Yopp, H. K. (2000). Sharing informational text with young children. *Reading Teacher*, 53 (5), 410-423.

Zimmerman, B. J. (1989). Models of self-regulated learning and academic achievement in B. J. Zimmerman & D. H. Schunk (Eds.) *Self-regulated learning and academic achievement: Theory, practice and research.* NY: Springer-Verlag.

APPENDIX A

IRB APPROVAL LETTER

UNIVERSITY OF NEW HAMPSHIRE

Office of Sponsored Research
Service Building
51 College Road
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(603) 862-3564 FAX

LAST NAME	*Kohn*	**FIRST NAME**	*Charlene M.G.*
DEPT	*Education Department, Morrill Hall 106*	**APP'L DATE**	*2/21/2003*
OFF-CAMPUS ADDRESS (if applicable)	*181 Park Street* *Portsmouth, NH 03801*	**IRB #**	*2891*
		REVIEW LEVEL	*EXE*
		DATE OF NOTICE	*2/21/2003*
PROJECT TITLE	*Documentation Panels in the Primary Elementary Classroom*		

The Institutional Review Board (IRB) for the Protection of Human Subjects in Research has reviewed and approved the protocol for your study as Exempt as described in Federal Regulations 45 CFR 46, Subsection 101 (b), category 4.

Approval is granted to conduct your study as described in your protocol. **Prior to implementing any changes in your protocol, you must submit them to the IRB for review and gain written, unconditional approval. If you experience any unusual or unanticipated results with regard to the participation of human subjects, report such events to this office within one working day of occurrence.** Upon completion of your study, please complete the enclosed pink Exempt Study Final Report form and return it to this office along with a report of your findings.

The protection of human subjects in your study is an ongoing process for which you hold primary responsibility. In receiving IRB approval for your protocol, you agree to conduct the study in accordance with the ethical principles and guidelines for the protection of human subjects in research, as described in the following three reports: Belmont Report; Title 45, Code of Federal Regulations, Part 46; and UNH's Federalwide Assurance of Protection of Human Subjects. The full text of these documents is available on the Office of Sponsored Research (OSR) website at http://www.unh.edu/osr/compliance/Regulatory_Compliance.html and by request from OSR.

If you have questions or concerns about your study or this approval, please feel free to contact me at 862-2003. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Julie F. Simpson
Regulatory Compliance Manager

cc: File
Thomas Newkirk, English