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String Theory and Our Relationship with Nature: The Convergence of Science, Curriculum Theory, and the Environment

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STRING THEORY AND OUR RELATIONSHIP WITH NATURE: THE

CONVERGENCE OF SCIENCE, CURRICULUM THEORY, AND THE

ENVIRONMENT

by

VIRGINIA THERESE BENNETT

(Under the Direction of John A. Weaver)

ABSTRACT

Curriculum Theory affords us the opportunity to examine education from a multitude of
directions. This work takes advantage of that opportunity to explore the relationships
between science, nature, and curriculum using string theory and our ideas about the
environment as a backdrop. Both the energy and multiple possibilities created by strings
and the rich history leading up to the theory help to illustrate the many opportunities we
have to advance discussions in alternative ways of looking at science. By considering the
multiple dimensions inherent in string theory as multiple pathways and interweaving
metaphors from Deleuze and Guattari, Michel Serres, and Donna Haraway, our approach
to environmental issues and environmental education allow us to include alternative ways
of looking at the world.

INDEX WORDS: C. A. Bowers, Curriculum Theory, Cyborgs, David Orr, Donna
Haraway, Ecofeminism, Einstein, Environment, Gilles Deleuze, Michel Serres, Physics,
Rhizomes, String Theory

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DEDICATION

This work is dedicated to my family: Bill, Ian, and Evan Bennett - while they often question my ideas, they are always ready to listen. Bill, your patience through this process has been more than I could ask for. It is also dedicated to my grandparents, George and Ruth Snider, whose quest for learning never left them and who instilled in me a desire to always explore and my mother, Virginia Liedel, who had the courage to continue her educational journey as a mother of five. Finally, it is dedicated to my aunt, Ruth Snider, who often reads ahead of me and provides hours of lively discussion to help keep my thoughts flowing. Her mind is awe inspiring.

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CHAPTER 1

RIPPLES, WAVES, AND CURRICULUM THEORY

> If physicists are right, things you thought were totally different are
> actually deeply related.
>
> George Musser (2008, p. 23)
>
> At the very moment when we are acting physically for the first time on the
> global Earth, and when it in turn is doubtless reacting on global humanity,
> we are tragically neglecting it.
>
> Michel Serres (1990/1995, p. 29)

Stick your finger into a pool of water. What happens ripples beyond just your physiological response, beyond the recognition of the wetness of the water, the temperature in relation to your body temperature, the visual distortion of your finger viewed through the water. There is a change in the water itself, its patterns of movement, chemical makeup, and appearance. Your relationship with the water has in turn changed its relationship with the living and non-living components that are a part of this pool of water. You have broken oxygen and hydrogen bonds, changed air patterns, influenced surface tension, and diverted the path of literally millions of living organisms; all from sticking your finger in a pool of water. For a brief time, you might ponder the effects of your action. Chances are, you really won't think of relationships at all but will instead focus on the more obvious cause and effect, giving only a surface snapshot of what has actually occurred.

Convergence, Divergence, and Curriculum Theory

Such is often our approach in education. We may conscientiously examine surface relationships but often fail to delve deeper, despite espousing critical thinking. We don't examine what radiates from the ripples or the myriad of consequences generated from each action, each thought, each perspective. One area of education,

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however, that consistently and purposefully does examine these ripples, looking well beneath the surface, is curriculum theory. It allows us to look in any direction and begin a discussion of what we, educators and students alike, experience. Curriculum theory is "the interdisciplinary study of educational experience" (Pinar, 2004, p. 2). So here we have an avenue with which to examine virtually any topic from an educational standpoint, yet the gap between this academic discipline within the educational field and "education" within most classrooms is perceived as ever widening. William Pinar argues that the current situation in public school precludes this "educational experience" (2004, p. 2), and as a public school educator, I have to agree. What happens in many of our classrooms cannot remotely be considered a quest for knowledge. Indeed, efforts to combat teaching for the test or more than a superficial understanding of many concepts can result in teachers being "written up" by their principals. I have been told by several elementary school teachers that instruction in science and social studies is not to take place for at least two weeks prior to the administration of the state standardized test (since neither subject "counts"). In spite of these obstacles, I also hold with the notion that what we do in curriculum theory influences our fellow educators at all levels or at least those who endeavor to continue their own education. While curriculum theorists in no way present their work as a part of instructional design, the ideas they explore provide educators with multiple perspectives about many diverse fields of study using an educational lens. Their work can serve to inform those who consider themselves life-long learners. Pinar (2007) describes this as "[l]inking lived experience to scholarship…" (p. xii) which is a crucial first step in making meaning of what we learn. If nothing else, keeping the dialogue open provides the opportunity for theorists to meet one another.

Thus, while the gap appears to be widening, examining the ripples made by curriculum

theorists may indeed present a different picture altogether. This is increasingly important

in today's educational disconnect between knowledge, learning (or study, as Pinar calls it

(2007)), and what local, state, and the federal government consider increased student

achievement. I have seen first-hand a propensity at all levels to rely on "canned"

curricula that "guarantee" improved student achievement that has nothing to do with

creating an environment open to discussion and genuine learning but everything to do

with the most effective way to teach for the test. Elizabeth St. Pierre (2004) of the

University of Georgia recounts a session where Grover Whitehurst, then president of the

Institute of Educational Sciences, "chided several hundred researchers…about the misfit

between research presented at the meeting [the 2003 annual American Educational

Research Association conference] and research that would help school superintendents

decide 'what works'" (p. 285). Whitehurst emphasized applied research as opposed to

"overly theoretical" and urged the audience to focus on getting the 'right answer' (p. 285)

and further stated that 'our customers do not need postmodern methods'" (p. 286).

According to St. Pierre, "Deleuze's 1990 statement identifying the desire of some to turn

education into a business has become federal policy in the United States" (2004, p. 286).

This seems apparent even with a new administration in the White House. During

Secretary of Education Arne Duncan's address at the 2009 National Science Teachers

Association conference in New Orleans, he referred to "proven strategies in the

classroom," President Obama's "understand[ing] that we need to educate our way to a

better economy" and the desire "to see states building robust data systems that allow

districts to better track the growth of individual students" (growth being equivalent to

higher test scores). While his comments were meant to inspire science teachers, those of us who firmly believe that curriculum theory provides a vital role in education did not hear anything to indicate that education is not just about economic growth and development. As long as our goal for education is to produce the best worker bees, we will continue to set the stage for graduates who do not see the value in knowledge for knowledge sake. If, however, our goal is to provide an atmosphere whereby dialogue is valued at least as much as memorization and testing, education does not narrow opportunities but instead provides multiple opportunities. I choose to believe that although we may have lost our way temporarily, ultimately a more thoughtful educational approach will take place. By focusing on curriculum theory in a way that develops Pinar's (2007) idea of "verticality" (p. xiii), one which situates the "intellectual history of the discipline" (p. xiii) at a place of primary importance, perhaps we can begin to see more of a movement in this direction. As Pinar states, "concepts have histories" (2007, p. xiii).

This work expands on that idea by focusing on the fluid connections of three areas: curriculum theory; environmental issues; and physics. Each on their own provides an arena for a myriad of research possibilities; collectively, the possibilities are endless. The use of the word "convergence" in the title rather than "intersection" is quite deliberate. Intersections suggest a journey that continues to a single point on a grid, a somewhat orderly passage that leads to specific choices, and once a choice is made, the journey continues on a linear path (back to a narrowing of opportunities). The relationship between science, curriculum theory and the environment, however, is not linear but is instead web-like. Thus, these three domains converge on a continuous basis

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at multiple points in time and space increasing the opportunities for multiple ways of learning.

Curriculum theory allows us to move beyond what is currently seen in many of our classrooms: standardized education whose "success" is gauged by maintaining passing test scores. More and more curriculum departments are being asked to conform their pre-service education classes to a model that is ultimately designed to help teachers teach a test. In my current capacity as a provider of in-service professional learning for fifteen plus K-12 school districts, I get to see and hear first-hand the emphasis being placed on passing the test and making AYP (Annual Yearly Progress), thus being eligible for federal dollars. Lost in all of that is a sense that learning should and can take place. It is my view that the job of curriculum theorists is to provide a space in which we refocus on learning and education and that we are not limited by or to any particular set of criteria. In a chapter entitled, "Curriculum Theorists as Spawns From Hell," John Weaver says, "As our colleagues construct illusions of detachment and seek out the ultimate curriculum design, we [curriculum theorists] seek out the improper and inefficient, the banished and subjugated, the subjective and passionate" (2004, p. 23). That is what originally drew me into the field of Curriculum Studies instead of pursuing a terminal degree in Biology, my original field of study. By studying and writing about science using a curriculum lens, science loses some of its mystique. By mystique of science I am not referring to what we haven't explored yet or the awe we often feel upon discovering something new but rather those aspects of science that traditionally remain hidden. Weaver, Carlson, & Dimitriadis (2006) in describing cultural studies of education state that the borrowing of theories from other disciplines "requires us to think

outside the limits of our own fields" and that, while risky, allows us "to step out of well-worn conventions and modes of understanding" (p. 4). Curriculum studies, of which cultural studies is "an important specialization" according to Pinar (2006, p. 68), is also all about opening up new avenues of understanding. By uncovering what remains hidden in science, in particular events, peoples and cultures that help inform science, we can expand the fields of science and curriculum studies.

Pinar (2007), in reflecting on Ted Aoki's work on listening in education, states "Present are the sounds of complicated conversation in which teachers are bridges between curriculum-as-plan and curriculum-as-lived, between the state and the multitude, between history and culture" (p. 46). It is this conversation, these sounds, that we must attend to. My original intent was to provide an examination of only curriculum theory and environmental issues, areas that had been addressed by a few scholars but not extensively so. While I considered this endeavor worthwhile as I felt I had something important to add to the conversation, two events occurred that have greatly expanded how I perceive science, nature, and curriculum. The first event was in the form of a movie released in 2004 by Twentieth Century Fox entitled "What tHe BL∈∈P D⊖ w∑ (k)πow!?" that combines the unlikely trio of quantum physics, consciousness, and spirituality in a sort of "docu-drama". I recall thinking after watching it the first time that the focus of my work had just shifted in a whole new direction, one that changed how I thought about nature and physics. Shortly thereafter I happened to catch a re-broadcast of NOVA's "The Elegant Universe" based on the book by Brian Greene (1999) and the possibilities for connections between science, nature and curriculum expanded even more. Ironically, out of all of the sciences I have studied, physics is the discipline I have felt least

connected to until now, struggling with seemingly abstract mathematical equations. As Jennifer Ouellette so succinctly puts it, "words = good; numbers = bad" (2005, p. xiii). In preparing this work, however, I have discovered that the universe is, indeed, as Brian Greene states, elegant. Accordingly, the recurring theme for each chapter of this work is one of connections, convergences, and multiplicities by examining string theory, environmental issues from a variety of perspectives and curriculum theory.

String Theory

There are five chapters in this work. I begin with a basic introduction to string theory and the rich history behind it in order to investigate the connections between curriculum theory, environmental issues, and string theory. Since current technology is just now approaching a point that allows for conclusive physical experiments to begin to be conducted, the experimental basis behind string theory is mathematical in nature. While problematic for some in the physics community, for the purposes of this work it is the ideas behind string theory that lend themselves to a connection to both curriculum theory and environmental issues.

It is important to note at the outset that, except in an historical context, it is generally understood that the term "string theory" actually denotes supersymmetric string theory which has evolved from the original string theory and makes up a part of what is termed "M-theory." Except for the aforementioned history, I will be using the term "string theory" throughout this work rather than confuse the reader by shifting back and forth from string theory to supersymmetric string theory to M-theory.

Physicists and mathematicians such as Albert Einstein, Theodor Kaluza, Oskar Kleine, John Schwarz, and Michael Green (Greene, 1999, 2004; Halpern, 2004; Kaku

and Thompson, 1987; Ouellette, 2005; Randall, 2005), were instrumental in providing the much needed analysis leading up to the introduction of string theory. During the late 1800s through the 1940s, physicists identified four forces in the Universe: strong, weak, gravitational and electromagnetic forces. Physicists, including Albert Einstein, have been attempting to find a unifying theory that unites all four of these forces. A precursor to M-theory, string theory proposes that the fundamental particles that make up atoms, and as such are integral to these forces, are vibrating, oscillating strings (Calle, 2001; Greene, 1999; Kaku, 2005), or "filaments of energy" (Greene, 2004, p. 17). This changed view of particle physics is significant in that it establishes the presence of many more dimensions to the universe than previously thought. Thus, strings are analogous to the ripples discussed earlier. There are different types of strings (closed loop and open looped), and these strings interact with each other in many different combinations (greatly increasing the number of "ripples"). When it was just beginning to be openly discussed by physicists, there were seemingly five individual theories that made up string theory. This led to quite a bit of consternation among those experimenting with the idea as it seemed to point away from a much sought after unified theory. It also provided fodder for those who looked upon the theory as a farce. Edward Witten, a physicist from Princeton, proposed that these seemingly different string theories were in fact different mathematical iterations of a single theory, which he termed M-theory (Duff, 1996). Witten (1998) left the meaning of "M" to the imagination by suggesting that it could "[stand] for magic, mystery, or matrix, according to taste" (p. 1129). The rich history of string theory, a layman's explanation of what the theory is, as well as its implications for science and writers of science will be discussed at length.

Perspectives On the Environment

The third chapter examines several scholars whose body of work has been predominately about the state of our environment, how the environment is viewed by the public at large, and what approaches need to be undertaken to mitigate our ecological crisis. With environmental problems front and center in the news, these issues are no longer relegated to the back burner or considered the exclusive purview of what were often termed radical environmentalists. Through a combination of careful political staging, some in your face weather events, and a scramble to obtain more of our very limited supply of fossil fuels at a fairly steep price, the environment is now (or once again) in the spotlight. The current public emphasis on environmental issues seems to have been precipitated by the popularity of former Vice President Al Gore's documentary "An Inconvenient Truth" (released in 2006), a steep rise in fuel costs, and the new Obama Administration who addresses both global climate change and the energy crisis frequently and has vowed to make it a key initiative. Additionally, it was evident to those following environmental issues throughout the Bush Administration that many of the environmental regulations that had been in place for decades were considerably weakened through a series of executive orders and a relaxation of regulatory enforcement. There were numerous allegations in the media that scientific research had been blocked that did not support his agenda. During the 2008 presidential campaign, many of these policies and shifts in regulatory enforcement were made public and became part of the campaign speeches. There seems to be a sustained effort coming from multiple sources to keep environmental issues in the public eye. Although interest in nature and the environment seems to come in waves, previous waves were fairly calm

compared to the present push. From my perspective, in addition to the reasons discussed above, part of this push has come about since corporate America has joined in (at least superficially). The phrase "Go Green" is being used at all levels of consumerism, from opting out of plastic bags and using reusable/recycled bags to personal hygiene items. There are so many "green" claims out there that a congressional hearing was held on June 9, 2009, titled, "It's Too Easy Being Green: Defining Fair Green Marketing Practices" (United States House of Representatives, 2009). While my intent is not to focus on corporate America per se, it is important to put environmental problems in the context of the work already done in the field. While there are a few scientists that do not believe humans are accelerating the increase in greenhouse gas emissions or that our current rate of extinction is part of an historical pattern, most are in agreement that we are living in a prolonged environmental crisis that cannot be ignored. Whether this current emphasis on environmental issues can withstand the current global economic downturn and real progress toward finding solutions be made is uncertain. Providing a forum for open discussion and multiple perspectives is an absolute necessity.

Scholars in science, education and curriculum theory have been publishing work about environmental issues and steps toward solving some of our current problems for a number of years. These scholarly works are in no way in agreement with what these steps might be, who or what is ultimately responsible for the state of our environment, or even to whom nature's resources belong. Indeed, there is a cacophony of voices all vying to be heard, often without listening to any other sides. It is my contention that this dissonance is drowning out the underlying problem of the extreme disconnect between human experience and the environment. There are numerous subgroups among these

scholars that include ecofeminists, deep ecologists, social ecologists, and many others.

While it is not my intention to place anyone in a box (several scholars could rightly be

identified as belonging to one or more of these subgroups), I intend to illustrate the often

contentious quality of their arguments for their own ideologies and against others. It is

the often ideological nature of these works that lead to my assertion that it is the

multiplicities of nature found in their writing that are all ultimately connected.

Nature as Metaphor

Chapter four considers the work of several scholars whose works include multiple

perspectives on nature and the environment in both metaphorical and physical terms.

Their work differs from those previously examined in that while many of these scholars

may well have considered the environment to be in crisis, their work has not focused

exclusively on that crisis. Instead, the full spectrum of their work is as varied and multi-

dimensional as anything described in science. By situating their discourse within nature

and the environment, either overtly or symbolically, they have provided readers with a

rich selection of ideas to choose from. Although a number of scholars are included in

this chapter, particular emphasis is given to Gilles Deleuze, Felix Guattari, Michel Serres,

Bruno Latour, Donna Haraway, and Noel Gough. Their examination of nature affords a

strong support for my idea of a convergence between curriculum theory, string theory,

and the environment.

Deleuze and Guattari's rhizomes provide an extensive examination of multiple

connections at many different levels. A rhizomatic view of nature and subsequent

approach to environmental issues opens the way for a multitude of possibilities.

According to Halstrom (2002), "The rhizome offers new theoretical space that gives both

flexibility and a more inclusive understanding of the world" (p. 3). He describes

connections "…not only between localized actions and global results, but between

humanity and the environment" (p. 6). The added dimensions described by Deleuze's

rhizomes help forge a connection with string theory not only in the way we view nature,

but in how our actions are linked in previously unseen ways. These connections can also

be seen in several aspects of the work of Michel Serres, particularly in terms of time. As

will be evident in chapter two describing string theory and its history, the events leading

up to the current iteration of string theory do not follow a linear progression. Indeed, the

behavior of strings is often articulated in Serres' work; his propensity for connecting

seemingly disparate historical events and disciplines is indicative of the constant

vibration and interaction of strings. Serres' background in the sciences gives his work

added dimensions that are quite useful in helping to describe the convergence of string

theory, curriculum theory and the environment.

Converging Ideas

Chapter five explores the convergence of string theory, environmental issues, and

how we look at nature. String theory expands the idea of the multiplicities of nature by

virtue of its multi-dimensionality. The introduction of string theory to the arguments

being put forth by environmental scholars and curriculum theorists negates the back and

forth battle over how to address the environmental crisis and instead uses these

arguments to illuminate their connections to each other. Indeed, instead of being on

opposite sides, the endpoints of each argument are the same. By examining each layer,

each perturbation, and acknowledging that they are all a piece of the whole, our approach

to environmental issues can drastically change. Just as curriculum theory resonates with

voices from all directions and backgrounds and thus adds multiple dimensions to our educational experience, so too does string theory. The fluctuations caused by vibrating strings, however, multiples our educational dimensions exponentially. The possibilities created by the marriage of string theory and curriculum theory are endless, furthering the "complicated conversation." String theory can also provide much needed changes in how the public at large views environmental issues and how we, as educators, view these issues from an educational perspective. Although much of the focus has been on environmental issues and our relationship to nature, I believe that this theory has major implications for connections between seemingly disparate topics addressed by curriculum theorists. The inclusion of string theory adds an arena with which to connect multiple topics that may have been artificially separated when looked at linearly. There are already innovative ways in which string theory is woven into popular culture through movies such as *Frequency* (2000), *Déjà vu* (2006), and *The Last Mimzy* (2007), documentaries such as *The Elegant Universe* (2003) on NOVA, and novels such as Mark Alpert's *Final Theory: A Novel* (2008). By weaving the concepts underlying string theory into our work, curriculum theorists can expand the range of their focus and provide an even richer body of scholarly endeavors.

This work is theoretical in nature and as such does not seek to create a new curriculum in either physics or environmental issues. Instead, my primary purpose is to present the idea of a new dialogue that examines the convergence of science, curriculum theory, and the environment. It is not intended to be viewed as a work of science but is, instead, one that opens particular aspects of science to both curriculum theory and our relationship with the environment. Thus, there is a more informal tone that allows us to

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explore the connections, the interwoven nature, of these seemingly incongruent areas by establishing a space for creativity. The formality in scientific writing often narrows ideas in order to make sound conclusions that will be acceptable to the scientific community. The writer must often focus on a very minute piece of a puzzle, like microscopically examining the appendage of a single organism found in a drop of water from a vast lake to make conclusions about the health of that lake. My intent is to work in the opposite direction, from string theory toward multiple directions that go beyond the confines of the lake before circling back to the lake again. In some ways this mimics the discovery of string theory itself, described by Michio Kaku as "evolving backwards" (2005, p. 188) by taking accidental discoveries and deciding what physical principles are the guiding principles. It is the idea of string theory joined with curriculum theory, with the continuous interactions and subsequent changes and non-traditional progression inherent in both that constitute the through line of this work. Given that, it must be stated that the intrinsic goals of string theory and those of curriculum theory are at the opposite ends of the spectrum. As will be discussed, string theory has emerged as a possible unified theory within physics, one that explains the universe. Curriculum theory, however, continues to expand by broadening and diversifying in disparate ways rather than coming up with a single set of rules or laws. As such, curriculum theorists are continuously adding to the complicated conversation that constitutes the discipline, providing multiple ideas to describe the world around them. Within the physics community, while complexities are inherent within the mathematics that describes the universe, physicists are attempting to simplify this description by providing a single theory that describes everything. Additionally, the word theory has very different connotations for science

compared to that of curriculum. In physics, theory refers to a mathematical framework

that describes nature whereas in curriculum it refers to ideas. Thus, this work describes

the ideas and history that comprise string theory in order to broaden the discipline rather

than reign it in.

CHAPTER 2

STRINGS, SUPERSTRINGS, AND A UNIFYING THEORY

The primary purpose of this work is to describe the convergence of science, curriculum theory, and the environment using different aspects of string theory as part of the through-line. Therefore, this chapter will not provide a detailed explanation of string theory from a physicist's perspective but instead will focus on its history, the importance of that history, a primarily non-mathematical explanation of string theory, and its relevance to the task at hand. So rather than begin with a "definition" of string theory, the history leading up to string theory and subsequent theories will provide a better understanding of this work. It is important to keep in mind that while this account may appear to have a linear timeline, there are instead numerous overlaps and interactions between scientists and scientific disciplines. Additionally, as stated in the introduction, the use of the term "string theory" today (and in most of this work) actually refers to supersymmetrical string theory, which is one component of M-theory. As I begin my description of the history leading through string theory and up to M-theory, I will be careful to denote the distinction between these terms.

On the Road to M-Theory

From Aristotle's early ideas about matter and classification of animals to Copernicus' heliocentric cosmology hypothesis to Einstein's theory of relativity, we have been searching for answers to how we came to be, why we are here, and how the universe functions. Much of the work and many of our discoveries about how the universe functions have come from mathematics and physics. In many cases, there were errors in thinking, or the answers were incomplete, but in each instance the science that followed

and tested these theories needed these first steps. Rather than delve into ancient history

to provide the background for what has led to string theory and ultimately M-theory, I

will begin with the much more recent history beginning with Albert Einstein, Theodor

Kaluza, Oskar Klein, Joel Scherk, John Schwarz, Michael Green, and Edward Witten as

the primary players.

What's Relativity Got to do With it?

In 1916, Albert Einstein published his general theory of relativity which describes

gravity. Einstein had been struggling with inconsistencies between his theory of

relativity (later renamed special relativity) and Newtonian physics. According to

Newton's laws of motion, the speed an object appears to move is dependent on the speed

of the observer. Thus, the speed in which gravity acts on an object would appear to be

instantaneous which would make it faster than the speed of light. This is often referred to

as Newton's concepts of absolute space and time since space has no dynamic (Greene,

1999, 2004; Halpern, 2004; Kaku, 2005). This was experimentally shown to be untrue by

physicists Albert Michelson and Edward Morley in 1887 when they compared the

"velocity of light waves moving identical lengths in two perpendicular directions"

(Halpern, 2004, p. 67). If Newton's laws were correct, the velocities would be found to

be different since the orientation of the light waves differs in respect to the Earth's

movement. However, Michelson and Morely found the values to be identical, disputing

the notion that space and time are absolute (Halpern, 2004). What the experiment didn't

explain was *why* this seeming anomaly occurred. Indeed, many physicists, while not

disputing the findings since the experimental results were repeated on numerous

occasions, set out to explain it away through mechanical or human error (Halpern, 2004).

Einstein approached the problem by mathematically explaining why Newton was incorrect with his theory of special relativity. Since Newton's law of universal gravitation had been the accepted view since the 1600s, Einstein's work was groundbreaking; it opened the doors for much of today's understanding of physics (Kaku and Thompson, 1987). Einstein recognized, however, that the mathematics did not always work since special relativity is calculated in the absence of gravity (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). Einstein continued to work on this problem for the next 11 years until he published his completed general theory of relativity which reconciles Newton's laws with gravity (Randall, 2005). According to Halpern (2004), Einstein was able to formulate his theory by picturing someone holding an object falling off of his roof. As the person falls, he lets go of the object. One would think the object (assuming it has less mass than the person) would fall at a faster rate than the person. However, general relativity states that the object and the person, in the absence of air resistance, fall at the same rate precisely because there is a space-time curvature (Musser, 2008). General relativity describes space as curved with that curvature increasing with the mass of an object. In the oft used rubber sheet analogy, think of space as stretchy; the heavier the mass of an object, the more curved space becomes (a marble in the center of a rubber sheet would cause very little curve whereas a bowling ball would cause much more of a curve). Relativity allows us to "subdivide [the universe] into manageable chunks. If it didn't hold, we couldn't understand anything without understanding everything" (Musser, 2008, p. 29). Space-time is reactive; "it curves, twists, grows, and shrinks…it becomes an active participant in the drama of life" (Musser, 2008, p. 41). So now Einstein had special relativity,

whereby the speed of light is the same for all observers, and general relativity, which describes gravitational force in terms of a space-time curvature. Einstein took things a step further and spent a sizeable amount of time and energy, especially in his later years, searching for the theory of everything (Greene, 1999, 2004; Randall, 2005). He thought, as do many physicists today, that there was one unifying theory describing how the universe functions, that would encompass both gravity and light. As Musser states, "Nature fits together seamlessly, yet the two theories don't" (2008, p. 88). Einstein and many physicists who have since followed grappled with this seeming inconsistency. How can both be right? "Quantum theory treats space and time as fixed and absolute – which general relativity denies. General relativity treats objects as having definite properties, such as position and velocity – which quantum theory denies" (Musser, 2008, p. 88). This emphasis on the search for a unified theory was a distinct shift from what Lisa Randall (2005) describes as the "bottom up" approach that emphasizes making connections from physical observations and producing models (mathematical or otherwise) and a "top down" approach in which one starts with the theory and derives the connections. The conflict between "bottom up" and "top down" approaches to science will be addressed in more detail later in this chapter. Although mainstream physics largely ignored Einstein's quest for a unified theory, it is the basis for what would later become string theory. Indeed, without Einstein's work on relativity and subsequent shift in his approach to science, string theory may not have been proposed at all.

Another Spatial Dimension?

Having studied Einstein's general theory of relativity, Theodor Kaluza, a German mathematician[1], pondered the idea of adding another spatial dimension to Einstein's equations (Einstein having worked with four; three spatial dimensions and one time dimension) (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Randall, 2005). In doing so, Kaluza discovered the new equations not only encompassed Einstein's general theory of relativity but also included James Maxwell's theory of electromagnetism (calculating the speed of light) which had seemed distinct from relativity (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Randall, 2005). Kaluza believed these reworked equations could be the "key to unifying all of nature" and submitted his paper to Einstein in 1919 (Halpern, 2004, p. 6). Einstein had many questions about this added dimension that Kaluza was unable to answer: where was this dimension and how did it differ from the other four? Despite his inability to articulate the specifics about the new dimension, Kaluza's paper was finally published in 1919 as Einstein thought the idea might have merit (Randall, 2005). Little attention was paid to the work (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Randall, 2005). Some speculate that the scientific community had difficulty understanding Einstein's four dimensions and could not comprehend a fifth (Kaku and Thompson, 1987; Ouellette, 2005). Although Kaluza continued to work on relativity throughout his career and maintained a relationship with Einstein, his work was not well known (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). This added dimension, however, became extremely important many

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[1] There is some dispute regarding Kaluza's nationality; some sources refer to him as German, others as Polish. Brian Greene refers to him as Polish in his 1999 text but German in his 2004 text.

years after it was first proposed. The questions raised by Einstein were partially

answered three years after Kaluza's publication when Oskar Klein, a Swedish physicist

who had been working independently on the idea of an added dimension, was able to

better articulate the differences between the fifth dimension and the other four (Greene,

1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005).

Instead of working exclusively with the mathematical equations, Klein based his idea of a

fifth dimension on a combination of experimental data involving particles in

electromagnetic and gravitational fields and the mathematical equations describing the

movement of these particles (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson,

1987; Randall, 2005).   Klein proposed that the fifth dimension was extremely small (10^{-33}cm) and curled up in a circle, making it virtually undetectable even with modern

technology (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Randall,

2005). He further postulated that every point in space has its own minute circles

(Randall, 2005). Because this dimension was so small and we cannot see time as a

dimension, we continue to only see three dimensions. Although this was the precursor to

string theory, the Kaluza-Klein theory (as it became known) was largely ignored for over

50 years as physicists set their sights on quantum theory (Greene, 1999, 2004; Halpern,

2004; Kaku and Thompson, 1987; Ouellette, 2005). The one notable exception was

Albert Einstein; he divided the last 30 years of his work between electromagnetism in

terms of the space-time continuum and the Kaluza-Klein theory (Greene, 1999; Kaku and

Thompson, 1987). It is important to note, however, that the progress made in quantum

field theory has played an integral role in the current iteration of string theory (Greene,

1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Randall, 2005).

Enter Rubber Band-Like Strings

In the years following the introduction of the Kaluza-Klein theory, research into quantum mechanics and general relativity proliferated at an astounding rate. Briefly, quantum mechanics describes the universe at the atomic and sub-atomic level (protons, electrons, neutrons, quarks, etc.). Quantum mechanics does not, however, describe gravity; the mathematical formulas no longer work when applied at cosmic levels (Greene, 1999, 2004; Halpern, 2004; Hawking, 2001; Kaku, 2005; Musser, 2008; Randall, 2005). Thus, physicists have worked in two different realms: quantum mechanics for the very small scale and general relativity for the very large scale. Periodically, someone working in one realm would stumble across something that seemed to answer a question in the other realm (Greene, 1999, 2004; Halpern, 2004; Randall, 2005). These discoveries would often either be put aside, ignored by others, or further connections would fail to be made (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987). Occasionally, however, important connections would be made. An example of this involved Gabriele Veneziano who in 1968, while working at CERN (the European accelerator laboratory in Geneva, Switzerland), discovered that a formula written two hundred years previously described the data he had been collecting while working on experiments with the strong nuclear force (the force that keeps atoms together) (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987). While he couldn't explain *why* this worked, three physicists working independently could: Leonard Susskind from Stanford, Holger Nielsen at the Niels Bohr Institute, and Yoichiro Nambu from the University of Chicago (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Ouellette, 2005). They were the first to describe "tiny, extremely thin,

almost rubber-band-like strand[s]" (Greene, 2004, P. 340) that make up the strong force

between two particles (later to be dubbed "strings") in a paper published in 1970 (Greene,

1999, 2004; Halpern, 2004; Kaku and Thompson, 1987). When string theory first

emerged, it was greeted with skepticism or ignored completely, particularly in light of

Einstein's inability to work out the "theory of everything" (Halpern, 2004). This

skepticism persisted in part because of its radical departure from the long accepted tenets

of quantum mechanics and a particle predicted by the mathematical equations that was

not previously known to exist (Halpern, 2004).   Thus, as with Kaluza fifty years before,

papers written by Susskind, Nielsen and Nambu were originally rejected (reviewers

considered their findings of minimal interest), eventually published, but set aside

(Greene, 2004). Physicists instead focused their attention on quantum chromodynamics,

which did not include strings but was instead guided by traditional particles and fields

(Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette,

2005; Randall, 2005). The physics community viewed string theory as a "theory in

search of an application" (Greene, 2004, p. 341) and the discovery of a particle that was

not part of the strong force, the force string theory was supposed to describe, didn't help

matters (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987).

However, instead of discarding the work of Susskind, Nielsen and Nambu and turning

away from string theory, several physicists continued to pursue it. In 1974, Joel Scherk

and John Schwarz hypothesized that the particle in question was, in fact, a graviton, a

particle associated with the gravitational force (Greene, 1999, 2004; Halpern, 2004;

Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). This was an

important idea since it meant that string theory not only described the strong force, it also

described the gravitation force (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987). Once again, the idea did not take hold with the physics community en mass for a number of reasons. First, physicists such as Einstein had been attempting to unite these two forces with no success for decades (Greene, 1999, 2004; Halpern, 2004; Randall, 2005) (the assumption being that a few lesser known scientists could not have succeeded, even in part, where Einstein had not). Second, this model could only exist in ten dimensions (relegating it to science fiction in the eyes of some physicists) (Kaku, 2005). Third, the Scherk-Schwarz model would only hold if the strings were much smaller than those described earlier, so small that it made it impossible to test the theory experimentally (Greene, 1999, 2004; Kaku, 2005) (a problem that persists today). Meanwhile, many gains were made in the field of quantum mechanics, reinforcing the decision to stay on the more traditional path made by many physicists (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005).

John Schwarz and others were persistent and continued to pursue string theory as the unifying theory that joins quantum theory with gravity, and in the early 1980s he began to work with Michael Green[2] (then of Queen Mary's College in London). While discoveries continued to be made in quantum theory, physicists were continually unable to unite it with gravitational theory and began looking at the previously ignored work of Scherk and Schwarz and now Schwarz and Green, thus opening the door for what Brian Greene refers to as the "first superstring revolution" (Greene, 1999, p. 139, 2004, p. 344). In a paper published 1984 entitled "Anomaly Cancellation in Supersymmetric D=10

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[2] Joel Scherk, John Schwarz's earlier collaborator, died from insulin shock in 1979 at the age of thirty-three.

Gauge Theory and Superstring Theory", Schwarz and Green resolved any lingering problems with string theory and quantum theory; indeed, they were able to show that string theory included all four forces: strong, weak, electromagnetic and gravitational (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987). The shift in emphasis from quantum mechanics to string theory was extraordinary, with over a thousand papers written on the subject within two years of the Schwarz-Green publication (Greene, 1999).

Witten's Mysterious "M"

With so many physicists working on string theory, a disturbing picture began emerging. First, there was still considerable resistance to the idea of so many different dimensions (string theorists were up to ten at this point) (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). Additionally, there seemed to be five *different* and competing mathematical models associated with strings, prompting several in the field to question whether this was, in fact, the unifying theory (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). Many physicists began to break away from work on string theory and return to more traditional avenues. Then in 1995, Edward Witten of Princeton (who had been working closely with several string theorists to include Chris Hull, Paul Townsend, Ashoke Sen, Michael Duff, and John Schwarz to reconcile these differences) announced during a superstring conference that he had found a way to link all five mathematical models making it once again a single theory (Greene, 2004; Kaku, 2005; Randall, 2005). Rather than continue with the string nomenclature, he called this new theory M-theory. There has been much speculation about what the "M"

stands for. Witten has never revealed its true meaning but offered such tags as "magical," "mystical," "membrane," and even "murky" (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Ouellette, 2005; Randall, 2005; Witten, 1998). Whatever the M stands for, Witten's announcement set off the "second superstring revolution" (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005). Although there continue to be critics, particularly since M-theory cannot as yet be experimentally proven, it continues to serve as the only theory that unites all four forces (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005). There are also strong indicators from the field of astronomy with their discovery that the expansion of the universe is accelerating, suggesting that empty space is not actually empty but has a substance that Einstein described with his "cosmological constant" (Chalmers, 2009). This could have implications for the eleven dimensions that constitute M-theory since this constant is very close to zero supporting the extremely small strings or loops that are integral to string theory (Calle, 2001; Chalmers, 2009; Greene, 2004; Halpern, 2004; Hawking, 2001; Kaku, 2005). It is also hoped that experiments conducted at the CERN particle physics lab in Geneva using the Large Haldron Collider (LHC) will provide much needed data to support string theory (Chalmers, 2009). (Although the LHC was due to produce its first collision in September, 2008, an electrical problem shut it down until November, 2009.)

With this brief history of string theory and M-theory in place, a description of string theory and supersymmetric string theory is next. M-theory will receive a much briefer examination since, as Randall (2005) remarks, "…M-theory is still a 'Missing theory' which is postulated but not fully understood" (p. 305). I will revisit the history

of these theories at the end of the chapter in terms of connection to curriculum theory and ultimately environmental issues.

Strings, Superstrings and M-theory

So what is string theory and why are so many physicists devoting so much time to it? Although the previous section provided a partial explanation, I will now offer a more substantial description. Originating from multiple sources but ultimately the work of Susskind, Nielsen, and Nambu, who described rubber-band like strands (strings) that made up the strong force, string theory states that the universe is not made up of what is thought of as point particles (atoms, protons, neutrons, electrons, etc.) but is instead made up of vibrating strings, or as Brian Greene describes them "tiny one-dimensional loops" (Greene, 1999, p. 14) or Paul Halpern as "cut pieces of twine" and "rubber bands" (Halpern, 2004, p. 251). This is not to say that describing matter as protons, neutrons, and electrons is incorrect, but it is definitely incomplete. Physicists have long known of the existence of other particles such as quarks, leptons, muons, gluons and more for decades (Becker, Becker, and Schwarz, 2007; Capra, 2000; Greene, 1999, 2004; Halpern, 2004; Hawking, 2001; Hawking and Mlodinow, 2005; Kaku, 2005; Kaku and Thompson, 1987; Lederman and Hill, 2004; Ouellette, 2005; Randall, 2005). The significance of the absence of mention of these particles at even the secondary school level will be addressed later in this work. For string theorists, though, one must continue to bore down much further, beyond our current capability to detect the vibrating stings or filament like particles that they speculate actually make up these so called "particles." In terms of the size of these strings, Musser (2008) provides this analogy: the string is to the atom as a human is to the observable universe (p. 4), which illustrates the difficulties in attempting

to experimentally observe strings (more on this later). What makes strings so important in trying to determine what makes up the universe, and how we function in that universe, is their constant interaction with one another and the subsequent variations in interactions that always already occur. When a string interacts with another string, the interaction affects both strings and all of the other strings they in turn are capable of interacting with (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987;Musser, 2008). Thus, there is no beginning, no middle and no end to the interactions; the universe is continuously changing. What makes this model even more powerful is not just the vibration of these strings, but their oscillations as it is the oscillation that helps predict what the particle actually is (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Ouellette, 2005; Randall, 2005). "…Each of the preferred patterns of vibration of a string in string theory appears as a particle whose mass and force charges are determined by the string's oscillatory pattern" (Greene, 1999, p. 15). So a proton is a string vibrating in one way and an electron is a string vibrating in a different way. Additionally, the frequency of the vibration has a direct correlation with energy; the higher the vibrational frequency, the higher the energy (Becker et al., 2007; Greene, 1999). So why is our universe not in total chaos with string interactions preventing any order whatsoever? Why are the keys I am typing on solid and (somewhat) unchanging? Recall Musser's analogy of the extremely small size of these strings – their direct effects are proportionally tiny. Put simply, it is the relationship between strings rather than the strings themselves that determine a particular particle's path; thus, the string doesn't change, only its behavior (Musser, 2008). Recall also that just as the cells in our bodies are differentiated to perform specific tasks and functions, the vibrations and oscillations of strings correspond with the

behavior and charge of a particle (Greene, 1999, 2004; Halpern, 2004; Musser, 2008; Randall, 2005). Moreover, there are certain constraints on how strings interact as is discussed in the following sections.

More Than One String Theory

As with any scientific endeavors, string theory has undergone several iterations and will, in all likelihood, continue to change as more experimentation takes place.

The First Iteration. In order to provide a more detailed explanation of the different iterations of string theory, a bit more history is needed. The first iteration of string theory (later termed bosonic string theory) posits that strings can be either open or closed with intrinsic tension and subject to the laws of relativity (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Ouellette, 2005; Randall, 2005). They have mass, and, in order to be described on the quantum level, these strings would have to have an infinite number of point particles in order to make them continuous objects (Mukhi, 1999). This results mathematically in 26 space-time dimensions, far beyond the four space-time dimensions described by Einstein and others (Greene, 1999, 2004; Halpern, 2004; Mukhi, 1999; Musser, 2008). Aside from the daunting number of space-time dimensions, the problem with the original string theory is that it produces tachyons, a hypothetical particle that travels faster than the speed of light and predicts the existence of bosons, particles associated with force (Greene, 1999, 2004; Kaku, 2005; Randall, 2005). Since force equals mass times acceleration (F=ma) and bosonic string theory provides both force and acceleration, the missing variable is mass which is an integral component in any gravitational theory. An added characteristic of string theory (via its mathematical equations), however, is a particle with a *vanishing* mass (Greene, 1999, 2004; Halpern,

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2004; Musser, 2008; Randall, 2005). Physicists working in other arenas took the

mathematical existence of both the tachyon and the mysterious vanishing mass as further

proof that string theory was not a viable theory at all (Greene, 1999, 2004; Halpern, 2004;

Kaku, 2005; Musser, 2008; Ouellette, 2005; Randall, 2005). Rather than looking at the

existence of this mass as the end to string theory, however, early proponents viewed it

from a different angle and postulated that this mass is actually a graviton, uniting

quantum mechanics and gravity (recall the work of Scherk and Schwarz). Of even

greater importance in uniting the four forces that fall under the umbrella of quantum

theory and gravity is the model of strings as completely smooth particles rather than a

scattering of point particles such as protons, neutrons, electrons, or quarks (Mukhi, 1999),

thus reducing the number of space time dimensions yet again. This was the primary

reason string theory was not put on the shelf permanently by everyone in the physics

community since it was one of the major arguments against the viability of string theory.

Tackling the problem of bosons and 26 dimensions led to superstrings or supersymmetric

string theory.

Supersymmetric string theory. Supersymmetric string theory actually consists

of five separate theories that have the same thing in common: all of them are described by

the interactions of the strings and the type of oscillation seen in that string (Greene, 1999,

2004; Halpern, 2004; Kaku, 2005; Musser, 2008; Ouellette, 2005; Randall, 2005).

Although numerous physicists were involved in discovering the foundations of

supersymmetric string theory, it is the work of Schwarz and Green that is most often cited

as providing the impetus for what followed (Greene, 1999, 2004; Halpern, 2004; Mukhi,

1999; Musser, 2008; Randall, 2005). By re-examining the mathematical equations and

approaching them from a different angle, it was determined that not only are strings

smooth (without point particles), tachyons are out and fermions (particles associated with

matter rather than force) and bosons are both present (Becker et al., 2007). With these

new mathematical equations, the number of dimensions needed for the existence of

strings was reduced from 26 to 10 (a much more manageable number in the physics

community), and a rigid set of characteristics of interaction was now in place (Greene,

1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Mukhi, 1999;

Randall, 2005). The following scenarios for interactions exist according to

supersymmetric string theory: one open string can join with another open string; the ends

of one open string can join to form a closed string; one closed string can form two closed

strings by pinching itself off (somewhat like cell division); or two closed strings can join

(Becker et al., 2007; Greene, 1999, 2004; Halpern, 2004; Mukhi, 1999; Musser, 2008;

Randall, 2005). These five types of interactions, each derived from different

mathematical equations, were considered by many non-string theorists as a further

argument against supersymmetric string theory being the much sought after unified

theory (Greene, 2004; Kaku, 2005; Musser, 2008; Randall, 2005). After all, how can a

unified theory be described in five different ways?

Thus far, physicists have gone from four dimensions (Einstein) to five dimensions

(Kaluza-Klein) to twenty-six (the first iteration of string theory) to ten (supersymmetric

sting theory). At this point, a discussion about dimensions would probably help to, at

least partially, provide a better basis for their importance in supersymmetric string theory

and M-theory. Robert Birnbaum, in a 2004 interview with Brian Greene, asked him to

explain dimension:

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Dimension is an independent direction…that you can move. In everyday life you

have left-right, that's one dimension. You've got back-forth, that's a second

dimension, and up-down, that's a third dimension…These theories really do say

there are other independent dimensions in addition to left-right, back-forth, up-

down...rather than being straight the way left-right, back-forth, and up-down are,

they are curved. And they are curled up and they are curled up very, very tiny.

That's why you don't see them with the naked eye.   Were we an ultramicroscopic

ant walking around, we would have other options for direction to move beyond

the ones we know about (para.100).

Without these extra dimensions, there would be no unification between general relativity

and quantum mechanics (Becker et al., 2007; Birnbaum, 2004; Greene, 1999, 2004;

Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Lederman and Hill, 2004;

Ouellette, 2005; Randall, 2005). When speaking about extra dimensions, Randall (2005)

says,

Recent advances suggest that extra dimensions, not yet experienced and not yet

entirely understood, might nonetheless resolve some of the most basic mysteries

of our universe. Extra dimensions could have implications for the world we see,

and ideas about them might ultimately reveal connections that we miss in three-

dimensional space… Arguments against them have too many holes to be reliable,

and physical theories without them leave too many questions unanswered (p. 3-4).

At this point, physicists working in the fields of string theory, membrane theory, and/or

M-theory view extra dimensions as a given (Greene, 1999, 2004; Halpern, 2004; Kaku,

2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005).

Under the umbrella. Supersymmetric string theory opened the door for over two decades of research by hundreds of physicists (Greene, 2004; Halpern, 2004; Kaku, 2005). As described earlier, however, many physicists who were not attempting research in the supersymmetric string theory field after the work of Schwarz and Green in the early 1980s continued to have serious problems with it (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Mukhi, 1999; Ouellette, 2005; Randall, 2005). They argued that the theory was not and is not experimentally testable (although this is expected to change within the next few years) and more importantly there seemed to be competing supersymmetric string theories which would make it out of contention for a unified theory (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Mukhi, 1999; Randall, 2005). Recall that it was Edward Witten's 1995 presentation at a string theory conference that changed all that by pronouncing all five iterations of supersymmetric string theory were in fact five iterations of the *same* theory (Greene, 1999, 2004; Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Mukhi, 1999; Ouellette, 2005; Randall, 2005; Witten, 1998). As stated by Witten (1998), "The five string theories traditionally studied are different limiting cases of one richer and still little understood theory" (p. 1129). And a big part of that richer theory includes membranes (also known as branes) which, as Randall states, "turned out to be the missing piece that miraculously completed several jigsaw puzzles" (2005, p. 304). There are numerous designations for branes that are denoted by letters of the alphabet; each indicates a different type of brane, but perhaps the two mentioned most often are D-branes and p-branes.[3] D-branes are an integral part of open string interactions (Randall,

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[3] p is a variable that refers to the number of special dimensions of the brane

2005; Siegfried, 2000). "D-branes provide surfaces, something like 'edges' in spacetime, for the open strings to end on. In this role, D-branes help show how the five versions of superstring theory relate to one another" (Siegfried, 2000). Wadia (2008) further describes the interaction between membranes and strings: "…the splitting and rejoining of a closed string creates a handle on the world sheet. A similar process for the open string creates a hole in the world sheet[4]" (Wadia, 2008, p. 1254). The energy from strings is thought to be able to grow and expand branes, which in turn may help to explain in part the stability of the orbits of planets in our solar system (Hawking, 2001). It is important to note that even though the term "string theory" is used almost universally when discussing supersymmetrical string theory and even M-theory, strings do not play a greater role than that of branes: "…there is a sort of democracy (in the sense of having equal voices) among supergravity, string, and p-brane theories: they seem to fit together, but none can be said to be more fundamental than the others" (Hawking and Mlodinow, 2005, p. 133). The supergravity referred to by Hawking describes black holes (a major field of study for him) that once again illustrates the unifying nature of M-theory: all four forces are united under one central theory. This is a major concept since black holes have magnified the seeming dis-unity between general relativity and quantum theory (Musser, 2008). "[The conflict] is not just a matter of teeny-weeny doodads. A black hole millions of kilometers across sings the song of quantum gravity, too" (Musser, 2008, p. 110). So placed under the umbrella of M-theory are strings, membranes, and black holes (Duff, 1998). This has created an environment whereby there are a multitude of researchers studying different aspects of M-theory from different perspectives, *adding* to

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[4] a two-dimensional surface made by strings as they move through space (Greene, 1999; Musser, 2008)

our body of knowledge rather than working in isolation. While M-theory certainly has distracters, the amount of work being done and papers being submitted is astounding. A search through the Galileo database using the terms M-theory, string theory, superstring theory, and supersymmetry yielded over 6,000 hits. This is even more amazing in light of the fact that, as with string theory, M-theory has as yet been impossible to experimentally test. But unlike string theory, current technology is not the only limiting factor. In a recent interview by Matthew Chalmers (2009), Edward Witten intimated that we just might not be "smart enough" to figure [string/M-theory] out in his lifetime given its extremely complicated mathematics. Michael Duff, one of Witten's key collaborators in working on membranes, describes their work as "glimpsing only small corners of M-theory" (Duff, 1998, p. 69). Although Duff is often described as a string theorist, the bulk of his work is on supergravity, membranes, and M-theory and he is known for referring to string theory as "the theory formerly known as strings" (Duff, 1998; Randall, 2005) in an effort to place more emphasis on the other components of M-theory and has cautioned against being distracted by only one aspect of the theory:

> …historians may judge the late 20th century as a time when theorists were like children playing on the seashore, diverting themselves with the smoother pebbles or prettier shells of superstrings while the great ocean of M-theory lay undiscovered before them (Duff, 1998, p. 69).

This observation has not gone unheeded as research into aspects of M-theory other than supersymmetric strings has greatly increased (Greene, 2004; Kaku, 2005, Ouellette, 2005; Randall, 2005). What differs from the earlier work of string theorists and membrane theorists is the increased and continuing collaboration among the different

theoretical fields that fall under M-theory (Greene, 2004; Halpern, 2004; Kaku, 2005; Ouellette, 2005; Randall, 2005; Siegfried, 2000). It is this collaboration, the interconnectedness of its history, and the openness of some of its proponents to other ventures that makes string theory so appealing outside of the realm of the theoretical physics field. While the current outside trends and possibilities will be discussed in the final chapter, I will turn now to the significance of string theory's interconnected history.

String Theory's Historical Web: There Are No Straight Lines

From the brief history earlier in chapter, it should be apparent that events leading up to the first iteration of string theory or subsequent iterations did not occur as a linear timeline. As Musser states, "Even by Hollywood standards, string theory has an improbably story. Physicists fell in love with it, then broke up with it, made up with it, lost the passion for it, and then found it again" (2008, p. 148). Although I began with Albert Einstein, there were dozens of others who contributed to its advent; some were physicists, some were mathematicians, some were just curious and not only asked "why" but "how." As Musser puts it, "This collective participation in science goes far beyond individual light bulbs going off in individual heads" (2008, p. 23). It is also clear that someone (or many someones) was in a position to judge whether a finding was "important" enough to garner consideration or if it would be rejected outright. If Einstein had not ultimately accepted Theodor Kaluza's paper or the work of Susskind, Nielsen and Nambu had continued to be rejected, it is difficult to say whether string theory would ever have been put presented, let alone become the leading area of theoretical physics today. One of the underlying problems for the string theory journey has been its deviation from the more traditional science method of beginning with the observation or

empirical science (Musser, 2008; Randall, 2005). Although Sandra Harding's primary

purpose in *Whose Science? Whose Knowledge? Thinking from Women's Lives* (1991) is

to examine science (both natural and social) from a feminist perspective, her analysis of

scientific methods certainly applies to the fits and starts of string theory:

> …the difficulty is not just that the picture of nature and social relations generated
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> by the sciences is shaped in large part by what individual scientists happen to
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> think of as a scientific problem. It is that what gets to count as a problem is
>
> linked with the purposes for which research is done – or at least for which it is
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> funded (p. 40).

While I am not arguing that Kalua, Klein, Susskind, Nielsen, Nambu, Scherk or Schwarz

(all integral in providing the impetus for today's string theory) were considered non-

scientists by their peers, their work was largely ignored precisely because their work was

not the work of the more mainstream quantum mechanics, so their *purpose* did not

coincide with what others in their field constituted as important for consideration.

Ultimately it is not just non-scientists who are not given the "privilege" of scientific

knowledge, nor is it withheld exclusively from female scientists. Instead, within the

scientific community itself, and within each discipline and subdiscipline, the power

behind who decides what advances and what gets put aside belongs to an elite few.

While this will be revisited in the final chapter, suffice it to say that it was the sheer

perseverance of a few and a more open minded approach by those in power that opened

the doors to the many who have advanced string theory.

One could say that I began this description of string theory in the middle since so

many from Greek philosophers to present day science fiction writers have played parts in

forming string theory as it is today. This folding of history and time is indicative of the work of Michel Serres and others who will be discussed more fully in later chapters. It is also the case with where we are in terms of our relationship with the environment and how we describe that relationship.

CHAPTER 3

THE ENVIRONMENTAL WEB: FROM PERSPECTIVES ON NATURE TO ECOFEMINISM

As is clear from an examination of environmental scholarship, there is no one way to view the environment. Each of us has a specific lens through which we regard the world around us, one that incorporates all of our lived experiences. Given those experiences, there can be little argument that as a species, humans have had an enormous affect on the Earth. It took millions of years to reach a population of one billion people; it took less than two hundred to increase our population to close to seven billion. With the advent of the Industrial Revolution, our capacity for the consumption of natural resources has reached astounding proportions. We know that we are rapidly running out of these resources and that our consumptive lifestyles have led to increased pollution and a reduction in biodiversity. With that knowledge at hand, how is it that we continue to ignore our impact on the environment? How have we become so detached from the world around us? How is our educational system perpetuating this detachment? In the forward to the book *Growing Up Green*, Thomas Berry states, "The twentieth century has been one of strange contrasts. We have learned a great deal about the universe, yet we have also lost our intimacy with it" (Berry, 1998, p. xiii). I believe that our disengagement from nature is, in part, a product of the binaries we construct and that are constructed for us, and that these binaries result in the silencing of the multiple voices that should be part of the dialogue surrounding environmental issues. Rather than using our collective minds and drawing on multiple perspectives, we are fragmented individuals seemingly unwilling to listen to anyone whose ideas differ from our own. In

reevaluating our approach to environmental issues by moving away from the polarizing effects of binaries and incorporating multiple perspectives, perhaps we can come up with collective solutions to the problems at hand. It is my contention that regardless of how loudly one speaks, if only one perspective is voiced, sustained, viable solutions are unlikely to be found.

Each day we make decisions about how we will live in our environment; while some of us do this on a more conscious level, all of us make decisions that affect our interaction with the world. In the text *On Flirtation*, Adam Phillips states, "If we cultivate unbearable choices, we create impossible lives" (1994, p. 130). While Phillips was addressing the fear in terms of difference and the loss of desire, his statement holds true for any choices we are presented with. In terms of environmental issues, thus far there have been no viable alternatives that might bring more voices to the argument. We fear what we do not know, and however much we might try to imagine the world as either/or, we do not know what our lives would look like. Hence our preoccupation with echoes of our *own* voice. This is not exclusive to environmental issues; it is seen more and more in our news media, an organization that used to pride itself on unbiased reporting. Now, unbiased reporting is more often than not fully biased to either the left or the right (more binaries). This has become so common over time that there is a collective desensitization in regards to the prevalence of *extreme* bias as evidenced by the lack of consistent outcries, further pulling us toward one pole or another. This desensitization spills over to all aspects of our lives.

In terms of curriculum, this continued exposure to bias (the over emphasis on evolution in one classroom and the under-emphasis in another as just one example)

contributes to the erosion of a middle ground. Students are rarely given opposing sides

let alone aloud to debate the merits of one side over another. While I am certainly not a

proponent of "teaching" both evolution and creationism as part of a biology class,

acknowledging that there exists a controversy between science and religion in this area

helps students begin to see nuanced arguments. If I only discuss the ill effects of

genetically modified plants, I fail to introduce the much needed discussion on food

shortages and food distribution on a global level and completely leave out the fact that

man has been genetically modifying plants for centuries. This negates not only the other

sides (there are usually many) of the arguments but does not allow for ideas and beliefs

students bring with them when they enter our classrooms. We present them with

"unbearable choices" from which they will naturally turn away in an attempt toward self-

preservation. Rather than foster an environment in which our students can be thinkers,

many students' education consists of an attempt to indoctrinate, dulling their curiosity,

thus closing the door on any practice with meaningful dialogue. As we breed apathy by

depressing curiosity in our students, the apathy of society as a whole becomes more

pronounced. Perhaps our collective apathy is a result of our fear of the unknown in

regards to an uncertain environmental future. Perhaps our depressive state is a result of

our narrowing of opportunities for curiosity, thus leading to more automation and fewer

ideas. Our students carry this figurative stone around their neck out of the classroom and

into society. Presented with an either/or binary, is it any wonder they don't seek out

difference?

So how do we begin to move away from these binaries and begin to embrace difference? An examination of some of the most entrenched binaries in terms of environmental issues may be a first step.

Perspectives on Nature: The Anthropocentric/Non-Anthropocentric Binary

An anthropocentric perspective of nature (one that is human centered) holds that as the only species that can engage in normative discourse, we are privy to a higher moral status than "lesser" species (Vogel, 1996, p. 10). Put another way, this view maintains that humans have dominion over nature; it is there for us to use and control (Capra, 1996; Hutchison, 1998; Latour, 2004; Orr, 1992) . The verbiage alone used to describe this perspective can be considered inflammatory, making anthropocentrism seem the more unpopular stance in this binary: "lesser" species, control, domination. Indeed, many of the descriptions involving anthropocentrism come from authors who are seemingly biased in the other direction (Capra, 1996; Hutchison, 1998; Orr, 1992, 2004). Yet it is an idea widely accepted by countless people around the world and in this nation in particular (as evidenced by our seemingly insatiable appetite for fossil fuels), either overtly or by omission. Our political climate in the United States, for example, is one in which the "needs" (read "wants") of the people are emphasized over a call for sustainability. The powerful voices of our leaders reinforce the perspective that while we respect nature (an idea questioned by many), our right to use its resources for whatever purposes we deem necessary is unquestionable as long as economic stability is our goal.

From the other side, an eco-centric view affirms that all things have intrinsic worth, with humans serving an equal, not greater, role in nature (Capra, 1996; Darier, 1999a; Latour, 2004; Merchant, 1996; Plumwood, 2002; Sessions, 1995). While this

perspective doesn't immediately garner an unfavorable response, it must be noted that the language used to describe eco-centrism is often of a softer tone: harmony, holistic, cooperation, partnership (Capra, 1996; Hutchison, 1998; Plumwood, 2002). In spite of this softer (one might say inviting) tone, the eco-centric perspective seems to have gained little traction, at least in terms of power. Those who subscribe strictly to this perspective are most definitely in the minority "party."

This anthropocentric – eco-centric binary elicits a religious-like fervor often associated with fundamentalism. One side claims the other is destroying nature (Capra, 1996; Hutchison, 1998; Orr, 1992, 2004; Plumwood, 2002), while the other claims that environmentalists are ignoring human rights and needs (Darier, 1999a; Latour, 2004). Indeed, eco-centrism has even elicited a warning against the endangerment of the human mind. Luc Ferry, in his text *The New Ecological Order*, states:

> Here it seems to me, is where the true danger lies, a danger to which we would be exposed should radical ecology succeed in winning over public opinion: by considering culture, in the manner of sociobiology, to be a simple prolongation of nature, the entire world of the mind is endangered (Ferry, 1995, p. 151).

Ferry's perspectives on eco-centrism – the idea that society will be unrecognizable – while to my mind are often inflammatory (particularly in regards to ecofeminism), is an oft repeated one for those who favor an anthropocentric perspective (Latour, 2004; Vogel, 1996). The irony here is that eco-centrists argue about the same said unrecognizable society should we continue on our current path (Capra, 1996, 2002; Hutchison, 1998; Orr, 1992, 1994, 2004; Plumwood, 2002). While the world envisioned by anthropocentrists looks quite different from that of eco-centrists, both are vastly

different from our present circumstances. Both sides of this binary have their proponents

who have written persuasively; those who are more eco-centric (Capra, 1996, 2002;

Merchant, 1996; Orr, 1992, 1994, 2004; Plumwood, 2002) and those who are decidedly

anthropocentric (Bailey, 2002; Ferry, 1995; Lomborg, 2001; Michaels, 2004). With so

much to choose from, how is it that, as Berry states, our presence in nature is in decline?

By setting up an either/or proposition when attempting to make sense of the thousands of

pages of statistics regarding the current state of our environment (or our educational

system, our health care system, or any other major system at issue), both sides echo their

own thoughts rather than responding to that murky area in between; between the human

as dominator over nature and the pristine nature of almost mystical proportions. So what

about that murky area, that more fluid of perspectives? They are found by closely

looking at the spaces between particular groups rather than at only the group's manifesto.

Thus, I will begin by presenting some of the ideas of different groups found in the

literature and then discussing areas that are not so clearly defined, areas where there is

common ground.

Social/Socialist Ecology

Prior to the publication of Rachel Carson's *Silent Spring,* Murray Bookchin,

described in turn as an "eco-anarchist" (Dryzek, 1997, p. 175), a "post-Marxist social

ecologist" (Merchant, 1992, p. 73), and a self-proclaimed "libertarian socialist"(Vanek,

2000, P. 1), began writing about chemicals in our food and environmental problems. He

was instrumental in advancing the U.S. Green movement, and is attributed with bringing

social ecology to the forefront of the environmental discussion (Merchant, 1992;

Zimmerman, 1994).   While Rachel Carson's name is usually synonymous with the

advent of the environmental movement in the public forum, it is Bookchin's work within the social ecology field that situates him in the historical context of this work. His contributions to the field have been linked to feminist social ecology (Y. King, 1990; Mellor, 1997; Plumwood, 1993; Warren, 1996) and have provided a lively debate between social ecology and deep ecology. Bookchin's perspectives on where humans are situated in nature place him outside the realm of curriculum scholars such as C.A. Bowers or David Orr (discussed later in this section) and place him in a more socialistic realm. Carolyn Merchant provides some insight into Bookchin's views,

> They [social ecologists] see scientific research as developing out of capitalistic social hierarchies and industrial and university relations. They offer technologies and social structures designed to keep human needs in balance with natural cycles and with energy requirements. A homocentric ethic guides choices concerning which research projects to fund, which technologies to implement, and which processes to use for decision-making. Such an ethic sets up the fulfillment of human needs as a priority, but gives full consideration to nonhuman nature in the process of decision making (Merchant, 1992, p. 73).

Thus, Bookchin in turn addressed human needs in a socialistic tone while still honoring "nonhuman nature," making his perspectives more palatable in some ways to eco-feminists and less palatable to deep ecologists (both will be discussed later in this chapter). Indeed, Bookchin quite vocally expressed his opposition to deep ecology, at one point calling it an "ideological toxic dump" (as quoted in Ellis, 1995, p. 264). Bookchin's main disagreement was with deep ecology's apparent lack of "the social dynamics of environmental problems" (Ellis, 1995, p. 265). It is in keeping with the flow

of human to nonhuman and back again that had Bookchin referring to an "indiscipline" rather than an interdisciplinary approach; this "indiscipline" would allow for "artfulness… and integrate critique with reconstruction, theory with practice, vision with technique" (Bookchin, 1991, p. 20). Rather than provide a demarcation between human and nonhuman needs, the veritable line in the sand if you will, Bookchin's perspectives try to incorporate society *and* nature. Bookchin described the main tenet of social ecology by explaining, "..human beings would complement nonhuman beings with their own capacities to produce a richer, creative, and developmental whole – not as a "dominant" species but as a supportive one (1993). He believed that incorporating societal functioning is crucial in dealing with environmental issues:

> At a time when a blind social mechanism, the market, is turning soil into sand, covering fertile land with concrete, poisoning air and water, and producing sweeping climatic and atmospheric changes, we cannot ignore the impact that a hierarchical and class society has on the natural world. We must earnestly deal with the fact that economic growth, gender oppressions, and ethnic domination – not to speak of corporate, state, and bureaucratic interests – are much more capable of shaping the future of the natural world than are privatistic forms of spiritual self-regeneration (Bookchin, 1993, para. 7).

Bookchin's continued emphasis on gender oppression in particular helped give rise to ecofeminism, discussed at length later in this chapter.

Cultural Approaches to Environmental Issues: Education Institutions

Although coming from a less activist background, there are a number of other social ecologists whose prolific work has helped to bring environmental issues to the attention

of curriculum researchers, theorists, and practitioners alike. Among them are scholars whose work has focused to a large extent on the relationship between ecological issues and education: C. A. Bowers, Annette Gough, Noel Gough and David Orr. All have made major contributions to the field, but Bowers, Annette Gough, and Noel Gough often delve into related areas of educational pedagogy ranging from political, to social, to cultural and technological issues in education.

Unlike Bookchin, these curricularists' approach to their work comes from social rather than social*ist* roots. Bowers in particular argues *against* an anthropocentric approach to ecosystems and calls on us to recognize that, as a result of this pervasive anthropocentric view, we are currently in a prolonged ecological crisis (Bowers, 1993a, 1993b, 2003). Like David Orr (discussed later), Bowers emphasizes the need to bring environmental issues to the forefront by pointing to the role educational institutions play in perpetuating this anthropocentric attitude, and thus, according to Bowers, deepening the crisis (1993a, 1993b, 2003). He goes well beyond a simple call of more education in order to attain environmental literacy, however. Instead, William Doll places Bowers "…among the few curricularists who encourage us to rethink our concept of relations, who see that *cultural relationships* extend beyond our personal selves to include the ecosystem – indeed the cosmos in which we live" (1993, p. 181). This is illustrated in *Educating for an Ecologically Sustainable Culture,* when Bowers addresses the problem of institutionalized education and its perpetuation of the environmental problems via the lack of ecological reform by stating that, "…the mainstream institutions will continue to reinforce the very aspects of modern culture that are now devastating the environment" (Bowers, 1995, p. 217). Unlike Bookchin who looked to all aspects of social hierarchy,

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Bowers singles out educational institutionalization as being both at fault and a possible solution to environmental problems. He again reiterates this argument in *Mindful Conservatism*:

> The main failure is not that students graduate from universities without a knowledge of the great Western thinkers that the so-called educational conservatives have been promoting for decades. Rather, the failure … is in graduating students without helping them understand the characteristics of ecologically sustainable cultures…(2003, p. 138).

Bowers argues that schools (public and/or private educational institutions) consistently undermine gains made via environmental legislation by reinforcing the belief that "the individual is the epicenter of the universe" (1995, p. 7); this idea is repeated by a number of other scholars whose works focus on ecology or environmental issues (Capra, 1982, 1996; Orr, 1992, 1994; Riley-Taylor, 2002). This is an important point in light of the continued emphasis on relevance in educational methodology courses and workshops for practitioners. In her text, *Ecology, Spirituality, & Education: Curriculum for Relational Knowing*, Elaine Riley-Taylor (2002) echoes these concerns regarding an educational institution that reinforces anthropocentric perspectives:

> While I support constructivist theories that encourage the active engagement of the student in her/his own learning process, I agree with Bowers that the focus on learning as the zenith of autonomous individuality can too easily slip into omission of the importance of the relations – the family, school, community, and ecosystem – in which the child is embedded (p. 15-16).

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Riley-Taylor expands on this notion by citing the corporate-school relationship and its focus on student achievement in terms producing students who help the continuation of capitalism and consumerism (2002). A visual representation of this can be seen in many of the public high schools where posters are prominently displayed promoting perfect attendance with a reward of a new car (often an SUV or vehicle with low fuel economy), situated next to vending machines with various drink products and, if present, a recycling container able to contain at most a day's worth of consumption. This reinforces the notion held by both Riley-Taylor and Bowers that education today does not focus on ways to reduce consumerism but instead encourages it.

In addition to his support of a non-anthropocentric perspective, Bowers has argued and continues to argue that society is under the false assumption that our technological advances will save the day (Bowers, 1993b, 1995, 2003); this concern is shared by many others in the field (Davidson, 2000; Orr, 1992, 1996; Riley-Taylor, 2002). Davidson, in *You Can't Eat GNP: Economics as if Ecology Mattered,* refers to this attitude as "Custer's Folly" and says that society "assumes that the technological cavalry will come over the hill in time to save us from ecological disaster" (p. 8). For Bowers, it is not simply society's naïve belief that technological advances will help us solve environmental problems, it is the extreme environmental degradation and social inequality brought on by technology that is much more disturbing (Bowers, 1993b, 1995, 2003). He argues for an educational system that stops educating as if technology is "culturally neutral" but instead allows students to understand the impact of technology in terms of unwanted societal changes and issues of ecojustice (2003, p. 169-170). While

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Bowers argues against an anthropocentric perspective of nature, his work is infused with social ecology and the use of natural resources framed within society.

Many of the educational considerations made by Bowers are shared by David Orr. Orr has consistently called for changes in how educational institutions view the environment, and, more importantly, environmental education. In *Ecological Literacy* (1992), Orr deconstructs academic-moral boundaries concerning environmental education and concludes that educational institutions at all levels have a moral obligation to create an environment in which the stewardship of our world is paramount. Orr states that we begin the reformation of education by recognizing that "…all education is environmental education. By what is included or excluded, emphasized or ignored, students learn that they are a part of or apart from the nature world." (1992, p. 90). His ideas on the importance of education (and the dangers) have led him to question the apparent paradox of increasingly sophisticated technologies and a decreasing awareness of their consequences. In typical Orr fashion, he asks, "Can it be that we are in fact becoming both more clever and less intelligent?" (1994, p. 52) and describes education as "unleash[ing] on the world minds ignorant of their own ignorance" (p. 17). From Orr's perspective, educational reform must take place; however, we cannot exclusively concentrate on preparing students to compete in the global economy (1996). He maintains,

> …there are better reasons to reform education that have to do with the rapid
> decline in the habitability of the Earth. The kind of discipline-centric education
> that enabled us to industrialize the Earth will not necessarily help us heal the
> damage caused by 150 years of industrialization (1996, p. 7).

Bowers infuses ecojustice and cultural concerns throughout his work; so too does David Orr, but he goes further in identifying exactly what is problematic in our educational system and provides possible solutions in order to bring us to sustainability. He seeks to answer the question, "Why should institutions of higher education, full of smart and learned people, be so slow to respond to the largest issues on the human agenda for the coming century?" (1996, p. 7). He cites three reasons: First, our fragmentation of curriculum and research into disciplines, subdisciplines and departments where we view things on a small scale and the big picture is rarely viewed (1996). This causes us to miss patterns and trends that point to severe environmental problems; instead, we see random events rather than connections (1996). The second reason he cites is a narrowing of academic fields themselves where good teaching and "service to the institution or the community" is valued less than publication and securing of grant monies (1996, p. 8). Orr also argues that leaders of higher educational institutions lack vision and boldness in regard to how our educational practices lead (or don't lead) to environmental stewardship (1996). For Orr, a fundamental shift in the purpose of education needs to be made whereby students leave with a "mastery of self through knowledge" rather than knowledge alone (1996, p. 9). Although Orr views the world through a non-anthropocentric perspective and has a consistent message of educational reform and sustainability, he makes it clear that he is not condemning all of the modern world but instead is looking for ways to situate us within the environment through education (Orr, 1992, p. x). As a part of his educational reform platform, Orr describes the need to overcome certain myths that we accept without question. These myths include ignorance, the ability to manage nature through technology, that our curriculum

should focus on increasing economic growth, and cultural superiority by virtue of our technological advances (Orr, 1994). Orr maintains that, "ignorance is not a solvable problem; it is rather an inescapable part of the human condition" (1994, p. 8). Ignorance in this instance refers to changing knowledge; what we might know and be able to do doesn't necessarily provide us with knowledge we might gain over time (Orr, 1994). An example is the knowledge it took to develop DDT as a mosquito and lice control in the late 1800s did not provide the knowledge that its negative effects on the environment would be long reaching and persistent. In other words, just because we have the knowledge to make something doesn't mean we have the knowledge of what the repercussions might be. As Orr puts it, "knowledge of how to do vast and risky things has far outrun our ability to use it responsibly" (1994, p. 13).

While Orr's work continues to focus on sustainable practices through educational reform, his more recent works, *The Last Refuge: Patriotism, Politics, And The Environment In An Age Of Terror* (2004) and *Down To The Wire: Confronting Climate Collapse* (2009), are more openly political and include a more serious discussion about language and its (mis)uses than in his previous work. *The Last Refuge* was written in response to, in part, policies of the George W. Bush administration and a lack of political accountability; "[we] do not have an environmental crisis so much as we have a political crisis" (2004, p. 247). Part of the political crisis and lack of accountability stems from language that is being used by both the media, political pundits, and politicians: "George Orwell once warned that the subversion of society begins with the corruption of its language. Words such as 'conservative,' 'liberal, ' 'patriotism'…have been twisted and distorted by those who stand to gain much from public perplexity" (Orr, 2004, p. 4). Orr

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echoes some of the same arguments made by Bowers (1995, 2003) about individualism and a "crisis in values and beliefs"(Bowers, 1995, p. 2). Just as Bowers (1995, 2003) points to the problems of a consumer base that focuses more on the individual than on society as a whole, Orr seeks to remind us that education must include the individual as situated in society and nature (1992). "Education…is not just about society, it is about persons. At the individual level, the goal is something like the Greek model of Paideia or that of the Renaissance person of wide understanding, competence, and commitment to the common good" (1992, p. 84). And although it is clear that Orr also believes that our values and beliefs have greatly contributed to our ecological crisis, he adds to Bowers' argument by pointing out that those values and beliefs have been shaped by an educational system that has failed to physically place students in nature rather than surrounded by walls (Orr, 1992, 1994, 2004). By including the political component in *The Last* Refuge, Orr presents an argument that goes beyond the confines of educational responsibility to one that supports the deconstruction of both politics and popular culture.

Orr continues his argument with *Down to the Wire* (2009). Orr helped create and author a climate action plan for the first one hundred days of the Obama Presidency. As Orr describes, the plan focused on "near-term specific policy changes" (p. xvii) while this book looks at the bigger picture, one that examines long term strategies and possible solutions. Orr is quite clear when describing our current situation, one that was put into motion over thirty years ago. Unlike media coverage and other books about climate change, Orr helps his readers understand that what we do now has repercussion for the future, not the present. Thus, less "painful" fixes that would have been appropriate three decades ago will not work now. Orr describes three strategies that must occur

simultaneously if we are to make a difference over the next few decades. First, we must

reform our political system. We can no longer view politics separate from the

environment (a concept also addressed in chapter four). Using the environment for short-

term political gain and misleading the public about what sacrifices need to be made

cannot continue. Second, while Orr acknowledges that advances have been made in

education (in particular, higher education) through a bigger focus on sustainability within

university campuses, he still calls for major changes in our educational programs to

include more real world problem solving. It is not simply a matter of recycling or using

more renewable energy on college campuses; educational programs themselves must be

overhauled to include an emphasis on more creative ways to solve our energy and climate

problems. Finally, we must redesign our infrastructure in terms of producing food,

energy, and how we use water.

None of this can take place, according to Orr, until we disabuse ourselves of the

notion that continued economic growth can be sustained. Development must take place

that improves the quality of life for everyone, not just particular peoples or nations. This

means more fairly distributing wealth, opportunity, and risk. The current uneven

distribution of wealth favors industrial nations over developing nations. Much of that

wealth is dependent on resources garnered from those developing nations. Thus, there

are more environmental and political risks to the people of these nations than are seen in

industrialized nations. This not only produces a world in which the poor are exposed to

environmental hazards at a higher rate than the wealthy, but it creates political instability

around the world as natural resources are removed from geographical locations from

which they originate and used by only a few. Moreover, using those natural resources

produces environmental problems such as increased CO_2 emissions, erosion, and toxic waste. To make a difference for the future, Orr states that the consumer culture must shift from needs, not wants. Not only is this a difficult proposition in the U.S. with the continued bombardment from our political leaders and the media encouraging us to spend, spend, spend (indeed, we are to spend our way out of bankruptcy), this is truly problematic in China where there is a new emphasis on acquiring wealth.

As blunt as Orr is about our current and future environmental crisis, it is surprising how hopeful he is about changing our direction. He is not supportive of optimism but instead of a realistic hope which he says "…requires us to check our optimism at the door and enter the future without illusions" (p. 187). He calls on our political leaders to be honest when discussing options and sacrifices instead of glossing over the true extent of our climate problems. As with many issues, our political leaders underestimate us. "Ultimately, this approach is condescending to those who are presumed incapable of facing the truth and acting creatively and courageously in dire circumstances" (p. 189). Orr's straight forward prose and attention to details lends a strong voice to the conversation.

While C.A. Bowers and David Orr are obviously not the only scholars whose work espouses the need for changes at the educational institution level, they have played an integral part in the continued dialogue between educators and environmental educators. The work of other equally influential scholars whose emphasis has been on environmental issues and environmental education such as Annette and Noel Gough, will be examined in later sections. All, however, include social and cultural interactions as

important aspects of any approach to environmental issues. It is this that sets them apart from deep ecologists.

Deep Ecology and Systems Thinking

Deep ecology has roots in the works of several naturalists including John Muir and Aldo Leopold. The work of John Muir, founder of Sierra Club, is replete with rich descriptions of nature. In describing Shadow Lake in the Sierra Nevada, Muir writes, "The hot sun sends down innumerable streams over the cliffs, streaking them round and round with foam. The snow slowly vanishes, and the meadows show tinting of green" (2001, p. 242). More important than his prose, however, was his activism and dedication to preserving wilderness lands. Although Theodor Roosevelt is often cited as the founder of our national parks, it was the work of John Muir that provided the impetus (Duane, 2004). Muir's understanding of interconnectedness provided a basis for many of the tenets of deep ecology and other environmental ideals: "When we try to pick out anything by itself, we find it hitched to everything else in the Universe" (1911, p. 110).

Deep ecology has also been influenced by Aldo Leopold. A forester for many years and a professor at the University of Wisconsin-Madison, Leopold was one of the founders of The Wilderness Society, an organization that continues to help protect the wilderness to this day. Leopold is perhaps best known for his book, *A Sand County Almanac,* published posthumously in 1949. In it, he not only describes the wilderness surrounding the cabin he and his family built on the banks of the Wisconsin River, he contemplated upon the interactions between humans and nature. In it he describes the land ethic: "The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (Leopold & Schwartz, 1987,

p. 204). Early on, Leopold recognized that politics, economics and industrialization were

having detrimental effects on the environment: "I suspect that the forces inherent in

unguided economic evolution are not all beneficent…I believe that many of the economic

forces inside the modern body-politic are pathogenic in respect to harmony with the land"

(Leopold, Leopold & Schwartz, 1993, p. 153). While influenced by the writings of John

Muir, Aldo Leopold, and others, the founding of the Deep Ecology movement is

attributed to Norwegian philosopher Arne Naess (G. Sessions, 1995). Arne Naess, who

is credited with coining the term "deep ecology," describes it by saying, "The essence of

deep ecology is to ask deeper questions. The adjective 'deep' stresses that we ask why

and how, where others do not" (Devall & Sessions, 1985, p. 74). His work, and that of

George Sessions and Bill Devall, is most often considered synonymous with deep

ecology. Other prominent scholars in the field include Gary Snyder, J. Baird Callicott,

Stephen Fox, Stephanie Mills, Max Oelschlaeger, Theodore Roszak, Charlene Sprenak,

and Michael Zimmerman. Each bring different personal perspectives but all focus on the

same set of ideals, the Deep Ecology Platform, which consists of eight statements that

include a call for substantially reducing human population and a recognition that,

"Richness and diversity of life forms contribute to the realization of these values and are

also values in themselves" and "The ideological change is mainly that of appreciating life

quality (dwelling in situations of inherent worth) rather than adhering to an increasingly

higher standard of living. There will be a profound awareness of the difference between

big and great"[5]. Thus, the emphasis is not on humanity but on the environment as a

whole with humanity a part of that environment. While agreeing with Bowers, Orr, and

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[5] http://home.ca.inter.net/~greenweb/DE-Platform.html

many others that current consumption rates cannot be sustained, how changes are to take place differ greatly. Deep ecology calls for a "spiritual/ecocentric value orientation" rather than an anthropocentric approach to the environment (Sessions, 1995, p. xxi). According to Fritjof Capra, often associated with the deep ecology movement, "Deep ecology recognizes the intrinsic value of all living beings and views humans as just one particular strand in the web of life. Ultimately, deep ecological awareness is spiritual or religious awareness" (Capra, 1996, p. 7). In other words, we as humans are not separate from the Earth but part of it. While on the face of it this sounds like a noble idea, who decides what that "inherent value" is? And are we aspiring to become one with nature and thus altering our behaviors accordingly in an effort to reduce our ecological footprint, or are we *actually* expected to become one with nature? Both George Sessions (1995) and Arne Naess (Bodian, 1995) make it a point to emphasize that, although deep ecologists maintain the same platform, those within the field often hold individually tailored views. Thus, answers to those questions (and many more), come from different sources with many different perspectives. Deep ecologists such as Arne Naess would argue that these are non-questions since there is no need to make these choices:

> What we propose is not a shift of caring away from humans and towards non-humans, but rather an extension and deepening of overall caring. It is unwarranted to assume that the human potential for caring is constant and finite, and that an increase of caring for some creatures necessarily reduces caring for others (1995, p. 466).

What Naess and others fail to take into account is that while many of us get to choose how we situate ourselves in nature, many others do not. Geographical location, economic

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and political stability (or instability), and societal pressures may force people to make untenable choices just to stay alive. For myself, trying to remain cognizant of my impact on nature is more attainable than trying to convince myself that I am one with nature. That is not to say that I disagree with many of the outcomes deep ecology could potentially bring about. However, as with every perspective on the environment, deep ecology appeals to some and is, at best, misguided to others.

Among those who finds deep ecology to be of benefit is David Orr who is cognizant of the resultant educational changes if the "sweeping changes in human relationship with the natural world" called for by deep ecology were to be realized (Orr, 1992, p. 141-142). Luc Ferry, with a decidedly derisive tone employed throughout his text, also references these fundamental changes, "This conversion – the religious metaphor is not unfounded here – presupposes a deconstruction of 'human chauvinism,' the root of anthropocentric prejudice par excellence…" (Ferry, 1995, p. 60). While the tone may be less than amenable to this particular goal of deep ecology, one might say its primary goal, it comes up repeatedly in other texts and articles (R. J. H. King, 1991; Plumwood, 1991, 1993). Put another way, "deep ecology works more toward the subversion of anthropocentrism" (Jagtenberg & McKie, 1997, p. 133) and has been referred to as an "anti-anthropocentric anthropocentrism", a radical form of anthropocentrism (Darier, 1999b, p. 236).

What sets deep ecology apart from social ecology is its perceived lack of social concern. As stated earlier, Murray Bookchin has criticized deep ecology for neglecting social needs. Bookchin delivered a blistering critique in a 1988 piece entitled "Social Ecology verses Deep Ecology: A Challenge for the Ecology Movement." In it he

compares deep ecology as "a vague, formless, often self-contradictory, and invertebrate thing" with social ecology as "a long-developing, coherent, and socially oriented body of ideas" (p. 12). He continues, "deep ecology, despite all its social rhetoric, has virtually no real sense that our ecological problems have their ultimate roots in society and in social problems" (p. 13) and further states that they are "evading the social roots of the ecological crisis" by calling for a "bio-centered" approach (p. 18). Sessions counters these arguments (and many others leveled by Bookchin) by labeling Bookchin's allegations as a misreading of deep ecology (1995). Indeed, deep ecologists criticize social ecologists in general and Bookchin in particular for his anthropocentrism (G. Sessions, 1995; Zimmerman, 1994), although Zimmerman acknowledges some common ground; a critique of capitalism and an "evolution…of consciousness" (p. 152). Their sometimes contentious debate has prompted a response from all sides, thereby continuing an open discourse.

Some of its most vociferous critics come for an eco-feminist perspective who point to a continued human/nature dualism that deep ecology fails to address (Plumwood, 1991) and "the role of androcentric thinking and acting…" (Y. King, 1990, p. 79), a charge reiterated by Riley-Taylor (2002). Additionally, Annette Gough charges that deep ecologists have a tendency to place egocentric and homocentric ethics in the realm of anthropocentrism (1997). As cited by Gough, Ariel Salleh contends that deep ecologists are not looking deeply at all since they seemingly ignore patriarchy altogether (Salleh, 1984). A similar rift persists between some feminists and poststructuralism that will be examined later in this chapter (Jagtenberg & McKie, 1997; R. J. H. King, 1991; Y. King, 1990; R. Sessions, 1991). Whatever the perspective, the volume of work dedicated to

deep ecology is impressive, making it a significant contribution to the conversation.

Much of that work has been provided by ecofeminists whose prodigious body of

literature is at least as varied as those of deep ecologists.

Ecofeminism

Ecofeminism, alternately called a movement, philosophy, or a consciousness,

emerged in the early 1970s as an outcome of the feminist movement coinciding with the

green movement. It is widely accepted that its name can be credited to Francoise

d'Eaubonne, a French writer, but that its inception in the United States and subsequent

spread on socialist, feminist, and spiritual levels was greatly enhanced by Ynestra King

while at the Institute for Social Ecology in Vermont (Merchant, 1992). While

ecofeminism was also becoming prominent in Germany, Venezuela, Japan, Finland,

Sicily, and Australia, it was dominated by the U.S., particularly in academic arenas

(Mellor, 1997). Some of the early pioneers in the field in the U.S. included Ynestra

King, Mary Daly, Susan Griffin, and Rosemary Radford Ruether. Ecofeminism today

has attracted a large number of proponents as well as detractors and thus plays an

important role in this work. Many of the ideas, concerns, and perspectives put forth by

ecofeminists have helped add greatly to the environmental discussion. What follows is

only a sampling of the work of some of the more prominent ecofeminists, a presentation

of different branches of ecofeminism, and a look at differences among ecofeminists and

between ecofeminism and other ecological discourses. This is done in the context of

multiple ways of viewing the environment and environmental issues.

Who Are the Contributors to Ecofeminist Scholarship?

With its many branches, ecofeminism attracts scholars from a wide range of backgrounds. Although I will address multiple areas of ecofeminism a bit later, for now it is helpful to place scholars in the field into two categories, those whose work focuses on the radical/cultural/spiritual, and those coming from a more social/socialist perspective. Those who are more associated with the radical/cultural/spiritual work include: Charlene Spretnak (1982, 1986, 1990), Starhawk (1979), Vandana Shiva (1993), Maria Mies (1993), Flo Krall (1992), Gloria Orenstein (1990), Irene Diamond (1990), and Judith Plant (1989). Their work tends to lean more toward the interconnectedness of the cultural and spiritual aspects of both feminism and ecology. For example, Starhawk (1979) brings a Native American perspective to her work, Susan Griffin (1978) adds poetry, and Flo Krall (1992) uses autobiographical narrative prose to help us transcend boundaries. "Social/ist" (Mellor, 1997, p. 58) ecofeminists include: Ynestra King (1990) Val Plumwood (1993, 2002), Carolyn Merchant (1989, 1992, 1996), Karen Warren (1996), Catriona Sandilands (1997, 1999a, b), Ariel Salleh (1984), and Mary Mellor (1997). It is important to note, however, that this is at best a partial listing and that by placing these scholars in either/or categories, I have set up a false binary as more than half of those listed have at some time written or given talks that incorporate both categories. While providing some initial insights into some of their work, I will specifically be drawing on the work of six of these scholars, almost all predominantly associated with the "social/ist" perspective: Val Plumwood, Carolyn Merchant, Karen Warren, Catriona Sandilands, and Mary Mellor. As my concentration comes more from the social/socialist areas of ecofeminism than from the spiritual areas, these scholars

provide me with ample material with which to work. It is important to note that none of

these scholars reject spirituality outright; indeed, most of their work either incorporates or

addresses a spiritual component. Each of these scholars brings something different to the

field, often intersecting with one another. Some, such as Ynestra King, are considered

more activistic than others, perhaps as a result of her close ties to the feminist movement

in conjunction with her work at the Institute for Social Ecology. As stated earlier,

Ynestra King is credited with establishing ecofeminism in the U.S. Her shift from

feminism to a concentration on ecofeminism was due to dissatisfaction with what she

perceived as dualistic thinking in each area of feminism as well as a deep conviction that

our ecological crisis was and is being precipitated by a male dominated society (Diamond

& Orenstein, 1990). Her primary objection centers around the belief that feminism,

particularly socialist feminism, has sufficiently addressed the domination of nature via

the "domination between persons" but has failed to truly articulate the domination of

nonhuman and "inner" nature (Y. King, 1990). Her emphasis is not on women as closer

to nature, rather it is on the matrix that is the domination of nature by a patriarchal,

hierarchal society. In examining relations between women and men, one can begin to

recognize the same failures in human relations to nature (R. J. H. King, 1991).

Glazebrook (2002) states "…the claim is not so much that feminist worries are

environmentally grounded, as that environmental issues warrant feminist analysis" (p.

13). Val Plumwood echoes some of the same beliefs but is more vociferous about the

adverse affects associated with a woman-as-closer-to-nature perspective. In *Feminism*

and the Mastery of Nature, she advances the idea of a "critical ecological feminism" that

focuses on resolving the dualism seemingly inherent in many ecological philosophies by

exposing the assumptions that support those dualisms (Plumwood, 1993, p. 49). She

calls for an end to the celebration of the feminine as she contends that one is only

celebrating a variation of the masculine/feminine dualism and adds that "ecofeminist

actions address the contradictions between production and reproduction" (Merchant,

1996, p. 7). She rejects a completely spiritual or a completely social approach; instead,

she calls for a partnership, one between males and females as equals both in personal and

social relations, as well as non-human nature (instead of controlling or domination)

(Merchant, 1996). It becomes clear quite quickly that ecofeminist perspectives are more

along a continuum than delineations of the field and are thus interwoven.

Feminists and Ecofeminist Philosophy

So why have feminists taken the environment into their own hands? Why invest

effort away from ongoing feminist work toward reproductive rights, equal pay, and an

end to sex discrimination? Why not join other so-called green movements in an effort to

protect/preserve our environment? Ynestra King explains,

> The piece of the pie that women have only begun to sample as a result of the
>
> feminist movement is rotten and carcinogenic, and surely our feminist theory and
>
> politics must take account of this, however much we yearn for the opportunities
>
> that have been denied to us. What is the point of partaking equally in a system
>
> that is killing us all? (1990, p. 106).

Thus, whether members of the green movement intend to be all inclusive or not, their

patriarchy and subsequent dominance over nature has caused a 'cancer' (in the form of

pollution and depletion) that is spreading throughout nature. A new response to the

environmental ills that were (and are) taking place was required. King continues,

The task of an ecological feminism is the organic forging of a genuinely

antidualistic, or dialectical, theory and practice…we seek to enter into history, to

a genuinely ethical thinking – where one uses mind and history to reason from

the "is" to the "ought" and to reconcile humanity with nature, within and without

(1990, p. 116).

Since social and cultural privilege have allowed white males to dominate the fields of

science and technology (Haraway, 1992, 1997; Harding, 1991; Merchant, 1989), which

has ultimately led to a domination of nature that continues to this day, King and others

saw the need for not a breaking off from feminism, but a weaving through in the form of

ecofeminism. The subsequent burden of this domination and its effects on nature is

placed on underprivileged women and subordinate groups (R. J. H. King, 1991; Mellor,

1997) who are ill equipped to either prevent it in the first place or fight back when it

occurs as there is an inherent lack of access to those who are in environmental decision

making positions. Thus, ecofeminism analyzes the combined ecological implications of

progress and women's disproportionate responsibility for carrying this burden (Mellor,

1997).   It is a field in which ecofeminists seek to establish a nature in which "difference

is neither reified nor ignored," one that includes both male and female (Y. King, 1990, p.

117). Mellor (1997) explains that for a social theory to be useful in regards to the

environment, it needs to begin with the recognition that humans need to be developed and

nurtured as a part of nature ("embedded in") or they risk becoming "disembodied" and

"disembedded" (p. vii). Like King, Mellor also makes it a point to include the male and

female in this social theory.

Many ecofeminists feel the need to address the connections between environmental degradation and reproduction (Merchant, 1992); this is an important connection in that it joins together the power man has over nature with the power man has over women's reproduction, both overtly and covertly. It is this emphasis on relationships that "[weaves] together the many strands of ecofeminism" (Merchant, 1992, p. 209) and that is part of the eco-centric or whole ecosystems approach ecofeminists look to. While they do not stand alone in promoting eco-centrism (a key idea for deep ecologists for example), ecofeminists focus on both the environment and the oppression of women. Ultimately, ecofeminism is dedicated to the continuation of life on earth (Merchant, 1992, 1996), something that is potentially in jeopardy at our current rate of degradation and depletion of our environmental resources. Thus, ecofeminism is based on the connection between the exploitation and destruction of the natural world and the subordination and oppression of women that are a result of the existence of hierarchal dualisms in western society (man/woman, public/private, society/nature, mind/body) (Mellor, 1997). As long as the man/woman dualism is seen as governed by biology or perceived as essentially different, ecofeminists believe that this dualism will always be present (Mellor, 1997; Merchant, 1992, 1996).

The Coming Together of Ecofeminists

As stated earlier, ecofeminism as a movement originated in the early 1970s following an almost parallel path as the feminist movement. While Ynestra King stressed the socialist aspects of a feminist analysis of the environment, other ecofeminists (although not yet termed as such) had been writing about ecological issues for quite some time. Women such as the poet Susan Griffin and Flo Krall began to weave nature into

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their writings. They began a dialogue with each other, with others who had a predisposition toward environmental issues, and with those who seemed to view nature as at their disposal. Their backgrounds were from the arts, sciences, and humanities, with the lines between the disciplines blurred or bridged by a common appreciation for nature, their interaction with nature, and their continued recognition of the oppression brought about by a patriarchal society. In her book *Ecotone: Wayfaring On The Margins* (1994)*,* Flo Krall describes the comingling of nature and the biological woman. She takes the reader on a journey through the boundaries of feminism, nature, and society. Krall spends her time dwelling on relationships and interactions.

> Our relationships are reciprocal. We are not isolated entities but rather are parts of a greater whole to which we have limited access. Our actions, like aftershocks, are felt throughout the system. Our landscapes intersect. A coparticipant, the grebe is note the object of my investigation, created because I think it exists, but a subject in its own right that enters my life intersubjectively…ˁOf what value is a grebe?' becomes a nonquestion (1994, p. 33).

Susan Griffin's book, *Woman and Nature: The Roaring Insider Her* (1978), uses prose to present the patriarchal male voice of authority attempting to take over the voice of a female nature (Sandilands, 1999a), a recurring metaphor found in many ecofeminist works. But what is still sometimes referred to as a movement began to incorporate philosophy and ethics, and has produced a considerable body of scholarship. Originating from multiple perspectives rather than a single perspective, ecofeminism has many different aspects.

Ecofeminism's Multiplicities

The initial affinity toward this movement for most ecofeminists comes from the feminist movement. There is a tendency, as is the case with all labels, to place all ecofeminists in the same category. Just as there are a myriad of perspective within the curriculum field, so too is there a broad range of perspectives voiced within ecofeminism. There are, however, two or three main branches from which ecofeminism is derived: the radical/cultural/spiritual, in which the natural affinity of women to the natural world is stressed; and the eco-anarchist/socialist/Marxist, stemming from social constructivism and radical politics (Mellor, 1997; Spretnak, 1990). Spretnak adds a third branch, that of environmentalists, as many feminists came from careers within the environmental or political realm (Spretnak, 1990). There is, of course, disagreement with which form of ecofeminism fits where, just as many ecofeminists move between and among its many branches. Ecofeminism is in turn associated with radical environmentalism, which consists of five branches: human centered, whereby radical social change will bring about a halt to our environmental crisis; social ecology, in which there is an equality between society and nature (thus mitigating the crisis); ecofeminism, through which a feminist analysis of oppression and ecological issues will promote change; bioregionalism, which proposes the search for specific bioregional ecosystems that can sustain human communities; and deep ecology, whose purpose is to completely reframe the relationship between the natural world and humanity (McLaughlin, 1993, p. 193, as cited in Mellor, 1997).

From the perspective of feminist roots, Carolyn Merchant describes four "feminist critiques of environmentalism:" 1) the liberal feminist perspective believes "man and his

environment leaves out women;" 2) the Marxist feminist perspective use a "critique of capitalist control of resources and accumulation of goods and profits;" 3) cultural feminism is unaware of (or disregards) the "interconnectedness of male domination of nature and women," that current male environmentalism "disregards hierarchy," and threats to women's reproduction through environmental pollution or risks; and 4) socialist feminists leave out the dynamic aspects of nature as well as women's role in reproduction, and uses a mechanistic systems approach (Merchant, 1989, p.104; 1992, p. 6). Thus, the different branches of ecofeminism address these critiques from a spiritual perspective, a social/cultural perspective, or both.

At this point, it is helpful to look at some of the many differences between these branches, keeping in mind that the core concept is to employ a feminist analysis to ecology and issues of domination. Merchant (1996) provides the following descriptions: liberal ecofeminists work within already existing political and economic structures to bring about change; radical ecofeminists use direct action to take apart those structures; cultural ecofeminists whose focus is on the cultural expressions of the relationship between woman and nature, goddess religions, "earth-based" spirituality, and witchcraft; social ecofeminists whose roots can be traced to Murray Bookchin's social ecology; socialist ecofeminists who have ties to neo-Marxist philosophies; ecological ecofeminists who share many similarities with ecosystem ecology; deep-ecological ecofeminists whose work is closer to that of Arne Naess who seeks to move away from anthropocentric and androcentric views; critical ecofeminists who work toward dismantling the masculine and feminine categories, thus removing the dualism inherent in these categories; and ecofeminists of the Third World whose focus is on the

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"maldevelopment" in developed countries (Merchant, 1996, p. 207). It is clear that with

so many different aspects of ecofeminism, it is fairly easy to move within and between

these different categories. It is this movement that provides the rich body of scholarship

incorporating gender, dominance, and ecological issues. Implicit in any ecofeminist

scholarship is a feminist analysis that examines both work within ecofeminism and work

outside of the field.

Critiques of and by Ecofeminism

      Deep ecology. Just as ecofeminists hold many different perspectives, so too do

deep ecologists, and just as ecofeminism has a central idea (a feminist analysis of ecology

and oppression), deep ecology aligns itself with some core ideals. As stated earlier, deep

ecology takes on an eco-centric perspective and proposes that a radical change in the

human-nature interaction is necessary. While ecofeminism often follows a parallel vein,

included in this human-nature interaction is the central theme of oppression and

dominance of *both* nonhumans and humans. According to many ecofeminists, it is the

oppression and dominance of humans by humans that is ignored by deep ecology. They

charge that deep ecology fails to recognize the "historical and philosophical connections"

between the domination of nature by men and the domination of women by men

(Merchant, 1992, p. 104). In so doing, it ignores androcentrism and gender differences

(Merchant, 1992), thus masking the biases inherent in patriarchy and capitalism. These

sentiments are echoed by a number of other ecofeminists (R. J. H. King, 1991; Mellor,

1997; Sessions, 1991). Deep ecology also overlooks (or discounts entirely) entanglement

of science with a "socially negotiated relationship with nature" (Merchant, 1992, p. 107-

108). Furthermore, the limitations to population growth advanced by deep ecologists in

an effort to gain species equality, one of the major tenets of its platform, is based on rationalism that negates women as bearers of life (Merchant, 1992; Mies & Shiva, 1993).

In promoting eco-centrism in opposition to anthropocentrism, deep ecology is setting up a dualistic conception of humanity versus nature (Plumwood, 1993, 2002), thus leading to tension between the concept of eco-centrism and humanity (Mellor, 1997, 2000). Indeed, deep ecology poses a problem with discontinuity as it divides humans from nature by employing a human/nature dualism based on a vague idea of identifying self with nature, furthering the perception that we are separate from nature. It is this disconnect that makes it much easier to view nature as commodity rather than part of us. Our relationship to nature then becomes an "opposition and value dualism" (Plumwood, 1991, p. 11). This is in part a result of relying on a set of abstract distinctions between humans and nature based on universal principles that impose a value hierarchy separating those who do and those who do not count morally (R. J. H. King, 1991). The subsequent conception of a moral community is thus defined through an emphasis on identity and sameness, ignoring uniqueness and difference. In searching for a new relationship with nature, deep ecologists seem ready to expunge or ignore differences among individual members of a natural community, setting up the identity of each within the whole (R. J. H. King, 1991). Ecofeminists view this as simply moving away from abstract differences to "abstract identity" (R. J. H. King, 1991, p. 79).

Women inherently closer to nature. While many ecofeminists consistently criticize deep ecology for ignoring the oppression of humans by humans in their ecological philosophy, there are many who also find the assumption that women are closer to nature than men equally problematic. Mellor (1997) provides a rejoinder by

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arguing that the question is more about understanding the gendered nature of the dominant proclivities of human development and their affects on the environment. This response, in my opinion, hints at the "you can't understand because you're not female" position although Mellor in no way precludes the contribution of men in ecofeminism. Additionally, by claiming that women by virtue of being women are closer to nature than men, ecofeminists lay themselves open to the charge of universalizing their experiences with nature at the least and epistemic privilege at worst. Mellor, however, says that ecofeminism seems to drift between *women's* experience and women's *experience* (Mellor, 1997)*,* in a tug of war between an essential representation of women and a historical, contextual way.

Flowing from the idea of woman as closer to nature is an ethics of care applied toward nature. Roger King (1991) provides a critique of the problems associated with employing this ethic. Foremost is included the plurality of "natures" (whose nature, what does it look like) and the plurality of the different forms of caring (R. J. H. King, 1991). What determines care? What do ecofeminists care about? Salleh (1984) argues that a woman's fertility cycle puts her closer to nature than man and that the recognition that women's "lived experience" based on this cycle is meaningful rather than abstract (p. 34). Thus, this lived experience can be used as a basis for a radical change in the human-nature relationship called for by deep ecology. However, if the ethics of care focuses on protecting women's reproduction from ecological assault, as is argued (Salleh, 1984), doesn't this imply an anthropocentric perspective? Further, a recognition of the oppression of women through our industrialized society does not directly suggest a closer

link to nature than that experienced by man (R. J. H. King, 1991). Finally, an ethics of

care does not necessarily lead toward an understanding of how to care *for* nature.

There are many ecofeminists who clearly do not subscribe to the idea that women

are closer to nature just by virtue of being female (Spretnak, 1990; Warren & Erkal,

1997). Mellor (1997) describes liberal feminist Mary Wollstonecraft position that

because males and females share a common humanity, one cannot say women are closer

to nature than men. Vandana Shiva, however, describes women as "knowers" that are

experts in survival, whether due to being singly responsible for care giving in many

instances or male oppression; this, then makes them closer to nature rather than any

biological attributes (Mellor, 1997, p. 104). Warren and Cheney (1991) and Glazebrook

(2002) look to this female/nature connection as possibly historically mitigated. Further,

Glazebook believes that although feminists and environmentalists can "form an alliance

in the face of a common enemy," the assumption cannot be made that feminism and

ecology must be connected unless "patriarchy is inherently naturist" (Glazebrook, 2002,

p. 15).

Spirituality in ecofeminism. One aspect of ecofeminist thought that has been

both an attractor and detractor is that of spirituality. Plumwood (2002) points to the

position of many ecofeminists that it is spirituality that will ultimately determine whether

the human struggle for survival will be won or lost. There has been an assumption,

however, that most if not all ecofeminists hold deeply spiritual views of nature and whose

philosophies stemmed from that spirituality. Mellor (1997) posits that this

misrepresentation probably came about due to the number of anthologies published in the

late 1980s and early 1990s that were identified for their spirituality rather than their social

ecofeminist views. She also speculates that the criticism of essentialism may stem from a

preponderance of early ecofeminist writers who were poets or theologians. So why is

this spirituality so problematic for ecofeminism? First, Western culture consistently

denigrates spirituality that does not emanate from the patriarchal hierarchy[6]. Indeed,

using the word "goddess" in any connotation outside of Greek or Roman mythology or

the humanities often prompts a derisive or dismissive response; bring up the Goddess and

you have introduced spiritual mysticism, taking your argument from logical to mystical,

often leading to its dismissal.   While this is, admittedly, a generalization, the dialogue

invoking Goddess *outside* of feminist writings is rather sparse. Additionally, in

employing a transcendent and rationalistic spirituality, ecofeminists "can subvert key

aspects of the dominant and political order or can be complicit with it" (Plumwood, 2002,

p. 218) by creating a dualism. Thus, ecofeminists who lean toward spirituality must

support those ethics that are nondualistic. Part of the problem lies in the broad concepts

of spirituality which make it difficult to transfer as a vehicle for environmental (thus

social) improvement. Once again, language becomes a problem; what constitutes

spirituality? who decides? how does this spirituality translate into helping change the

oppression of women and nature?

Warren attempts to diffuse the argument that ecofeminist spirituality reinforces "a

harmful identification with nature" by claiming that these spiritualities serve to remind us

that the distinction between human and nature is a "false dichotomy" and are thus a

positive aspect of ecofeminism (Warren, 1996, p. 130). Her point is an important one as it

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[6] Take for example the Southern Baptist Convention that disallows female participation in any position of
authority and the Roman Catholic Church's position on women in the priesthood.

is the artificial divorcing of human from nature that many think ultimately leads to our apparent disregard for the nonhuman component of the world around us[7].

Are women complicit? Regardless of the spiritual aspects of ecofeminism, my own difficulties with ecofeminism centers around the question of women's participation in our ecological crisis. Glazebrook (2002) posits that while environmental destruction in the Western world may have its roots in patriarchy,

> …women also participate in patriarchy and its oppressive practices…Part of feminist empowerment consists in women acknowledging their autonomy and being accountable for their choices, without simply abnegating responsibility on the basis of social influence and conformist necessity (p. 14).

When placing the blame on a patriarchal society, it is important that ecofeminists recognize that they too are complicit in the current state of our environment. One of the challenges to ecofeminists is a recognition that just as the language employed by deep ecologists seemingly "erases" the oppression of women while defining a new human-nature relationship, so too can ecofeminist terminology lead toward a charge of dualism or essentialism. By deconstructing the human-nature relationship, ecofeminists can expose possible problems associated with their respective perspectives.

Poststructural Connections and Reconciliation

Before beginning a discussion of the relationship between poststructuralism and ecofeminism, a brief history and explanation of poststructuralism is in order. In one of my favorite passages exemplifying the problems associated with language, Humpty Dumpty and Alice argue over the meaning of the word "glory"; Humpty explains,

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[7] The same can be said regarding education; the more removed students are from their school environment the less likely they are to learn

'I meant "there's a nice knock-down argument for you!'

'But "glory" doesn't mean "a nice knock-down argument",' Alice

objected.

'When I use a word,' Humpty Dumpty said in a rather scornful tone, 'it means

just what I choose it to mean – neither more nor less.'

'The question is,' said Alice, 'whether you can make words mean so many

different things.'

'The question is,' said Humpty Dumpty, 'which is to be Master – that's all.'

(Lewis Caroll's *Through the Looking Glass* quoted in Belsey, 2002, p. 1-2).

For Belsey, this quote illustrates one of the conditions of language, that one must use the

language at hand rather than a private language in order to communicate (Belsey, 2002).

However, there is an added component that becomes apparent when viewing this passage

through a poststructural lens, that of the implicit power of whomever gets to "choose" the

meaning. While readily understood that private language will not allow one to function

in society, the every day or "common" language brings with it attempted meanings,

control, and power (not one in the same thing). In attempting to choose a single meaning

for words such as "environment", "nature", "ecosystem", "anthropocentrism", we are

attempting to exert the power that comes with our insistence on *our* meaning, *our*

concept. A poststructural lens does not negate the fact that my "nature" carries with it

power over my student when I give her/him my concept of "nature." It does, however,

acknowledge the existence of that power and attempts to include it in reformulating the

new "nature" now held by my student.

Poststructuralism, a *set* of positions rather than a single position, emerged as a response to structuralism (Barry, 2002; Cherryholmes, 1988; W. Pinar, W. Reynolds, P. Slattery, and P. Taubman, 1995). Its roots can be traced to existentialism through Nietzsche and Heidegger (Sarup, 1989; Wolin, 1992), but poststructuralism can also be tied to Saussure's linguistic theory (Belsey, 2002; W. Pinar et al., 1995), "structural analysis… [in] Western discourses"(W. Pinar et al., 1995, p.456), and a critique of phenomenology and semiology (W. Pinar et al., 1995). Often presented as oppositional, poststructuralism is more of a response to the limitations presented by a structuralist perspective (Barry, 2002; Belsey, 2002). Conley argues in her introduction to *Ecopolitics* "…poststructuralism, contrary to some received ideas, refers to a current of thought that grows from the sociopolitical and environmental awareness of what structuralism had established" (Conley, 1997, p. 5). Thus, structuralism propped open the door and poststructuralism flung it wide open.

Tilottam Rajan posits there are two types of poststructuralism, "affirmative" or "emancipatory" (Rajan, 2002, p. 35-36)and "negative" or "inhuman" (Rajan, 2002, p. 38). Part of the difficulty in attempting to discern scholarship as poststructural stems from this attempted delineation between positive and negative tones. Some of the negativity can be traced to a misreading of the effectiveness of multiplicities, one of the many aspects of poststructuralism that I find useful. If multiplicity is read as just noise, a blending of all voices at all times, it becomes useless. If however, multiplicity is read not as a blending but the honoring of all voices, it is extremely useful in continuing dialogues as this brings with it a richness rather than a narrowing of interpretations. Along with multiplicities, poststructuralism has several other through lines: deconstruction,

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differánce, interruption, resistance, repetition, and the constructed subject. There are numerous major theorists associated with poststructuralism: the works of Michel Serres (1995, 1997, 2007) and Gilles Deleuze (1987) will be presented in chapter four. In addition to those listed above, there are many feminists who have either come to terms with or embraced poststructuralism and others who refuse to be labeled as poststructuralists but who often employ a poststructuralist perspective in their work: Val Plumwood (1991, 1993, 2003), Karen Warren ((1996), Verena Conley (1997), Catriona Sandilands (1997, 1999a, b), Donna Haraway (1989, 1991a, b, 1994, 1997, 2004, 2008), and Annette Gough (1997) are some of the major poststructural feminists and ecofeminists whose work is currently adding to the discourse.

While these ecofeminists (and feminists) employ a poststructural lens in their work, there are many others who object to poststructuralism/postmodernism. Arguments against a poststructural perspective range from it being an exercise in words that is removed from the "reality" of nature (Mellor, 1997; Merchant, 2004; Soper, 1995), to nihilism (Mies, 1993), to erasure of identity due to the death of the subject (Mies & Shiva, 1993; Mohanty, 2000; Moya, 2000; Murphy, 1997; Plumwood, 1993). In presenting these arguments, I will attempt to show that poststructuralism and ecofeminism are not mutually exclusive; indeed, much can be gained by approaching both ecological issues and issues of oppression from this perspective as a way to work in the spaces between rather than the ends.

The "reality" of nature. While some ecofeminists agree that deconstruction may be useful for an analysis of texts, they argue that the reality of nature is physical, thus

rendering a poststructural reading of nature useless (Mellor, 1997; Merchant, 1990).

Mellor argues,

> Meanings may change with discourses, human knowledge or power relations may affect physical and social conditions of life, but the physical materiality of human life is real, however it is described or 'constructed' (Mellor, 1997, p. 7).

The argument is leveled that regardless of the social construct of nature within Western culture and science, it is still physical and dynamic (Mellor, 1997; Soper, 1995). If, however, the nature-culture dualism is socially constructed, then, I argue, that dualism is subject to change.

While acknowledging the usefulness of deconstruction in some instances, Merchant claims that "deconstruction posits a nonmaterial world of differences as meaningful" (Merchant, 2004, p. 201), lending a type of reality to the words themselves rather than the material things they strive to describe. Although Merchant qualifies this perspective with a call for the interweaving of reality and narrative (Merchant, 2004), neither Mellor nor Merchant address the question of whose nature and whose reality should we be interested in? Perhaps Merchant has a point when she alludes to the historical aspects of deconstruction by arguing that it only deconstructs master narratives that are originated by men, for men, told by men (Merchant, 1996):

> …feminism exposes certain postmodernist approaches to the study of science and its history that entail domination. Male critics of their intellectual fathers' stories fail to deconstruct the assumptions behind their own postmodernist terms such as "master narrative," "representations," and "witnessing." The "master narratives"

questioned are male stories about great men told by male historians of science. (p. 62).

Implicit in this, however, is the assumption that women do not construct nor can they deconstruct the metanarratives that surround science and nature. While it is true science has been dominated by men or at least a patriarchal hierarchy, this argument leaves women behind while at the same time exonerating them from the responsibility of forming or taking part in these metanarratives. The idea of *using* an analysis or deconstruction of metanarratives is not precluded by the notion that all of this originally came about through males, specifically white males; indeed, it behooves us to use this discourse to examine the human-nature relationship (Sandilands, 1999b).

In addition to the text/reality debate, Mellor also charges poststructuralism with offering "a false choice between radical social constructivism and…forms of universalism and essentialism" (1997, p. 7). However, she concedes on the very next page that there is a great deal of confusion around the meaning of various words associated with ecofeminism and its treatment of nature (again, whose nature?). So is leveling a claim against the usefulness of poststructuralism because the "physical materiality of human life is real" a valid one? Doesn't this beg the question, whose reality? And isn't it the deconstruction of that reality that is more rather than less inclusive? Mellor follows with a discussion incorporating Donna Haraway's "embodied objectivity" as representing an "earth-wide network of connections" (Haraway, 1991a, p. 187), reading this as support for her argument against postmodernism/poststructuralism. Mellor's point is that it is the physical aspects of the object of knowledge that lend a relationship to the object and allow us to begin to know that object rather than "the

particular perspective of particular people" (Mellor, 1997, p. 125). She uses this as a precursor to the argument that poststructural perspectives are inherently devoid of a sense of responsibility; thus, ecological crises are never addressed. In using "embodied objectivity" (cautioning against omniscient scientists), however, Mellor is missing a key point in poststructural thought, that deconstruction helps us better understand that object by examining the social constructs and/or power around/in/on that object. Secondly, while Haraway does not claim the label of poststructuralist, she does acknowledge the similarities of her work with Derrida's in deconstructing science (Haraway, 2000).

A crisis of identity. Catriona Sandilands, in her text *The Good-Natured Feminist*, criticizes "cultural identity politics" that is inherent in the work of many ecofeminists as "essentializ[ing] women and domesticat[ing] nature" (Sandilands, 1999a, p. xix). Her argument is *not* that ecofeminists should not negotiate an attempt to create identity but rather that ecofemin*ism* should refrain from attempting to create a fixed, single identity. Sandilands has brought up this point before in discussing the work of Val Plumwood,

> …I would argue that identities have *never* been (and are certainly not now) as monolithic, stable, or singly positioned as many ecofeminists seem to argue, and that it is a dreadful mistake to require that they become so in order to create a narrative of future liberation or sustainability (Sandilands, 1997, p. 19).

From Sandilands perspective, the reliance on a "solid" identity in ecofeminist politics in order to be effective creates a situation in which ecofeminists are relegated to remaining in "mother earth's closet" thus rendering them *in*effective; instead, they need to "play more visibly in the gap between life and construction" (Sandilands, 1997, p. 36-37).

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In critiquing the work of other ecofeminists, Sandilands sees many examples of poststructuralist leanings, particularly in regards to developing room for multiplicities. What is lacking in these same works is an acknowledgement that this can be viewed as a definite rejection of metanarratives (Sandilands, 1997), including questions of identity.

The death of the subject.

What we lose by looking for an easy way out – for example, by denying all identities validity because they are always tied to personal experience and subjective judgments – is the capacity to make useful and important distinctions between different kinds of identity, different kinds of value and judgment (Mohanty, 2000, p. 64).

Much has been made regarding poststructuralism and the death of the subject. The argument posited is that the death of the subject denotes a lack of agency (Allen, 2000; Brodribb, 1992; Eagleton, 1996; Mohanty, 2000; Moya, 2000; Hames-Garcia, 2000; Norris, 1982; Sidorkin, 2002; Zammito, 2000). If there is no subject, there is no repression since there is no one to repress. The charge stems from one of the main assumptions of poststructuralism that "all is text", which leads us to social construction and multiple interpretations, and, some would argue, paralysis (Belsey, 2002; Brodribb, 1992; Chow, 2002). Attributed to Jacques Derrida (Bush, 1995; Cherryholmes, 1988; Davis, 1997; Pinar et al., 1995), the phrase in Derrida's native French is 'il n'ya pas de hors-texte' which translates to 'there's nothing outside the text' (Davis, 1997; Derrida, 1976). From Derrida's perspective one references everything through language and thus must acknowledge that limitation (Derrida, 1976). One then becomes limited to a situated understanding of what 'female' is or what 'nature' is. The idea that simply by

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acknowledging the limitations of language and our understanding of that language everything disappears is not reasonable. The idea that one must, in acknowledging those same said language limitations, always remain cognizant of socially constructed meanings and interpretations is, I contend, eminently reasonable. Further, if there is "nothing outside the text", power attributed to an individual or group is minimized or eliminated.

That being said, one cannot discuss the problems, limitations, and multiple interpretations of the supposed death of the subject without examining the work of Michel Foucault. Amy Allen (2000), in an extensive article analyzing 'subject' and Foucault, agrees that if, indeed, Foucault posits the literal death of the subject, the arguments leveled against poststructuralism cannot be refuted. Thus, responsibility for unjust actions, be it social or political, cannot be determined (Allen, 2000). She further agrees that the idea of injustice itself is a fallacy since it makes no sense to claim injustice if there is no subject upon which injustice is served. Further, the death of the subject negates any idea of the resistance Foucault so often refers to since there is no agency, only "anonymously functioning power/knowledge regimes" (p. 118). Her claim, however, is that a reexamination of Foucault's work leads to a different interpretation than that which is commonly held. Allen maintains that Foucault makes an important distinction between subject as "merely an affect" and subject "as an effect of discourse and power" (p. 120). To say that subjects are the products of forces that are largely out of their control, as Foucault does, is not to say that they have no control over anything whatsoever (Allen, 2000, p. 120). Allen's interpretation of Foucault's subject/subjectivity centers on the idea that his intention is to focus philosophical

investigation on "the concept of subjectivity itself" (p. 122) rather than to take away the concept of subject. This reading of Foucault then finds subjectivity contingent rather than necessary, providing readers with a way to perceive the interdependence between structure and agency (p. 128).

Jacques Derrida also decries the death of the subject (Kearney & Ricoeur, 1984). Due to the continued misreading of his thoughts on this subject, his words warrant quoting:

> I have never said that the subject should be dispensed with. Only that it should be deconstructed. To deconstruct the subject does not mean to deny its existence. There are subjects, 'operations' or 'effects' of subjectivity. This is an incontrovertible fact. To acknowledge this does not mean, however, that the subject is what it says it is. The subject is not some meta-linguistic substance or identity, some pure cogito of self-presence; it is always inscribed in language. My work does not, therefore, destroy the subject; it simply tries to resituate it (Kearney & Ricoeur, 1984, p. 125).

As with Foucault, Derrida makes an important distinction between the death of the subject and one that is situated (or resituated). This distinction is made on a number of occasions by different scholars who favor a poststructuralist perspective. Perhaps one of the most eloquent explanations comes from Bronwyn Davis (1997):

> …the point of post-structuralism is not to destroy the humanist subject nor to create its binary other, the 'anti-human subject' (whatever that might be), but to enable us to see the subject's fictionality, whilst recognizing how powerful fictions are in constituting what we take to be real (p. 271).

Davis not only helps clarify the concept of subject but also acknowledges how that concept is molded by forces outside of the subject, thus a situated identity. Davis further expands on the concept of subject with her interpretation of Foucault. She sees Foucault as not getting rid of the subject but illuminating how humans are made into subjects (p. 271). So if one views subject as 1) not dead, and 2) changing, one can also begin to see subject not as a noun but a verb, a process per se. This idea is not exclusive to Davis but is put forward by many others who take a poststructuralist perspective (Jones, 1997; Sarup, 1989; St. Pierre & Pillow, 2000; Yapa, 1996). Indeed, St. Pierre & Pillow (2000) contend that the idea of the subject as verb or in progress might benefit feminism in that if 'woman' is finally defined, same said 'woman' will not have the benefit of the deconstruction of political oppression (p. 8).

Political commitment and the metanarrative. There are those whose main disagreement with poststructuralism (outside of the death of the subject) is the lack of political commitment (Brodribb, 1992; Eagleton, 1996; Francis, 2000; Hames-Garcia, 2000; Mohanty, 2000, Moya, 2000; Sidorkin, 2002; Wolin, 1992; Zammito, 2000). The argument goes something like this: by viewing everything as text and subject to interpretation, oppression is not possible since there is no oppressed, nor is there an oppressor. Thus, any social movement, be it based on gender, race, or environmental issues is a non-sequitur as *there is no gender, race or environment*. While this argument ties directly into the death of the subject addressed earlier, it is often employed against the multiplicity called for in poststructuralism. Sidorkin (2002) contends that while postmodernist theory may promote multiple ways of looking at an issue, it does not give one reason to act toward change (p. 177). This sentiment is echoed by Wolin (1992) who

states "…poststructuralism has excelled at challenging inherited epistemological positions & hierarchies" but has failed to provide a reason for one to act on those positions (p. 9). Francis (2000) joins the fray in a paper both complimentary and critical of poststructuralism. She points to the benefits of poststructuralism when attempting to identify discursive practices. She claims, however, that the emphasis on deconstruction leads to paralysis, both ethically and politically. Thus, emancipation is not possible. Chow (2002) puts it a bit differently; while he begins to reiterate this view, he also opens the door just a bit by referring to an "as yet unresolved outside" (p. 181). This speaks to the movement between subject/subjugation or a subject in progress. Maria Mies refers to this as "nihilistic hedonism and individualism" a sort of free for all that promotes criticism for its own sake (Mies, 1993, p. 160). According to Mies, "this position can always count upon being on the right side because it does not take sides at all." (p. 160). This is a severe misreading of poststructuralist thought, albeit a common one.

While arguments have been made that poststructuralism prohibits personal responsibility by rendering one incapable of making a choice (Belsey, 2002), I believe the opposite to be true. Recognizing the differences and multiplicities in our world leads toward personal responsibility rather than away from it. While the angst of existentialism is missing from a poststructural position, human dignity is very much in existence. Thus, poststructuralism is not incompatible with ecofeminism. On the contrary, using a poststructural voice to examine ecological and feminist issues illuminates the oppression of nature and females rather than minimalize it or render it invisible, one of the central arguments against deep ecology by ecofeminists.

Isms, Binaries, and Environmental Education

Ecofeminism has many faces and a myriad of voices; it speaks to spirituality, philosophy, ethics, and nature. While ecofeminism has differences with other ecological endeavors and even within its own ranks, the central theme of opening a dialogue about our place (and impact) in nature is shared by many. So why have ecofeminists taken the environment into their own hands? Sandilands answers that question with the following:

> Fundamentally, this project is about opening the world to public discussion. It is
> about showing the undiscussed assumption upon which dominant understandings
> of the common world rest and making them negotiable in light of new claims…It
> is about showing that the common world between us is a far richer and more
> varied place than the hegemonic imagination of Western society allows, including
> environmentalism (Sandilands, 1999b, p. 224).

There is no point in a society that is predominantly patriarchal *or* matriarchal if our environmental policies are not sustainable. Ecofeminism, like everything around us, is not one-size-fits-all. It is in the varied discourse, and the spaces between those discourses, that we begin to understand our interconnectedness with the material and non-material world around us.

Whether one espouses to social ecology, ecofeminism, deep ecology, or anything in between, they all try to illuminate the human-to-human and human-to-nature relationships. The idea that environmental education can eventually lead to environmental literacy and a renewed connection to nature seems to be further away than ever before. Although it seems environmental issues are at the forefront of media attention today, there has been what I consider a backsliding in public education. With the advent of performance based education at the K thru 12 level, one would assume that

students would now begin to be *in* the environment rather than looking through the much distorted lens that has been (and I contend continues to be) public education. Prior to Georgia adopting performance standards for Environmental Science at the high school level, the state curriculum included government, economics, and quality of life issues in addition to species interactions, pollution, and sustainability. The new performance standards fail to include an overt reference to government, economics or quality of life, thus distancing our students from what may be relevant in *their* lives. This change may have been made in order to create a course more geared toward hard science and less toward the social sciences. As Annette Gough pointed out in her text, *Education and the environment: Policy, trends and the problems of marginalization*, this only serves to further detach our students from the environment around them (1997). In this light, and our continually propensity toward setting up binaries, it is no wonder a concerted effort to solve some of our most pressing environmental problems still seems to be out of reach.

So why *do* we continue to cling to our binaries? Karen Hawkings (2003) suggests, "…the investment of time, energy and identity that individuals and societies make in the construction of their conceptual boxes offers an explanation for why those boxes are so fiercely defended (para. 9)." By acknowledging this, we can feel safer about looking at other perspectives without having to entirely give up our own. It may be that as the dialogue progresses, we begin to move back and forth from our original convictions, bringing with us more and more parts if you will, thus forever changing the original idea into a newly emerging idea. By moving beyond that point, we can see that while the edges may be somewhat blurred, they still exist. This blurring of boundaries is an important concept in relieving the either/or pressure that is presently driving

environmental reform. However, the importance of recognizing that those boundaries

exist, albeit blurred, cannot be overlooked. Without it, the often bitter fighting over

positions relative to environmental issues has produced an alienation or emotional

numbness to our connection to nature. The inclusion of multiple perspectives, in which

all sides are recognized as contributing to the discussion, allows for a more flexible

discussion, incorporating the subtle shifts experienced through time.

Hailwood (2003) posits, and I agree, that it is not a question of either

anthropocentric or non-anthropocentric, but the "instrumental view" of nature that drives

our environmental problems (p. 227). He addresses the problem of using the doom-and-

gloom approach that seems prevalent particularly in the anarchistic perspective of social

ecologists such as Murray Bookchin: "The suspicion is invited, when the claimed

political remedy is particularly radical, that the gloominess is being *talked up* to provide

extra powerful-seeming reasons for political change…" (2003, p. 226, my emphasis).

When solutions to environmental problems (or any problems for that matter) are a radical

departure from what we know, the tendency is to either run away from the problem or

exhibit a fatalistic attitude. A prime example of this is seen among young soldiers being

deployed to war zones. Many of them go on spending sprees prior to deployment with no

regard for the financial consequences precisely because they don't believe they will

survive.[8] In Hailwood's example, "if things are *that* bad" (environmentally) it may as

well be business as usual (p. 226, author's emphasis). He further states, "If instead we

emphasize nature's non-instrumental value, then fatalistic, fantasy and escapist responses

are condemned explicitly from the outset" (p. 226-227). While I agree that a fatalistic

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[8] Based on personal experience as a Bed Debt Manager for military banking through the first Gulf War.

attitude gets us nowhere fast, there is an issue Hailwood does not take into consideration:

our increasing disconnect with nature. If humans, particularly those in heavily

industrialized nations, do not feel connected to nature, it seems "valuing nature for its

own sake" as the starting point for a more non-anthropocentric perspective (Hailwood,

2003) might be exceedingly difficult to achieve. By examining where we are situated in

our binaries (anthropocentric/non-anthropocentric; social ecology/deep ecology;

feminist/ecofeminist, etc.) and moving between and among those binaries, we may begin

acknowledge the multiplicities of nature and the human spirit. Perhaps by viewing nature

with a more theoretical lens, as discussed in the upcoming chapter it will be easier to

loosen our tight hold on an either/or perspective.

CHAPTER 4

NATURE IN THEORY: RHIZOMES, FOLDED TIME, SCIENCE, AND CYBORGS

Multiple and diverse perspectives on science and nature have generated much discussion and a plethora of texts. It is in the examination of the convergence of these perspectives that one begins to unravel some of the rhetoric and develop a sense of connectedness. From an exploration of the elite world that has been and, it can be argued, continues to be science, to the call for a return to nature, these varied views of the environment, science, and our relationship to both serve to facilitate a multi-dimensional approach to both curriculum and pressing environmental issues. While discipline specific papers and texts provide detailed facts and analysis of scientific endeavors, the work of curriculum theorists and many of the philosophers and social scientists whose work informs them has provided a much needed connection to education. This however, does not refer to the science education courses taught at many universities; indeed, there is a distinct difference between what constitutes courses in science education and curriculum studies within the context of science. It is from the work of notable scholars situated within curriculum studies and the philosophy of science such as Gilles Deleuze (1987, 1990), Felix Guattari (1987), Michel Serres (1995, 1997, 2007), Bruno Latour (1987, 1993, 1998, 2004), Donna Haraway ((1989, 1991a b, 1992, 1994, 1997, 2004, 2008), and Noel Gough (1989, 1990, 1991, 1993, 1999, 2001, 2002, 2004b, 2006) that this chapter draws on. These scholars are of particular interest because of their diverse and often interconnected perspectives on nature, science, and our relationship with the world around us. Examining their work in the context of the connections that resonate within Gilles Deleuze and Felix Guatarri's rhizome, Serres' perspectives on the "educated

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third," or Harraway's "modest witness," allows us to consider curriculum in new ways that open a more robust dialogue. These connections are not limited to environmental issues or perspectives on nature; they are intimately tied to the previous discussion of string theory. Just as Edward Witten's reexamination of mathematical equations moved several different iterations of string theory under the umbrella of M-theory, exploring nature through a more theoretical lens provides us with much richer ideas with which to attempt to solve pressing environmental issues to include an ever increasing disconnect with nature. This exploration begins with Deleuze and Guattari's rhizome.

Rhizomes, Nature, and Curriculum

Although the work of Gilles Deleuze and Felix Guattari encompasses much more than rhizomes, it is the idea of the near infinite possibilities inherent in both the biological and metaphorical rhizome that I draw on here. In *A Thousand Plateaus* (1987), Deleuze and Guattari use the rhizome to describe everything from evolution to faciality to linguistics. According to Delueze and Guttari, "…the rhizome is made only of lines: lines of segmentarity and stratification as its dimensions, and the line of flight or deterritorialization as the maximum dimensions after which the multiplicity undergoes metamorphosis, changes in nature" (1987, p. 21). It is this line of flight, the ability of the rhizome to produce shoots, to move in multiple directions that Deleuze and Guattari expound on. By using the rhizome to describe a system of connections rather than simply a plant structure, they are able to apply the *idea* of the rhizome to concepts not normally thought of in these terms. It is important, therefore, to formulate an understanding of the intricate ways in which Deleuze and Guattari use rhizomes. Firstly, rhizomes always already have multiple connections: "any point of a rhizome can be connected to anything

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other, and must be" (Deleuze and Guattari, p. 7). Secondly, rhizomes are not part of a closed system: "It is composed not of units but of dimensions, or rather directions in motion. It has neither beginning nor end, but always a middle (*milieu*) from which it grows and which it overspills" (p. 21, author's emphasis). This particular portrayal reiterates the always in motion loops, both open and closed, described by string theory. Thirdly, rhizomes are not destroyed: "A rhizome may be broken, shattered at a given spot, but it will start up again on one of its old lines, or on new lines" (p. 9). Thus, there is a continuity to the rhizome. It is primarily these three attributes that make Deleuze and Guattari's rhizome such a powerful concept for education. It underscores how learning takes place, not in stutters and starts but by flowing from one place to another. In using the metaphor of a rhizome for education, we move away from distinct disciplines that often seem unrelated. No longer is it an educational arboretum where learning branches out but ultimately stops when it reaches the tip; instead, it is a rhizome in which unexpected turns take place, and connections between seemingly unrelated events/concepts/ideas can be made. By using the rhizome as a metaphor for nature, one can clearly see interconnections that are constantly being made.

Scholars from diverse fields have used many different iterations of the rhizome. Lars Hallstrom (2002) examines the use of the rhizome "to develop an environmentally oriented critique of sovereignty of the state" (p. 1) by those researching international politics and security. In *Ecology and the State: Seductive Theory and Limits to Reality*, he states, "The rhizome offers new theoretical space that gives both flexibility and a more inclusive understanding of the world" (p.3). Hallstrom allows that in several models dealing with eco-politics, "the rhizome is an understanding of the world that places

humanity within a conception of the environment, yet allows for the constant possibility of change, permeation and connection" (p. 7). However, while analyzing these studies, Hallstrom argues that one runs the risk of substituting the model for reality when it is presented as an eco-political model. Instead, he contends that the focus should be on the content of the model rather than "to generate a picture of the real" (p. 9). This is an important argument in terms of limiting knowledge. This substitution of the model for the real is seen more and more frequently in many venues, especially in education. When we rely on models to educate, those models often become "real" to our students. The fluid mosaic model of the cell membrane is just that, a model. In order to provide a visual basis for learning, we substitute an artistic rendering of the cell membrane that leaves our students with more misconceptions than understandings. We choose models for several reasons. We are often not able to examine the "real" thing due to inaccessibility or impracticality. But part of the justification for this is our choice to simplify, especially for those who are in all likelihood not going into that particular field, be it biology or international studies or linguistics. We also use models because we understand that mere words are often not enough to convey complex concepts. John Weaver, in the introduction to *(Post)modern Science (education): Propositions and Alternative Paths* (2001), discusses the use of models in science: "The satisfaction of science is not discovering truths or universals but is found in the creative process of inventing models and interpretive approaches that provide answers to our problems *without forgetting that we are using models and interpretations*" (p. 9, my emphasis). Some scientists, however, lose sight of the fact that the model is just that, a model. Weaver continues; "The only thing scientists should be criticized for is believing their

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own illusion that the models they construct really, somehow, are representations of the natural world rather than representations of their minds" (p. 15). For Weaver, a postmodern science education includes a discussion that emphasizes models as "evidence to support their usage" (p. 15) for it is in the discussion that our students move away from models as "real." This is particularly important when attempting to "bring nature" to our students. The oft repeated model of nature as pristine and untouched gets substituted for the real without providing for the discussion Weaver refers to above. This is also the case with naming, categorizing, or labeling. Donna Haraway (1992) addresses this when she states; "Human beings use names to point to themselves and other actors and easily mistake the names for the things" (p. 313). This is particularly true for those who are just beginning to learn about the intricacies of science. Thus, if we use the idea of Deleuze and Guattari's rhizome as a metaphor or model for the environment, we must emphasize the context with which it is presented.

Scott Lawley (2005) suggests using rhizomes in terms of appropriation; "It is suggested that an interplay – between the use and appropriation of the rhizome in the study of organization and the building of rhizomatic ontologies of flow – is desirable for maintaining the rhizome as an open and useful concept" (p. 36). Lawley echoes Hallstrom in cautioning against using the rhizome "as a proxy for organizational structure or simplistic metaphor" (p. 36). By appropriating the rhizome as an open concept, Lawley sees the powerful ways in which the comparison of the static to "rhizomatic movement" (p. 39) can create moments of creativity and insight and further that these movements move us beyond the rigid into the supple. It is this creative moment that arises from the rhizome that lends itself to new ideas; "…there is always the possibility

for rhizomatic movement to take the organization to novel, unexpected outcomes" (p. 43). Curriculum theory is not stagnant; it is replete with the potential to spur new ideas, new ways of looking at the world. Thus, whether one is using the concept of the rhizome to describe organizational theory, literary theory, or eco-political theory, it is more than appropriate to examine such disciplines using a rhizomic lens. Using a rhizomic lens in engaging a dialogue concerning environmental issues is particularly useful; its flexibility and fluidity open avenues that may have previously seemed unrelated. Inna Semestsky (2003) states that "The rhizome *becomes*, or is becoming, at any moment of its own entry" (p. 18, author's emphasis). If this same concept is applied to curriculum or an idea meant to solve an environmental problem, the act of entry changes the direction or flow of what would have occurred without its entry.

> Rhizome, as embedded in the perplexity of the situation, goes in diverse
> directions instead of a single path, multiplying its own lines and establishing the
> plurality of unpredictable connections in the open-ended, what Deleuze called
> *smooth*, space of its growth (Semetsky, 2003, p. 18).

Just as the concept of string theory adds multiple dimensions and thus multiple opportunities and directions for us to move forth, so too does the concept of the rhizome.

> The rhizome's renewal of itself proceeds autopoietically: the new relations
> generated via rhizomatic connections are not copies, but each and every time *a*
> *new map*, a cartography. A rhizome does not consist of units, but of *dimensions*
> and *directions*" (Semestsky, p. 27, my emphasis).

While Deleuze and Guattari's rhizome has been written about in numerous contexts, articles and/or texts analyzing Deluze's perspectives on nature are more

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difficult to find. Patrick Hayden (1997), however, explores what he calls Deleuze's "naturalism" which he contends can be found in much of Deleuze's work.

> It is my contention that Deleuze promotes a type of naturalism that highlights the diverse interconnections between human and nonhuman modes of life, in such a way as to provide some overlooked philosophical resources for integrating ethical and political considerations with ecological concerns, while resisting the reductive temptation to turn nature into a static metaphysical foundation (1997, p. 186).

While the *idea* of the rhizome is present here, particularly when Hayden refers to Deleuze "resisting" being drawn in to the creation of "a static metaphysical foundation," Hayden does not rely exclusively on the rhizome as an argument for Deleuze's naturalism. Indeed, much of the paper discusses Deleuze's assertion that philosophy should be practical, and thus, "implies a commitment to, among other things, a strong environmentalist stance" (Hayden, 1997, p. 186). Hayden points to what he describes as Deleuze's call for a reversal of Platonism in *The Logic of Sense* (1990). In it, Deleuze suggests "the abolition of the world of essences *and* the world of appearances" (Deleuze, 1990, p. 253, author's emphasis). Hayden argues,

> …[this] can thus be regarded as a naturalistic strategy aimed at eliminating the dualism of essence and appearance while affirming the continuous becoming of a fully natural reality that is in no way indebted to or derived from any form of hidden, metaphysical transcendence (1997, p. 188).

This is a key suggestion both in terms of advancing Hayden's argument and in illustrating one of the reasons perspectives about nature can be so contentious. We are often confronted with the idea of a pristine nature and what Steven Vogel (2002) refers to

as a "nostalgic appeal to a lost world independent of the humans" (p. 28). This dualistic

approach, one that attempts to simultaneously hold up the essence of nature alongside the

nature we actually inhabit, has forced us to maintain an illogical and unattainable ideal.

Our inability to reconcile the problem of living in nature while "returning" to the ideal of

nature is but one of the difficulties we face in trying to solve environmental issues and, I

would suggest, is resultant in a disconnect with nature. Hayden argues that "Deleuze

desires to eliminate the dualism that postulates a realm of metaphysical essences separate

from and more real than the natural world itself, which is consigned to the status of mere

appearance" (1997, p. 187). Thus, according to Hayden, Deleuze considers nature or the

natural world to be fully intertwined with humans and, more importantly, one that is in a

constant state of change. "Deleuze clearly holds that all of nature, including its human

elements, is in constant flux and that there is no essential, foundational, or sacred state of

nature to be found" (1997, p. 197). By removing this sacred state of nature and

reinserting humans, we are no longer relegated to working on a solution to a single

environmental problem, that of returning the world to a pristine nature, something that

was always already unattainable. In describing Deleuze's perspectives on

interconnectedness, Hayden concludes by saying, "Deleuze's ecological naturalism

amounts to the practical affirmation of the common destiny shared by all modes of life on

Earth, not in spite of, but because of their multiple yet always intersecting and fragile

lines of difference" (1997, p. 204). One is struck with the thought that while using the

rhizome as a model may be problematic, it certainly provides an elegant way of

illustrating multiple connections.

As does Hayden, Campanile (2005) also sees Deleuze and Guattari's relationship with ecology and nature as an integral part of their work. His interpretation looks less at the biological definition of ecology and rhizomes in particular and more at the spiritual nature. "Deleuze and Guattari invigorate in ecology a sense of never ending space and time that is lost in many biological (or sociological) definitions" (p. 1-2). A rhizomatic ecology that always already is *and* is infinite by virtue of its ever changing connections leads Campanile to describe what he calls a "radical spirituality" (p. 1), one that encompasses the "political, social, and individual selves" (p. 1). Further, he sees an interconnectedness between the individual self and the smallest atom and furthest galaxy, creating a "social and spiritual…continuum" (p. 2). Perhaps it is this idea of a continuum and the infinite connections created within the continuum that brings to mind a relationship between Deleuze and Guattari's rhizome and string theory. While regarding the universe from two seemingly different vantage points, one from physics and mathematics, the other from biological and social interactions, both serve to reveal ever changing, always present connections between the largest and the smallest constituents. There is a constant flux both in the world around us and how we continue to see that world.

Of course Deleuze and Guattari do not limit themselves to discussions of rhizomes. Arnott (1999) explores their "Thought-forms" (philosophy, art, and science) as boundaries that serve to differentiate between each form, thus providing an understanding that "no one of these forms is reducible to the other, and that any attempt to blur the boundaries is to be resisted" (p. 49). The discussion then becomes more about intersections of these Thought-forms and how one interferes with the other, preventing

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one from asserting that it has more of a claim on knowledge than the other. Thus, the boundaries inherent in Thought-forms provide us with a disruption, causing us to re-examine the claims of science in isolation, for example, by the existence of the claims of philosophy and art in terms of our knowledge of the world around us.

The Folding of Time and Subsequent Perspectives On Nature

There are three recurring themes found throughout the work of Michel Serres: the folding of time, the importance of noise, and the excluded middle. His perspectives on science, nature, and history are driven in particular by his concept of time (Assad, 1999; Paulson, 1997; Serres, 1995; Serres & Latour, 1995). Given his background in mathematics and science, it is not surprising that Serres rejects the idea of time as linear; instead, time is folded, woven, or multi-layered, one event touching multiple others. History or historical events "percolate" into the future, bringing with them original particles if you will that leave their mark on what is or will occur (Serres & Latour, 1995, p. 58). Discoveries in science by the Greeks for instance affect discoveries made today if by no other means than by virtue of the knowledge we gained from them. "…Every historical era is …multitemporal, simultaneously drawing from the obsolete, the contemporary, and the futuristic" (Serres & Latour, 1995, p. 60). If we lay out time such as in a time line, distant points remain distant; if we view time as folded or as "percolating," distant points become close. Our concept of nature is also affected by this folding, with what we often look at as isolated events influencing on both a global and local level. This folding permeates throughout Serres' work, whether it is about literature, science, politics, or history. It allows him the freedom to connect Lucretius to the space shuttle and employs angels and Hermes as conduits. This results in a patch

work of ideas that, at first glance, appear to be unrelated but are actually related in heretofore unexpected ways. "Divisions in knowledge become blurred...This paradox of closeness between events that are otherwise historically well removed from one another recurs throughout Serres work" (Brown, 2000). This is an important facet of Serres' work, curriculum theory, and an examination of the environment. This "blurring" is a result of interconnectedness; indeed, attempting to disengage one from another leaves gaping holes and presents an incomplete picture. According to Serres, "Nothing in nature, then, either inanimate or living, or in culture, either verbal or visual, refers to a space or a time that is homogeneous or isotropic, reversible, that one can divide in an equal or symmetric manner…" (1997, p. 15). Be it in reference to gender, knowledge, or nature (or any combination thereof), we cannot dice up space and or time to suit our needs or advance a cause; it is all intertwined and always changing. Presenting our students with bits and pieces often prevents them from making much needed connections, further distancing them from nature.

For Serres then, it is not just time that is non-linear, he also regards knowledge as non-linear. Thus, as we add new knowledge, it is based on previous knowledge, pulled through the woven fabric of time. Bell (1997) describes this in terms of mathematics: "…Serres speaks…of a history of mathematics sparked by rediscoveries of previous discoveries, rediscoveries that plunge mathematics into its own past, from which it re-emerges when old discoveries are reformulated to become new theoretical configurations" (p. 84). This is supported by the historical developments in string theory and the exponential advances in biotechnology. While this may seem to be a constructivist approach to knowledge, constructivism relies on building blocks; Serres'

folds are moveable, not stationary. This perspective is somewhat analogous to the fluid-mosaic model of the cell membrane referred to earlier in this chapter. It is described as a two-layer fluid, or liquid crystal, in which the components such as lipids and membrane proteins are constrained within the plane of the membrane, but are free to diffuse laterally. These lipids and proteins influence the cell and ultimately the organism in which the cell resides. While one can isolate these proteins or lipids, doing so only gives partial clues as to their purpose in the cell. This is also how strings described by string theory work: vibrating stings in the form of closed loops and open loops interact with one another; open loops can become closed loops, closed loops can become open loops, and loops of both kinds can change the other. Yet we live in a society that is based on categories and distinctions, particularly in academic realms. Serres' addresses this in an interview by Francois-Bernar Huyghe where he discusses the gap between scientists and the "cultured people who know nothing about science" (Huyghe, 1993). This gap has occurred primarily by a curriculum that separates the humanities and science in what Serres describes as a "dangerous way" (Huyghe, 1993).

> Education today produces scientists who, generally speaking, are ignorant outside their own fields, and cultured people who know nothing about sciences. Most of today's problems stem from the separation between these two groups. Both have become decision-makers but they no longer understand each other. (Serres in Huyghe, 1993).

This idea will be explored further in the next chapter. Returning to our fluid mosaic analogy, by ignoring the natural connections (the folds), the education system at all levels is blocking the channels that would otherwise allow the proteins and lipids to be used in

the cell. By unnaturally separating topics or labeling discussions and works in

curriculum theory as unrelated to everyday classroom practices, the connections that are

inherent in curriculum theory and that occur naturally in the world around us are never

allowed to enter the classroom. In *Conversations on Science, Culture, and Time*, Serres

discusses the idea of "cross-fertilization" as a means to correct or remove the

aforementioned gap (Serres & Latour, 1995). Usually associated with plants, cross-

fertilization in this instance refers to the combining of sciences and humanities in such a

way that students gain an understanding of both, creating a "hybrid offspring" (Huyghe,

1993) or an "educated third party" (Serres, 1997). (The idea of a hybrid will be revisited

with Donna Haraway.) Without this hybrid offspring, we have been engaging in a

dualistic system; that of nature as defined by science and nature as defined by culture.

This has led to a nature-culture dichotomy that persists today. It is Serres' contention that

this dichotomy can be resolved by employing a global perspective, whether through

curriculum changes or our day to day interactions with each other (Klaver, 2003). Our

continued disconnect, however, has caused us to be unable to recognize that the global is

now local and the local is now global; thus, our current environmental crisis (Serres,

1995).

Messengers Along the Way

    Much of Serre's work centers around the idea of connections and connections

made by messengers. These messengers allow us to speak to the educated third party,

"…a nomad who is always *becoming*, moving across established categories" (Zembylas,

2002, p. 496). "In Serres' logic of communication, interconnectivity reigns supreme. In

the network, every node is connected to several others" (Letiche, 2004, p.149-150). This

has given Serres the freedom to look outside of a particular field, be it philosophy, science, or history, to learn about those very same disciplines, which helps explain his ability to discuss ostensibly unrelated subjects or events in the same sentence. Rather than being constrained by preconceived notions of what "fits" within a category or label, Serres moves in between and through to create work that is woven. He states, "The spaces *between* – that of conjunctions, the interdisciplinary ground – is still very much unexplored" (Serres & Latour, 1995, p. 70, author's emphasis). He further illustrate this in a discussion of history and time with Bruno Latour,

> The word *contemporary* automatically takes two contradictory meanings. It means that Lucretius, *in his own time,* really was already thinking in terms of flux, turbulence, and chaos, and, second, that *through this, he is a part of our era*, which is rethinking similar problems. I must change time frames and no longer use the one that history uses (Serres & Latour, p. 47, author's emphasis).

By spending time in the between rather than any single discipline or form, Serres encourages us to be messy, to embrace complexity, and thus allow for more creativity. Bell (1997) adds,

> But this is interdisciplinatiry with a twist that the communication theorists had not imagined. Not only do previously separate domains of scientific research find common ground, but Serres puts into question the Kantian epistemological divide between hard science and the humanities (p. 85).

To aid us along this path, Serres used Hermes, the Greek messenger god, as a conduit for communication in several of his works. Letiche (2004) describes Serres as a "radical empiricist" whose goal is to acknowledge as many connections as possible. Hermes

allows him to do so: "*Hermes*, in Serres work, symbolizes crossing back and forth across the boundaries between painting and epistemology, thermodynamics and literature, mathematics and history" p. 156. In sometimes dizzying prose, Serres is quite adept at intertwining science, society, and a sense of place in such rapid succession that his readers fluctuate between a fleeting understanding of what he is trying to portray and those "aha" moments of clarity. He forces us to examine the in between, those spaces that we often overlook but are integral to our understanding of connections. Levy (1997) describes it this way, "…his position as a thinker and a writer is at the intersection between disciplines, between thinking and the world, between concepts and their often metaphorical and analogical expressions" (p. 3). Thus, it is the passage from one discipline to another, one concept to another, one event to another that provides us with an understanding of our universe much more so than our distinct labeling of each. Levy expounds on this idea by stating, "These paths often intersect, and in so doing suggest the notion that knowledge is an environment" (1997, p. 5). If our understanding of an environment is the interaction of an individual or community with its biotic and abiotic components, we now can specify knowledge; it behooves us to expand that knowledge environment. As Bell points out, Serres' ability to communicate the interconnectedness of our historical past to our present means that "singular acts can now provoke ripple effects that magnify them beyond anything previously imagined" (1997, p. 92).

Serres' work is often difficult to read and understand, precisely because of his intersecting pathways and seemingly chaotic thoughts. We have been taught, particularly those of us in the sciences, to find logical patterns, to think sequentially, and to make connections in outline form. In doing so, however, we often never see the connection

between *I* and *II*, especially if *I* concerns science and *II* concerns society. The seeming

chaos that is a large part of Serres' work helps us bridge that gap. "…Serres's use of the

sciences of disorder and order provide a good example of the synthetic ambition of his

writing, of the extent to which he has taught that the world of theory belongs to the world

of matter" (Paulson, 1997, p. 24). By combining metaphors with descriptive, prose-like

writing while examining history, science, and society, Serres manages to bring his

readers to an understanding of the need to examine the world from a multitude of

directions, each informing us of different aspects. This is particularly evident in Serres'

description of nature as he concludes *The Natural Contract,*

> Here, then, is nature today, new and fresh, being born: global, whole, and
>
> historiated before the eyes of global humanity as a whole; theoretical, soon,
>
> provided that the disciplines are willing to join in federation… (1995, p. 110-
>
> 111).

Rather than state scientific facts and figures, rather than exclusively dwelling on how

humans are utilizing and expending natural resources, Serres reiterates the need for

disciplines to come together, for us to view nature in terms of relationships.

Paulson (2000) refers to "Serres's utopian work [that] calls forth a virtual

community of readers who want, at least, to *think* outdoors…" (p. 219). Paulson, who

has helped translate some of Serres work, at one point thought that Serres would become

as big a name as Derrida or Foucault and postulates about some of the reasons this never

occurred (2000). According to Paulson, "Serres's work tries to speak to the whole world,

to the reader and subject of knowledge as potentially a citizen in all senses of the entire

world in all dimensions" (2000, p. 216). Deleuze and Guattari refer to this as "nomad

science" which juxtaposes "royal science" or pure science (1987, p. 367). While royal science has a tendency to purloin nomad science, "…nomad science continually cuts the contents of royal science loose" (p. 367). If royal or pure science is considered legitimate (this will be explored further in chapter 5), then Deleuze and Guattari contend, "nomad science is portrayed as a prescientific or parascientific or subscientific agency" (p. 367). This is problematic as it precludes an understanding of the very relationships Serres attempts to bring to light. Once again this reiterates the complexity of Serres' thoughts in regards to the world as networked rather than piecemeal. The unfortunate consequence, however, is that discipline specific scholars and readers often miss his work altogether.

Interrupted by Noise

Although the folding of time is woven throughout Serres' work, the importance of noise and the excluded middle cannot be ignored, for these two concepts greatly influence curriculum and how we experience our environment. Serres gives us noise the in the form of the parasite. As Cary Wolfe explains in his introduction to the new edition of Serres' *The Parasite* (2007), the term parasite has three meanings in French as opposed to the two in English: "1. biological parasite; 2. social parasite; 3. static or interference" (p. xiii). For Serres, who concentrates more on the third iteration, noise is necessary to advance the conversation. Noise or the parasite is the interrupter. As Maria Assad puts it, "The parasite is the interfering Other who, for good or bad, forces a given system to adapt to its presence" (2001, p. 40). It is sometimes jarring, sometimes unobtrusive, but always allows change to occur. According to Serres, "Systems work because they do not work. Nonfunctioning remains essential for functioning" (2007, p. 79). Simply put, we cease feeling the need to improve/adjust/change the world around us

without the input of noise. This has vast implication for curriculum as envisioned by Marla Morris: "Curriculum is not about neat and tidy interrelations between students, teachers, and texts. Rather, curriculum might become noisy. Lived experiences in schools and universities might be considered interference" (2001, p. 95-96). Beginning a class with the question "what if…" and inviting noise instead of calling for an orderly agreement about a concept or expecting our students to readily accept our interpretation of a text brings about that interference Morris describes. "Education is a process whereby we feed off of one another, we interrupt taken-for-granted knowings, we generate new orders out of disorders," Morris continues (p. 103). Words like "interruption," "disorder," even "chaos" should readily describe education if we are truly creating a learning, thinking environment. This is equally important outside academia and is a necessary part of any approach to the problems we face today. Without this noise, Serres suggests "there would be no spaces of transformation anywhere" (2007, p. 79). We shun noise, however, particularly in the form of dissention as we often view it as threatening. If we were to view noise in the sense Serres intends, that of a necessary interruption if we are to accomplish anything rather than a menace, the idea of noise becomes much more appealing. If we now equate noise with the "excluded middle," the space created by this interruption (Assad, 1999, 2001; Serres & Latour, 1995; Serres, 1997; Winkler, 2005), we are left with something that is neither for nor against something but simply exists. According to Assad (2001), "If the third position is accepted as the undecidable that floats between positions and can never be pinned down to a firm 'yes or no,' or an 'all or nothing,' then the parasitic multiplicity is no longer threatening" (p. 43). This very same idea, applied to science and society, helps us navigate through the many binaries we

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encounter daily. By listening to the noise or admitting the parasite, quantum physics and string theory do not need to be an either or argument in the scientific community. Likewise, advances in technology allowing us to reduce our reliance on fossil fuels and increase the use of renewable energy resources will only take place at a useful rate with the inclusion of the excluded middle.

Politics, Nature, and the Space Between the Two

Although more of Bruno Latour's work will be discussed in the final chapter, it is appropriate to now examine his 2004 book, *Politics of Nature: How to Bring the Sciences Into Democracy*. Long associated with Michel Serres, Latour's exploration of science and nature incorporates some of the same ideas discussed in Serres' *Natural Contract* : historical timelines don't exist; we are at a point whereby we can no longer ignore the inextricable human-nature ties; and the false dichotomy between science and society perpetuates rather than solves environmental problems. Earlier in this chapter I discussed Hallstom's (2002) caution to be mindful when using Deleuze and Guattari's rhizome as a model for inclusion of environmental issues into international politics. While Hallstom discussed distinguishing between the concepts of the model and the tendency to substitute the model for the real, he also explored environmental degradation in terms of international security and relations. In *Politics of Nature*, Latour takes us much further than Hallstrom and places nature squarely in the realm of politics. Bringing environmental issues into politics and removing them from purely scientific endeavors is not new. As was discussed in previous chapters, focusing on the social, cultural and economic (mis)uses of natural resources has been ongoing. The advent of the national park system in the United States, the banning of the use of

dichlorodiphenyltrichloroethane (DDT) in the United States in 1972 and world-wide

(with the exception of malaria control) since 2004, and the ban of chlorofluorocarbons

(CFCs) in most industrialized nations in 2000 are all examples of this interweaving

between society and the environment. For Latour, however, there has always already

been conflict about how or if we characterize and acknowledge these connections,

primarily because of society's tendency to pick and choose when and where to play the

nature card. This presents a false impression that nature and politics are or can be

separated.

> …we cannot choose whether to engage in political ecology or not; but we can
>
> choose whether to engage in it *surreptitiously*, by *distinguishing* between
>
> questions of nature and questions of politics, or *explicitly*, by treating these two
>
> sets of questions as a single issue that arises for all *collectives* (Latour, 2004, p. 1,
>
> emphasis in original).

According to Latour, when we are acting surreptitiously, we fail to acknowledge that

there is no separation between what he terms as "scienc*es*," "natur*es*," and politics (p. 3,

my emphasis). In using the term "collectives," Latour is referring to the "associations of

humans and nonhumans" (p. 238), further emphasizing not simply a relationship but an

intertwining. Latour further states, "…at no time in its short history has political ecology

ever had anything to do with nature, with its defense or protection" (p. 5). Instead, most

of what has been couched in terms of political ecology has simply been legislative

interventions rather than any real reform. "If our goal is to put a stop to noise pollution,

to shut down city dumps, to reduce the fumes of exhaust pipes, it really isn't worth

making the effort to move heaven and earth: a cabinet ministry will do" (p. 5). In

deploying a legislative approach to solving environmental issues, we are further
distancing human stakeholders from acknowledging the inextricable relationship between
nature and society.

According to Latour, part of our difficulty in seeing and feeling the
political/nature relationship stems from our failure to distinguish between Science and the
sciences that inform it, which are quite distinct from one another. If we do not separate
the two, he contends, it is impossible to arrive at a single conclusion about *any* issue. "If
we were trying to approach the question of political ecology as if Science and the
sciences were one and the same enterprise, we would end up in radically different
positions" (p. 10). This is one of Latour's critical points, in which he argues that how we
go about the business of science is quite distinct from Science. Latour advances this
argument in a section entitled, "First, Get Out of the Cave." Latour briefly describes the
allegory of the Cave as told by Plato in the *Republic* in terms of science with the
following, "The Philospher, and later the Scientists, have to free themselves of the
tyranny of the social dimension, public life, politics, subjective feelings, popular agitation
– in short, from the dark Cave – if they want to accede to truth" (p. 10). He argues that
this is a false premise, as scientists are fully able to function in society, and that this
argument "has been used for twenty-five centuries to silence politics as soon as the
question of nature comes up" (p. 12). He further states,

> The goal of this form of epistemology is by no means to *describe* the sciences,
>
> contrary to what its etymology might suggest, but to *short-circuit* any and all
>
> questioning as to the nature of the complex bonds between the sciences and

societies, through the invocation of Science as the only salvation from the prison

of the social world (p. 13, emphasis in original).

This is a sentiment shared by Donna Haraway who, from a technoscience perspective,

discusses the ripples made by technosciene that are felt within political and societal

realms (which *include* nature) and those ripples have ramifications on "the *practice* of

scientific objectivity" (Haraway, 1992, p. 112, emphasis in original). Ignoring these

ramifications doesn't negate them, it only obscures them in such a way that those outside

of science get information that is filtered. We don't see what we don't look at and unless

you are part of the scientific community, we are only provided with what someone else

has determined what matters. Latour states, "…the lab coats are the spokespersons of

the nonhumans, and, as is the case with all spokespersons, *we have to entertain serious*

but not definite doubts about their capacity to speak in the name of those they represent"

(2004, p. 65, emphasis in original). This call for a healthy skepticism allows us to sift

through what is presented to us as strict objectivity. Additionally, what matters to us is

sometimes only what we see in the present. When we look outside of the present or

outside of what we are told matters, we begin to see the world through a different lens.

If, however, we separate Science from the sciences that inform it as Latour suggests, "we

can start from nature, not in order to move toward the human element, but – by making a

ninety-degree turn – to move *toward the multiplicity of* nature, redistributed by the

sciences…" (2004, p. 40, emphasis in original). The question is not about politics or

politicians that make a choice between human or nature since, as Latour says, the laws of

nature and humans can't be extricated from one another, and simply bringing nature and

man together isn't the solution or there would be no longer be ecological issues. Kristin

Asdal, who refers to both Donna Haraway and Bruno Latour as post-constructivist authors, states in her critique of *Politics of Nature,* that, "Latour's stance thus implies a confrontation with humanism, but not, and this is the key, to be replaced by Nature….it is political ecology itself that has finally detached us from nature" (2003, p. 71). If Latour is correct and political ecology has been more about legislation and regulation than about a defense of nature, then Asdal is on the mark. A mandate against dumping doesn't make me feel closer to nature but an approach to politics, science, and education that has less of an emphasis on what we can take from nature and more of an emphasis of how we exist in nature does. Although Asdal uses the work of both Haraway and Latour to advance her argument that "post-constructivism has the potential to productively address many of the shortcomings of environmental history's theories and models…" (2003, p. 60), it is important to note that there are vast differences in Haraway and Latour's social perspectives. While Latour espouses bringing back a nature that includes what he terms "collectives" through a true politics of nature, one that is more than mere legislation, Haraway insists on being cognizant of situated knowledge by acknowledging who is speaking for whom and at what cost, ideas that will be explored next.

Why Cyborgs, Coyote, and OncoMouse® Matter

While Deleuze and Guattari employ the use of the rhizome and Serres describes the intertwining of history's past present and future, Donna Haraway's perspective on interconnectedness describes the world as a human-nature-machine interface, with no one participant more important than the other (Haraway & Goodeve, 2000). Indeed, Haraway contends that the three are so completely intertwined that they are impossible to distinguish between (Haraway, 1991a; Haraway & Goodeve, 2000; Kunzru, 1997). In

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introducing her book, *Simians, Cyborgs, and Women,* Haraway tells her readers that the "…book is about the invention and reinvention of nature – perhaps the most central arena of hope, oppression, and contestation for inhabitants of the planet earth in our times" (1991a, p. 1). Current events have certainly illustrated this contestation, from the BP Deep Water Horizon oil spill in the Gulf of Mexico to the debate over Cap and Trade legistlation in the U.S. House and Senate. That the contestation is being greatly publicized is no surprise; the oppression and hope, however, have received much less notoriety. Thus, Haraway's early work is just as important today as her more current work in that she looks at more than just one side.

Like Serres, Haraway operates from the middle, forcing us to examine our notions of science and nature more closely. Nature is constructed, not discovered; truth is made, not found (Haraway, 1991a). Haraway believes that what has historically been defined as nature has often been someone else's nature (Asdal, 2003). By defining nature, or science for that matter, we allow for nature or science to be spoken for by an "expert," someone who can speak on its behalf (Asdal, 2003; Haraway, 1992, 1997). This sets up the subject-object dichotomy which often leads to an attempted domination of the object. Haraway does not look at nature as ideology, thus inviting the argument against transcendence; instead, she views true constructions of nature, science, and culture (Asdal, 2003). Both Haraway and Bruno Latour argue that humans are not above nature but rather with nature, with Haraway favoring "partial connections" and Latour describing "attachments" (Asdal, 2003). Thus, our perspectives on nature are formed by our politics, our cultural backgrounds, and our laws.

Young (1992) further reiterates Haraway's aversion to nature as ideology. To view nature from an ideological stance invites validation or invalidation by someone with the power to do so (again, the subject-object dichotomy)(Young, 1992). Young goes on to say that he "sometimes feel[s] seduced away from both the outer and the inner worlds and into a playful space" (para. 68). He cautions against spending much time in this playful space and away from the true work needed for changing ourselves and the world. In this I disagree wholeheartedly, for it is in those playful spaces that we begin to entertain and accept differences and different ideas. Without the playful spaces, we lose our perspectives and accede to someone else's. According to Haraway, science is culture; one does not explain or define the other (1991a). As such, it is easy for us to accept without question unless we spend time in those in between spaces where questioning takes place. In trying to illustrate the intertwining of science and culture, Haraway states, "If the world exists for us as 'nature,' this designates a kind of relationship, an achievement among many actors, not all of them human, not all of them organic, not all of them technological" (p. 297). If this is indeed the case, and I believe it is, one "actor" cannot exist without the other.

While heralded as a feminist, some make the mistake of assuming Haraway is a champion of ecofeminism (addressed in chapter 3). The nature-culture continuum is a key part of Haraway's work but is sometimes overlooked in order to support the ecofeminist contention that women are one with nature or less complicit in the degradation of nature than men. According to Instone (1998), Haraway attempts to dismantle "the division between nature and culture leaving no stable ground of identification from which women can build an alliance with nature based on shared

oppression" (p. 454). Instone contends that Haraway attempts to bring us to an area of

discomfort, to make us think about the partial connections between nature, humans, and

machines. Whether talking about discomfort, playful spaces or border zones, Haraway

recognizes that it is the spaces in between, or as Serres calls it the excluded middle, that

allow us to see connections (Asdal, 2003; Brown, 2000; Instone, 1998; Young, 1992).

Haraway views nature as "a co-construction among humans and non-humans"

(Haraway, 1992, p. 297). She expands on this view in *Modest Witness* by describing the

discovery of certain genes to be in reality a discovery of the *interaction* between, as she

calls them, "a variety of actors" (Haraway, 1997). Celia Roberts, in reviewing *Modest*

Witness, explains that for Haraway, nature is not to be found in a pure state, unaffected

by culture, nor is it completely constructed by culture; instead, science is an articulation

with nature (Roberts, 1999). Thus, technoscience is an integral part of the connections

that make up nature. Indeed, OncoMouse® can be described as the splicing of nature and

culture (Roberts, 1999), just as genes are now spliced.

Infused throughout that work and all that follow is the importance of connections

and networking.   Hari Kunzru (1997), in a profile of Haraway detailing her ideas on

technoscience and cyborgs, states, "For Haraway, the realities of modern life happen to

include a relationship between people and technology so intimate that it's no longer

possible to tell where we end and machines begin" (para. 7).

>   These hybrid networks are the cyborgs, and they don't just surround us – they
>
>   incorporate us. An automated production line in a factory, an office computer
>
>   network, a club's dancers, lights, and sound systems – all are cyborg
>
>   constructions of people and machines (Kunzru, 1997, para. 11).

This blending of animal and machine necessitates our relinquishing of the us/them human/nature mentality that is so prevalent even today since now us *is* them and vice versa. " As Haraway puts it, 'Human beings are always already immersed in the world, in producing what it means to be human in relationships with each other and objects… We're living in a world of connections – and it matters which ones get made and unmade'" (Kunzru, 1997, para. 19).

Like Serre's parasite, much of Haraway's work concentrates on uncovering ideas that reside in between. In *Modest Witness*, Haraway attempts to uncover both the power structures inherent in the tenets of science and the resultant manipulations that often occur. Just as Delueze (according to Hayden, 1997) and Vogel (2002) discuss the false dichotomy between a nostalgic nature and the nature we always already exist within, Haraway explains how this dichotomy comes about.

> First, nature is a materialized fantasy, a projection whose solidity is guaranteed by the self-invisible representor. Unmasking this figure, s/he who would not be hoodwinked by the claims of philosophical realism and the ideologies of disembodied scientific objectivity fears to 'go back' to nature, which was never anything but a projection in the first place (p. 34-35).

The problem, she speculates, is the success of this projection in spite of ample evidence to the contrary. This further sets up a continuation of the power struggle that is an integral part of science (to include biotechnology, politics, and other sciences), and that of situated knowledge. "The power to define what counts as technical or as political is very much at the heart of technoscience" (Haraway, 1992, p. 89). Her goal, she states, "…is to help put the boundary between the technical and the political back into

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permanent question as part of the obligation of building situated knowledges inside the materialized narrative fields of technoscience" (Haraway, 1992, p. 89).

In the transcribed interview that concludes *The Haraway Reader* (2004), Haraway describes the common thread between

> …entities that are neither nature, nor culture. The cyborg is such an entity, and the coyote; and the genetically engineered laboratory research animal OncoMouse™ is also in this odd family – this queer family that is neither nature, nor culture, but an interface…All these are entities that require one to be confused about the categories of nature and culture (p. 332).

Confusion, disruption, and noise all cause us to rethink how we view nature and culture and the false separation between the two. This separation allows us to research and discuss nature isolated from culture and vice versa, leading us to discoveries that are only partially accurate. In her paper, *The Coyote's at the Door*, Lesley Instone (1998) says that, "What [Haraway] envisions is a change from a relation of *discovery* of the 'real world' to *conversations* with it" (p. 454, emphasis in original). This perspective prevents us from treating nature as a thing that needs to be researched and dissected instead of something we are an integral part of.

Such is the importance of Haraway's recurring theme of the network of culture/science/technoscience/nature that Haraway states in the introduction to *The Haraway Reader* (2004), "Sometimes, re-reading the essays that make up this volume, I feel that I have written the same paper twenty times. All of these papers take up one or another aspect of inherited dualisms that run deep in Western culture" (p. 2). What she doesn't say is that she employs several different figures to act as the "modest witness" or

messengers to illustrate her point to include cyborgs, coyote, OncoMouse® and, more recently, dogs. She describes it this way: "All of my writing is committed to swerving and tripping over the bipartite, dualist traps rather than trying to reverse them or resolve them into supposedly larger wholes" (p. 2). If she were to repackage these bipartite, dualist traps in an effort to resolve issues of oppression and contestation, she would be creating those very same traps on a larger scale rather than disrupting the status quo. Our multiple choice selections need to be expanded beyond the usual choices; "In the face of many established disorders we need to practice saying "none of the above" (Haraway, 2004; p. 3) if we are to experience the in between. Haraway uses what she describes as "peculiar boundary creatures" which she also refers to as "monsters" (1991b, p. 21) to help her readers begin to question the world around them. All of her creatures – simians, cyborgs, coyote, OncoMouse® - "have had a destabilizing place in Western evolutionary, technological, and biological narratives" (Haraway, 1991b, p. 21). It is this destabilization through the use of boundary figures that I now turn to.

Haraway's work has helped redefine how we view science and nature in a postmodern world. One of her overarching themes is the acknowledgement that we are none of us, human and nonhuman, innocent (read "pure") but are instead a compilation of our lived experiences with all that entails. Her writing style is reminiscent of Derrida's in that she forces the reader to reexamine what is written through use of metaphors and complex relationships that we might not have thought about on our own. She describes it by saying, "The search is for the trickster figures that might turn a stacked deck into a potent set of wild cards for refiguring possible worlds" (Haraway, 1991b, p. 25). Her incorporation of technoscience into the realm of feminism and the questions of a

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scientific objectivity help inform us of the culpability of a scientific construction of race, gender, and class, ideas that will be further explored in chapter 5.

One of the ways that Haraway disrupts her readers is through her use of metaphors and distruptors. One such disruptor, the coyote, is a Native American symbol who is known as a trickster figure. As Haraway describes it, "Coyote is about the world as a place that is active in terms that are not particularly under human control" (2004, p. 328). Indeed, according to Haraway, when coyote is present, coyote becomes the focus rather than nature and culture. Thus, when the spotlight is on coyote, the false dichotomy between humans and nature no longer needs to exist. Haraway states, "The Coyote or Trickster…suggests our situation when we give up mastery but keep searching for fidelity, knowing all the while we will be hoodwinked" (1991a, p. 199). Coyote calls into question our objectivity (if we are willing to acknowledge its presence), showing us we are not in charge, that the false premise that there are separate categories of human and nature is just that – false. According to Instone, Haraways's use of Coyote creates a break in the ecofeminist argument that women are one with nature and "from the romance of recovery of innocence and paradise lost" (Instone, 1998, p. 461). Haraway couples Coyote with situated knowledge stating that this "brings in another set of story cycles, where there is a resistance and a trickster, producing the opposite of – or something other than – what you thought you meant" (1991b, p. 10). Haraway suggests that it is in our interest to learn to converse with Coyote, providing an avenue for hope whether it be in the area of environmental politics, science, or ecofeminism (1991a). Indeed, the disruption caused by Coyote brings forms of differences to the forefront rather than relegating them to the back (Instone, 1998, p. 464).

Haraway is well known for her use of cyborgs as another boundary figure or disruptor. In the interview transcribed at the end of *The Haraway Reader,* Haraway describes her initial interest in the cyborg as "a figure that collected up many things" (2004, p. 322), one that encompassed technoscience and culture at once. According to Noel Gough (2004a), "Haraway's cyborgs are constructed to serve the rhetorical purposes of a materialist feminist politics" (p. 96). While I agree, I think Haraway's cyborg and those that follow are much more. For Haraway, being cyborgs allow us to be a "communication-control-system" (2004, p. 322). She describes it as "…the joint implosion of human and machine, on the one hand, and human and other organisms, on the other…" (2004, p. 322). From Haraway's perspective, cyborgs are both figures and places, which allows her to incorporate more than just biological or scientific facts into her writing but to include the narratives that help inform those facts (Bell, 2009). Perhaps most importantly, Haraway relies on the ambiguity between "the literal and the figurative" created by cyborgs to illustrate the fluidity of the world around us. "Cyborgs are also places where the ambiguity between the literal and the figurative is always working. You are never sure whether to take something literally or figuratively. It is always both/and" (Haraway, 2004, p. 323). This is a critical concept when attempting to navigate Haraway's work as it often seems that she is in two places at once. I equate it to the idea that two plus two sometimes equals four and sometimes does not depending on which statistical equation employed; both answers (two or something other than two) are correct at the same time depending on what you are trying to describe.

According to Chris Gray, a former graduate student of Haraway's, "A cyborg is a self-regulating organism that combines the natural and artificial together in one system"

(2002, p. 2). Like Haraway, Gray doesn't stop with the cyborg as part human, part

machine; instead, with his definition including the broad term "artificial," Gray's cyborgs

include those whose immune systems have been altered through vaccination (2002, p.2).

Thus, the likelihood that you are *not* a cyborg is greatly diminished. Indeed, thinking in

much larger terms, if the biosphere is regarded as a self-regulating system as described in

Gaia Theory, it too is a cyborg (Gray, 2002; Haraway, 1997). This is supported by Bell

(2009), who posits that long-standing ideas about the world are challenged by the mere

existence of the cyborg, thus advancing Haraway's argument that the cyborg is a

boundary creature that is not confined by its origins (Haraway, 1991b). Given this

freedom, the cyborg can take us in multiple directions rather than keep us on a single

track determined by others.

Yet another boundary figure utilized by Haraway is OncoMouse®[9], the world's

first patented animal (Haraway, 1997). A mouse genetically modified to be more

susceptible to cancer, OncoMouse® is considered an invention with rights held by

DuPont . DuPont's patent, purchased from Harvard University, "actually grants Harvard

and DuPont the rights to any 'transgenic nonhuman mammal' whose cells have been

altered to make it susceptible to cancer" (Gray, 2002, p. 116) thus leading the way toward

the official industrialization of living things. Haraway says of OncoMouse® that s/he "is

a figure in the story field of biotechnology and genetic engineering…A kind of machine

tool for manufacturing other knowledge-building instruments in technoscience…"

(Haraway & Goodeve, 2000, p. 139). Haraway's use of the term "story field"

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[9] Note that OncoMouse™ has become OncoMouse® in the ensuing years since the publication of
Haraway's book, *Modest_Witness@Second_Millennium.FemaleMan_Meets_OncoMouse™: Feminism and
technoscience.*as s/he has emerged as a registered trademark.

characterizes her insistence on incorporating the narrative or back story involved in how science is done. In this case, the story is not just the leading up to a genetically modified being (thus putting is squarely in her "border" description) but the subsequent corporation of OncoMouse®. In *Modest Witness,* Haraway describes OncoMouse®,

> Whether I agree to her existence and use or not, s/he suffers, physically, repeatedly, and profoundly, that I and my sisters may live. In the experimental way of life, she is the experiment. S/he also suffers that we, that is, those interpellated into this ubiquitous story, might inhabit the multibillion-dollar quest narrative of the search for the "cure for cancer" (1997, p. 79).

Once again, Haraway is not describing the science behind the cure for cancer or in creating OncoMouse® for that matter. Instead, she focuses our attention on the *story that informs science,* one that is often left out of the discussion. This is the story that includes Henrietta Lacks whose cancerous tumor cells produced the HeLa cell line used by Jonas Salk to cure polio and countless experiments to help find the cure for cancer all without her or her family's permission or knowledge (Skloot, 2010). It includes John Moore whose genes were patented by someone else when it was discovered that his white blood cells "produced strong anticancer and antibacterial biochemicals" (Gray, 2002, p. 117). The California Supreme Court who heard the case when Moore sued did not find that he owned his own cell line but was entitled to compensation since those holding the patent benefited monetarily (Gray, 2002). As Gray states, "An individual cannot patent part of his or her body but an institution… can" (2002, p. 117). Haraway expounds on this in reference to the Human Genome Project:

According to the Human Genome Project, for example, we become a particular

kind of text which can be reduced to code fragments banked in transnational data

storage systems and redistributed in all sorts of ways that fundamentally affect

reproduction and labor and life chances and so on" (Haraway in Penley & Ross,

1991, p. 6).

Thus, the inclusion of technoscience and the narratives behind it must be in place if we

are to understand the who, what, and why of science. It is also critically important that

we include not just a litany of the timeline that leads up to scientific discoveries but also

include the stories that are part of what informs those discoveries when we educate our

children and those "outside" of science.

In her paper, "A game of cat's cradle: Science studies, feminist theory, cultural

studies," (1994), Haraway describes how these stories form a network that includes

human and nonhuman and that it is important for us to recognize all of the actors and

partners in this network in order to reconfigure what is considered knowledge. Not one

actor or partner is more important than the other, one does not contribute more than

another, but instead it is the collective that make up this network. For, as Haraway says,

"nature is also about figures, stories, and images" (p. 60).

The Commingling of Rhizomes, Cyborgs, and Narrative

This chapter concludes with an examination of the work of Noel Gough, whose

dedication to environmental education through curriculum theory and practice is

exemplified by his use of rhizomes, cyborgs, and narrative. This idea of multiple

connections and multiple perceptions is infused throughout his work. Gough often uses

Deleuze and Guattari's rhizome to explore different ways of looking at curriculum,

education, and science. In "RhizomANTically Becoming-Cyborg: Performing Posthuman Pedagogies," Gough weaves rhizomes with actor-network theory and Donna Haraway's diffraction, "the production of difference patterns" (Haraway, 1997, p. 34), in order to "question, provoke, and challenge some of the dominant discourses and assumptions of curriculum, teaching, and learning" (Gough, 2004b, p. 253). Gough emphasizes the need to get away from education as definition and move toward an education that honors narrative, thus allowing for students to bring their experiences to their learning environment.

In an early work, Gough describes himself as having an "ecopolitical world view" that emphasizes perceptions over cognition (1989). Rather than take an epistemological approach to education, particularly environmental education, an ecopolitical world view emphasizes the reasons behind why we make choices by not separating the cultural, political, and scientific aspects of our lives. Gough refers to standardardized educational approaches as "instrumentally conceived forms of environmental education [that] can address the technical problems of, say, fouling our own nest with chlorofluorocarbon gases without addressing 'the culturally embedded pattern of consciousness' which causes such problems in the first place" (1990, p. 15). If education is all about facts, figures, and quick activities that take no intellectual reasoning to accomplish, we will remain distanced from nature. Gough maintains that "we may be able to learn how to recover our sense of identification with the earth by listening to stories from other cultures" (1990, p. 15). This idea of narrative is woven throughout Gough's body of work and is an integral part of his teaching philosophy (Gough, 1989, 1991, 1993, 1999, 2002, 2004a, 2007, 2008, 2009; Gough & Price, 1994). Moreover, an environmental

education without this narrative moves us further away from understanding interconnections. According to Morris (2002), "Gough emphasizes that when educators re-imagine what an ecologically sustainable education might be, they must keep in mind that there are many stories to tell, not one" (p. 572). Gough has long called for a postmodern science that leaves behind the notion of "environments as collections of distinct objects or object-like phenomena" (1991, p. 37). This postmodern science "embraces the relatedness of the observer and the observed, the inseparability of organisms and environment, the ambiguities of a non-realistic, chaotic, universe" (1991, p. 38). From this perspective, science and science education, in particular environmental education, can no longer ignore both the personal and cultural narratives that inform us.

Like Haraway, Gough speaks of using metaphors to help make connections between ourselves and the environment, or, as Gough states, "… 'sing' the earth into existence *in the conditions of urban and late industrial lifestyles*" (1991, p. 40, author's emphasis). Rather than paint a picture of a pristine nature or employ nostalgia for something that never existed in the first place, Gough calls for us acknowledge the differences, for instance, between my rural existence nestled among trees and wildlife and that of my brother whose environment includes the streets of Boston. How I experience nature in Georgia – a mere fifteen minutes from downtown and less than a minute from my nearest neighbor – is vastly different from how my friends experience it in British Columbia, whose nearest neighbor is at least thirty minutes away.

While Gough interweaves narrative throughout his work, he also intersperses a myriad of other strategies, to include the use of science fiction to help students begin to forge their own connections with science and the environment. Although this will be

explored further in the next chapter, it is important to note that one of Gough's rationales is that "SF often registers new scientific knowledge long before it is recognized by the general public – and even longer before it is registered in textbook science" (Gough, 1993, p. 616). And it is not simply the scientific knowledge that science fiction brings to our students but how it is employed in the story; thus, the accuracy of the science is much less important than the consequences of using the science and where the scientific knowledge came from in the first place (Gough, 1993). *How* we come to know is thus often as critical as *what* we come to know. To further support this idea, Gough often includes metaphors derived from Deleuze and Guattari's rhizome and Haraway's cyborg. It is helpful to understand Gough's perceptions on the implications of Deleuze and Guattari's rhizome and what rhizomes bring to environmental education. First, analysis of thinking becomes "flows or movements across space" (Gough, 2007, p. 282) rather than stagnant points of view. Gough describes the concepts of rhizomes, lines of flight, and assemblage (all hallmarks of Deleuze and Guattari's writings) as ways of "conceiving ourselves and other objects moving in space" (2007, p. 282). This allows us to think and work outside of traditional boundaries and move in and out of a variety of genres in order to gain a better understanding of our environment. Rather than being tied to a more arborescent definition of nature, rhizomatic thinking allows for the movement between and among what are considered the "hard" sciences and humanities. Gough describes "aborescent conceptions of knowledge as hierarchically articulated branches of a central stem or trunk rooted in firm foundations" (2006, p. 625). While we (by "we" I mean those teaching science education at all levels) often espouse that a firm foundation in basic science is necessary for students to advance to more complex concepts, we rarely

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question where that firm foundation comes from. For Gough, the where is inextricably tied to the what and why and disregarding it provides yet another opportunity to widen the gap between education and the experience of learning.

As stated above, Gough not only uses the rhizome to describe his approach to curriculum but he also utilized cyborgs. For Gough, "cyborgs are produced at certain intersections between technologies and the stories of which our subjectivities are parts" (2004a, p. 95). As productions, cyborgs share the histories of those that produced them. This means that "cyborgs…can be imagined, recognized, or named in a wide variety of culturally interconnected sites and discourses" (Gough, 2004a, p. 95), lending themselves as conduits. The difficulty in examining cyborgs as part of curriculum or curriculum inquiry is a propensity toward viewing the cyborg as "hardware" and disregarding what Gough refers to as the "machineries of texts" (a term he attributes to Bukatman, 1993) (2004a, p. 97). Gough describes encouraging his students to examine "how cyborgs work, and what they do, but not what they are" (2004a, p. 99), in an effort to get them to look beyond the obvious. It is Gough's contention that cyborgs hold significant possibilities in examining the "hybridization of humans" and regarding such hybridization not as the "Other" but as an integral part of our own stories. Additionally, including cyborgs as a significant part of studying science gives students a better sense of a world that is made up of complex systems. As described in chapter two of this work, science is not (and indeed never has been) simply a matter of steps. Instead, as Serre's says, the folding of time weaves the past with the present and the future. The history infused throughout string theory, the theory of relativity, and the theory of evolution is as

important as what these theories can tell us. For Gough, then, cyborgs, rhizomes, and narrative are all an integral part of how we come to know science.

In the tradition of Deleuze and Guattari, Donna Haraway, Michel Serres, and many others, Noel Gough wants to explore boundaries and shake things up. He describes his propensity for moving away from "semiotic spaces of science education textbooks…[as] a deliberate effort to unsettle boundary distinctions and presuppositions" (2006, p. 640). The authors and scholars from whose work I have drawn on in this chapter all have that in common; each in her/his own way are "shaking the tree" in order to move away from a stagnant perspective to the more fluid landscape that is nature. The work of Gough, Haraway, Serres, Deleuze and Guattari, and others previously mentioned will be revisited as a means to illustrated the convergence of science, nature, and curriculum theory.

CHAPTER 5

THE CONVERGENCE OF SCIENCE, CURRICULUM THEORY AND

THE ENVIRONMENT

> An articulated world has an undecidable number of modes and sites where
> connections can be made. The surfaces of this kind of world are not
> frictionless curved planes. Unlike things can be joined – and like things
> can be broken apart – and vice versa.
>
> Donna Haraway (1992, p. 324)

The quote above exemplifies the field of Curriculum Theory, for it is in this field
more than any other in education that we can explore *any* concept or idea through an
educational lens. Haraway's quote also exemplifies the interaction of loops described by
string theory – closed loops can open, open loops can close, and all loops have the ability
to interact. Finally, Haraway's quote exemplifies the environment. Nature is fluid, not
stagnant; changes in the environment are continuously made due to something as small as
an insect flying in a particular path to something as large as a hurricane or a major oil
spill. So, indeed, "an articulated world has an undecidable number of modes," and it is
our job as educators to help our students visualize those modes. Some of those modes are
easily seen or easily understood. Others, many others, need to be uncovered through the
interruption of the status quo by digging deeper and changing the directions we take.

Shake Up Education

There is no doubt that changes must be made in education. This has always
already been the case since, as Serres contends, and I agree, nothing happens without
"noise" (2007) and of late things have seemed fairly quiet. Many educational venues,
particularly in the K-12 arena, continue merrily along the way with canned curricula that
is designed to "guarantee" results (results = higher test scores or better evaluations).
Teachers are rapidly becoming technicians (Pinar, 2004; personal observation) whose

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areas of expertise include exercises in s(kill) and drill, implementing the "Workshop Model[10]," and the use of kit based science that includes step by step instructions on what to say and how to say it. As we progress further and further down this rabbit hole, it becomes even more evident that we (educators) must allow ourselves to feel discomfort, to move away from what has become "second nature." From my very first exposure, this has been a hallmark of curriculum theory. This discomfort has been articulated in a variety of ways: disruption, lines of flight, noise, and more. Pinar examines the work of Kevin Kumashiro and describes a curriculum that embraces Kumashiro's idea of "troubling knowledge" as a "curriculum that is unfamiliar…that disrupts taken-for-granted conceptions of what is" (Pinar, 2004, p. 64). Although Kumashiro uses "troubling knowledge" to discuss oppression, it is also an idea that can be incorporated into this work. The convergence of science, curriculum theory, and the environment is all about interconnectedness and spending time in the boundaries. All of these ideas, interconnectedness, troubling knowledge, and spending time in the boundaries, allow us to advance an understanding of curriculum theory and the understanding that education involves much more than educating for a test or creating a workforce. For Pinar, this is the difference between education and schooling (2004) and, as educators in the curriculum field, our concentration should be on continuing to push the boundaries. This is not a call to blur the lines so much that what remains is an indistinguishable conglomeration of ideas. As Haraway (1991a) puts it, "The only way to find a larger vision is to be somewhere in particular" (p. 196). If our "somewhere" is in curriculum theory, Pinar states, "our primary scholarly commitment is to that field's intellectual

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[10] See http://lizditz.typepad.com/about.html for information about mandatory use of the Workshop Model

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advancement" (2007, p. xvi). Pinar reinforces the importance of this intellectual

advancement and a continuation of the field's pursuits: "It is through the discipline that

we work to understand – and thereby change – the world. It is through study and

teaching of the discipline that we work to educate the American public" (p. xix). It is

with this in mind that I have embarked on this journey. Curriculum theory is all about

examining the world in new ways using multiple perspectives – if education is a

continuous process, the topics studied cannot remain stagnant, nor can they be from a

single perspective.

Science Education

> Our argument involves the notion that we can do better, go further, and
> address the limitations inherent in the Newtonian-Cartesian system – in
> particular, the limitations Einstein had to overcome to develop his frame-
> shattering theories.
> Joe Kincheloe, Shirley Steinberg, and Deborah Tippins (1999, p. xii)

How we do science, how we share scientific discoveries, and how we interpret

those discoveries has been and continues to be hotly debated. It is therefore important to

give attention to these three aspects of science while discussing their implications for

science education, especially since science education also includes many pedagogical

assumptions based on these traditions.

In their book, *The Stigma of Genius: Einstein, Consciousness, and Education,*

Kincheloe, Steinberg, and Tippins (1999) examine the way Einstein learned in an effort

to illustrate the ways in which education, then and now, mistrusts or doesn't recognize

different ways of thinking. They describe Einstein as having been a troubled student due

to his unorthodox way of looking at the world, which was perceived as "disrespectful" or

"inappropriate" (p. xvi). However, the authors take a postformal approach to education

and advocate the assumption "that little in the universe is as it appears to be. Postformalists argue that considering an entity only as a thing-in-itself can be viciously misleading" (p. xiii). Further, they state, "….we are contending that there are important flaws in accepted forms of logic, research, and knowledge production" (p. xiii), all of which are an integral part of how we currently do science. In earlier chapters, I discussed the importance of understanding some of the historical context leading up to the current iteration of string theory. Just as Einstein struggled in the classroom because of his different way of looking at the world, so too did many of the physicists and mathematicians who have helped develop string theory. If several of them had not taken a different look at a discarded mathematical equation or laboratory result and examined them from multiple perspectives, the theory may never have evolved.

> Gunckel (2009) calls for applying queer theory to science education:
>
> …the emphasis in science education on some science process skills, such as classification, promotes the view that all things and all beings can be categorized, labeled, and organized into neat packages based on identifiable characteristics and relationships…I argue that the processes of classification naturalize "order" so that anything that does not fit into the reduced order is viewed as not normal (p. 68).

This further exemplifies the need to question who gets to decide what is important, and how they got to be in that position of power. It also reinforces Kincheloe, Steinberg, and Tippins' notion that "a thing-in-itself can be viciously misleading" (1999, p. xiii). As Morris states, "There are many ways of arriving at many kinds of truths" (2002, p. 46). If the scientific community and science education does not allow for multiple ways of

approaching questions we have about the universe around us, the whole thing becomes an exercise in memorization of terms whose definitions may have been made be a privileged few. This can only be accomplished by allowing for the narrative called for by so many involved in science education and curriculum studies.

In the book, *Poststructuralism, Politics, and Education,* Michael Peters (1996) discusses the continued corporatization of science education. Like Latour, whose work is cited in his book, Peters argues that the idea of science without politics is not possible. He describes Latour's account (1987) of the laboratory scientist who claimed objectivity in her experimentation while her supervisor was fully immersed in political fundraising and committee meetings, thus changing the dynamics of her study. Peters includes this description to support his contention that science education is now more about global economics and power than ever. He states, "public good science and state education have been commercialized and commodified in the name of increasing national competitive advantage" (1996, p. 129). Written fifteen years ago, this trend has escalated in light of global competition and the multiple wars on terror we are now engaged in. It is ironic, however, that at every conference I have attended over the last six years that involved keynote speakers from business and industry, the emphasis has been on the lack of preparedness of students for the workforce, particularly in the science, mathematics, and engineering fields. Their main criticism is the inability for newly graduated students to think for themselves. Thus, the "public good science and state education" don't seem to be reaching their goal. Perhaps it is because science is taught as occurring only in the laboratory and only using the scientific method with results being objectively reported. However, as Weaver states, "Students need to know that science does not work in a

vacuum but functions within a cultural and historical context that shapes how people think and act" (2001, p. 16). There are reasons why some questions get researched and others don't, and many of those reason have little to do with pursuing "pure" science (which, it has been argued, doesn't exist in the first place).

How we do science. The history of science is replete with examples of exclusion and a propensity toward releasing information in a limited capacity. In *Modest Witness* (1997), Donna Haraway provides us with a description of Robert Boyle's demonstration of the air pump in the 1600s. She briefly explains Boyle's importance in terms of the scientific revolution, but, more importantly, she suggests to us that *how* Boyle conducted his demonstration and *to whom* the knowledge was imparted set in motion one of the key ideas in science, "to establish matters of fact independent of the endless contentions of politics and religion" (1997, p. 24) or claims of objectivity. Haraway's inclusion of Boyle's demonstration provides the impetus for questioning whether "…gender, with all its tangled knots with other systems of stratified relationships, was at stake in key reconfigurations of knowledge and practice that constituted modern science" (1997, p. 27).

This idea is not without precedent. Bruno Latour, in *We Have Never Been Modern* (1993), also discusses the importance of Boyle's demonstration, beginning with how it led to claims of objectivity and provided the foundation for what he refers to as the "new Constitution" (p. 23) . Through examining various texts such as Shapin and Schaffer's *Leviathan and the Air-Pump* (1989) (also discussed by Haraway), Latour describes Boyle's process in creating an air of objectivity: "…credible, trustworthy, well-to-do witnesses gathered at the scene of the action can attest to the existence of a fact, the

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matter of fact, even if they do not know its true nature" (Latour, 1993, p. 18). The problem, of course, is what constitutes a credible, trustworthy and well-to-do witness? In Boyle's time (and for centuries to follow), this meant affluent white men of European decent. Further, according to Latour, Boyle discarded any evidence by the mere masses and instead included nonhuman as witnesses: "...inert bodies, incapable of will and bias but capable of showing, signing, writing, and scribbling on laboratory instruments before trustworthy witnesses" (Latour, 1993, p. 23). Latour further elucidates Boyle's reasoning, "These nonhumans, lacking souls but endowed with meaning, are even more reliable than ordinary mortals to whom will is attributed but who lack the capacity to indicate phenomenon in a reliable way" (1993, p. 23). Ordinary mortals of course did not include scientists who were primarily men.

While Latour examines scientific objectivity more in terms of politics excluded from science on the part of Boyle and science excluded from politics on the part of Thomas Hobbes[11], Haraway takes precise aim at the question, "How did some men become transparent, self-invisible, legitimate witnesses to maters of fact, while most men and *all women* were made simply invisible, removed from the scene of action…" (1997, p. 29, my emphasis). Haraway acknowledges that during that period of time, society dictated that women were, as she puts it, "literally offstage" (1997, p. 29), but maintains that Robert Boyle was instrumental in "[constructing] the new man and woman appropriate to the experimental way of life and its production of matters of fact" (p. 30). Women's place in society aside, we can read from Haraway's account that women were particularly banned from participating as witnesses to the creation of scientific facts, a

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[11] Latour describes Robert Boyles and Thomas Hobbes as "arguing over the distribution of scientific and political power" (1993, p. 15). This is quite distinct from Haraway's question of science and gender.

state of affairs that lasted for centuries. Indeed, Haraway reports that the admittance of a woman to the Royal Society of London occurred in 1945 on the advice of lawyers (1997, p. 32).

So what does this mean in terms of how we *do* science? Firstly, there is a rich history of doing science in isolation of culture and politics in order to maintain the illusion of objectivity. This presupposes that scientists and the science that informs them are able to divorce themselves from personal experience *except in regard to the experiment at hand*. More importantly, doing science in isolation calls into question who decides what constitutes "good science," what (or who) informs science, and who is privy to scientific knowledge. Haraway's point is not that science is suspect, just that science done in the dark is suspect. Privileged knowledge that keeps others from participating in what constitutes science prevents them from having a say in what can make a difference in their world, or who gets to participate in changing that world (Haraway, 1989, 1991, 1997; Brickhouse & Kittleson, 2006). For Haraway, "Knowledge-making technologies, including crafting subject positions and ways of inhabiting such positions, must be made relentlessly visible and open to critical interventions" (1997, p. 36). Sandra Harding (1991) calls for "strong objectivity," whereby scientists and science educators recognize "the basis on which some data are examined and other data are ignored" (Fendler & Tuckey, 2006, p. 599). Latour goes further in asking the question,

> If science is based not on ideas but on a practice, if it is located not outside but inside the transparent chamber of the air pump, and if it takes place within the private space of the experimental community, then how does it reach

'everywhere'? How does it become as universal as 'Boyle's laws' or 'Newton's laws'? The answer is it that it never becomes universal (Latour, 1993, p. 24).

In other words, taking the covers off of how science is done and how results are interpreted is imperative if we are to reach parity in terms of who is privy to the world of science. "For Latour, science, or rather, a false image of science, is what has kept Us apart from Them…The 'We' on the dust-cover of his book who have never been modern is Us in the West, who despite the reign of a new symmetry are still *not them*" (Elam, 1999, p. 4). From an educational standpoint, the perception (or reality?) of science being done by an elite few brings with it many complications. It is already difficult at best to promote engagement in our students, a criteria that must be met for learning to take place (as opposed to the ability to recite). Many students perceive science as being "too hard," "boring," or well beyond their abilities. Combine that with a sense that science is so far removed from their daily lives that it holds no interest, and the result is fewer and fewer students pursuing careers in science or science education. If the advancement of science does not seem to be a part of solving pressing personal, political, and social problems, there is no impetus to study something that doesn't make a difference. David Blades states, "in its present construction, school science education is an organization of procedures aimed at transmitting to children a particular set of knowledge…infused with an agenda of control, of mastery of the world" (2006, p. 658). Is it no wonder there is a lack of interest, and, in many instances, an active dislike of science? Even more problematic, the issues facing science education aren't isolated to the classroom – the repercussion ripple throughout society. From parents to school boards to state and federal educational policy makers, science is considered important, but not important

enough to support as a foundational discipline in the K-12 classroom. Despite recent rhetoric, education in the United States has spent most of its efforts on reading and mathematics and has essentially ignored science (and, ironically, social studies) to the point that parents of elementary and middle school aged students question the need for science classes at all. Indeed, in many of our elementary classrooms, science may be ignored completely or taught for only a few minutes per day. Budgetary constraints and a lack of emphasis by school and state administrators make it virtually impossible for many students to experience hands-on science, let alone any in-depth discussion of the intertwining of science and society. There *are* school and central office administrators who fully support putting science on an equal footing with reading and mathematics, and for them, there is a push to make a move back to interdisciplinary studies, an exceedingly difficult process. From a pedagogical perspective, it has long been argued that for learning to take place, students need to see relevant connections and that this can be more easily accomplished by integrating disciplines. There is certainly an interest, at least here in Georgia, to press teachers into lessons that include multiple content areas. Teachers are now offered "Alternative Integrated Frameworks" from which to teach science. However, in my previous capacity as a K-12 science curriculum specialist in a rural school district, I watched the difficulty classroom teachers had in attempting to teach across the curriculum, partly because most of their experiences as students had been in learning distinct disciplines, and partly because the authors of these integrated frameworks felt the need to force certain concepts together[12] rather than recognize that

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[12] See for instance the first grade integrated unit entitled "Fall" whereby teachers and students are invited to explore the connection between why leaves turn colors and what attracts and repels magnets (https://www.georgiastandards.org/Frameworks/GSO%20Frameworks/1%20Science%20Alternative%20Integrated%20Framework%20Fall.pdf)

some connections aren't meant to be made (perhaps they were out of practice). Further,

these integrated units are primarily a means to increase literacy using approved of reading

strategies. "School science stresses reading for information contained in the text rather

than reading texts to inquire about what is missing" (Gunckel, 2009, p. 69). Reading

informational text is one of the genres given precedence on standardized tests; thus, the

desire to analyze what might be missing or how that text was generated is not there.

Given the contestations described above, it is no wonder science education is ripe for

continued debate.

So where does this take us? First, we must understand that we have been here

before. As is evident by the scholarship cited herein, this discussion has been and will

continue to be ongoing, and while it is not my intent to provide yet another script to

follow to teach science "the right way," it is important to note the value in continuing the

conversation. By putting a spotlight on some of the ways knowledge has been withheld

and power has been extended through science, I turn now specifically to environmental

education.

Environmental Education

> Unless we can find ways to influence the curriculum, ecological events
> will.
>
> (William Pinar, 2007, p. xxiii)

I deliberately separate science education from environmental education for the

precise reasons that first, teaching about the environment with a scientific lens is vastly

different from teaching about the environment through a social lens, and second, the

repercussions inherent in successfully reconnecting our students with the world around

them are enormous. As discussed previously, an environmental ecology without

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including both social and cultural considerations is simply an exercise in conquering definitions. Indeed, it has been argued by many that it is impossible to have one without the other (Conley, 1997; Dryzek, 1997; Haraway, 1991a, 1992, 1994, 1997, 2004, 2008; Haraway and Goodeve, 2000; Hutchison, 1998; Latour, 1987, 1993, 2004; Orr, 1996, 2004, 2009; Serres, 1995; Serres & Latour, 1995). However, as we have seen, what happens in the classroom is often quite different from what we argue outside of the classroom; this work is about a less superficial treatment of environmental education than that currently seen in our schools.

As discussed in previous chapters, there are a number of curriculum scholars whose work has concentrated on environmental issues and education. David Orr, from his early work in the 90s to his most recent work has called for a change in education to promote sustainability, not just by changing a course here and there but by taking action from all levels of education (1992, 1994, 1996, 2004, 2009). Rather than emphasizing the usual recycling programs and turning off the lights to conserve energy, Orr discusses ways in which universities and businesses can build more energy efficient structures and provide ways to minimize the amount of resources needed to function – in other words, walk the walk as a means of further educating our students. C. A. Bowers continues to work toward moving away from the very idea of environmental education as a separate subject in school and more toward the idea that everything we teach is or should be a part of environmental education and sustainability (2006). Eric Davidson asks us to change neoclassical economics in order to better understand the true cost of environmental degradation (2000). Jennifer Price espouses asking simple questions as a means to raise awareness, such as "Where *did* this table come from?...Why are nature shows on the

Discovery Channel so slow, with low-voiced male narrators and lots of flute music?"
(1996, p. 450, author's emphasis). Price continues,

> We have to see nature in order to *re*-vision it – to think about how to integrate
> nature into everyday urban life in more sustainable or livable ways, to create
> urban landscapes that actually teach us about nature and our connections to it,
> rather than urge us to escape (p. 451, author's emphasis).

This urge to escape has helped promote the burgeoning eco-tourist industry, where one
can get away and experience a pristine nature. In fact, The International Ecotourism
Society (TIES) "promotes responsible travel to natural areas that conserves the
environment and improves the well-being of local people" (2010). It is yet another
indication that we (collective we) don't recognize that we are *already in nature*.
Acknowledging this disconnect, Morris (2002) urges an ecocentric approach in
education:

> Schools are, for the most part, deaf to the sound of a dying planet…Ecocentric
> thinking shifts the focus from students and teachers in an isolated schoolroom, to
> students and teachers in society-in-the-world. Ecocentric thinking is a more
> integrative way to think about ourselves as creatures living in an ecosphere
> (Morris, 2002, p. 581).

This is not the same integration touted by performance standards. Instead, this is a way
for us to get away from the us/them, human/nature dichotomy that is so prevalent today.
By drawing on what we know about science, culture and curriculum, we can begin the
path toward the more ecocentric thinking Morris refers to and, as Weaver states,
"…begin the process of getting our students to see the natural world not as nonmediated

realm of reality, but as a human endeavor in which our role is crucial in constructing science and naming nature" (2001, p. 20).

Environmental issues are inextricably tied to knowledge and power. Latour has convincingly argued that politics and nature cannot and should not be separated (2004). Given that, it is critical that we know how this intermingling affects our approach to environmental education. Constant media bombardment about the loss of jobs and income and the need for consumers to save less and spend more in order to stimulate the economy sends a powerful message. On one hand we are told we need to protect the environment. On the other, we are told environmental protections are costing jobs. This was painfully illustrated when, despite millions of gallons of oil gushing into the ocean, the governor of Louisiana was outraged over the Obama Administration's ban on offshore drilling. The rampant consumerism that is our patriotic duty creates an environment where we are less likely than ever to understand the true cost of maintaining our lifestyles. Morris speaks to this when she states, "Consumer capitalism reproduces dangerous value systems that serve to exploit and degrade the earth" (2002, p. 582). This is eminently obvious in our approach to the economics of food production. Eric Davidson, in *You Can't Eat GNP: Economics as if Ecology Mattered* (2000), describes our approach to the soil that grows our food and the difference between an ecologist's pyramid and an economist's pyramid. The ecologist's pyramid depicts soil at the base of the pyramid, thus giving it greater importance than the categories above it (in decreasing order of importance: plants, herbivores, carnivores). This is because the ecologist perceives soil as providing the stability to the system; without healthy soil the organisms above soil in the pyramid are no longer successful, thus collapsing the system. The

economist's pyramid depicts marketed consumer products (such as bread) as the most

important with processed foods, crops, and soil in decreasing order of importance,

missing the idea that, again, without healthy soil there *are* no marketed consumer

products such as bread (pp. 18-19). David Orr takes it a step further with his book, *Down*

to the Wire: Confronting Climate Collapse (2009). In it he calls for a change in how we

view democracy.

> …the hardest tests for our Constitution and democracy are just ahead and have to
>
> do with the relationship between governance, politics, and the dramatic changes
>
> in Earth systems now under way (p. 17).

Environmental conditions are such that, as Orr (2009) says, policy makers and our

political leaders must stop trying to pacify the public at large and discuss the problems

openly. Weaver states, "postmodern science education needs to put an end to the notion

that the public is too ignorant to understand and take part in major scientific policy

decisions" (Weaver, 2001, p. 17). This goes back to what Serres says (see Chapter 4 p.

102) regarding the disconnect between scientists and the public at large. It is imperative

that scientists begin to immerse themselves in more than just their science; they must

begin to acknowledge how they are situated in society and the influence that plays in

their decisions within their sciences. At the same time, science must become much more

important to those outside the field. For this to take place and for environmental policies

to be an integral part of these decisions, it is clear that relying on environmental science

as a discipline is not nearly enough.

> The domestication of environmental crisis into our everyday vocabularies is a
>
> story many educators choose to ignore, but it is an extraordinarily important one.

What is erased are strategies for collective knowledge of social nature that could

construct a dialectic of environmental justice and ecojustice and a relational ethic

of 'species being' for humans and nonhumans – one that, as Donna Haraway

(1992) powerfully appeals – ought not to include either reification or possession

(McLaren & Houston, 2004, p. 34).

We don't own nature, we can't rule nature, and we can't act as if attempting to do so has

not caused immeasurable harm. As Orr points out, the symptoms of a degradated

environment are not from our current practices but from thirty years ago (2009); what we

did in the past, what we are doing in the present, and what we will do in the future

matters.

Where Does String Theory Fit In?

Serres states, "We are proposing only short-term answers or solutions, because we

live with immediate reckonings, upon which most of our power depends" (1995, p. 30).

But Serres has also described our flawed notions of time (Serres & Latour, 1995)

whereby we consistently overlook the fact that time is a construct of our making. If,

instead, we begin to look at the folding of time, the interconnections between seemingly

distant events and what is presently occurring, perhaps we can better imagine our place in

the universe. There are two things at play here: vibrating strings of energy and how we

came to envision those vibrating strings; both are equally important in advancing our

connection with the environment. So let's briefly re-examine strings and their energy.

Recall that Einstein discovered both the general theory of relativity and special relativity;

the former describes light (or quantum mechanics) and the latter describes gravity

(Greene, 1999, 2004; Musser, 2008; Randall, 2005). Einstein and others since have

sought to find a theory that would unite light and gravity since particle physics only works in the absence of gravity (Greene, 1999, 2004; Halpern, 2004; Kaku and Thompson, 1987; Musser, 2008; Randall, 2005).   In a nutshell, strings are 1-dimensional slices of a 2-dimensional membrane vibrating in 11-dimensional space (Greene, 1999, 2004; Musser, 2008). Indeed, there is so much movement going on that strings can "stop vibrating in one way and start vibrating in another…in this way a particle can metamorphose from one type to another" (Musser, 2008, p. 151). Also recall that some of those 11 dimensions are curled up so tightly they are impossible to see (Birnbaum, 2004; Greene, 1999, 2004). As Morris so aptly puts it, a universe other than our own could be "right next to the place where we extend our hand" (2005, p. 6).

In trying to wrap our heads around these different dimensions and what that means for our place in the universe, it is probably easier to look at the possibilities inherent in strings themselves. If they can change from one type to another and can easily interact with one another, it stands to reason that change is constantly taking place. For every interaction between strings, there is a multitude of other interactions that can also take place. If we take that same idea and apply it to our possible interactions with nature, it is easy to see there are an infinite number of possibilities. Thus, choices we make in fuel consumption, food production, and use of natural resources need not be limited to what is commonplace to us. Instead, by opening our minds to the different possibilities that already exist, and those that may be right where we extend our hands allows us to change the dynamic currently in play. In our classrooms, it means honoring different ways of thinking instead of expecting a single or specific answer to questions we may ask. When we ask questions we already know the answers to, we really don't

want to hear the answers. When we ask questions we *think* we already know the answers to but then acknowledge and celebrate unexpected answers, that begins to open multiple avenues for learning to take place.

Having described the importance of strings and the energy and possibilities contained within them, it is equally worthwhile to look again at the history behind (through, between?) string theory. Recall the mathematics and experimentation that took place in the late 1800s and early 1900s wasn't readily available to everyone in those fields (and certainly not to the public at large). Aside from logistics, in many instances, results were withheld by those who had the power to share them or leave them lie (Halpern, 2004; Kaku, 2005; Kaku and Thompson, 1987; Ouellette, 2005; Randall, 2005). The persistence and curiosity of many mathematicians and physicists who thought differently from others (recall Kincheloe, Steinberg, and Tippins' (1999) description of Einstein's difficulties) finally led to what is today called M-theory. Thus, string theory brings to mind the cycle that has taken place for centuries; that of science being conducted in isolation by a select few "witnesses" with fewer still being privy to what that science meant. Supposed objectivity seemed to be missing when often times a single individual got to decide what information counted and what didn't. Indeed, as with any untested theory, there are many detractors who believe string theory is nothing but fantasy and a waste of valuable time and resources (Smolin, 2007; Woit, 2007). What string theory brings to curriculum theory, however, is a way to examine how knowledge is constructed in science and its ideas of multiple dimensions.

Multimedia, Science Fiction, and String Theory

While the world of physics may have ignored the Kaluza-Klein theory discussed in chapter two, and some detractors calls for a moratorium on future research, popular culture has fully embraced many of its ideas. Science fiction movies and books often explore the idea of extra dimensions or a parallel universe in some fairly creative ways. C.S. Lewis' *The Chronicles of Narnia* (published in the 1950s) not only has the protagonists stumble upon and spend time in a parallel universe, they also experience a change in time; hundreds of years may have elapsed in Narnia during a year in England. The 1960s brought us Madeleine L'Engle's *A Wrinkle in Time*, in which a young girl travels to a "fifth" dimension with her younger brother and a friend in search of her father using a tesseract (allowing time and space to fold). Having grown up with transporters on *Star Trek* and Rod Serling's *The Twilight Zone*, time travel and particle reformation seemed eminently possible. As Paul Halpern describes in *The Great Beyond: Higher Dimensions, Parallel Universes, and the Extraordinary Search for a Theory of Everything* (2004), many of the stories told on *The Twilight Zone* were based on the work of H. P. Lovecraft, whose work often included extra terrifying extra dimensions[13]. Halpern also describes a short story entitled "A Subway Named Mobius" written by an astronomer from Harvard in named A. J. Deutsch based on his community experiences on the Boston subway system.

> Deutsch envisioned it becoming so tangled up that it spontaneously transformed itself into a multidimensional Möbius strip. While part of the system remained in the real world, a segment became hidden in hyperspace tunnels. Trains would

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[13] Halpern particularly notes Lovecraft's "Through the Gates of the Silver Key," and "Dreams of the Witch House" as classic stories.

whirl by, heard but unseen, because they rolled along tracks through higher

dimension. (Halpern, 2004, p. 204).

What is interesting to Halpern is that although these stories were extremely popular with

the public at large, research by physicists and mathematicians turned away from extra

dimensions (and subsequently the Kaluza-Klein theory) in favor of pursuing particle

physics, further supporting Noel Gough's contention that science fiction often "registers

new scientific knowledge" long before we see it in our textbooks (1993, p. 616).

More recently, popular movies such as *Frequency* (2000), *Déjà vu* (2006), and

The Last Mimzy (2007) have all dealt in some way with multiple dimensions and all have

involved work by physicist Brian Greene. In *Frequency,* a New York police detective,

John Sullivan, discovers that he can make contact with his father through his father

Franks' old ham radio, even though his father has been dead for 30 years. This contact

allows John to warn his father about the fire that will take his life, thus preventing Frank

from being killed in the fire. This sets up a new "history," allowing John and Frank to

work together over the airwaves to catch a killer now bent on murdering John's mother.

This changing of history through time travel presents ethical dilemmas that can act as an

impetus for discussions about science.

Déjà vu involves an ATF agent, Doug Carlin (played by Denzel Washington),

who joins a government run group using a new program called "Snow White" that

allows them to look into the past in order to discover who has blown up a ferry full of U.

S. Navy sailors and their families in New Orleans. As Carlin begins to unravel the

mystery, he pushes the limits of the Snow White program in order to physically go back

in time to prevent the disaster from happening in the first place. The movie blended

current ideas in physics with science fiction and, in order to be sure this blend made

sense, producer Jerry Bruckheimer hired Brian Greene. One of the reasons science

fiction films and texts can be considered instructional is this attention to detail, not

necessarily to get the science "right" but to make sure the audience can make sense of it.

Finally, in *The Last Mimzy*, toys are sent to the past to two children who, upon

interacting with them, develop special psychic powers and greater intellegence. Their

mission is to avert ecological disaster that has occurred in the future when human DNA

was corrupted by pollution. The toys are to be used by the children to construct a time

machine in which to return Mimzy (a stuffed rabbit) along with some of the children's

uncorrupted DNA. Not an ordinary rabbit, Mimzy has been created using

nanotechnology by the Intel Corporation. Once again, Brian Greene was hired as a

consultant and also played the role of the Intel scientist. The film, which is rated PG, is

geared toward a younger audience, and provides background information in multiple

dimensions, the time-space continuum, and nanotechnology.

Films and texts in science fiction provide a wide audience access to science and

the imaginative possibilities science holds. For some of our students, it is the only time

they feel a connection to science, so regardless of the validity of some of the concepts

included in science fiction texts and films, they serve as a springboard for questioning

science. Marla Morris discusses the role of science fiction in curriculum in "Chronicles

and Canticles: Curriculum as Science Fiction Text." In it, she discusses the role science

fiction has played in helping her "articulate [her] worries, especially around nuclear

disasters" (2004, p. 38). She further describes the derisive attitudes toward science

fiction held by many academics. "The academy, for the most part, thumbs its nose at

things 'popular.' If something is popular, it can't be academic: it can't be worth the trouble" (p. 39). Gough (1993, 2004a), however, has argued that science fiction plays a significant role in science education. And as Morris points out, "Some sci-fi texts help readers to think about the unthinkable in intelligent and sensitive ways" (2004, p. 39). Science fiction spurs the imagination and allows us to think beyond ourselves. The idea that by entering a parallel world such as Doug Carlin does (Denzel Washington in *Déjà vu*) and prevent a tragic loss of lives is comforting. The scientific explanations interspersed throughout the film (provided by Brian Greene) may be partial explanations or stretches of the imagination, but they help the audience understand a bit more about how the universe *might* work, and that goes a long way toward a more scientifically conscious public.

Continuations

William Doll, Jr. in *A Post-Modern Perspective on Curriculum* (1993) describes exactly what I envision science and curriculum to be in light of string theory. The interaction of strings leads to constant changes; not vast changes, but often very subtle changes. Doll describes the possibility of science moving away from "The linear, sequential, easily quantifiable ordering system dominating today – one focusing on clear beginnings and definite endings…" (1993, p. 3) and moving toward something much more complex and unpredictable. For Doll, this means that science moves "from its premier position within a closed system where its methodology dominated, to a more equitable position among many methodologies in an open system" (p. 3). Although Doll's vision has yet to be realized in many educational settings, the continued conversation means that it is not unattainable. Indeed, if we think of how we approach

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environmental issues, those inexorably entwined with socio-economic and political agendas, using the same ideas of networks and open systems, perhaps we will be more successful at providing creative ideas. Doll goes on to describe challenges for open systems: "The primary challenge in open systems is not to bring process to closure…but to direct the transformations in such a manner that the *becomingness* of process is maintained" (p. 15, my emphasis). Becomingness of process provides the same opportunities for multiplicities as Deleuze and Guattari's rhizome with no beginning and no end.

> What drives a thinker to set aside familiar spatial boundaries and contemplate the great beyond? Why consider bizarre scenarios that bear scarce resemblance to our sensory experience? Given all the opportunities in ordinary physics, why search for something extraordinary? Perhaps it is the human aversion to limits. We want to know what is just outside the frontiers of knowledge. It disturbs us to be told 'No trespassing beyond this point.' If nature counts to three, we want to count to four, five, or more (Halpern, 2004, p. 298).

"No trespassing beyond this point" raises the proverbial red flag for curriculum theory. For it is in trespassing into diverse areas that we not only take the covers off but air them out. As discussed throughout this work, the process of science – where it is performed, by whom it is performed, who analyzes the results, and who gets to share in those results – has serious implications for education and our approaches to environmental issues. I am not naïve enough to think that everyone can and should do science as a profession. However, understanding how science is performed gives us the opportunity and ability to ask necessary questions about what we do with what science brings to us. As noted in

chapter 4, we must acknowledge that continuing to treat the public as ignorant in the ways of science and what science informs us prevents them from partaking in major scientific policy decisions. Science and environmental education that goes beyond the step-by-step recipe labs and an emphasis on facts and figures will go a long way toward providing a foundation for a better understanding of how we are fully intertwined with the universe.

Many years ago, my four year old son was given a magic set for Christmas. My husband painstakingly went through step by step instructions on how to make it look like the foam bunny had fallen through the cup, demonstrating each step along the way. At the end of the lesson, my son looked at him with awe and asked, "How'd you do that?!" We get so enmeshed in the steps, we often forget where they are taking us. We all know students are not going to understand the theory of relativity by presenting them with the theory and leaving it at that. Instead, we lead up to what the theory entails in bits and pieces, sometimes step by step. There is nothing wrong with that, and, in many cases, it makes sense to do it that way. We are taught to label and categorize, but we cannot stop there. "There is nothing wrong…with separating entities for the purpose of labeling and analysis as long as this step is followed by the act of putting them back together" (Kincheloe, Steinberg, & Tippins, 1999, p. xiii). It is my contention that we have lost the art of not only putting them back together, but looking at them anew. Most of us can easily take things apart. Some of us can put those things back together, with even fewer able to put them back together and have items still function. Fewer still recognize that when we put things back together, they may function in unexpectedly new ways. It is time to begin stepping outside of the script. To do so will mean recreating science

education, doing away with the idea of the "foundation" of science as being the most important and infusing the idea of interconnectedness. It means communicating across, between, and through multiple disciplines, all of which provide equally important components of education. Can you visualize those vibrating strings?

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