

**Science as a way of knowing:
Using Reader Response as a means to construct
a personal understanding of science literature.**

by

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Literature is a special way of knowing *only* if one accepts the fact that it *is* a special way of knowing, only if the reader lets the piece evoke feelings and trigger deep personal memories and associations. (Blake, nd)

Purpose

The purpose of this paper is to present a literary theory, known as Reader Response, as a means of engaging pre-service elementary education students in the construction of scientific understanding and the creation of personal meaning of science literature. As we apply the strategies of Reader Response to reading scientific literature, we move beyond the content of a piece to extending our understanding of how scientific information impacts on our personal lives. Such an approach – using techniques based upon the notion of “literature as a way of knowing” to the idea of “science as a way of knowing” – allows us not only to understand scientific knowing as relevant to our lives but ultimately to link our own experiences to the scientific

literature to allowing us to embrace science as a relevant, meaningful, and useful endeavor, and allows us to link our own experiences to the literature to create personal meaning.

Theoretical Framework

A constructivist framework of teaching and learning science is embedded in the current fabric of science education reform. Implicit in this framework is the understanding that learning is not an isolated endeavor, but a process that is actively engaging. In constructivism the learner pulls from previous experiences, applies this knowledge to new experiences (usually teacher created), juxtaposes old and new experiences, and then constructs or reconstructs a personal understanding. A constructivist framework also embraces a collaborative, social process, where learning and understanding are done within a community of learners. Thus, learning is mentally and physically engaging as well as a socially collaborative endeavor.

Just as constructivism is counter to a traditional behaviorist, empiricist paradigm of teaching science (Blake, 2002; Goodlad, 1984, cited in Oakes, 1990; Novak, 1991; Shymansky and Kyle, 1992; Yager, 1991b), reader response theory is opposite to a logical-mathematical (Gardner, 1985, Havelock, 1963), a paradigmatic (Bruner, 1985), or a rational/scientific means of knowing in responding to literature (Blake, n.d.). Traditional literary response has a longstanding, systematic formula for students to follow (Blake, n.d.). They include 1) Placing an emphasis on the text as text; 2) Finding the “correct” meaning of the text (typically the teacher’s meaning); 3) Using a systematic, concrete, inductive, “scientific” method to interpretation; 4) Sharing criticism only with the teacher; and 5) Analyzing *parts* of the literary piece, yet viewing them as an “organic whole” (Blake, nd).

Such an approach to literary response is reminiscent of Lemke’s (1990) “stylistic norms” (p. 131) of talking science, where students are to be explicit and technical, avoiding colloquial,

metaphoric, and figurative language. We propose, as Lemke does, that these stylistic norms of talking, writing and responding to science sets science in opposition to human experience, and exempts learning “from social processes and real human activity” (Lemke, 1990, p. 134). These stylistic norms, therefore, continue to “mystify” the process of literary understanding, whether it is from a Robert Frost poem, George Schaller’s *The Last Panda*, or Rachel Carson’s *Silent Spring*. We agree with Lemke that these norms “veto” the techniques of communication that are “necessary for engaging the interest of an audience” (p. 134). Table I provides a comparison of how traditional literary response and reader response differ.

Table 1.

Objective (Traditional) Literary Criticism Versus Reader Response

Objective Criticism	Reader Response
1. Emphasis on Text as Text	1. Emphasis on Reader's Response to Text.
2. Reader finds "Correct" Meaning.	2. Reader Creates Personal Meaning.
<u>Close Reading</u> for Purpose of Getting Content Knowledge only.	
3. Approach is systematic, concrete, inductive, and "scientific." (Traditional critical apparatus)	3. Feelings are Allowed.
4. Analyzes parts of literacy piece but view them as an organic whole.	4. Memories and associations are encouraged.
5. Usually shares criticism with the teacher only.	5. Shares responses with others in learning community.
	6. Intuition is Invoked.
	7. <u>Close reading</u> techniques are used to substantiate the personal response.
	8. Reader comes to understand her response as a reflection of distinct personality.

Relevance to Science Teacher Education

As a means for creating personal understanding of science literature reader response is relative to recent discussions in teacher preparation. For example, Korthagen and Kessels (1999) suggest that we, as teacher educators, should focus our teaching efforts on "reflective

approaches,” where students have considerable opportunity to explicitly link their experiences to their developing notions of what it means to teach and learn. Bryan and Abell (1999) echo the same sentiment in their discussion of the development of a teacher’s professional knowledge, or stance (the relationship of their teaching to student learning), and the crucial link between reflection and the teacher’s practice. They wonder: “How do we help them to articulate, analyze, and refine their beliefs about teaching and learning?” (p. 172). In presenting and modeling reader response as a means of scientific knowing, we allow students the opportunity to pull from previous experiences, link these experiences to the literature, and to construct their own meaning of the science content in the literature. We also allow them to apply their understanding of this content to life in and outside the classroom.

It becomes apparent that to improve teacher preparation and thus the teaching and learning of science, we may consider alternatives in the way we prepare teachers and the way we engage them in literary understanding. Reminiscent of Schaller’s statement regarding the objectivity of scientific research: “Any biologist who observes a tiger, gorilla, panda, or other creature and says he or she has done so with total objectivity is ignorant, dishonest, or foolish” (George Schaller, The Last Panda, 1993, p. 105), reader response allows for an affective, an emotional, even a subjective component of learning, and provides opportunities for students to reflect and engage in a socially collaborative environment, one that they can then help to construct and employ when they are teachers in their own classrooms.

Reader Response Components

Figure 1 provides the general structure of reader response. Key to the response process is allowing time and opportunity for the initial response. Next, students can articulate feelings and memories that link to the text. Figure 2 proposes additional responses for the students, ones

where they construct personal meaning and value for themselves. Responses can therefore become understood as a reflection of each student's distinct personality.

Figure 1.

General Categories of Writing for Reader Response.

1. Initial Response: An initial, immediate response written upon completion of the text.

a. Key: Emotional, intuitive response.

2. Feeling Response: Affective

a. Focuses on asking the question of "how do I feel about this?"

b. "I" has a big role in the response.

3. Memory Response: Relational

a. What does this remind you of? Any experience, young or old, that reminds you of what you read.

b. Allows memory to inform understanding.

Reader Response Samples: Pre-Service Elementary Teacher Interns

Context

The following responses are samples collected from thirteen pre-service teacher interns enrolled in an environmental science class conducted at the Harford Glen Environmental Education Center (The Glen) and part of an Environmental Science Professional Development School (PDS) at Towson University, Towson, Maryland. The PDS is a two-semester, one-year internship. Teacher interns were immersed in the elementary school culture at the very beginning of the school year (September). Interns had a minimum of one full day of teaching in the elementary classroom and a maximum of three consecutive teaching days towards the end of

the semester. In addition, two required courses, reading assessment and general curriculum, were conducted at the elementary school site.

Figure 2.

Other Responses and Issues to Consider

1. Judgment of Subjective Value: Judgment of Importance
 - a. Importance to Whom?
 - b. What is meant by “importance?”
 - c. Important Word, Passage, Feature?
 1. Supported with passages from reading: criteria for you.
 - d. Linked to Perceptions, Feelings, and Memories.
 2. Close Reading: A traditional means to literary response
 - a. Done AFTER other responses.
 - b. Used to Substantiate Initial Response(s)
 - c. Used to Discover why you responded the way you did.
 3. Creation of a Classroom Community: Interpretation as a Communal Act.
 - a. Group Value and Validation.
 - b. Enhances community authority.
 - c. Involves Social Knowledge and Social Skills
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Written Responses to “The Perfect Integration of Panda and Bamboo” from The Last Panda by George B. Schaller.

Following are written responses to a brief passage from The Last Panda. This passage was used to initiate reader response and to allow ample classroom opportunity to share writings and to ask questions of clarification and/or concern. The interns read the passage, immediately

responded in writing, shared responses in small groups (three to four interns), and then came together for a full class discussion. Student samples are categorized as outlined in Figure 1.

Intuitive Responses

Links to Biology: Animal Behavior and Ecology

I thought it was a very colorful piece. It was very descriptive. The story is of a panda in her own environment and how she interacted in such a smooth yet methodical way. She knows her surroundings and has everything she needs, such as food, water, her mate and a place to bar her children. Even though her environment is simple she is comfortable. She can navigate her territory with ease, even while eating. She knows where he boundary is by the different trees. She can even tell when a male has been there. She does sense confrontation when her home is invaded with the sound of an ax and moves away to avoid it. She is the essence of nature itself. She is quiet and peaceful and in perfect balance with her surroundings, she supports them and they support her. (Myia, 9/15/00)

Raising Questions of Morality

Very emotionally provoking in how it was written. Devastating this creature is living in a false sense of security. Her instincts tell her that she is safe, provided for, at "home". However, her "home" is being destroyed little by little. Where will she go? She knows that her place is where there is bamboo, but what about when that is gone? What right do we have as humans to take away the natural habitats of animals? If done to us, it would be in court, in the media, books would be written, and movies made. What hypocrites we are! (Marie, 9/15/00)

Cynicism: To Good to Be True?

I was waiting for it. Establishing the perfect tranquil scene only to destroy it. This is an accurate portrayal of an animal in a closed environment. She has everything she needs within 3000 feet radius. However, man is always lurking close behind.

(Paul, 9/15/00)

Feeling Responses

Typical Response: Anger, Sadness, and Disgust

I feel embarrassed that humans can be so cruel. This panda did not bother us, yet we feel so powerful that we have to go in and take her universe. I feel sorry for the panda and her life that is being chased away. Why do we feel so big that we can just go in and ruin another organism's home? (Julie, 9/15/00)

Atypical Response: Feeling of Peace

This passage makes me feel peaceful. I became the animal and felt the peace and serenity that comes with being in harmony with nature. I felt like all of my senses were taking in the scenario in my mind's eye. It also made me feel like I was an outsider (from the human perspective) and like I wanted to preserve the memory (and even the reality of such a thing) from invasion by those that were in the process of destroying it. To me it felt very fragile. (Myia, 9/15/00)

Memory Responses

Memories from Childhood

I remember playing hide and go seek with my cousins and how I would always pretend to be the animal. I used to hide in the bamboo patch pretending I was a

panda. It was difficult to be found and caught by my cousins. I remember eating the sweet shoots and bitterstalks just to try them. (Bo, 9/15/00)

I remember seeing my aunt when she had her second child. She was in the hospital and her child was on her chest sucking. It again felt like I was an outsider and I could see the balance and connection between mother and daughter. The child was getting substance from the mother and the mother was receiving the love and bond that only exist between mother and child. It was a delicate and fragile balance that I believe should be preserved. (Myia , 9/15/00)

This kind of reminds me of the innocence of children. Everything is simple and comes easy to them (well most of them). Just like the panda life was there for her to live, she had her food and she had her surroundings. There wasn't much work involved. (Susan, 9/15/00)

Often times my memory concerning the environment goes back to a commercial I saw in the seventies. I was in elementary school at the time. A Native American in a traditional dress is on a hilltop looking out over what should be nature but it is a landfill. The camera zooms in on a single tear streaming down his face. No words are necessary. The meaning has stuck with me since then. (Sarah, 9/15/00)

Judgment Responses

Constructing Personal Meaning

The main important thing in the article was the fact that animals rely on certain things to survive-the panda needs bamboo. When their food supply is depleted,

they will slowly die off and the world will lose another precious animal. (Laura, 9/15/00)

I see the quote in the first column bottom of the page, “Within a circle of 3000 feet was her universe, all that she needed: bamboo, a mate, a snug tree den in which to bear young.” That is not much space at all but man will never allow it. (Paul, 9/15/00)

Descriptive Writing and a Sense of Reality

The one thing that stood out the most was the idea that the panda’s life is very calm and peaceful. I know that they are endangered species. I think the article was written to help to understand the panda’s need for bamboo and to raise our awareness of the animal. The last paragraph shows the reality of the endangerment of the pandas by pointing out that someone is chopping something down near the edge of the bamboo forest. That is scaring the pandas up the ridge. (Stacey, 9/15/00).

Human Intervention, Destruction, and Environmental stewardship

This passage is setting the picture for all habitats being ruined around our world. “Within a circle of three thousand feet was her universe, all that she needed: bamboo, a mate, a snug tree den in which to bear her young.” This really creates the whole meaning of the story. Organisms are finally at ease and peaceful, not harming anyone and their habitat is being destroyed constantly. (Julie, 9/15/00).

End of Book Responses to Silent Spring.

The following responses were written upon completion of *Silent Spring* (Carson, 1962/94). At this stage of the reader response process the interns were asked to focus their writings on the articulation of the worth, the value and a sense of personal meaning of the text. What is evident in these responses is the sense of overlap among the categories. There appears to be no artificial separation between the initial, feeling, and memory responses and the construction of personal meaning and value. As represented in the samples, the interns often began with initial responses, pulling in feelings and memories and then using these to make a statement of value.

Initial Response

Initial Response Tied to Feelings and Science Content

My initial responses throughout the entire book have always referred back to my feelings of Carson's strength as a person. She is not afraid to tell it like it is and she is not scared to tell the truth. Her research backs her up although people will still deny it. ... As I read on in this book, I grew angrier at the fact that many people who were causing the problems constantly defended themselves and took no responsibility for their actions. "This is an era of specialists; each of whom sees his own problem and is unaware of or intolerant of the larger frame into which it fits." (p. 13).

The Cartoon Book mentions how protein in foods becomes less concentrated in a food as it goes down the food chain, but chemicals become more concentrated. Carson mentions milk, seafood, beef, etc ... as foods that all contain some sort of chemical. I really felt sick after reading the following quote:

“To find a diet free from DDT and related chemicals, it seems one must go to a remote and primitive land, still lacking the amenities of civilization.” (p. 179).

Finally, I feel sad and scared about the chemicals that are carcinogenic. Cancer has hit my family hard and I can’t believe that things like weed killers and insecticides containing arsenic can cause cancer. Dr. Hueper, as quoted by Carson says, “The goal of curing victims of cancer is more exciting, more tangible, more glamorous and rewarding than prevention” (p. 241). My final word: disgusting. (Julie, 10/20/00)

Memory Response

Author Title: Eyes Wide Open

I would like to be a mother someday soon. As a future mother I think about the state of the world and the state of our future world. . . . I have wonderful memories of growing up on a mountain in central Pennsylvania. I remember the lush Mountain Laurel growing around us, playing hide and seek in a forest of baby hemlocks, catching crayfish in the stream, and my parents waking me up at three in the morning to watch from our window, a bear playing with her cubs. I want to share the same beauty of nature with my children and I am concerned that they will not have that opportunity. (Sarah, 10/10/00)

Application, Meaning, and Value

Application to the Teaching and Learning of Science

One of the most important aspects of teaching, especially in science, is that you want your students to relate the concepts that are learned to real world experiences. This is what the theory of constructivism is all about. Constructivists

follow the instructional 5-E model. . . .Constructivists believe that learners need to build their own understanding of new concepts and apply them to their own life. Reading *Silent Spring* allowed me to complete this process. The book made me look at the big picture of the environment and how everything is linked together in interrelated cycles. This book changed my view on the environment and my place in it.

Throughout the book as I gained knowledge on the subject, I was able to explain why all of these problems happened. Everything that occurred kept coming back to the big idea that our environment is made up of interrelated cycles that work together. If something is altered from one cycle, then all of the other cycles are affected. For example pesticides were used to control insects so that crop yields could be raised, but these pesticides got into the ground water and endangered the plants, animals, and humans.

I am now able to extend my knowledge gained from reading Silent Spring and apply it to things that are occurring in our environment now. For example, the spraying that is being done in Baltimore City to kill mosquitoes that might contain the West Nile Virus. The first thing that came to mind is what chemical are they using and what affect does it have on the plants and animals. The research done on the chemical used shows that it is only harmful to bees. So that's good right because no one likes bees? Wrong, the bee population is already lower than needed which makes pollination lower and affects flowers. . . . and we are in another cycle of animals dying. (Lisa, 10/20/00)

The final responses, samples of which are not included here, were in reaction to Ishmael (1992), by Daniel Quinn. Students responded throughout the book and with a final response paper to the story of a telepathic gorilla who attempts to persuade the narrator that the story of the world and humans' place and existence within the world is a myth: a cultural myth told to use throughout the generations that explain our superiority and dominion over the earth and all of its creatures. Students responded to whatever themes or ideas they found relevant, a few of which included here:

- Why Ishmael as the gorilla's name?
- Why is it that humans seem to be the only animals to live outside the laws of nature?
- How can we balance (or do we want to) between a Taker and Leaver culture?
- What does it mean that humans are conducting a "holy war" against the world?

What occurred in these responses were student attempts to make sense of environmental science, the meaning and applications of previous readings and activities as they apply to their current beliefs, and thoughts on a plan of action, or a means of educating themselves as well as the children they will teach about the nature of the environment. Reader Response became a way to sort through these ideas to construct a personal understanding of the topics/issues presented throughout the texts and quite possibly a belief to resist the status quo of how we live and engage in our world, and to

help young people generate and ever increasing awareness of the beauty and fragility of our natural environment.

Using Reader Response to Explore the Nature of Science

Our aims in this exploratory study were several. We wished to engage pre-service students emotionally and personally in worthwhile science writing, in this case, a short but evocative selection from George Schaller's *The Last Panda* and Rachael Carson's whole book, *Silent Spring*. For their short, intuitive responses to the two pieces of writing, the students were instructed not to worry about the "correctness" of sentence structure, punctuation, and even spelling. Even more importantly, they were urged not to be restricted by a supposed "correctness" of what they wrote, certainly not of what they thought the meanings of the pieces were or what the teacher considered the meanings to be. Essentially, we urged them to "create," not "find," their own individual, personal meanings.

As we examined the student responses, we noticed that they responded in two categories. First, they flourished in a classroom environment free of teacher restrictions and displayed all the elements of Classroom Reader Response. They responded freely, immediately, and intuitively. They reacted emotionally to what they read, and they effortlessly and tellingly related their reading to their own real life experiences through what we call "memory responses." In a surprising fashion, several of the students reflected on the nature of their responses, a high level intellectual act, a meta-linguistic—or meta-scientific—skill, if you will.

The other category of responses dealt with the distilled essence of the "nature of science," observation and inference. The evidence of observation was slight, but since the prompts asked for short, intuitive responses, then the lack of extended observation—evidence or cataloging of concrete details—might be expected. With respect to inferences, the students uniformly were not tentative in making their inferences, conclusions, and moral judgments about the content clearly and decisively

known. It is interesting to note that the students judged with no inhibitions the morality of situations described in the science writing. None, however, judged the value of the writing itself, a common form of evaluation in literary criticism.

Where to next, after this exploratory study? Since one of our aims was to provide elementary school teachers, both pre-service and in-service, with many joyous experiences with worthwhile science writing through Classroom Reader Response techniques and training in the elements of the Nature of Science, we shall provide future teachers with many more examples of valuable science writing. Since the other major aim was to ensure that elementary school children come to experience the wonders of the natural world and perceive the study of science as a gateway to the beautiful and wondrous world of nature, we shall use valuable picture books with primary grade children first to simply observe without intervention how they react orally and in writing to accurate science writing, beautifully presented. Later, as the children become comfortable with their personal, intuitive responses, we shall provide prompts—in the children’s own language—which guides them toward the basic elements of scientific knowing—observing carefully and inferring confidently and boldly.

Here are some of the books we shall be having the children—and their teachers—read and respond to.

Carle, Eric. 1997. *A house for hermit crab*. New York: Simon & Schuster Books for Young Children.

This beautifully illustrated book is filled with opportunities for children to sharpen their observation skills. Carle says, “his book is about beauty, nature, symbiosis and adjustment to growth and change.”

Carle, Eric. 1998. *Hello, red fox*. New York: Simon & Schuster Books for Young Children.

In this lovely picture book, children learn about Johann Wolfgang von Goethe's theory of the three primary colors—red, blue, and yellow—through actual experiments with vibrantly colored illustrations of creatures and objects.

Martin, Jacqueline Briggs. 1998. *Snowflake bentley*. The Caldecott Medal Winner. Boston: Houghton Mifflin Company.

In this book, “gracefully told” and brought to life in “lovely woodcuts,” the writer and artist give “children insight into a soul who had not only a scientist's vision and perseverance, but a passion for the wonders of nature.”

Peet, Bill. 1974. *Wump world*. Boston: Houghton Mifflin Company.

This story of environmental destruction of the Wump's habitat by extraterrestrial invaders is similar to what happens in Dr. Seuss's, *The Lorax*. Eventually the environment becomes inhabitable to the invaders and thus, they leave to find another world to pollute. The Wumps, who escaped underground, eventually reemerge to rebuild their beautiful world. This story evokes strong “feeling” responses” as students are saddened by the fate of the Wumps and relate the Wumps predicament to situations in their own real-life surroundings.

Finally, three books by Lindsay Barrett George: *In the snow: Who's been here?* 1995; *In the woods: Who's been here?*, 1995; and *Around the pond: Who's been here?*, 1996, (New York: Greenwillow Books, HarperCollins Children Books.) are outstanding readings that engage students in the science processes of observation and inference, and used prior to outdoor excursions, can be an excellent way to motivate students to focus on observing the outside world.

Further Considerations

Reader response allowed these teacher interns to read science related literature not strictly for content understanding but for the construction of an emotional, affective meaning as each

related the text to her or his life. If teachers can construct multiple meanings of science text, meanings that have relevance and evoke memories of their own lives, what is the potential in allowing elementary students to create their own scientific understanding of age appropriate science related literature? How can we link science to the language arts, allowing students access to scientific understanding while at the same time “demystifying” the processes and products of science. In a true constructivist sense how can children use literature to aid in the construction of understanding and application of science in their everyday lives? These questions, and many more like them, are the focus of continued studies into science as a way of knowing.

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