NOTE TO USERS

University of Alberta

Education for Global Survival: The Emergence of Biocentric Education

by

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Abstract

In this thesis I develop a conceptual framework for biocentric education as an educational response to global crises. Biocentric education is based on the value and concept of life as a source of common ground from which intercultural dialogue and collaborative action on global issues may ensue. I argue that today's humanitarian and ecological crises are being exacerbated by the ideological dominance of neoliberalism, where human development is pursued through unending accumulation of profit. I critique neoliberalism as reductionist due to its exclusive focus on economic systems and therefore as an inadequate response to systemic global problems. Today's popular conception of life as discretely bounded in living organisms is also based largely in the reductionist paradigm. I draw on complexity thinking to develop a systems view of life as a response to these reductionist tendencies and suggest formal education as site of cultural evolution toward biocentric complexity thinking.

Preface

This thesis reflects a journey that accounts for complexity and change. Its origins can be attributed to an evolving understanding of my own diverse and complex identity. My passion for resolving cultural conflicts that impede intercultural dialogue and cooperation can, in part, be understood as an expression of the need to resolve my own internal cultural contradictions. In this thesis I argue that a wider identification with the living world, engendered through formal education, may aid in facilitating the collaboration required to address global issues such as climate change, AIDS/HIV, and rapid losses of biological and cultural diversity.

The ideas forwarded in this thesis emerged through experiences as a person of mixed ancestry teaching, learning and living in culturally diverse contexts. I have consistently been amazed by the similarities and differences that unite and divide human populations. The search for a common ground from which to address and resolve cultural conflicts has led me to consider humanity's shared embeddedness in a complex matrix of systems. The widely recognized inherent value of life positions it as a concept around which collaborative intercultural dialogues may be pursued.

Although most would agree that life is intrinsically valuable, the prevalence of today's global crises begs the question of the degree to which human actions reflect the value of life. To clarify, my intention here is not to flatly accuse humanity of not valuing life but rather to provide impetus to an examination of some of the way(s) in which people perceive life. Different perceptions of life (e.g. individual organisms vs. living systems) may lead to different actions even when based upon a shared respect for life. Planetary crises are being exacerbated by ongoing ideological conflicts but also provide a context in which cooperation on a global scale has begun to emerge; in every challenge lies an opportunity for change. The conceptual framework for biocentric education developed in these pages is offered as a means for thinking about and enacting the continuation of these collaborative efforts.

Through my studies I have come to understand that responding to global crises may require the development of a more expansive and widely shared way of thinking about life, a cultural adaptation to our worldviews. Currently, the dominant ideology of neoliberal economic rationalism has largely reduced life to a commodity to be exploited in pursuit of material wealth, positioning financial gain as more important than the sustenance of human and planetary health. This thesis forwards both a critical analysis of the origins of global crises as well as a creative synthesis toward potential resolutions. In a living system both creativity (i.e. mutation) and criticality (i.e. selection) are required for continued survival through evolution.

My experiences throughout the globe as an educator have generated considerable personal reflection upon formal education, especially on the *aims* of formal education. What is it that we are trying to achieve through education? Although I recognize the multi-dimensional nature of any response to this question, I am most interested in how education might be used to facilitate global survival, an aim that is of increasing relevance in today's context. As such, I have chosen to focus this thesis on an area of educational research that is both socially and globally relevant and aligned with my own perspective on and experience with the world. In addition to theorizing a way of thinking about education that might be useful in addressing global issues, this research has helped me begin a deeper understanding of who and what I am, furthering my own process of learning and development as a living organism. It is an expression of my need for roots.

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Chapter 1: Introduction

Statement of Purpose

In this thesis I forward a tentative educational response to global humanitarian crises by developing a conceptual framework for *biocentric education.* Biocentric (i.e. life-centered) education is based upon the intrinsic value of life, an ethical stance that is not always reflected in the actions of our species. While there is ample evidence of biospheric degradation in general, there is also reason to consider the degree to which human life is regarded as valuable. For example, in the 2006 United Nations Human Development Report (UNHDR) it was estimated that 1.1 billion people lack access to clean water and 2.6 billion lack access to adequate sanitation (p. 33). Although water resources and services are largely taken for granted in Western nations, each year globally nearly 2 million children perish due to water-borne disease (2006).

Unfortunately, the humanitarian crisis described in the 2006 UNHDR is but one example of a multiplicity of crises that are presently unfolding. The global realities of HIV/AIDS, climate change, and continuing armed conflicts are rapidly diminishing the capacity for a significant portion of humanity to simply survive. The broad question that my research addresses is 'How can formal education contribute to global survival?' The formulation of biocentric education developed in this thesis is an initial response that emphasizes the value of life over material wealth and explores the importance of the diverse culturally dependent ways in which the concept of life itself may be understood. It is my hope that this work will aid in interrupting the dominant ideologies of neoliberalism and reductionism that have contributed to the 'commodification the life-world' (Habermas, 1981).

The Crisis of Perception

Physicist and systems theorist Fritjof Capra (1982, 1996, 2002) has identified today's global crises as "different facets of one and the same crisis", which he believes "is essentially a crisis of perception" (1982, p. 15). Capra's 'crisis of perception' can also be cast as a 'crisis of cognition', as "how one conceives of

the world shapes how one perceives of and acts in the world" (Davis, Sumara & Luce-Kapler, 2008, p. 212). From this perspective, actions based in the dominant modernist (e.g., mechanistic, linear and reductionist) conceptual framework developed by figures such as Bacon, Descartes and Newton are ill-suited to effectively address the complex systemic problems we are now experiencing, and may even have been associated with their emergence.

The notion that global crises result in part from the misapplication of an outdated mode of thought is becoming widely shared (e.g., Capra, 1982, 1996, 2002; Csikszentmihalyi, 1993; Ehrlich, 2000; Hubbard, 1998; Ornstein & Ehrlich, 1989; Russell, 1995; Stewart-Harawira, 2005) and has particular relevance for education. For environmental educator David Orr (2004), the disordering of the Earth's planetary systems by human actions:

> reflects a prior disorder in the thought, perception, imagination, intellectual priorities, and loyalties inherent in the industrial mind. Ultimately then, the crisis concerns how we think and the institutions that purport to shape and refine the capacity to think. (p. 2)

Schools are the primary institutions charged with 'refining the capacity to think' and are thus positioned to act as agents of both social reproduction and social change. The social domain of formal education is an important site of cognitive development that may contribute to the hegemony of the status quo or enact social transformation through engagement with alternative ways of thinking.

Emphasizing the crucial point that global problems cannot be understood in isolation, Capra (1982, 1996, 2002) has advocated for a general conceptual shift toward 'systems thinking' as a means of mediating the crisis of perception. In contrast and complement to the mechanistic paradigm of modernity, systems thinking is focused on understanding the characteristics of complex nonlinear systems whose behavior cannot be understood through reductionist analysis of their parts alone. In *The Web of Life* (1996) Capra adopts systems thinking to synthesize recent scientific research into a 'systems view of life', contributing a cogent theoretical framework to the general movement away from the

conventional reductionist perspective of life upon which today's Western biological and medical sciences are predominantly based (1982).

Systems thinking is also foundational to the work of educational complexity theorists Brent Davis and Dennis Sumara (2006), who use the term 'complexity thinking' to refer to their attentiveness to "the philosophical and pragmatic implications of assuming a complex universe" (p. 18). In this thesis I draw on complexity thinking to develop 'biocentric complexity thinking' as an interpretive frame for thinking about life in terms of complex systems, and for thinking about the role of formal education in shaping the cultural worldviews through which humanity is cognitively embedded in these systems. As developed in Chapter Six, the conception of living systems emerging from the frontiers of Western scientific inquiry is curiously similar to the belief systems of many Eastern and Indigenous traditions in their mutual recognition of the unity of humanity and nature and the presence of life in all things (Cajete, 2000; Capra, 1975; Knudson & Suzuki, 2006; Stewart-Harawira, 2005). The consilience among these varied understandings of life is foundational to biocentric education as a source of commonality required for achieving wider participation toward the shared goal of global survival.

The view of biocentric education developed in this thesis constitutes an interdisciplinary conceptual framework that critiques the neoliberal economic imperative that has commodified life and positions the concept of life at the center of educational work as an important potential source of common ground. Following Capra (2002), my intention is to contribute "a way of thinking about life [and education], including new perceptions, a new language and new concepts" (p. xvii) to educational academia.

Global Survival

The term 'global survival' refers to an ethically-based approach to the survival of life on Earth that reflects the interconnections between humanity and the planet implicit in the systemic perspective (Lazslo & Seidel, 2006; Vittachi, 1989). Potter and Potter (1995) define global survival as 'acceptable sustainable

survival'. The authors' use of the term 'acceptable' ascribes an ethical dimension to global survival; humans can survive in contexts of wasteful opulence as well as contexts of disease, war, and malnutrition, but should these be considered acceptable modes of survival? While arriving at universally agreed criteria for 'acceptable' will inevitably prove difficult, a dogmatic set of criteria may not be required to establish collaborative efforts aimed at ameliorating many of today's global crises. Work toward establishing a widely acceptable global ethic has already begun through processes of planetary-wide collaborative dialogue (e.g., Küng, 2001; Potter, 1971; 1988).

The identification of global survival as 'long-term' survival is closely tied to its ethical dimension; neither 'wasteful opulence' nor 'disease and poverty' are viable contexts for long-term survival. The widespread movement toward sustainable practices can also be cast in terms of long-term survival, as sustainability, ultimately, is about sustaining life (Baker, in press). For Potter and Potter (1995), global survival stands in direct contrast to the dominant short-term strategy of irresponsible survival, which they link to the overpopulation and overconsumption that are decimating the biosphere (p. 187).

Research Methodology

In this thesis I use a complementary interdiscursive analysis, focused on "how discourses intersect, overlap and interlace" (Davis & Sumara, 2006, p. 159), to develop a conceptual framework for biocentric education. The similarities in patterns of behavior observed in phenomena across disciplinary and discursive boundaries (e.g., ant hills, cities and brains (Johnson, 2001)) are a main focus of complexity theorists, and provide rich sites for analysis. In this work I attempt to identify congruencies among the areas of complexity theory, biocentric philosophy and cultural evolution to develop an understanding of educational systems as embedded agents within broader living systems. As Indigenous educators Barnhardt and Kawagley (2005) have expressed, there is much to be gained from mining the fertile ground that exists at the intersection of converging knowledge systems and worldviews (p. 15).

This methodology responds to Davis and Sumara's (2006) call for the increased use of complementary analyses in educational research, as "most often in the contemporary literature, discourses are presented as oppositional rather than complementary" (p. 160). Complementary interdiscursive analyses generate broad descriptions rather than narrowly focused critiques of competing discourses or suggestions for educational improvement. Radford (2006) has identified these descriptions as pivotally important for educational research as they produce theories that can be continually modified to increase their explanatory power—a capacity that is of great relevance in a context where educational theories and practice are required to adapt and evolve with ever-changing world.

Qualitative, Critical and Interdisciplinary Research

This research methodology is at once qualitative, critical and interdisciplinary. In addition to the use of an interdisciplinary literature review instead of quantitative data as my primary source of information, this research satisfies several other criteria for qualitative research. Drawing on the work of Becker (1996), Denzin and Lincoln (2003) have listed 'securing rich descriptions', 'acceptance of postmodern sensibilities', and 'capturing the individual's point of view' as key criteria for qualitative research (p. 15-16).

By 'securing rich descriptions', Denzin and Lincoln (2003) are referring to the preference for an abundance of detail to be included in qualitative research. This preference reflects the desire of qualitative researchers to understand the multiplicity of influences that contextualize their research. This profusion of detail detracts from the clarity sought by quantitative researchers who aim to establish a more linear causality between fewer variables. The conceptual framework being developed in this thesis may be considered a rich description. A synthesis of concepts from a diversity of discourses is used to develop a thick description of education as an integral aspect of a living system. While I hold the belief that there is a profound connection between our ontological and ideological underpinnings and actions that contribute to the emergence of global humanitarian crises, I do not attempt to trace a path of linear causality between them.

The use of complexity thinking as my primary interpretive frame satisfies Denzin and Lincoln's (2003) second criterion of 'accepting postmodern sensibilities'. Complexity thinking is postmodern in its presentation of a way of thinking that departs from the linear-reductionist analysis of modernity. It also reflects postmodern thought through its acknowledgement of the uncertainty inherent in the analysis of dynamic, nonlinear systems and the inability to fully separate oneself from these objects of inquiry. As expressed by Davis and Sumara (2006):

> Rather than thinking of scholarly engagement in terms of depictions of the way things are, research reports and theoretical accounts must be considered as forms that contribute to the shape of possibility. They are partial rather than comprehensive, active rather than inert, implicated rather than benign. In complexity terms, one cannot represent things as they are, simply because the representation contributes to the transformation of an always evolving reality. (p. 160-161)

This thesis is not an end in itself. Instead, it represents the initiation of a process of ongoing dialogue and investigation into a potential educational response to global crises centered on the concept of life.

Although complexity thinking is aligned with postmodern thought, its application here is distinct from strictly critical, deconstructionist postmodernism in the effort to re-think (i.e. reconstruct) the world through a postmodern lens. As a form of 'constructive postmodernism' (Doll, 1993; Griffin, 1988; Slattery, 2006) this work embraces postmodern sensibilities (Center for a Postmodern World, 1990), providing a descriptive framework that is cognizant of the deconstructions of modernity. It must not be construed as a 'grand narrative' (Lyotard, 1984) but as a conceptual framework that may be of relevance for today's context. Slattery foreshadows the potential significance of biocentric complexity thinking in his assertion that in constructive postmodernism "the strength of the whole is derived from a respect for the contribution of each

individual, a contribution that is preserved only if the entire edifice of life is understood as an integrated and interdependent whole" (p. 185).

Denzin and Lincoln's (2003) third criterion, 'capturing the individual's point of view', refers to gaining an understanding of the perspective of the research subject. In this work, however, rather than attempting to capture the perspective of a research subject, I attempt to develop and articulate my own perspective. As described in the preface, this thesis emerged from my experiences as an international educator and a person of mixed ancestry. These experiences provided the impetus for me to leave the classroom as a teacher and return as a student interested in learning how formal education might effectively establish a common ground, a source from which intercultural dialogue and action on global crises may ensue. The desire to come to a cogent understanding of myself as a person with a pluralistic identity has manifested itself in my interest in resolving cultural conflicts in a pluralistic world.

Despite the use of complementary (rather than critical) interdiscursive analysis, the awareness of my complicity in global crises from which this thesis emerged aligns it closely with critical research. For Kincheloe and McLaren (2005), the critical researcher "abandons the quest for some naïve concept of realism, focusing instead on the clarification of his or her position in the web of reality" (p. 316). The response to global crises contained in this work also parallels the focus of critical research on the identification and eradication of inequitable power relations that lead to social injustice. From the perspective forwarded in this thesis, it is the inequitable power relations between different aspects of our interconnected living system that are contributing to its deterioration. In some cases, these power inequities result in environmental and ecological destruction for the sake of human interests. In others they result in the exploitation and death of groups of humans. Clearly, the violation of the human right to life is among the most fundamental forms of social injustice.

As a response to crisis, this thesis can also be considered an example of 'survival research', an academic response to growing recognition of global humanitarian crises (Herz, 2003; Lazslo & Seidel, 2006). As defined by Laszlo

(2006), this is an interdisciplinary research area that seeks to "create an open-ended dialogue centered on what we need to, and can, do to ensure the survival of our species" (p. viii). From a perspective of life as a complex system, the survival of 'our species' must be considered inextricably connected to the survival of the systems with which we have evolved. Rather than a narrow focus on human survival, survival research must critically consider the survival of a broad range of interrelated living systems. This requires simultaneous analysis of multiple aspects of living systems, which necessitates the use of multiple areas of disciplinary knowledge.

According to centenarian and political scientist John Herz (2003), survival research "must be *interdisciplinary*, requiring the cooperation of any and all the social sciences with other scientific disciplines" (p. 140). The need for research that crosses disciplinary boundaries to address issues of global significance is becoming widely recognized. Nissani (1997), for example, has aptly observed that, "many complex or practical problems can only be understood by pulling together insights and methodologies from a variety of disciplines" (p. 210). Kincheloe and McLaren (2005) also share this view, stating that "a deep interdisciplinarity is justified by an understanding of the complexity of the object of inquiry and the demands such complications place on the research act" (p. 320).

Interdisciplinary research provides a multifaceted approach to alleviating the proliferate crises we are presently facing. To achieve the goal of global survival, it is prudent to use all of the resources at one's disposal; including the broad spectrum of approaches contained within the falsely dichotomized science-humanities divide (Snow, 1959). The need for the integration of diverse agents, in this case disciplinary insights, for survival is clearly evident in the structure of living systems.

Research Procedure

The procedure used to construct this conceptual framework follows Capra's (1982) suggestion that developing a systems view of life requires "gradually

formulating a network of interlocking concepts and models" (p. 265). Capra continues, stating that:

> None of the theories will be any more fundamental than the others, and all of them will have to be mutually consistent. They will go beyond the conventional disciplinary distinctions, using whatever language becomes appropriate to describe different aspects of the multileveled, interrelated fabric of reality. (p. 265)

This description captures the essence of my research. While conducting an expansive literature review of biocentric philosophy, complexity theory and cultural evolution, I have compiled groups of consilient concepts and synthesized them into a framework for biocentric education.

Rather than a narrowly focused critical analysis, this thesis has been produced through a broadly based creative synthesis of elements from diverse disciplines. It can be considered a form of scientific narrative, not necessarily telling 'Truths' about the world, but retelling the story of life through complexity thinking. While there is an appreciation of scientific evidence, the arguments presented here are primarily based on metaphor. The exploratory nature of this research is viewed as a strength, rather than weakness, of this thesis. In the words of Chilean biologist and philosopher Francisco Varela (1988): "The chances of surviving with dignity on this planet hinge on the acquisition of a new mind... Thus, over and above their intrinsic beauty, I take these epistemological meanderings as vital" (p. 205).

Overview

Biocentric education, as portrayed in this thesis, focuses on three key points: 1) the intrinsic value of life; 2) a complex systems perspective of life; and 3) the importance of culture for past and future human evolution. I begin by considering the aims of education in a context of global crisis and acknowledging the intrinsic value of life as a source of common ground. I then draw on complexity thinking to describe educational systems as connected to living systems both physically and, more importantly, through their influence on the cultural worldviews of the

students they serve. Culture is presented as critical to human evolution through its contributions to the emergence of today's crises and its potential provision of a source of resolution of these crises. I conclude with a brief discussion of the implications of this perspective for formal education and an exploration of the connections among a systems view of life and traditional cultural worldviews.

In Chapter Two I discuss the need for educational objectives to reflect the changing needs of both local and global contexts. As the global context is widely recognized as one of crisis, I argue that educational aims must include a response to these crises. I describe contemporary Western educational aims as heavily influenced by the neoliberal objective of achieving economic development through open competition among individuals and groups in a free-market. While acknowledging the dire need for economic development to combat poverty, I critique the neoliberal view as reductionist, and therefore inadequate as a response to systemic global crises. Biocentric education, with global survival as its fundamental aim, is presented as complementary to existing educational aims, enlarging the narrow focus on economics to include consideration of other aspects of living systems.

I develop the conceptual framework for biocentric education in Chapters Three, Four and Five. In Chapter Three conventional conceptions of life based in Western thought are identified and rethought in terms of complex systems. A brief introduction to complexity theory is presented, noting its challenges to the linear-reductionist thinking associated with modernity. Key characteristics of complex systems (i.e. emergence, nestedness, and adaptation) are used to develop the notion of biocentric complexity thinking as a way of thinking about life in terms of complex systems. From this perspective, formal education is viewed as integral to global survival due to its influence on the worldviews through which humanity is culturally embedded in living systems.

In Chapter Four I review a selection of the literature in Western biocentric philosophy, providing a brief history of ideas about life's intrinsic value and highlighting the tensions among biocentric, anthropocentric and ecocentric approaches to ethics. I conclude the chapter by speculating on an ethic of

biocentric complexity. I use Varela's (1999) concept of 'ethical know-how' to develop a non-moralistic ethic where ethics are simply reflected in one's actions, a concept that departs from the conventional notion of ethics as moral standards. From this perspective, an ethic of biocentric complexity essentially requires that we learn more about the functioning of living complex systems, which is one of the fundamental aims of biocentric education.

In Chapter Five I review the literature on cultural evolution and develop concepts of relevance to biocentric education, highlighting the importance of cultural evolution for past and future human survival. I trace the emergence of culture as an adaptation closely tied to the evolution of human cognitive capacities before addressing some common evolutionary misconceptions (e.g., genetic determinism, teleology), discussing the roles of diversity and redundancy in biological (genetic) and cultural (memetic) evolution, and introducing the concept of 'evolutionary hangovers' (resulting from mismatched rates of genetic and cultural evolution) and linking them to today's global crises. Formal education is proposed as a conscious form of cultural evolution—a potential means of addressing the evolutionary hangovers that have contributed to global crises.

I conclude the thesis in Chapter Six by drawing together the themes developed throughout the preceding chapters and acknowledging biocentric complexity as consilient with, rather than validation for, similar perspectives held by Indigenous peoples. Biocentric education is forwarded as a response to Capra's (1996) 'crisis of perception', developing a common understanding of our embeddedness in living systems in an effort to achieve cultural symbiosis and facilitate global responses to global humanitarian crises. From this perspective learning is considered in terms of evolutionary dynamics rather than Newtonian mechanics; it is a process of adapting to new circumstances rather than compiling pieces of objective knowledge. In the remainder of the conclusion I highlight some implications of biocentric education for formal education, drawing on the literature review and examples from recent educational initiatives to make suggestions for the content, pedagogy and structure of biocentric education.

Chapter Two: The Aims of Education

What is education for?

In conversations with educational practitioners across the globe I have heard widely varied, sometimes even contradictory, opinions regarding the purposes and aims of education. For some, education's main contribution to society is maintaining stability and coherence. For others, education is a primary means of creating the social change required to address the oppressive practices that proliferate in today's societies. As Davis and Sumara (2006) have noted:

> If one seriously considers the range of theories and philosophies invoked in current discussions of education, it is obvious that there is little agreement on what formal education is doing, much less on what it is intended to do. (p. x)

Though fundamental to educational theory and practice, the question of educational aims has proven highly resistant to definitive answers.

In part, this resistance can be attributed to the question's hidden depth. Inquiring into the purpose of education can lead, ultimately, to inquiring into the purpose and meaning of life. The question's resistance to conclusive answers can also be understood as a result of the diversity of environments in which education is practiced. As John Dewey (1916) stated in *Education and Democracy*, the aims of education "must be based upon a consideration of what is already going on; upon the resources and difficulties of the situation" (p. 104). The aims of education, then, are dynamic and must be constantly adapted to new circumstances as they arise. Education should be practiced for different reasons in different places and times.

Examples of the 'educated person' that illustrate this historical variation include Plato's 'philosopher king', Aquinas' 'rational Christian', Hitler's 'nationalist Nazi', and Lenin's 'dedicated Communist' (Gutek, 1995, p. 9-10). These educational ideals arose in distinct geographic and cultural circumstances and were rendered irrelevant as contexts changed. Social change is inevitable with the passage of time and the faster social changes occur the more quickly the goals

and methods of education must be adjusted if they are to remain relevant and effective. As educational historian Gerald Gutek has noted, "in times of rapid social change, formal education either grows increasingly formalized and remote from the realities of life or appears to be confused as new educational patterns compete for supremacy" (p. 10).

The contemporary aims of Western formal education have been heavily influenced by neoliberal ideology, where the generation of financial wealth is considered the fundamental aim of all enterprises. From this perspective, the ideal 'educated person' would recognize "exchange, the market, and capitalism as their most fundamental human possibilities and the surest sources of freedom" (Jameson, 2001, p. 58). I critique this position as reductionist due to in its narrow focus on economic development and its use of reductionist science to justify increasing levels of standardization in educational institutions. Reductionist approaches are deemed inadequate as responses to the systemic crises that characterize the global context.

Greater levels of global interdependence are increasing both the need and capacity for schools to consider their objectives in relation to a global context. As the global context is widely recognized as one of a multiplicity of humanitarian and ecological crises, I argue that the aims of formal education must include a response to these crises. This chapter both critiques the relevance of contemporary Western educational objectives for global survival and introduces biocentric education as a potential alternative. Biocentric education, with global survival as its fundamental aim, perceives 'educated persons' as those who recognize the inherent value of life and are conscious of their physical and cognitive/cultural embeddedness in a living multi-system of which economic systems are simply one aspect (albeit an important one) (Hawken, 1993). Alleviating and preventing conflicts arising from the increasing intercultural contact associated with globalization is considered paramount to biocentric education, as these conflicts limit the degree of international collaboration necessary to address global issues that threaten global survival. This chapter begins by investigating the globalized economic and cultural context of contemporary Western education.

The Contemporary Context of Globalization

Assessing the relevance of today's educational aims requires an understanding of the contemporary context. The unofficial buzzword of the 90's, *globalization* refers to the increasing global interconnectedness that is presently occurring, a phenomenon that has had dramatic impacts on communities across the planet. The term first appeared in the *Webster* dictionary in 1961 but the definition and origin of globalization have been highly contested. Mignolo (2001), for example, has commented that globalization can "be conceived as the last of three stages of global transformation since 1945 [but can also] be linked with Western expansion since 1500" (p. 32). In this thesis I follow the insight of Waters (1995), who has argued that globalization might be better understood as a phenomenon that has emerged over a longer period of time. For Waters, "globalization has been in process since the dawn of history... it has increased its effects since that time and there has been a sudden and recent acceleration" (p. 4). The transformative processes of globalization have been hastened by ongoing technological innovations and are generating unprecedented rates of change in societies worldwide.

Economic and Cultural Globalization

There are numerous approaches to understanding globalization (e.g., political, technological, ecological, and social) but for the purposes of this thesis I focus predominantly on its economic and cultural aspects. *Economic globalization* refers to the economic expansion that, from some perspectives (e.g., Chase-Dunn, 1999), began in the fourteenth century when European nations began to obtain wealth and power through exploitation of the natural resources and people in the New World and 'other' nations to the South and East. Although its mode of implementation has changed from one of direct violent conquest to a more subvert form of political and economic control, the goal of generating wealth has remained unchanged. The exploitative practices that proliferated through economic globalization have arguably had the greatest detrimental impact on

humanity and the biosphere, and are thus oppositional to the aims of biocentric education.

As culture is predominantly learned, *cultural globalization* is of great relevance to education, and occurs to varying extents whenever contact between distinct cultural groups takes place. Cultural globalization often results in a transfer of culture, sometimes involving conflict, but inevitably altering the everyday lived experiences of the individuals and groups involved. Frederic Jameson (2001) has contrasted the concepts of the cultural and economic by proposing two alternate visions of globalization. In the first, he posits cultural globalization as "a postmodern celebration of difference and differentiation: suddenly all the cultures around the world are placed in tolerant contact with each other in a kind of immense cultural pluralism which it would be very difficult not to welcome" (p. 56-57).

Although contemporary and historical accounts of inter-cultural contact clearly depart from his euphoric vision, Jameson contrasts it with a second, less hopeful image of economic globalization. "If, on the other hand, your thoughts turn economic, and the concept of globalization becomes colored by those codes and meanings, I think you will find the concept darkening and growing more opaque" (2001, p. 57). Jameson's comments reflect the general notion that contemporary economic globalization driven by neoliberalism "can be reduced, despite the rhetoric of liberalization, to hard statistics about slashed wages, massive unemployment and increasing destitution in the heart of the metropolitan North. As for the South, even facts shrivel before the bitter farce played out against its interests" (Kapur, 2001, p. 191).

Even though today's neoliberal economic globalization occurs with little need for direct contact between individuals of differing cultures, a globalization of culture can easily be identified. A general definition of contemporary globalization embodies the economic and cultural domination of Western neoliberal ideology. For example, proponents of economic globalization have intentionally targeted 'culture industries', which are "private or state-owned institutions that produce, sell or distribute cultural products and services" (Milner

& Browitt, 2002, p. 228), as marketable resources ripe for exploitation. As Jameson (2001) has noted, Hollywood films have not become an international standard based on their high production and entertainment value alone. Instead, policies regarding international trade regulations are specifically designed to open up new markets for Western cultural products. "American insistence on opening the quota barriers on film in foreign countries should not be seen as a North American cultural eccentricity... but rather a hardheaded business necessity – a formal economic necessity irrespective of the frivolous cultural content" (p. 60).

Despite the existence of cultural traffic flowing in many directions, the predominant flow must be seen as occurring from the 'globalizer' to the 'globalized' (Barker, 2002). Having lived internationally for many years, I can personally attest to the large number of American and British television programs seen abroad in comparison to the virtually nonexistent international programming on North American television. This immense flow of cultural information to nations around the world "is deeper than anything known in earlier forms of colonization or imperialism" (Jameson, 2001, p. 58). Although this uneven flow of cultural commodities "is not *necessarily* a form of domination" (Barker, 2002, p. 132), it is of great significance when analyzing modes and effects of economic and cultural globalization.

Export of cultural commodities results not only in financial gain for the 'globalizer' but also in a form of cultural imperialism where the overarching ideology of one culture is imposed upon another. Rather than the direct conquest and domination associated with traditional imperialism, the remote use of mass media "provides ideological support for capitalism in general and transnational corporations in particular" (Barker, 2002, p. 132). The images and narratives found within these types of exported text invariably contain information about the culture in which they were produced. This information is taken up by the foreign viewer in many ways, one of which is an adoption of these new cultural values as their own. This results in the formation of new hybrid or syncretic cultural forms through which North American consumer culture is merged with pre-existing cultures.

The transmission of cultural commodities rather than physical contact between people may also globalize misrepresentation through the transmission and consumption of non-culturally representative material. The exported images seen around the world portray a false image of Western society as a paradise of wealth and luxury. This contributes to a greater desire for the apparently easily attainable wealth of the West and fuels the further spread of consumer culture.

While this mode of cultural globalization primarily affects those in foreign countries, it also impacts individuals in the countries that generate these consumer texts, as any parent can tell you during 'back to school' shopping or gift-giving holidays. The necessary product of a neoliberal society intent on continued growth and profit, consumer culture with its empty promise of salvation through accumulation of goods is now being promoted unabashedly to the entire world. Consumer culture is "the very linchpin of our economic system, and also the mode of daily life in which all our mass culture and entertainment industries train us ceaselessly day after day, in an image and media barrage quite unparalleled in history" (Jameson, 2001, p. 64).

For some, resisting the overpowering forces of economic globalization seems futile—this is the way that the world is heading, and we need to deal with its inevitability. Within this attitude is a dangerous view of globalization that "appears to justify the spread of Western culture and of capitalist society by suggesting that there are forces operating beyond human control that are transforming the world" (Waters, 1995, p. 3). This view of globalization as a phenomenon occurring of its own volition is simply inaccurate. To the contrary, individuals and groups can and do use the tools of globalization for their own purposes. Agents of neoliberalism are presently using them for the accumulation of wealth and power. By aiding in the cross-border dissemination of knowledge, however, globalization is also contributing to a movement toward the creation of a more just and equitable world. Growing use of the Internet and other information and communication technologies have even prompted speculation that we are witnessing the emergence of a 'global brain' that is capable of a

'global intelligence' which might be used to facilitate human development (Bloom, 2000; Russell, 1995; Spariosu, 2004).

If educational aims are indeed context dependent, educational institutions must develop their own sets of objectives derived from the communities in which the schools are embedded. These aims will undoubtedly vary, as each school addresses the needs of the local people it is meant to serve. In addition to the unique local contexts in which schools are situated, however, they are also embedded in a shared global context. Increasing rates of cultural and economic globalization (both physical and virtual) combined with greater access to information are transcending traditional community boundaries. While the needs of local communities must continue to remain important, globalization has vastly increased the capacity for these communities to consider themselves and the aims of their educational institutions in relation to the global context.

The Global Context of Crisis

Increasing recognition of global realities via globalization has contributed to an emergent awareness of the global context as one characterized by a multiplicity of crises. As described by ecumenical theologian Hans Küng (2001), "the globalization of markets, technology and the media has also brought about a globalization of problems" (p. 98). Although their roots are intricately intertwined, these crises are commonly divided into humanitarian and ecological categories when discussed in the popular press and other forms of popular media. Humanitarian crises generally include issues such as poverty, HIV/AIDS (and other forms of infectious disease), war (and the introduction of depleted uranium in weapons), slavery, and the continued oppression of the world's women, children and Indigenous peoples. From an ecological perspective, climate change, pollution, environmental destruction, and biodiversity loss are frequently listed among the most pressing issues of our time.

In my experience, both humanitarian and ecological crises are most often addressed in schools by extra-curricular clubs or in classrooms with a specialized subject-specific focus (e.g., climate change and pollution in science or human

rights in social studies or history). These issues, though of global relevance, have yet to gain the broad integration into curricula that they deserve, limiting wider acknowledgement of links and interconnections that exist among them. In most cases, the ideology of economic rationalism that values material wealth over life contributes to the proliferation of these crises and is an important element in their interconnectedness. The failure of today's formal educational institutions to engage critically with these global issues in a more holistic manner is also a failure to challenge the hegemonic status that financial concerns have achieved through processes of economic and cultural globalization.

Examining the Crises

One of the greatest humanitarian crises presently unfolding is the HIV/AIDS pandemic. Over the past twenty-five years approximately twenty-five million people have perished due to AIDS-related illness, including an estimated 2.8 million in 2005 alone (Joint United Nations Program on AIDS (UNAIDS), 2006). The 2005 United Nations Human Development Report (UNHDR) bluntly states that HIV/AIDS constitutes the single largest reversal in human development in history. The neoliberal economic mantra of 'profits over people' has contributed to this crisis by limiting the availability of antiretroviral drugs required to treat those infected with HIV (UNAIDS). The magnitude of this massive loss of human life is unprecedented and the long-term effects of this devastating pandemic remain to be seen. Despite the prevalence of this crisis in sub-Saharan Africa, the HIV/AIDS crisis is undeniably a global crisis. HIV/AIDS has impacted communities across the planet and finding a remedy to the human suffering it is causing will require nothing less than a global collaborative effort (UNAIDS).

Climate change and biodiversity loss are two prominent examples of crises that are commonly categorized as ecological. The warming climate has been closely linked to the addition of greenhouse gasses (e.g., CO_2, CH_4, CFC's, N_2O) to the Earth's atmosphere by human activity, primarily the use of fossil fuels and deforestation (Intergovernmental Panel on Climate Change (IPCC), 2007). There is considerable evidence that global greenhouse gas emissions have increased by a

stunning 70% between 1970 and 2004 (2007), contributing to an overall warming of 0.7°C over the last 100 years (Kump, Kasting & Crane, 2004). Predictions for warming over the next 100 years vary from an increase of just over 1°C to nearly 6°C (IPCC, 2001). The effects of a change of this magnitude could quite literally alter the face of the planet. Although there is evidence that at several times in its history the Earth has been both warmer and colder than it presently is (Ruddiman, 2003), today's concerns stem from the rapid rate of present change and its close connection to human activities.

Increased frequency of extreme weather events, changes in the migration of biotic communities, droughts and floods have all been cited as evidence of climate change (Tol, Downing, Kuik & Smith, 2004). One of the most widely agreed upon effects of the warming climate is a rise in sea level, due to the thermal expansion of water and melting glaciers (IPCC, 2001). It is estimated that sea level has already increased by 12cm since 1880 (Kump et al., 2004) and projections of sea level rise over the next 100 years range from approximately twenty to seventy centimeters (2001). The warming climate could also potentially disrupt global oceanic and atmospheric cycles that circulate energy throughout the planet, with unforeseeable consequences (Kump et al., 2004).

Contemporary rates of loss of biodiversity are also cause for alarm. The Millennium Ecosystem Assessment (MEA) (2005) has estimated present rates of species extinction at 1000 times faster than the average rates found in the geologic record. Ten years before the MEA, paleoanthropologists Richard Leakey and Roger Lewin (1995) had already acknowledged this dramatic loss of biodiversity, describing the human-induced decimation of the biosphere as 'the sixth extinction'. Of the previous five mass extinctions over the four billion year history of life on Earth, only one was a result of the actions of living organisms. That occurred over two billion years ago in a time of relatively low biodiversity when photosynthetic microorganisms initially appeared and began to increase atmospheric levels of oxygen (Sleep, 2001).

The AIDS/HIV crisis, climate change and loss of biodiversity are all examples of crises that have been exacerbated by the neoliberal desire for the

unrestricted generation of material wealth. The evolution and dominance of 'homo economicus' has reduced all natural resources and forms of life to sources of capital (e.g., 'human capital') to be used and exploited in accordance with the imperative for unending profit. Neoliberal economic policies and practices have also contributed to a widening gap between the rich and poor at levels of the individual, social (e.g., racial, cultural, and socio-economic) group and nation (Jameson, 2001; Kapur, 2001; Kellner, 2002; Stewart-Harawira, 2005). It is this common thread that links these global issues that will be examined in the following section.

The Systemic Nature of Global Crises

Although a valuable means of identifying specific issues, the categorical separation of humanitarian and ecological crises fails to reflect their systemic nature. As Capra (1996) has noted, "the more we study the major problems of our time, the more we come to realize that they cannot be understood in isolation. They are systemic problems, which means that they are interconnected and interdependent" (p. 4). From a systems perspective humanitarian and ecological crises are inextricably connected; they are crises of different aspects of an integrated living system.

As the interconnectedness of these crises may not be immediately apparent, the role of poverty will now be introduced as a vector through which to explore their hidden connections. The HIV/AIDS pandemic is severely undermining progress towards the Millennium Development Goals, which include poverty reduction, the provision of primary education, achieving gender equity, reducing child mortality and increasing the status of the health of mothers (UNAIDS, 2006). AIDS-related diseases predominantly claim peoples' lives in their most productive years, severely diminishing the capacity for HIV/AIDS afflicted nations to build a strong economy and provide basic public services such as health, education, and security (2006). Attending to the needs of the millions of children who have been orphaned by this pandemic places a further strain on

national social and economic systems that are already in a state of extreme distress (2006).

Nations experiencing current economic and social strife will also be ill-equipped to adapt to the adverse effects of climate change (Kates, 2000; Tol et al., 2004). As predicting the exact type, amount and location of changes to be expected is beyond the scope of current climate models (Hitz & Smith, 2004), assessing the impact of climate change on human societies has been focused on specific regional warming and capacities for adaptation. The consensus of climate researchers is that Africa and the Polar Regions will very likely experience larger than the global annual mean warming (Holland & Bitz, 2003; IPCC, 2001, 2007). These regions are populated primarily by Indigenous peoples, many of whom are presently struggling to recover from the devastating effects of colonization (Kates, 2000; IPCC, 2001; Berkes & Jolly, 2002). There is a sad irony in the fact that the people most adversely affected by climate change will be those who have received the least benefit from the use of fossil fuels and deforestation for economic development.

Climactic effects will be most devastating to nations already struggling to provide food for their citizens. In a comparative analysis of the effects of climate change on agriculture, Hitz and Smith (2004) reported that "the existing disparities in crop production between developed and developing countries [are] estimated to increase" (p. 205). In most developing nations, agricultural activity is centered on small, labor-intensive farms that do not generate large surpluses of food (Brown, 2003). Thus, any decrease in food production will have dire consequences for the people of these nations. In addition to food shortages, the financial poverty of these nations will limit their ability to respond to other problems, such as extreme weather events and disease brought on by climate change. Any further increase in sea level will also result in an increase in the occurrence of coastal hazards such as erosion, saltwater intrusion, floods and tsunamis. With a recent study locating 1.2 billion people currently living in coastal areas (Small & Nichols, 2003), the cost of sea level rise could be

staggering in its effects upon human geography and the economic systems of coastal countries.

Poverty is also closely linked to the loss of biological diversity, which results from the combined effects of habitat destruction, invasive species, pollution, population and over-harvesting (Wilson, 2002, p. 50-51). From this list, only the occurrence of invasive species is not linked directly to poverty, but instead is at least partially attributable to changes in the migration of biotic communities in response to climate change. The state of the Earth's coral reefs, which are the natural habitat of over one quarter of all fish species (Tibbets, 2004), provides one example of the interconnectedness of these issues. A recent study by marine biologist Terry Hughes et al. (2003) identified thirty percent of coral reefs as 'severely damaged' and suggested that up to sixty percent could be lost entirely by 2030, due primarily to overfishing, pollution and climate change. Population has also had a significant impact on coral reefs, as they are generally located in close proximity to highly populated coastal areas (2004).

In addition to its aesthetic and ethical value, the economic value of biodiversity is beginning to be recognized. Biological diversity plays a pivotal role in the healthy functioning of ecosystems, which provide humans with numerous goods and services such as food, fuel, structural materials, medicines, water, and climate regulation (MEA, 2005). It has been estimated that each year coral reefs alone generate $375 billion (USD) in goods and services, with half a billion people reliant on them for food, materials or income (Wilkinson, 2002). The vast majority of biodiversity is also located in the poorest nations (Davis, 1993), nations that are generally desperate for economic development and willing to sacrifice biodiversity for the lives of their citizens.

The issues of poverty are not restricted to the developing world—the increased flow of diaspora populations throughout the globe combined with local pressures arising from economic globalization have created social problems in many developed nations. "As countries face increasing rates of poverty...global migration patterns and other challenges...the need to undertake development work in the disadvantaged communities of the 'First World' as much as the 'Third

World'" is being recognized (Rankin, 2004, p. 493). As a new global economy and post-Fordist markets emerged in the early 1970s, more profitable production of goods became available overseas and many industrial-manufacturing plants that supported entire communities were closed (Kenway & Kraak, 2004). As such, reasonably paid skilled and semiskilled industrial employment opportunities were lost, and replaced by a demand for cheap service workers, and "out-of-reach white-collar work" (Willis, 2004, p. 182).

This situation is exemplified at a school in Manchester where "declining employment opportunities for the White working-class youth, on the one hand, and increasing levels of postcolonial immigration, [are] leading to a great deal of racial unrest, on the other" (Rizvi, 2004, p. 83). Likewise in an Australian town examined by Bochner and Parkes (1998), similar economic changes have had dire health consequences for the population, including higher levels of stress and insomnia, increased use of prescription drugs, feelings of powerlessness, heightened fear of family breakup and of not being able to meet financial commitments, and higher levels of physical and verbal violence (p. 18-20).

HIV/AIDS, climate change, loss of biological diversity, poverty and increasing stress-related health issues provide clear examples of the interrelatedness of the crises that characterize the global context. As Capra (1996) has stated:

> Stabilizing world population will be possible only when poverty is reduced worldwide. The extinction of plant and animal species will continue as long as the Southern Hemisphere is burdened by massive debts. Scarcities of resources and environmental degradation combine with rapidly expanding populations to lead to the breakdown of local communities and to ethnic and tribal violence. (p. 4)

These crises are inextricably interconnected; attempting to address each of them individually involves the inevitable risk of exacerbating other crises or contributing to the emergence of new ones. The interdependent nature of these crises necessitates the use of a systems approach that locates economic systems

within the parameters of a larger living system. The next section explores the potential role of formal education in contributing to the resolution of humanity's contemporary global crises.

Contemporary Educational Objectives

In the present context Western formal education is identified variously as a means for achieving numerous social, political and economic objectives. These aims have been inherited, relatively unchanged, from the origins of Western public education, where the development of a patriotic citizenry and skilled workforce supported the larger national agendas of colonization and industrialization (Katz, 1976; Osborne, 1999). Liberal and, more recently, neoliberal ideologies, also inform our educational objectives. From these perspectives the success of society as a whole is dependent on the ability of its individual members and groups to succeed in a variety of increasingly competitive milieus.

Classical liberalist ideology grew out of John Locke's seventeenth century political writings on 'individual freedom', and Adam Smith's eighteenth century economic writings that emphasized market capitalism and minimal state control (Feinberg & McDonough, 2003). In a relevant critique of classical economics published in 1884, William Hanson described the ideology of the free market as 'abnormally selfish' (p. 142). Hanson's analysis is consistent with Stuart Hall's (1988) critique of neoliberal Thatcherism as 'selfish individualism'. Neoliberal economic theory proposes economic growth and privatization as necessary for maximizing individual opportunities for achievement. From this perspective, development will occur through a reduction of state control over international trade, thereby facilitating competition in a free market, allowing technology and wealth to spread to areas in need of development (Sowell, 2003; Vickers, 1997).

Neoliberal individualism as a means towards development, however, has been widely criticized as limiting, rather than facilitating, human development (Jameson, 2001; Kapur, 2001; Kellner, 2003; Khor, 2001; Nef & Robles, 2000; Stewart-Harawira, 2005). Though human development is stated as an aim of neoliberal economics, recognition of financial wealth and technology as the

means of accomplishing this goal establishes these products as paramount, removing focus from the people in need. Slaughter and Rhoades (2004), recognize this myopic perspective; "the neoliberal state focuses not on social welfare for the citizenry as a whole but on enabling individuals as economic actors" (p. 20). To what degree are these educational aims appropriate for the rapid changes that are occurring in today's world?

The Aims of Neoliberal Education

Informal learning has always been crucial to the efficacy of the production, distribution and consumption of goods needed for human survival. Today, education is described as a means for generating 'productive' members of society (Dewey, 1916) and preparing students for competition in the global marketplace (Axelrod, 2002). While education and economics are mutually influential, recent trends clearly establish the dominance of economics over the realm of education. The contemporary relationship between neoliberal economics and education is characterized by the privatization, commodification and marketization of both schools and knowledge (Axelrod, 2002; Etzkowitz & Leydesdorff, 1997; Slaughter & Leslie, 1997; Slaughter & Rhoades, 2004).

While contemporary Western discourse continues to include social and political objectives as goals for formal education, there has been a marked shift toward the prominence of economic aims. As observed by Orr (2004), "most people agree on the basic aims and purposes of education, which are to equip our nation with a 'world-class' labor force, first, to compete more favorably in the global economy and, second, to provide each individual with the means for maximum upward mobility" (p. 26).

Neoliberalism has directly impacted education through its desire to limit government interference and permit optimal functioning of the free market (Jameson, 2001). How well fit neoliberal ideology is for creating 'educated persons' aware of and responsive to global crises is highly questionable; quoting Nef and Robles (2000) neoliberal discourse "has been far more successful in articulating a rationalization for the globalization of market relations and

unprecedented (as well as unencumbered) capital accumulation than in effectively improving the living conditions of most human beings" (p. 28).

In *All You Can Eat* (2001), Linda McQuaig describes the fundamental ethical shift in social-economic theory that has occurred since the fourteenth century. McQuaig relates how the 'medieval legal code' identified "excessive private gain to the detriment of the well-being of the community" (p. 6) as illegal. She continues, stating, "the enemy today is no longer believed to be individual greed but rather any collective action aimed at curbing that greed, restraining it in the name of the broader collective interest" (p. 6). This shift from public to private interests, and its associated desire for unlimited profit, has influenced every level of education. Even the language used to describe education and educational institutions has been infused with the discourse of economics. Parents are described as 'consumers' and students as 'products' of education. 'School (business) plans' that demonstrate the 'efficiency' and 'accountability' of the institution are now required from school administrators or 'managers'.

Neoliberal policy has profoundly impacted the nature of education as revived neoclassical forms of Human Capital Theory, which made their first appearance in the second half of the nineteenth century, became popularized throughout the OECD countries (Marginson, 1993 cited in Olssen, Codd & O'Neill, 2004). The radical restructuring of states into neoliberal forms that engulfed firstly, developing, and secondly, developed countries in the 1980s has also impacted strongly on state-indigenous peoples' relationships. For example, at the signing of a Memorandum of Understanding between an aboriginal educational institution and a major research university, the Provincial Minister for Advanced Education spoke with eloquence about "the role of higher education in promoting the knowledge economy and the responsibility of graduates to contribute back to the Province and facilitate provincial engagement in the global economy" (Stewart-Harawira, 2007, p. 27) thus fulfilling their roles as 'good citizens'.

Academic Capitalism

Institutions of 'higher learning' have not been exempt from the effects of neoliberal economic globalization. One theorization of these effects, *academic capitalism* (Slaughter & Leslie, 1997; Slaughter & Rhoades, 2004), "sees groups of actors...as using a variety of state resources to create new circuits of knowledge that link higher education institutions to the new [knowledge] economy" (2004, p. 1). In this context, academic students, faculty and staff have become 'state-subsidized entrepreneurs, expending their human capital stocks in increasingly competitive situations' (2004).

The effect of neoliberal policy on universities is radically altering the culture of these institutions. The incipient proverb 'publish or perish' refers to the necessity of publishing to ensure future funding within academia. This, in turn, leads to 'favors' being done for credit as an author (resulting in multiple-authored papers), premature publication, and sensationalized results (e.g., Kerr, 1998). It has also resulted in the 'prostitution of science', where labs are rented to industry (preventing use by faculty and students), and the occurrence of 'unpublishable' theses due to financier-protected data. Slaughter and Rhoades (2004) relate these occurrences to the new 'circuit of knowledge' that has been created. The private sector has become a new (often overbearing) partner with the academy and government in the creation and transmission of knowledge.

The most profound contribution of neoliberal ideology to academic capitalism has been a marked shift in funding that has allowed 'private' interests to prevail over the traditionally 'public' good of the university. Neoliberal economic policies of federal 'fiscal restraint' limit state and provincial funding for public and social institutions (Thelin, 2004). This, in turn, increases opportunities for the involvement of private companies and industry in all aspects of education. As a result, incidents of non-disclosure of funding for published work have become commonplace (Axelrod, 2002), and credentialism (education as a means of individual achievement) is now the norm (Labaree, 1997).

The importance of 'intellectual property' has also become more pronounced with implementation of neoliberal economic policy. As a result, for-

profit businesses are now built upon publicly funded research (Natural Sciences and Engineering Research Council of Canada (NSERC), 2005). Despite the fact that research institutions operate primarily on federal or provincial funding (Thelin, 2004), it is possible for faculty and research groups to patent and privately own (and sell) results. All parties involved in academic enterprises now stand to gain, or lose, depending on their ability to function in the free market.

Rapid advances in information technologies, aided in part by neoliberal economic globalization, have resulted in an inflation of the value of knowledge and information within both economic and social institutions. The recent transformation to a 'knowledge economy' and an 'information society' places additional importance on public institutions of learning and research. As Foucault (1979) has aptly pointed out, there are "no power relations without the constitution of a field of knowledge, nor any knowledge that does not presuppose at the same time power relations" (p. 27). As institutions dedicated to the creation, refinement and application of knowledge, universities are imbued with a considerable amount of power.

Eroding the 'Conscience of Humanity'

The importance of educational institutions within society is obvious. In addition to the role that schools play in the cognitive and social development of students, formal educational institutions of 'higher learning' are sites of considerable intellectual and technological innovation that impact society in diverse and profound ways. There is some irony in the fact that neoliberal policies now limit the freedom available to academics to pursue their own research interests, as it was this very freedom that allowed the neoliberal ideological constructs of individualism and free-market economics to be theorized, developed and taught (Peters, 2004, p. 41). For educational theorists, neoliberal policy further limits the transmission of alternate educational perspectives to students and teachers in training—imposing a major disconnect between counter-hegemonic educational theory and classroom practice.

Keohane (1994) argues that in addition to the theorization and creation of

knowledge universities have "a *responsibility* [italics added] to see that such knowledge is used to improve the human condition" (p. 155). This responsibility necessarily includes working towards goals of equity, social justice and human development. The social sciences and humanities, disciplines steeped in critical theory, have traditionally been free and even encouraged to critically analyze the current social order, often with an aim to improve the development of people within it (Barr, 2002; Coffield & Williamson, 1997).

Through the application of neoliberal economic policies, private interests are engulfing the public domain and controlling the commons, including education. Research funding is being directed towards commercially profitable projects, and less funding is available for the traditionally 'free-thinking' and 'critical' work done in the arts and humanities. As a result, an erosion of 'the conscience of humanity' is occurring within tertiary education institutions. Universities, as socially sponsored institutions, are viewed as legitimately purveying socially desirable attitudes and behaviors. As neoliberal ideology infiltrates the structure and content of schools, the students, parents and societies served by these institutions increasingly accept its ideology (including its ethics) as an authentic social norm. It will be difficult for those suffering under globalized neoliberalism to impede its progress without a legitimate place from which to resist.

Assessing Neoliberal Education and Economics

The underlying belief of neoliberalism is that economic development through the free market will eventually address issues of poverty and human development. Despite overall increases in life expectancy, infant mortality, and the percentage of children attending school, the gap between the rich and poor continues to grow (World Commission on Environment and Development, 1987; UNHDR, 2005). The rabid consumption required for economic growth is promulgating ecological degradation and severely limiting the capacity of billions of people to survive.

In a very real sense, neoliberal ideology has resulted in the unrelenting 'commodification of the life-world' (Habermas, 1981). Based on human and

corporate actions, we seem to be living in a world that values money over life. Is life a commodity? Is life a resource that can be bought and sold in pursuit of the neoliberal dream of unlimited growth and profit? Or have we got it backwards? Perhaps it would be more appropriate to think of economic systems as an aspect of the living systems that created them. From a systems perspective, the failure of the neoliberal approach to resolving global issues of poverty has resulted from an abysmal lack of appreciation for the value of life and a failure to recognize that economic systems do not exist in isolation from the rest of the living world (Hawken, 1993).

The Aims of Biocentric Education

> When the scientific interest conflicts with, say, the religious, or the economic with the scientific or aesthetic, or when the conservative concern for order is at odds with the progressive interest in freedom, or when institutionalism clashes with individuality, there is a stimulus to discover some more comprehensive point of view from which the divergencies may be brought together, and consistency or continuity of experience recovered. (Dewey, 1916, p. 326)

Conflict, to some degree, must be expected in any system composed of diverse agents. While the use of violence to resolve conflicts unnecessarily destroys both living organisms and the ecological systems upon which they depend, the impediment to cooperation and collaboration that results from cultural conflicts may be regarded as equally deadly. Biocentric education is a response to the stimulus of global crises. It is an attempt to locate a 'more comprehensive point of view' (Dewey, 1916) from which divergent cultural groups may be brought together in pursuit of global survival.

Formal education presents one realm of civil society that is capable of challenging the dominance of the narrow aims of neoliberal forms of economic globalization. It is therefore critical that broader goals such as global survival are reflected in the aims of educational institutions. Biocentric education is a

conscious attempt to contribute to what Edmund O'Sullivan (1999) has referred to as 'transformative ecozoic education', an attempt to forge a new sustainable relationship between humanity and the planet through education. It is my belief that the framework of complexity thinking, especially as applied to life, is an important conceptual lens that may play a pivotal role in this transformation.

Acknowledging life as a source of common ground, biocentric education aims to contribute to the broad goal of global survival by fostering a wider appreciation of the miracle of life, an awareness of the systemic nature of global crises, and an understanding of life as a complex system as an adaptation to our cultural worldviews. Biocentric education, as a process of conscious cultural evolution, aims to reconnect students with the living system from which we have emerged and with which we have evolved.

Life as Common Ground

I have chosen to investigate a biocentric perspective in an effort to find a common foundation for diverse educational aims—inescapably, we are all living organisms. By centering educational discourse on the concept of life as a complex system I hope to establish a broader measure of commonality that may facilitate engagement in dialogue and collaboration with people from diverse cultural backgrounds. Formal education possesses the potential to facilitate the global sense of common purpose from which processes of inter-cultural collaboration needed to address and resolve crises that threaten global survival may emerge. As Seymour (2004) has noted, "to redeem our view of the possibilities in education, we need to explore common ground and allow our differences to recede enough to achieve unity of purpose" (p. 3).

The importance of developing a widely shared life-centered philosophy lies in its potential provision of a common framework for intercultural dialogue. While there are diverse cultural approaches to understanding life, centering discourse on life and its inherent value may bring these voices together in a dialogue on the shared goal of global survival. Somewhat ironically, the emergence of global crises resulting from ongoing conflict and competition has

spurred a growing recognition of the need for collaborative responses to these issues. As Indonesian president Susilo Bambang Yudhoyono remarked in his keynote address at the 2005 APEC CEO summit, "when you fight for ideology, territory, or natural resources, you can be locked in a conflict with one another. But the fight against the [Avian Flu] virus turns everybody into allies".

In some cases the discord among competing cultural worldviews, including ideas about what life is and which forms of life are of most value, may appear to drastically limit the possibility of cross cultural collaboration. In this thesis I present a potential remedy for this perspective, introducing biocentric complexity as a means of viewing divergent cultural forms as integral agents of a living complex system. From this perspective, attempting to establish *conclusive solutions* to cultural conflicts that in some cases have been ongoing for millennia is viewed as an inappropriate response. Through the lens of biocentric complexity *dynamic resolutions*, which at times may simply require acceptance of conflicting views, may be the only viable response to these conflicts. Rather than attempting to establish concrete solutions to these problems, biocentric complexity suggests the need for ongoing 'recursive solutioning' in which individuals with diverse cultural perspectives make a conscious effort to peacefully coexist without diminishing possibilities for the shared goal of global survival.

The Miracle of Life

For many it is the aesthetic beauty of living organisms and systems that makes them inherently valuable. I certainly agree that living systems can exhibit extraordinary beauty, however, I also must also contend that these aesthetic judgments are both subjective and relative. In addition to their visual splendor, living organisms are capable of behaviors that can only be described as ugly. Anyone who has witnessed a collective of coral polyps extruding their digestive tracts to devour a group of rival polyps would most likely agree. There is also, of course, the long list of human atrocities that have been committed over millennia, many of which continue to this day. Life in its diverse manifestations may be beautiful, but it can also be horrifyingly repugnant.

For me it is the miraculous nature of the emergence of life that makes it intrinsically valuable. The term 'miracle' is used here to signify an event that either violates the laws of nature or is exceedingly unlikely. Although the miracle of life is most often associated with theistic accounts of Creation, I perceive the scientific accounts of the origins and evolution of life as equally extraordinary. From a scientific perspective, it is the unlikely existence of our planet's diversity of life that qualifies it as a miracle. Through the lens of biocentric complexity, it is doubtful that 'replaying life's tape' would result in the same arrangement of living organisms on Earth that is observed today (Gould, 1989).

The apparent scarcity of complex life in the universe also contributes to a scientific understanding of life as a miracle. Until recently, however, it was believed by many that self-conscious 'civilized' life forms may be abundant in the universe. In the latter half of the twentieth century the search for intelligent extra-terrestrial life prompted astronomer Frank Drake to develop an equation that attempted to estimate the number of civilizations that might exist in our galaxy. According to the 'Drake Equation', approximately one million civilizations capable of interstellar communication may inhabit the Milky Way (Sagan & Drake, 1975). Recent scientific advances contributing to the emergent field of astrobiology, however, have posed significant challenges to this astonishing estimate.

Geologist Peter Ward and astronomer Donald Brownlee (2004) have pooled together updated data from geology, biology and astronomy to propose the 'Rare Earth' hypothesis, complete with its own 'Rare Earth Equation'. While agreeing that microbial life may be abundant in the universe, they argue that the emergence of complex multi-cellular life capable human-like consciousness is exceedingly rare. Acknowledging the limitations associated with basing their hypothesis on the DNA based life forms found on Earth, the authors claim that the complex interaction of a myriad of interconnected variables required for the emergence of multi-cellular life renders the possibility of Earth-like life on other planets in the galaxy extremely unlikely.

Whether one believes that life was breathed into the world by the Creator or God, or that today's diversity of life is the result of an unimaginable procession of genetic mutations and recombinations over billions of years, life can and should be considered a miracle. Although the conceptual framework developed in this work is based largely on a scientific account of life, the implications of the sciences of complexity pose remarkable similarities to many ancient Indigenous and Eastern spiritual worldviews and do not necessarily exclude the possibility of the supernatural. From the perspective of biocentric complexity presented here, "we evolved here, one among many species, across billions of years, and exist as one miracle linked to others" (Wilson, 2002, p. 40).

Biocentrism and Neoliberalism

Recognizing life as 'miraculous' provides a stark contrast to neoliberal conception of living organisms as 'commodities' for trade. Since the aims of education must be constantly adapted to a dynamic world, the current context of globally interconnected crises warrant serious consideration of global survival as an aim of formal education. As Orr (2004) has stated, "the worth of education must now be measured against the standards of decency and human survival" (p. 8).

Biocentric education constitutes a notable shift in focus from the dominance of economic concerns in today's educational models. It is a shift from a neoliberal educational perspective dominated by the 'bottom line' (i.e. the financial concerns of the business model of education) to one that is centered on the concept and value of life. The life-centered approach to education forwarded here is attentive to the implications of systems thinking, thereby attempting to address Capra's (1982, 1996) crisis of perception. The limitations associated with the reductionist nature of neoliberal education are, in my view, augmented by a biocentric complexivist approach to education.

By moving the concept of life to the center of the discussion, economics becomes only one of the many systems that impact and constitute living systems. Biocentric education complements the neoliberal aims of education by situating individuals and groups in the context of a living system and acknowledging the

importance of co-operation in addition to competition for the emergence of adaptations needed to evolve and survive in a dynamic universe. As Capra (1982) has noted, "all struggle in nature takes place within a wider context of cooperation" (p. 34).

The broad goal of global survival as the primary aim of biocentric education is a context within which more narrowly focused aims of education may be considered. A key question here is whether specific aims of education contribute to the objective of acceptable, sustainable survival (Potter & Potter, 1995). Drawing attention to the need for biocentric education is not an attempt to circumvent other interests but to simply include the issue of global survival in dialogues on the purposes of education. We are living in an unprecedented time of accelerating global change, the challenges of which appear to be only slowly emerging into the collective conscience of the education community. The failure to recognize the shortcomings of the neoliberal model by Western formal education systems is an indication that they have yet to effectively respond to the rapidly changing physical and cultural landscapes in which they are embedded.

Centering education on the concept of life reflects the need to understand what life is if we would like it (including us) to survive. By 'understanding life', I am not referring to a deeply personal and philosophical *meaning* of life, but to a scientific description of living systems. Biocentric education is a way of thinking about education in terms of complex living systems, recognizing that the survival of our species is dependent upon the survival of the multiplicity of systems with which we are enmeshed. Capra's (1996) crisis of a perception may be, above all else, a crisis of how we perceive life. Shifting our perception of life from one of individual organisms to one of organisms enmeshed within a living system may contribute to a wider awareness of ourselves as part of a larger entity, constituting a source of common ground from which efforts to address global crises may proceed.

Chapter 3: Biocentric Complexity Thinking

Complexity and Life

The interconnected humanitarian, economic and environmental crises discussed in Chapter Two constitute persuasive evidence that humanity has acted in ways that are at least disrespectful to, and are perhaps even ignorant of, both other living organisms and the systems that sustain our collective survival. If the mechanisms that are presently deteriorating living systems are rooted in a human crisis of perception as Capra (1982, 1996) has suggested, then perhaps the way in which people commonly perceive 'life' requires analysis. Identifying perceptions and conceptions of life is a necessary step in efforts toward global survival through biocentric education, as what we think life is will likely impact actions taken to sustain it. In this chapter I identify conventional Western conceptions of life and propose a complexivist alternative. I attempt to develop a set of concepts that can be used to describe and think about life as a complex system, exploring the possibility that a renewed appreciation of humanity's dynamic interdependence with the world may be achieved through the lens of biocentric complexity thinking.

The term 'biocentric' has been used in discourse on medical ethics (Steinbock, 2007) and wildlife management (Loomis, 2002), and has also been used in relation to transgender and transsexual rights (Cvetkovich, 2001). In this thesis, however, the term is applied more broadly, with a definition stemming from its etymological roots; *bio* the Greek term for 'life' or 'living' and *centric* derived from the Latin *centrum* for 'centered'. Biocentric thinking is simply 'life-centered thinking'. Complexity theory, which both challenges and complements the linear-reductionist thought of modernity, is drawn on to develop the notion of *biocentric complexity thinking*—a way of thinking about life as a collective of intertwined complex systems. The broad, multi-dimensional understanding of living systems emanating from complexity theory underscores the intrinsic value of all aspects of the living world and provides useful analytic for survival research.

Biocentric complexity thinking also provides an emergent conceptual framework for biocentric education in its provision of a description of life that acknowledges humanity's physical and cultural embeddedness in multiple systems. Complexivist discourses provide a vocabulary that describes the structure and behaviour of complex systems, which I use in this chapter to illustrate the relevance of complexity thinking for the development and promotion of a life-centered perspective for education. From this perspective, formal education is viewed as integral to global survival through its influence on the worldviews through which humanity is culturally engaged with the world. The concept of biocentric complexity that I present draws on both traditional linear-reductionist science and the 'new' sciences of complexity to depict living organisms as emergent manifestations of complex systems. Although many of the ideas I draw on were developed through highly technical specialized science, my intention is to translate these insights into a more easily understood language that can be communicated to a broad spectrum of educators. In this chapter I provide a complexivist understanding of life, a word that evokes strong emotions and is inherently difficult to define, while accepting that biocentric complexity provides just one of many possible ways to think about life.

Recognizing Life

Addressing this aspect of the crisis of perception requires *recognizing* life in the dual sense of 'identifying' conventional perceptions of life and 're-thinking' life in terms of interconnected complex systems. A dearth of research studies on conventional perceptions of life indicate that this approach to assessing and addressing the crisis of perception has not yet received adequate attention. The absence of relevant research in this area has also resulted in an identification of common perceptions of life through dictionary definitions and personal authorial and editorial experience. Personal experiences of people's everyday understandings of life pose obvious limitations for generalization. Dictionaries, however, represent a widely used resource, and thus provide an accessible means of investigating popular understandings of the term.

Dictionary definitions of life reflect the linear-reductionism that has characterized much of contemporary Western thinking. Common definitions of 'life' listed in a popular online dictionary include the following:

> 1. The condition that distinguishes organisms from inorganic objects and dead organisms, being manifested by growth through metabolism, reproduction, and the power of adaptation to environment through changes originating internally.
> 2. The sum of the distinguishing phenomena of organisms, esp. metabolism, growth, reproduction, and adaptation to environment.
> 3. The animate existence or period of animate existence of an individual: *to risk one's life; a short life and a merry one.*

Before initiating my own process of reflection on life my perceptions were remarkably similar to these definitions, which describe life as physically and temporally bounded in finite living objects that exist separately from their surrounding non-living environments. These definitions are clearly reductionist in their focus on discrete individual organisms and linear in their identification of distinct beginning and end points of organisms' lives.

As with all language and vocabulary, the meaning of the word 'life' is susceptible to subtle and not-so-subtle shifts as its context of use changes through time. In the preface to *The Web of Life* (1996), Capra reflects on the influence that fellow Austrian Erwin Schrödinger's work has had on our present conception of life. In *What is Life?* (1944), Schrödinger speculated on the possibility that our genetic information might be stored in complex molecules contained within each of our cells. His text inspired many to pursue research in the field of genetics, including James Watson and Francis Crick, who were awarded a Nobel Prize for their discovery of the molecular structure of deoxyribonucleic acid (DNA) in 1962. Consequently, the relationship between an individual living organism and the genetic material contained within each of their cells, though infrequently reflected in dictionary definitions, is now widely acknowledged.

In Capra's (1996) text he contributes to the development of a more recent scientifically based reconceptualization of life by proposing a synthesis of recent

discoveries into a systems view of life. This time, the way we think about life is being expanded beyond individual organisms directed by genes to include a webbed existence where life arises from and is enmeshed within a multiplicity of complex systems.

Introducing Complexity

Complexity theory, the principal conceptual lens through which life is 're-thought' in this chapter, constitutes one branch of the broader field of general systems theory (Bertalanffy, 1968; Skyttner, 2001). General systems theory includes numerous systemic perspectives that have been developed and applied in areas as diverse as computer science, organizational and management theory, cognitive science, and artificial intelligence. The most influential and long-lasting application of ideas from general systems theory in education has been the use 'scientific systems management' (based on mechanistic-industrial systems of efficient production) in curriculum development (e.g., Tyler, 1949).

In recognition of the limits of this systemic model for curriculum and educational work in general (Kliebard, 1975), Apple (2004) has suggested that, "educators must engage in continuous and in-depth analysis of other forms of systems theory" (p. 112). In this chapter, I pursue complexity theory as one example of "the lenses of open systems and biological systems that could provide excellent disclosure models for further examination" (p. 112). Initially rooted in scientific disciplines (e.g., thermodynamics, molecular chemistry and particle physics), complexity theory has also been applied in the social sciences (Byrne, 1998) including numerous recent applications in the field of education (e.g., Davis & Sumara, 2006; Davis, Sumara & Luce-Kapler, 2008; Doll, Fleener, Trueit & St. Julien, 2005).

Mechanical and Complex Systems

Rather than a single discipline-specific body of theory, complexity theory has emerged from a collective of divergent areas of inquiry that take complex systems as primary objects of inquiry. Chaos theory, cybernetics, artificial intelligence,

fractal geometry and nonlinear dynamics have all contributed to the emergence of the interdisciplinary field of complexity (Davis & Sumara, 2006, p. 8). Physicist and information scientist Warren Weaver (1948) made an early contribution to the academic discourse on complexity by identifying three types of systems: simple, complicated, and complex. Weaver described simple and complicated systems as linearly organized mechanistic systems, with simple systems composed of fewer parts than more complicated systems. As noted by Davis and Sumara (2006), it was simple mechanistic systems that "captured the attention of Galileo, Descartes, Bacon and Newton" (p. 9). These systems can generally be understood through a reductive analysis of their components, leading to identification of fundamental particles and basic laws. Despite their mechanistic nature, the large number of parts in more complicated systems can often make reductionist analyses very difficult if not impossible, necessitating the use of mathematical probability and statistics for meaningful analysis (p. 10).

Weaver categorized complex systems as distinct from both simple and complicated systems due to their adaptive, nonlinear nature. Typically, both the agents and interactions among agents in complex systems are capable of change in response to perturbations, thus they exhibit dynamic behavior that is not reducible to the sum of their parts. Their adaptive capacity results in part from nonlinear communication or feedback loops among their parts (a concept that was central to the development of the related field of cybernetics (Weiner, 1961)). As a contemporary example of feedback and complexity, the Internet is commonly identified as a complex system, while the unidirectional communicative medium of television is not (Johnson, 2001). As T. S. Elliot reportedly quipped, 'television is a medium of entertainment which permits millions of people to listen to the same joke at the same time, and yet remain lonesome'.

Complexity theory resonates with the ecological focus on relationships and interconnections and is frequently used as a descriptive framework for social, economic, cultural and living systems. The stock market, ant colonies, cells, cultures, brains, ecosystems, communities, and classrooms have all been listed as examples of complex systems (Johnson, 2001; Davis & Sumara, 2006). The broad

suitability of complexivist descriptions for phenomena across disciplinary boundaries speaks to the deep interrelatedness of these varied objects of study, drawing attention to what cyberneticist Gregory Bateson (1979) referred to as the 'patterns that connect'. Drawing on Bateson's work, Volk (1995) has used the term 'metapattern' to refer to "a pattern so wide-flung that it appears throughout the spectrum of reality: in clouds, rivers, and planets; in cells, organisms, and ecosystems; in art, architecture, and politics" (p. iix). This perspective of interconnectedness presents a significant departure from the part-whole dichotomy (e.g., man-nature, mind-body) that has underpinned much of contemporary Western thought.

Complexity and Chaos

Complexity theory is frequently paired with chaos theory, which is associated predominantly with the mathematical study of complex systems. James Gleick brought chaos theory to the popular lexicon in his (1987) *Chaos*, where he introduced concepts such as 'the butterfly effect', 'fractal patterns' and 'strange attractors'. Gleick also includes a narrative of the emergence of the field of complexity studies. He vividly describes how a few researchers in diverse disciplinary specializations came to believe that "simple, deterministic systems could breed complexity; that systems too complex for traditional mathematics could yet obey simple laws; and that, whatever their particular field, their task was to understand complexity itself" (p. 307).

In *Complexity* (1992), physicist M. M. Waldrop provides a useful analysis of complex and chaotic systems, positioning complex systems at the 'edge of chaos' between orderly mechanistic systems (e.g., a clock) and disordered chaotic systems (e.g., weather systems) (p. 293). Waldrop described complex systems as dynamic networks of agents acting in parallel with highly decentralized control that are capable of generating coherent patterns on multiple levels. "In every case, groups of agents seeking mutual accommodation and self-consistency somehow manage to transcend themselves, acquiring collective properties such as life, thought, and purpose that they might never have possessed individually" (p. 11).

In the same text, Waldrop also describes the origins and work of The Santa Fe Institute, an internationally renowned interdisciplinary center for complexity research that attracts scholars and researchers from a broad range of cultural and disciplinary backgrounds. From the comments of a former president of the Santa Fe Institute, it appears that complexity may have particular relevance for survival research. As Waldrop relates, George Cowan "privately thought of the place as an 'institute on the art of survival'" (p. 72-73). The relevance of complexity for describing and sustaining life has also been recognized by biologist and complexivist Stuart Kauffman (1995), who believes that life "is not to be located in its parts, but in the collective emergent properties of the whole they create" (p. 24). For Kauffman, "life exists at the edge of chaos" (p. 26)

I share the conviction that complexity may be useful in addressing the crisis of perception by rethinking life and contributing to global survival. It is important to note, however, that complexity theory can be used to exploit systems as easily as it may be used to sustain them. Some neoliberal economists are undoubtedly applying insights from complexity to maximize profit from complex economic systems. For example, whereas Lewin (1999) asserts that "the world of business represents the most immediate experience of complex systems on a day-to-day basis" (p. xi), this thesis proceeds from the biocentric view that humanity's most intimate connection to complex systems is its biological nature. Identifying life as more valuable than money is central to prompting consideration of the complex interactions between economic systems and other aspects of living systems.

I have adopted complexity in this research primarily through what Davis and Sumara (2006) have dubbed 'complexity thinking', which is "concerned with the philosophical and pragmatic implications of assuming a complex universe—a way of thinking and acting" (p. 18). Their description of complexity thinking is particularly appealing because of the connection made between thought and action. Complexity presents not only a way of rethinking life as a living system; it presents a framework in which we may consider the cultural and physical ramifications of our actions.

Acknowledging Uncertainty

The breadth of complexity thinking makes 'complexity research' inherently difficult to define. As Davis and Sumara (2006) note, "it is not even clear whether it should be called a field, a domain, a system of interpretation, or even a research attitude" (p. ix). In part, this difficulty is a result of the relatively recent emergence of the complexity sciences. Complexity's refusal of tidy descriptions also results from its shift away from traditional reductionist thinking, which is epistemologically and ontologically based in an expectation of accurately deciphering and analyzing discretely bounded mechanistic systems. The adaptive dynamics of the systems that are the focus of the new studies of complexity have resulted in the need to constantly evolve and adjust complexivist approaches and methodologies. These nonlinear dynamics have also given rise to the complexivist acknowledgement of a degree of uncertainty with regard to accurately predicting the behavior of complex systems.

The acknowledgement of uncertainty in complexity science constitutes a notable shift from the 'standard account of science' as "a form of knowledge that produces facts" (Erickson, 2005, p. 55). Identifying the products of science as factual implies that all scientific knowledge provides an accurate, true description of the world, a view that has become known as 'scientism'. This perception of science is based largely on the philosophy of logical positivism associated with the Vienna Circle (1929/1973), a group of influential philosophers and mathematicians based at Vienna University. Logical positivists saw science as "a unified project with a unitary method: the most important, and best, form of knowledge existing in modern society" (2005, p. 16). For A. J. Ayer, a prominent philosopher within the Vienna Circle, there was "no type of speculative knowledge about the world beyond the power of science to give" (1971, p. 64).

Despite the persistence of the 'standard account' as a popular understanding of science, the philosophy of science has evolved considerably since the Vienna Circle's bold proclamations. Following the insights of Fleck (1935/1979) and Kuhn (1980), Austrian philosopher of science Paul Feyerabend

(1993) contends that the identification of scientific knowledge as "peculiarly positive and free from differences of opinion is nothing but a chimera" (p. 242). Sociologists (e.g., Collins & Pinch, 1998; Pinch, 1986) and feminist philosophers of science (e.g., Nelson, 1993) have, furthermore, identified multiple worldviews at play within the quasi-domain of science. For these theorists, it is the social coherence of these worldviews, rather than an objective, neutral examination of reality, that establishes these domains as epistemologically relevant and able to generate scientific knowledge.

As diverse perspectives are at work within the varied disciplines of science, a multiplicity of inchoate forms of knowledge are being created. Through acknowledging this uncertainty, science can be considered "just one form of knowledge among many, neither necessarily better or worse" (Erickson, 2005, p. 77). Critiquing the 'standard account' of science, however, "is not to be critical of science or even the importance of scientific inquiry...it is to be critical of a simplistic and vulgar scientism" (Kliebard, 1975, p. 45). Changing public perceptions to reflect this new philosophy of science is one of the central tasks faced by today's science educators. This change would do much to improve public acceptance of and participation in scientific endeavors in general, and acceptance of the complexivist acknowledgement of uncertainty in particular.

The Challenge of Complexity

The shift away from the abstractions and idealized predictable situations of traditional science toward complexity's attention to disorder, nonlinearity, unpredictability and uncertainty has sparked debate regarding the compatibility of complexivist and linear-reductionist approaches to education. For educational theorist Mike Radford (2007), complexity thinking constitutes nothing less than a paradigm shift from the linear-reductionist science upon which contemporary 'school improvement' discourses are founded.

Thomas Kuhn, who coined the term 'paradigm shift' in *The Structure of Scientific Revolutions* (1980), described paradigms as sets of ideas or worldviews that are incommensurable. Following Kuhn's definition, competing paradigms are

incompatible, fully lacking the commonality required to make any meaningful comparison. Contrary to Radford's conjecture that complexity thinking requires a paradigm shift, however, I believe that complexity might be better viewed as complementary to traditional linear-reductive methodologies. Support for this notion can be found in the fact that complexity theory has itself emerged from the work of traditional reductionist analytic scientists. To acknowledge the distinct implications of complexity thinking in different academic domains, Davis and Sumara (2006) have drawn on the work of Richardson and Cilliers (2001) to classify complexity into 'hard' complexity science dominated by physicists and 'soft' complexity science applied in the biological and social sciences. They note that the reductionist 'hard complexity sciences' have provided the metaphors and principles that 'soft complexity science' applies to social and living systems (p. 18).

Complexivist approaches developed largely in response to the limitations of linear-reductionist approaches for analyzing complex systems. Physicist and Nobel Laureate Philip Anderson (1972) describes this relationship in terms of the familiar metaphor 'more than the sum of its parts':

> The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research that I believe is as fundamental in nature as any other. (p. 393)

Complexity can be reductionist to varying degrees depending on the level of structure or behavior that is being studied. Some systems are best studied through both complexivist and linear-reductionist lenses—a bifurcate collaboration of perspectives that are certainly not incommensurate. Russian physicist Ilya Prigogine's work on dissipative structures provides a clear (Nobel-prize winning) example of how the two perspectives can be combined to provide novel understandings of complex phenomena (Prigogine & Stengers, 1984).

Complexity may challenge a strict adherence to linear causality but does not present a challenge to the utility of this approach for analysis of mechanistic systems. Depending upon the object of study, linear based approaches may be entirely appropriate. In many cases linear interpretations of causal relationships may simply approximate aspects of complex systems that have achieved a high degree of consistency and stability. For example, the belief that one's cultural knowledge influences one's actions, a central axiom of this thesis, may appear to be a linear relationship. The use of the term *influences*, rather than *causes*, however, indicates that this relationship can only be approximated as linear when in fact it is nonlinear. On occasion one's actions may deviate significantly from one's ideals due to circumstances (of environmental, biochemical, or temporal nature) that influence cognitive operations and action.

Complexity does not constitute a total refutation of modernist linear thinking but rather provides a means of augmenting the shortcomings of linear-reductionist approaches. For example, in this thesis I draw on both complexity thinking and reductionist science (e.g., genetics) in developing a framework for biocentric education. It is my belief that approaching these ways of thinking as mutually informative and complementary is pragmatically preferable to a solely competitive approach. Both cooperation and competition characterize the relationships among agents in complex living systems. It is the areas of consilience that exist between modernist linear-reductionist and postmodern complexivist approaches that are of greatest importance for the development of biocentric education. These consiliences are perhaps best illustrated in discourse surrounding the origins and definitions of life.

The Structure and Behavior of Complex Systems

The metaphor of living organisms as machines has been present at least since Descartes' seventeenth century description of non-human organisms as soulless, non-thinking automata. Biological organisms, however, are clearly not mechanistic in nature as they exhibit characteristic structures and behaviors that are attributable only to complex systems. The complexivist concepts of emergent

behavior, nested structure, and adaptive capacity have been well described (e.g., Capra, 1996; Casti, 1994; Cohen & Stewart, 1994; Davis & Sumara, 2006; Johnson, 2001) and are particularly suited to framing biocentric complexity thinking, as they provide a means of verbalizing life in complexivist terms. These characteristics have been noted by numerous complexivists working in diverse fields, but educationists' Davis and Sumara's (2006) framework and lexicon is particularly relevant for educational purposes, as it has been tailored for an audience of future and present educators and educational theorists.

Emergence

The term 'emergence' is used by complexivists to describe how "agents that need not have much in common—much less be oriented by a common goal—can join into collectives that seem to have clear purposes" (Davis & Sumara, 2006, p. 83). Emergence is also referred to as self-organization, or as Stuart Kauffman (1995) describes it, 'order for free'. Complex systems like ant colonies, brains, and cities arise and are able to maintain a coherent unity not through centralized control but due to the nature of the relationships among their parts (Johnson, 2001).

The concept of emergence has been recognized throughout the dynamics of living systems. As Capra (2002) explains:

> The spontaneous emergence of order at critical points of instability is one of the most important concepts of the new understanding of life... It has been recognized as the dynamic origin of development, learning and evolution. In other words, creativity—the generation of new forms—is a key property of all living systems. (p. 14)

For Kauffman (1995), the observation that complex systems can spontaneously arise through the interaction of agents without centralized control also acts as an important supplement to Darwin's (1859) theory of evolution by natural selection.

From this perspective, natural selection acts on emergences of natural order rather than random genetic mutations or accidental assemblages of organic molecules. For Kauffman (1995), this amounts to nothing less than the

'reinvention of the sacred' as it provides impetus for a shift in a scientific perception of life on Earth from 'we the accidental' to 'we the expected'. Kauffman shares my optimism in the potential for a complexivist view of life to contribute to a broader appreciation of the miracle of life and a more equitable and sustainable world:

> To undergird the pluralistic global community that is aborning, we shall need, I think, an expanded intellectual basis—a new way to think about origins, evolution and the profound naturalness of life and its myriad patterns of unfolding. (Kauffmann, 1995, p. 5)

There are many competing scientific narratives that relate the origins of life but today most biologists and biochemists believe that life originated on Earth as the result of a series of events "subject to the laws of physics and chemistry and to the nonlinear dynamics of complex systems" (Capra, 2002, p. 17).

With respect to the emergence of living organisms on Earth, it is estimated that roughly four billion years ago the conditions for organic life to emerge were satisfied. An emergent perspective on the origins of life, however, involves a shift away from origins as specific points on a linear timeline to a nonlinear interaction of multiple agents over a longer temporal period. From a complexivist perspective of emergence any 'point of origin' for a living organism is a somewhat arbitrary matter of choice. Does life begin at birth, at some stage of development in the mother's womb, or in the act of conception itself? (This confusion is abundantly clear in debates on legislation regarding abortion). The extended roots of the emergence of an individual organism might be traced back even further, to the origins of life on Earth, or perhaps even to the origins of the universe itself.

Regardless of where one chooses to place the boundaries of life, one of the most important outcomes of an emergent understanding of life is the deep interconnectedness that exists among all forms of life and the universe. From this perspective living organisms are a natural emergence of the universe, temporary manifestations of a living system that has existed for billions of years. In light of their common origins, differences between living organism and non-living objects might appropriately be considered a matter of degree rather than kind. From a

complexivist perspective, life is differentiated oneness—a constantly emerging and evolving unity of diversity. Following Davis and Sumara's (2006) definition of complexity thinking, biocentric complexity thinking may be considered 'a way of thinking and acting that assumes a universe that is both complex and alive.'

Nestedness

Structurally, complex unities are described as "simultaneously autonomous unities, collectives of autonomous unities, and subsystems within grander unities" (Davis & Sumara, 2006, p. 90). Complex systems exhibit organization and behavior at a number of nested levels of emergence. Each level of a complex system both emerges from lower levels of complex activity and contributes to the emergence higher levels of complex coherence. Living organisms provide an excellent example of this structure; an individual organism can be considered an autonomous unity, a collective of autonomous unities (e.g., genes, cells and organs), and part of a subsystem within a grander unity (e.g., a community, society or ecosystem). With respect to educational contexts, an individual student is nested within a classroom, a school, a community, a city, and so on (2006).

The concept of nestedness bears close resemblance to what Arthur Koestler (1967) has described as a holon (Capra, 1982, p. 43). Koestler derived the term holon "from the Greek *holos* = whole, with the suffix *on* which, as in prot*on* or neutr*on*, suggests a particle or part" (p. 48). A holon, like a complex system, can be considered both a part and a whole. Koestler's philosophical work can be considered a precursor to Capra's (1982, 1996) suggestion that systems thinking is required to remedy the crisis of perception. Koestler recognized that "the two-term part-whole paradigm is deeply engrained in our unconscious habits of thought" and was confident that "it will make a great difference to our mental outlook when we succeed in breaking away from it" (p. 49).

Like emergence, the concept of nestedness implies a deep interrelatedness among complex systems. While emergence speaks to historical commonalities of origin, nestedness draws attention to the interconnectedness of the present. As a holon is both a part of a larger whole, a whole in itself, and itself composed of

other parts, its structure constitutes a medium for feedback to travel between multiple layers of a system. As Johnson (2001) describes it, "agents that reside in one scale start producing behavior that lies on the scale above them: ants create colonies; urbanites create neighborhoods" (p. 18). Due to the interconnectedness of nested levels of complex systems they are often described as having 'fuzzy' or 'ambiguous' boundaries. Davis, Sumara and Luce-Kapler (2008) describe these boundaries as 'enabling constraints'; "The rules that define complex systems maintain a delicate balance between sufficient structure, to limit a pool of virtually limitless possibilities, and sufficient openness to allow for flexible and varied responses" (p. 193). All complex unities are open to the exchange of energy and matter from both above and below but are organizationally closed in the sense that they are generally stable and capable of adapting to perturbations.

In the previous examples of biological and educational nestedness, the relationships among systems are situated in a geo-spatial context. Each system exists within or is comprised of systems at correspondingly larger or smaller levels. In this sense, the various planetary chemical cycles (e.g., nitrogen, water, and carbon cycles) can also be considered nested aspects of living systems, as it is upon these very systems that life depends. Patterns of human behaviour, including the economic, political and social systems that have emerged through human cultural interactions, are also nested with living systems.

These systems are physically nested through the materials and energy required to build the infrastructures of their institutions and technologies that support their continued functioning. They are also culturally nested through the promotion of their knowledge, beliefs and values, which in turn amounts to a physical connection through the actions that these varied cultural forms prompt individuals to undertake. Acknowledging these systems as 'alive' or at the very least intricately intertwined with our own existence brings a heightened intensity to present concerns regarding the global crises and effects of the culture of neoliberal economics described in Chapter Two.

We are culturally nested with the world through a worldview that compels us to act, but our cultural worldview itself can be considered an emergence of the

nestedness of our physical bodies in the spaces and places we inhabit. Varela, Thomson and Rosch (1991) refer to this interplay as 'embodied' or 'enactive' cognition, which questions the assumption that cognition is a process of abstract representation and proposes instead that cognition is the enactment of a world and a mind on the basis of a history of lived experience. 'Embodiment' is used in two senses in complexivist discourse; for individual humans it both "encompasses the body as a lived, experiential structure, and the body as the context or milieu of cognitive mechanisms" (Varela, Thompson & Rosch, 1991, p. xvi). As Ehrlich (2000) explains, from a perspective of embodied cognition, "impressions of the natural world are emergent properties of a complex interaction between that world and our physical organization (nervous systems, endocrine systems, etc.) and cultural attitudes that may forever resist satisfactory reductionist interpretation" (p. 317). Through culture we are both physically and cognitively embedded in the complex web of life.

Adaptation

Of the characteristics of complex systems described in this work, adaptation is perhaps most directly connected to the concerns of formal education. Adaptation, or the propensity to change in order to maintain 'viability' or 'fitness' in dynamic contexts, is a characteristic of all complex systems. The concept of adaptation has obvious relevance to the evolutionary considerations outlined in Chapter Five but its importance to the development of biocentric complexity and biocentric education is revealed by its synonym, *learning.* As Davis (2004) has stated, "the capacity to learn is a defining quality of all complex systems" (p. 169).

To a complexivist, learning is "a matter of transformations in the learner that are simultaneously physical and behavioral" (Davis & Sumara, 2006, p. 13). As complex systems adapt, these experiences are recorded in their physical structure—complex systems embody their histories. In humans this occurs both biologically (at the genetic level) and culturally (through processes of embodied cognition), albeit at vastly different evolutionary paces. It is the physical embodiment of our lived experiential structure that engages with the world

through embodied cognition and gives rise to our conscious cultural worldview. These structural changes influence the system's behavior as the physical composition of the system constrains the adaptive possibilities available to the system and thereby impacts its behavior in response to dynamic circumstances.

Lave and Wenger's (1991) concept of 'situated learning' reflects this complexivist stance. "Learning is a process that takes place in a participation framework, not in an individual mind.... It is the community, or at least those participating in the learning context, who 'learn' under this definition. Learning is, as it were, distributed among coparticipants, not a one-person act" (p. 15). From this perspective, learning is not limited to the 'receipt of knowledge by a specific individual', but is extended to an embodied "activity in and with the world... on the view that agent, activity, and the world mutually constitute each other" (p. 33).

Davis and Sumara (2006) define a learner as "a complex unity capable of adapting to the sorts of new and diverse circumstances that an active agent is likely to encounter in a dynamic world" (p. 14). This broad definition includes numerous phenomena under the purview of learning:

> In complexity terms, learners can include social and classroom groupings, schools, communities, bodies of knowledge, languages, cultures, species—among other possibilities. One might also move in a micro direction, extending the list to include organs or bodily subsystems, cells, neurons, and so on. (p. 14)

From a complexivist perspective, changes in behaviour can emerge from adaptation or learning at any level of nestedness, providing vectors not only for students to learn, but also for societies to also learn, adapt and change.

The complexivist identification of learning as adaptation is driving a shift in the perception of learning from a process of linear Newtonian mechanics to one of complex evolutionary dynamics. As Davis and Sumara (2006) have noted, "cause-effect interpretations make little sense when learning is understood in terms of recursive and elaborative processes" (p. 13). Understanding learning as

adaptation is a useful heuristic for envisioning formal education as an important site for efforts toward global survival.

Biocentric Complexity Thinking and Formal Education

Facilitating the development of biocentric complexity thinking is one of the fundamental aims of biocentric education. The disconnectedness inherent in Western mechanistic thinking has had a devastating impact on the biosphere, including a large portion of humanity, and has allowed the pursuit of individual financial gain to attain a position of value above that of life itself. Centering formal education on the value and concept of life as an intricately woven web of complex systems is an effort to develop an alternative conceptual framework for thinking about the possibilities and potentialities for creating more just and sustainable societies through education.

Formal education presents a socially mandated site for the cultural transmission of knowledge, and thus influences the types of adaptations available to students through the generation of learning experiences. Through formal education the possibilities for understanding and identifying with life may be expanded to include connections at both local and global levels; an intentional cultural adaptation aimed at forging reconnections. Providing students with the opportunity to learn about and embody the concepts of emergence and nestedness, which both speak to the deep interrelatedness of life and the universe, may interrupt the feelings of isolation that flow from the common belief that we are subjective cognizers of an objective universe. From the perspective of embodied cognition, our conscious experience of the world emerges through our connection to, rather than our separation from, the world in which we live.

The link between cognition and action developed in this chapter suggests that a shift in conventional conceptions of life may provide a means of addressing the crisis of perception that has paved the way for the emergence of global crises (Capra, 1982, 1996). Through the framework of biocentric complexity thinking, humans may develop cognitive identities not only as individual living organisms but also as organisms embedded within broader living systems. This partially

decentered identity may provide the potential to reconnect individuals to the wider world of lived experience and provide a renewed impetus for action.

In contemporary educational discourse learning is often considered a phenomenon that is situated at the cognitive level of the individual. Complexity challenges this myopic perspective by identifying all complex systems as capable of learning. The structure of complex systems allows for feedback among the components of any given system (e.g., students in a classroom or classrooms in a school) and various other systems in which they are nested (e.g., families, social groups or society at large). By these avenues adaptations may reverberate throughout multiple layers of these systems. In terms of initiating adaptations capable of addressing the contemporary global crises described in Chapter Two, learning is likely to be required, and will inevitably be affected, at multiple levels of nestedness.

The emergence of order in multiple layered nested systems from the communal, decentralized activities of individual entities has particular relevance for biocentric education as it indicates that the cognition of individuals has potential to influence group cognition and behaviour, and vice versa. From a biocentric complexivist perspective, this yields the hopeful potential that efforts to foster individual and group recognition of the value and systemic nature of life may, in time, also produce emergent, life-respecting and life-sustaining patterns of behaviour at the level of human communities and societies.

Much as an individual's worldview is a composite embodiment of the multiple subcultures that they experience (Aikenhead, 1996), dominant cultural values and beliefs emerge as a result of collective experiences and contextual circumstances. At the human level, our capacity to learn is manifested in culture, which has traditionally emerged through adaptation to local environmental and socio-political influences. As today's popular culture (i.e. consumer culture) is predominately shaped through mass media at the behest of powerful corporate interests it will be difficult for alternative cultural forms to be adopted and adapted by society at large (Klein, 2000). It is therefore crucial that institutions of

formal education, with their considerable social cache, take on this challenge as an opportunity for enacting change toward global survival.

Biocentric Complexity and Humanity

In *The Future of Life*, E. O. Wilson (2002) provides a vivid depiction of the situatedness of humanity on a dynamic and complex planet that is consistent with biocentric complexivist thought:

> Earth, unlike the other solar planets, is not in physical equilibrium. It depends on its living shell to create the special conditions on which life is sustainable. The soil, water, and atmosphere on its surface have evolved over millions of years to their present condition by the activity of the biosphere, a stupendously complex layer of living creatures whose activities are locked together in a precise but tenuous global cycles of energy and transformed organic matter. The biosphere creates our special world anew every day, every minute, and holds it in a unique, shimmering physical disequilibrium. On that disequilibrium the human species is in total thrall. (p. 39)

The collective actions of our species reflect a potentially catastrophic lack of respect for the precarious context of human existence.

Human behavior emerges through processes of embodied cognition that involve a complex interplay of biochemical, environmental and circumstantial variables, not the least of which are the embodied lessons learned through past adaptations to one's cultural worldview. This experiential history can be understood as constituting one's 'ethics', as it dictates the possibilities for action based in one's system of values, beliefs and knowledge. As one's embodied history is a major contributor to the actions that emerge through cognition, actions associated with a biocentric ethic will vary greatly depending on the way in which one understands life. It is to a discussion of the potential for an ethic of biocentric complexity that I turn to next.

Chapter 4: Toward an Ethic of Biocentric Complexity

The Life Ethic

Biocentric complexity thinking, which places the value and concept of life at the center of efforts to perceive and contextualize the worlds of human cognition and experience, has many parallels in ethical philosophies that encourage reverence of and respect for life. Indeed, a review of Western biocentric philosophies reveals numerous similarities (and some important differences) with the development of biocentric complexity thinking forwarded in Chapter Three. This chapter traces out the relationship between biocentric complexity thinking and discourses of ethical biocentric philosophy, from Schweitzer's (1923) 'Reverence for Life' to the recent emergence of the forms of thought that encompass radical ecology (Zimmerman, 1994; Merchant, 2005).

Through this discussion of biocentric complexity thinking and biocentric ethical philosophy I propose a tentative formulation of an ethic of biocentric complexity. The implications for a complexivist life ethic arising from this analysis include the expansion of the boundary of one's 'ethic of care' (Noddings, 1984) and a shift in thinking about ethics toward the concept of 'ethical know-how' (Varela, 1999). Embracing the nestedness of human cognition in the biological and physical worlds, this ethical framework shifts away from the conventional view of ethics as abstracted moral standards toward a non-moral perspective where ethics are embodied in the actions of individuals and collectives of individuals.

Introducing Ethics

The Collins English Dictionary defines an ethic as "a moral principle or set of values held by an individual or group" (1999). A definition of morality is also helpful here, as the cognate concepts of ethics and morality are often used interchangeably. Morality is defined as "conformity, or degree of conformity, to conventional standards of moral conduct". Combining the two definitions, we arrive at a conventional definition of an ethic as *an accepted moral principle or*

set of values that regulates moral conduct. Simply put, ethics are commonly perceived as the mechanisms through which humans differentiate between actions that are 'right' and 'wrong'.

As MacIntyre (1998) has aptly stated, ethics can only truly be understood in context. The cultural, spatial and temporal variation of ethical codes is evidence of their dynamic nature. Culturally defined ethics, while maintaining solidarity within a given group, have also been a source of much conflict (Attfield, 1999). Until the advent of industrialization, an individual's survival had been solely dependant upon the tribe or group to which one belonged. In egalitarian tribal and agrarian societies all members of a socio-cultural group are deemed valuable and therefore co-operate (to varying extents) toward the success of the group as a whole. Persons outside of this group are often considered to exist outside the boundary of the group's 'ethic of care' (Noddings, 1984) and are therefore not generally viewed as being as ethically relevant (1999)

An important aspect of the definition of ethics given above is that the moral principles associated with an ethic can be either accepted or rejected. The possibility to reject or alter an ethical stance, including the dominant conventional moral code, provides the potential to develop and adopt new ethical frameworks for an ever-changing world. In the complexivist terms developed in this thesis it is an opportunity for adaptive cultural learning. In today's world, ethical negotiations have become increasingly complex with the growth of the human population, the onset of industrialization, and increased globalization and technological innovation. Nearly sixty years ago Leopold (1949) commented on how much simpler it was, "to define the anti-social uses of sticks and stones in the days of mastodons than of bullets and billboards in the age of motors" (p. 238). I wonder what Leopold might have thought about ethical negotiation in the context of our increasingly complex globalized and nuclear world?

The emergent crises of today's globalized and globalizing context have provided humanity with the historically unique challenge of developing a planetary-wide ethic that will serve to unite, rather than attempt to homogenize, the diverse socio-cultural groups of the world. Historically, the many divergent

interests represented within larger social groups have often caused them to fragment into conflicting aggregate populations (e.g., the Roman Empire, Ottoman Empire, and USSR). It is my view that a complexivist understanding of life, tentatively developed in Chapter Three, may provide a foundation upon which a globally unifying ethic may take root that respects the delicate balance of diversity and unity that characterizes all complex systems.

Biocentric Philosophy

Numerous biocentric philosophies have emanated from the field of Western environmental philosophy but none have established wide practical appeal in the neoliberal age. The biocentric philosophers' interest in ethics that reflect the intrinsic value of life often come into direct conflict with the neoliberal values that promote the intrinsic value of individual economic security. As discussed in Chapter Two, however, life-centered philosophies capable of promoting 'survival agendas' are becoming increasingly relevant as foundations for responding to crises of global magnitude.

Disagreements over the definition of what life is (and which aspects are of most value) have also proven highly problematic for the development of widely acceptable biocentric ethics and philosophies. Arriving at a set of 'life-centered' statements or guidelines that delineate the morality of human actions requires a specialized definition of life, one that inevitably excludes or limits the value of other forms of life (Agar, 1997). As Agar (2001) has opined, "we need to draw and defend the moral significance of a boundary between living and nonliving things to prevent our life ethic from degenerating into an everything ethic" (p. 68). Discourse on biocentric ethics within environmental philosophy has, unfortunately, been largely stymied by ongoing debates between dichotomized perspectives on life and its associated value (e.g., anthropocentric vs. non-anthropocentric, individualistic vs. ecocentric, sentient vs. non-sentient) (Agar, 2001).

Biocentric complexity thinking provides a new approach to the debates that have dominated traditional Western biocentric philosophy. While

acknowledging that considerable tensions exist among the varied branches of biocentric philosophy, I focus attention to their areas of commonality in this analysis. Through the lens of biocentric complexity, the conflicts among these philosophies do not originate from their diametrical opposition, but rather from a failure to recognize that they are simply attentive to different aspects of the same living system. A biocentric complexivist perspective troubles these dichotomous perceptions of life and opens space for formulation of an ethic of biocentric complexity.

From an understanding of life as a series of highly integrated complex systems, no single aspect of the system can be considered ultimately valuable for its continued survival. Instead, the value of a life is distributed among its varied constituent parts and systems. As a member of the human species, I do admit some bias toward the value of human survival (i.e. anthropocentrism) but still maintain the intrinsic value of all aspects of living systems as both valuable in themselves as well as valuable for the roles they play in contributing to human survival.

Biocentrism and Ecocentrism

Identifying the perspective of ethics being developed in this chapter as 'an ethic of biocentric complexity' is a deliberate attempt to distance this conceptualization from the notion of 'biocentric ethics'. In the lexicon of Western environmental philosophy the term 'biocentric ethic' is associated with the conventional understanding of life as individual organisms, a view that is exemplified in the work of Nobel Laureate Albert Schweitzer (1923) and philosopher Paul Taylor (1981).

Schweitzer (1923) was clearly cognizant of the miracle of life, dubbing his biocentric philosophy 'Reverence for Life'. The term 'reverence', which is synonymous with respect, admiration, worship, awe, veneration, astonishment, and amazement, is an entirely appropriate response to recognition of life's miraculous nature. Schweitzer proposed that all living things are intrinsically valuable as they each exhibit a 'will-to-live', the successful manifestation of

which is experienced as pleasure, and its denial as pain (p. 254). Acutely attuned to the sacredness life, Schweitzer also appears to have understood the need to reconcile the diversity of 'wills-to-live' with a sense of common purpose. In his words:

> The world is indeed the grisly drama of will-to-live at variance with itself. One existence survives at the expense of another of which it yet knows nothing. But in me the will-to-live has become cognizant of the existence of other will-to-live. There is in it a yearning for unity with itself, a longing to become universal. (p. 257)

For Schweitzer, ethics are reflected in the compulsion to show the same 'Reverence for Life' to all that will-to-live; "ethics in its unqualified form is extended responsibility with regard to everything that has life" (p. 255).

From Schweitzer's (1923) perspective, ethical behavior requires the resolution of conflicts among those that will-to-live. In a relevant example he comments that, "if I rescue an insect from a pool of water, then life has given itself for life, and again the self-contradiction of the will-to-live is removed" (p. 258). Unlike the majority of biocentric philosophers who succeeded him, Schweitzer did not attempt to delineate an ethical code by which to judge the morality of human actions (Pojman, 1994). Instead, Schweitzer believed that ethics are reflected in one's actions, which in turn are based on what one knows, thinks, believes, and values (i.e. one's culture).

Paul Taylor's (1981) 'biocentric egalitarianism' also reflects the reductionist understanding of life reflected in dictionaries. Similar to Schweitzer's (1923) 'will-to-live', Taylor considered all living beings intrinsically valuable as they each have a goal or *telos*. In contrast to Schweitzer, however, Taylor believed that all living organisms are *equally* valuable, explicitly aligning his philosophy against anthropocentrism, where behaviors are judged as right or wrong according to their impact on human populations. Although Taylor's 'biocentric outlook on nature' implies a separation of humanity and life from nature, he also appears to have been aware of the 'great lesson we have learned

from the science of ecology'. One of the central tenets of his biocentric outlook on nature is "the interdependence of all living things in an organically unified order whose balance and stability are necessary conditions for the realization of the good of its constituent biotic communities" (p. 205). These statements provide an early hearkening of a shift from linear-reductionist depictions of the natural world to forms of more ecological and complexity oriented thinking.

Aldo Leopold's (1947) *Land Ethic* is widely regarded as the primary source of the modern ecocentrism movement (Pojman, 1994, p. 64). Leopold had an innate love of nature and was employed by the United States Forest Service before becoming a professor of Wildlife Management at the University of Wisconsin in 1933. Like Schweitzer (1923), Leopold (1947) refrained from delineating a moral code for his Land Ethic. Instead, he summarized the Land Ethic by concisely stating that, "a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (p. 262). The key question now becomes, 'What constitutes the biotic community'? Leopold's work provides a clear indication of the depth of his ecological thought and more closely approximates a biocentric complexivist view of life than the philosophies of Schweitzer (1923) and Taylor (1981).

Both Leopold's (1947) and Taylor's (1981) works heralded in critique. Taylor's philosophy, despite recognizing the ecological interdependence of the living world, was deemed anti-ecological due to his egalitarian approach to the value of all individual organisms (Pojman, 1994). Unsurprisingly, both Leopold's and Taylor's philosophies were also critiqued as anti-anthropocentric, as they assigned no special value to humanity (Pojman, 1994). These critiques are emblematic of the ongoing debates among biocentric, anthropocentric and ecocentric philosophers' approaches to ethics—debates that continue to rage on while the realities of global crises continue to proliferate.

As noted above, conceptualizing life as a multiplicity of intertwined complex systems may provide a useful perspective on these apparently contradictory philosophies. A similar view is held by ecological educators Smith and Williams (1999), who believe that:

> Arguments over a human-centered or earth-centered orientation miss the point. There is no way to disentangle human beings from the earth, and as long as our species exists, no way to separate the earth from humans. (p. 3)

Acknowledging multiple aspects of living systems as interdependent and valuable poses an obvious challenge to the typical consideration of biocentric ethics as a moral code based on a narrowly considered definition of life.

Ethical Extension

For Leopold (1947), "all ethics so far evolved rest upon a single premise: that the individual is a member of interdependent parts... The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (p. 239). The sequential enlargement of the boundaries of ethical consideration provides a useful context in which to situate this discussion. In Nash's (1989) sketch of 'the evolution of ethics' he provides a simplified overview of a typical sequence of ethical extension beginning with the self and gradually expanding to include family, tribe, region, nation, race, humans, animals, plants, life, rocks, ecosystems, planet and finally, the universe (p. 5).

An ethic of biocentric complexity, however, takes a different approach to Nash's (1989) conceptualization of sequential ethics. Rather than positioning life as a single step between plants and rocks in a 'natural' procession of ethical evolution, a biocentric complexivist views the boundaries of one's ethic of care as being enlarged with a wider identification of interconnectedness with a living universe. For example, James Lovelock's (2000/1979) Gaia hypothesis extends the individualistic view of life to the level of the geocentric, treating Gaia (i.e. planet Earth) as a single 'superorganism'. Lovelock's hypothesis, which is based in his work as an atmospheric scientist (1988), has received wide attention and can be credited with at least some degree of popular ethical extension. From the perspective set forth in this work, it is not a natural linear progression that is resulting in the observed expansion of ethical boundaries, but a growing cognitive

comprehension of the importance of all aspects of living systems for human survival.

Although biocentric complexity decenters the individual as the primary locus of value, expanding the realm of one's ethic of care (Noddings, 1984) to include the complex systems in which living organisms are enmeshed should not be interpreted as anti-anthropocentric. This expansion is necessary because of the interdependence among all organisms (including humans) and the systems within which they are nested. Rather than a statement of human dominance, biocentric complexity is based on the belief that humanity is capable of coexisting with the biosphere for millennia to come. This should not be interpreted as an idealistic, utopian, vision for the future. The conflicts that are contributing to the deterioration of living systems are very real and will require ongoing efforts toward resolution. An ethic of biocentric complexity accepts conflict as arising inevitably from the diverse agents that compose complex systems but requires that these conflicts do not deteriorate the systems upon which all organisms depend for survival.

Radical Ecology

The most recent school of biocentric philosophy, the one that poses the strongest resemblance to biocentric complexity thinking, is known as radical ecology. The term 'radical' reflects the desire for major shifts in dominant modes of thinking being espoused by these philosophers, and is therefore consistent with the emerging systems view of life (Capra, 1996, p. 6-9). Radical ecology, like biocentric education, "emerges from a sense of crisis in the industrialized world. It acts on a new perception that the domination of nature entails the domination of human beings along lines of race, class, and gender" (Merchant, 2005, p. 1). Radical ecology must be distinguished from 'typical' ecological thinking, which is a form of systems thinking that is related to living systems but is generally restricted to the food and energy webs that exist among organisms and species. Through radical ecology the study of relationships among aspects of living

systems is now being expanded to include knowledge systems and social systems, providing further conceptual congruencies with biocentric complexity.

Radical ecologists make a firm distinction between themselves and 'reform environmentalists' who seek to simply "curb industrial pollution and to use natural resources more wisely, but do not call for basic alterations in modernity's instrumentalist view of nature" (Zimmerman, 1994, p. 3). While numerous ecophilosophies fall under the umbrella of radical ecology, this analysis follows Zimmerman's (1994) identification of three main branches: deep ecology, social ecology and ecofeminism. Despite the anthropocentric-ecocentric tensions that exist among the philosophies of these branches, they all share the common goal of overcoming ecological and humanitarian crises.

Deep Ecology

Norwegian ecophilosopher Arne Naess (1973) coined the term 'deep ecology' to distinguish it from what he referred to as 'shallow ecology' (i.e. reform environmentalism). Deep ecologists are primarily concerned with questions of ontology (what is the nature of the world and the relationship of humans to it?) and advocate for a shift in worldview that acknowledges the interdependence of humans and the world around them. Deep ecologists consider the contemporary ecological crises as a product of the anthropocentric humanism of modernity (Zimmerman, 1994). Although sometimes critiqued by ecofeminists and social ecologists as 'ecofascist' (i.e. anti-anthropocentric) for their insufficient sensitivity to "social issues, especially regarding population, race, class, and sex" (Merchant, 2005, p. 152), deep ecologists share all radical ecologist's critique of human dominance implicit in the modern worldview.

Deep ecology resonates with biocentric complexity through its attention to the innate interdependence among living organisms and the universe. As Capra (1996) has acknowledged, "by calling the emerging new vision of reality 'ecological' in the sense of deep ecology, we emphasize that life is at its very center" (p. 12). The concept of the emergent origins of life and the nestedness of living systems echo the deep ecologist's desire for humanity to come to a wider

consciousness of its interconnected and interdependent nature. To a deep ecologist, a human being is inextricably intertwined with its environment. To a complexity thinker, a human being is a natural emergence of a complex system without which it cannot exist. In the words of Zimmerman (1994), we are all quite literally "nature rendered self-conscious" (p. 2).

Social Ecology

Like deep ecology, social ecology also critiques the prevalent modern world view, focusing its disapproval on the overly centralized, authoritarian organization of social, economic and political structures (Zimmerman, 1994). These structures are viewed as inherently anti-ecological because of their stark contrast with the decentralized, scale-free networks found in living systems (Barabási, 2002). Scale-free networks balance efficient communication with stability and aptly describe ecological, neurological and conceptual (i.e. knowledge) systems (Davis, Sumara & Luce-Kapler, 2008). Social ecologists assert that highly centralized structures of dominance function to maintain themselves through the exploitation of both ecosystems and people. This sentiment is echoed in the words of Stewart-Harawira (2006), whose research examines the role of indigenous ontologies in disrupting the re-emergence of American empire. For Stewart-Harawira, "the most urgent task facing us today is to effect transformation of the ontological underpinnings of the terms in which world order is conceived and the meaning of existence articulated" (p. 3).

The social ecologists' critiques of the deleterious effects of today's social structures on living systems is closely aligned with the complexivist concept of nestedness. Through the lens of complexity thinking, all social, economic and political systems are both physically and culturally nested aspects of living systems. The highly centralized, authoritarian structures through which we go about our day-to-day lives are not only structured according to anti-ecological principles but their underlying ideology is often uncritically taken up and reproduced through popular culture. From this perspective, biocentric complexity shares social ecologists' assertion that the poor fit between contemporary social

structures and structures found in healthy living systems are a contributing factor to both humanitarian and ecological crises.

Ecofeminism

Feminist ecologists or 'ecofeminists' explain the ecological crisis as the result of patriarchal ideologies that follow the 'logic of domination.'

> According to this logic, whatever is defined as superior to something else is entitled to use the 'inferior' thing in any manner the superior so chooses. Under patriarchy, maleness, rationality, spirit, and culture have been regarded as superior, whereas femaleness, emotion, body, and nature have been regarded as inferior. (Zimmerman, 1994, p. 2)

In essence, a parallel is drawn between the domination of 'humanity over nature' and the domination of 'male over female' (Warren, 1994). Through the lens of biocentric complexity, a culture of domination disserves living systems by systemically reducing the diversity and autonomy of their agents. As summarized by critical pedagogue Paulo Friere (1970), "oppression—overwhelming control—is necrophilic; it is nourished by love of death, not life" (p. 64).

The complexivist acknowledgement of uncertainty provides further fuel for arguments against the 'logic of domination'. A complexivist critique of attempts to control or dominate is perhaps best expressed in Leopold's (1949) notion that 'the conqueror role is eventually self-defeating':

> It is implicit in such a role that the conqueror knows, *ex cathedra*, just what makes the community clock tick, and just what and who is valuable, and what and who is worthless, in community life. It always turns out that he knows neither, and this is why his conquests eventually defeat themselves. (p. 240)

Complexity, like postmodern thought in general, asserts that any understanding of the universe must be partial. As any system of knowledge is therefore an incomplete representation of reality, attempts to control what we do not fully understand are destined to fail.

Acknowledging that we may never fully understand complex living systems to the degree where we can accurately predict and control their behavior does not entail an abandonment of efforts to understand them. When approaching these systems of life from a position of harmonious coexistence rather than dominance or control even a limited understanding will be useful. Furthermore, acknowledging a degree of uncertainty limits the promulgation of a perception of scientific knowledge as a flat, dry description of the universe that is slowly removing the mysteries from life.

Understanding that outright control and dominance are not viable approaches for complex systems also highlights the need for dialogue. Questions such as 'Who is to decide what behavior is biocentric?' take on new significance with the realization that we do not, and possibly cannot, have a complete understanding of living systems. The need for ongoing dialogue is a prominent theme in Doll, Fleener, Trueit, and St. Julien's (2005) *Chaos, Complexity, Curriculum and Culture: A Conversation.* Complexity underscores the need for collaboration—if the complex whole is indeed greater than the sum of its parts then we need to work to become parts of larger entities—to reconnect by learning from and contributing to the work of others. An acknowledgement of uncertainty provides impetus for a shift away from attempts to control and determine toward the exploration of potentialities and possibilities.

How can a rigid ethical code be formulated in the face of the uncertainty of predicting long-term consequences of actions on complex living systems? Rather than using a linear logical analysis to arrive at a suitable code of ethics to regulate human behavior, an ethic of biocentric complexity requires continuous learning and adaptation with the goal of long-term coexistence.

An Ethic of Biocentric Complexity

A conventional understanding of ethics as *moral principles* or *values that regulate moral conduct* presupposes that ethics exist beyond action. In effect, this definition situates ethics in an abstract realm. This notion is supported by the comments of Nash (1989) who explains that, "as self-imposed restraints on

conduct, ethics are ideals. Some humans, after all, commit murder and kill members of their families" (p. 5). Biocentric complexity thinking, however, rejects Nash's analysis—as products of cognition, ethics cannot exist as ideals, but are intimately connected to action. In the case of the 'ethical' murderer, the connection between the 'ideal ethic' and the action are indirect, but the connection between the embodied ethic and the murder is clear. Ideal ethics are oversimplifications that rarely play out in complex, dynamic circumstances. A complexivist orientation to ethics resonates with Schweitzer's (1923) belief that, "true ethic begins where the use of words stops" (p. 260). For a complexivist, ethics, not ideals, are reflected in the actions that compose our day-to-day lives.

Schweitzer's (1923) pragmatic view of ethics parallels Varela's (1999) concept of 'ethical know-how'. Varela points out that most human day-to-day activity is not the result of long pontification over ethical implications but instead occurs spontaneously as we 'cope' with what is directly in front of us. This 'coping' is very much 'in the moment', and, according to Varela, occurs through processes of embodied cognition. Thus, our actions emerge through the interaction of our 'ethical know-how' (i.e. embodied history) and the situation at hand. In order for an individual to act according to a certain ethic, they must therefore embody sufficient knowledge of what is of value.

Dogmatic ethical codes (e.g., 'thou shalt not kill') attempt to establish an external control over behaviour, and can be likened to the installation of software on a computer's processor (the most common contemporary metaphor for the human brain as the site of cognitive processes). Ethical know-how, in contrast, is based upon an embodied view of cognition where actions emerge from the interplay between ones body and its surroundings. Therefore, all actions reflect the individual's embodied ethical know-how but are also influenced by the individual's multivariate context. Some variation in behavior is then to be expected due to the adaptive nature of ethical know-how and the dynamic contexts in which actions are enacted.

Evaluating the dominant neoliberal embodied ethics at the current time reveals underlying ego and anthropocentric ethical know-how, upon which the

needs of individual humans or specific groups are valued above, and apart from, those of other living organisms and other nested levels of the Earth's living systems. In the neoliberal system (which includes education), people are required to embody the knowledge that leads to the generation of individual financial wealth, enabling them to get jobs, make money and purchase homes, vehicles and other material goods. The variation in 'ethical' behavior described above, however, provides two interrelated vectors through which human behaviors may be altered. The first is through making changes to people's ethical know-how, which can and should be taken up by today's institutions of formal education. The second is to understand the role of context in human behavior. At the purely speculative level, it seems unlikely that the actions of individuals that live in contexts of stress, abuse, poverty and oppression (i.e. unhealthy contexts) would reflect a 'health-conscious' ethical know-how. It would appear that there is a very intimate connection between one's ethical know-how and the contexts in which one lives and learns.

Due to the intensity of human consciousness, it is somewhat natural that humanity in general should embody an egocentric ethic. From an evolutionary perspective (developed more fully in the following chapter) self and group interest would have been beneficial during much of humanity's evolutionary past. Indeed, the very capacity for complex systems to adapt stems from the need for viability and integrity at the level of organization at which the adaptation occurs. Any individual or group with an ethic (i.e. pattern of behavior) that did not place value on personal health would be unlikely to survive and reproduce.

As developed in the previous chapter, however, all complex unities are nested. The exponential growth of the human population through an accelerating spiral of resource use, technology, and warfare has left an indelible impact on many of the systems with which we are nested. The ego and anthropocentric neoliberal ethical know-how of our ancestors (perhaps even including ourselves) is no longer suitable for our present context. The ongoing debates among anthropocentric, and ecocentric philosophers also do not appear to be of much relevance in the face of systemic problems that are global in scope. A new body

of knowledge, a new ethical know-how, will be needed to resolve the new problems that we are faced with. It is my belief that the conceptual framework of biocentric complexity may contribute in some small way to this knowledge.

Educating for Ethical Know-how

Ethical action emerges from our biological and cognitive situatedness in the physical world, and, like other emergent behaviors, is adaptable to changing circumstances. For an ethic of biocentric complexity to emerge there must be easily accessible opportunities for embodying the knowledge of complex living systems, especially how our actions impact these systems. This requires learning about life as a complex system, which is a foremost aim of biocentric education. Formal education has a unique role as a venue for the conscious transmission of knowledge, and is a pivotal locus for consciously prompting learning as adaptation.

As Ehrlich (2000) points out, although the human capacity for ethical consideration arose through processes of genetic evolution, "cultural evolution is the source of ethics" (p. 317). The exact origins of human ethical consideration is unknowable but likely coincided with the evolution of human consciousness, infusing *Homo sapiens* with the ability to reflect on their actions. The earliest recorded philosophical consideration of ethics occurred in early Greece around 500 BC (MacIntyre, 1998). It is also here, with the early Greeks, that evidence of a link between changing circumstances and a change in ethics became apparent. Movement toward a new ethic in ancient Greece was precipitated by:

> social changes [that] had not only made certain types of conduct, once socially accepted, problematic, but had also rendered problematic the concepts which had defined the moral framework of an earlier world. (p. 5)

Ethics are not timeless, unchanging entities. Rather, they are tightly bound by their historical and geographic context. As the social scope of human groups changes, so must its accompanying ethic. In the terminology of the argument presented in this thesis, the contemporary context of crisis requires the

introduction of relevant ethical know-how. It requires the adaptation of biocentric complexity thinking in our cultural worldviews.

While biological adaptations usually occur in response to random or environmental pressures, adaptation and learning in complex social and cognitive systems have the potential to evolve 'consciously.' As the principle aim of biocentric education is to foster actions that reflect respect for life, biocentric education seeks to provide students with the opportunity to examine their role in the nested living systems of Earth. The next chapter explores the evolution of human culture, developing a complexivist understanding of 'conscious cultural evolution', which may be applied to explore ways in which biocentric educational aims might be realized.

Chapter Five: Resolving Crises through Cultural Evolution

Conscious Cultural Evolution

The prevalence of reductionist, mechanistic thinking and its instrumental view of nature have resulted in broad aspirations of dominance and provided justification for the exploitation of both human and natural resources. The scale and scope of these exploitative practices have increased through time with the growth of the human population and have contributed to our contemporary context of global humanitarian and ecological crises. Attempting to address and resolve these crises therefore necessitates challenging these dominant modes of thought and instigating the adaptation of alternate ways of thinking.

As developed in Chapter Three, one's mode of thought can be considered analogous to the cultural worldview that emerges through processes of embodied cognition. In this terminology, adapting a new way of thinking can be considered a form of cultural evolution. Formal educational institutions are the central sites for socially mandated enculturation, whether simply reproducing dominant cultural forms or shaping new ones. In terms of the latter, schools have been pivotal loci for social and cultural change, housing the first desegregated learning environments in the United States in the 1950's, supporting the holistic and environmental movements of the 1980's, and more recently spearheading integration of new technologies into the social consciousness (Gutek, 1995). Changes in schools reflect changes in public values, attitudes, and expectations.

This chapter forwards a description of a "new kind of educated evolution", which Ornstein and Ehrlich (1989) refer to as "conscious cultural evolution" (p. 202). Following the notion of evolution from its origins in the natural sciences to it's current metaphorical importance in social and cultural contexts, this chapter develops a framework for understanding biocentric education as a form of conscious cultural evolution, introducing biocentric complexity thinking as a means of interrupting the dominant worldview and contributing toward global survival. Discussion of cultural evolution requires, first and foremost, clarification

of what is meant by 'culture' and 'evolution', as these terms are both contested and controversial.

Theorizing Culture

The term *culture* is etymologically rooted in the Latin *cultura*, referring to processes of growth or cultivation, a meaning that is echoed in the words 'agriculture', 'horticulture' and the 'culturing' of bacteria in biology labs. The extension of this concept to the 'culturing of mind' through education arose in the early sixteenth century (Bocock, 1992), an understanding that is closely linked to the nineteenth century anthropological meaning of culture as 'the total way of life of a people' (Williams, 1989).

Recent descriptions of culture in educational literature include terms such as *repertoire of knowledge*, (Phillips & Norris, 1999), *background beliefs* (Dagher & BouJaoude, 1997) and *world* (Aikenhead, 2001; Costa, 1995). The term *worldview*, which Cobern (1994) has defined as 'a person's perceptions of the world, shaped by the totality of lived experiences, both mental and physical', is also widely used by educational theorists (Aikenhead, 2001; Costa, 1995; Dagher & BouJaoude, 1997) and reflects the complexivist notion of learning as adaptive embodied experience. Bates and Plog's (1990) definition of culture as "a system of shared beliefs, values, customs, behaviors and artifacts that the members of a society use to cope with their world and with one another, and that are transmitted from generation to generation through learning" (p. 7) is also apt for this work. The identification of culture as a system composed of a multiplicity of interacting variables that contribute to the human capacity for survival, rather than a static, distinctly bounded entity, is consistent with a biocentric complexivist perspective of culture as an integral aspect of living complex systems.

In *The Culture of Education* (1996), Jerome Bruner argues "that culture shapes mind, that it provides us with the toolkit by which we construct not only our worlds but our very conceptions of ourselves and our powers" (p. x). Through the lens of biocentric complexity thinking, formal education represents a form of enculturation that shapes the knowledge systems through which individual

students engage with the world. Conscious cultural evolution, as a "deliberate style of cultural evolution" (Ehrlich, 2000, p. 326), is an attempt to create change in the ways that individuals perceive and interact with each other and their natural environment. Although all forms of education contribute to cultural evolution, Ornstein and Ehrlich (1989) characterize many of these efforts as 'unconscious' cultural evolution, due to their hegemonic reproduction of cultural knowledge with no attempt to interrupt dominant patterns of thought.

Biocentric education is an example of conscious cultural evolution as it has been prompted by recognition of current global crises and is concerned with the task of facilitating the emergence of biocentric complexity thinking—infusing students' diverse cultural knowledge systems with the 'ethical know-how' for global survival. Bruner (1996) has also stated that, "how one conceives of education...is a function of how one conceives of culture and its aims" (p. x). As an evolutionary adaptation arising from the human capacity for learning, the original function of human culture was survival.

Chapter Three explored the complex nature of life, an infinitely layered system upon which our biological survival depends. Human cultures are situated in these complex networks both biologically and cognitively, and also exhibit nestedness though the emergence of coherent cultural patterns at many levels. For example, in a recent analysis of global cultural groups a team of researchers identified eight distinct geographic cultural regions (Lazslo, 1993). Within each of these global cultural regions are dynamic integrations of smaller cultural units such as nations, neighborhoods and individuals. Even at the level of an individual culture must not be considered a singularity but rather a dynamic collective of numerous sub-cultural influences. Through the lens of complexity these 'distinct' cultural unities must be considered ambiguously bounded, being continuously transformed through the constant exchange of people and information.

Bates and Plog's (1990) identification of culture as a learned (rather than genetically inherited) phenomenon is central to understanding the importance of conscious cultural evolution. Cultural groups are established through the knowledge learned through shared experiences; hence the experiences that

establish sub-cultural groups are common to some but not all members of society. As Aikenhead (1996) has pointed out, the degree to which any sub-culture influences an individual's worldview is relative to the amount of experience they have within that sub-culture. The diversity of worldviews possessed by students in many of today's classrooms is a result of what they have gleaned from their widely differing experiences with the world. Culture, as the medium through which each of us engages with each other and the world, emerges through our experiences and is therefore connected to the places and people that contextualize these experiences.

Popular culture can also be understood in this way, as it is the common experiences of vast numbers of a population that combine to produce the 'popularity' of some cultural forms. Popular culture is increasingly separated from natural settings, however, migrating instead to electronic venues of shared experience. It is much easier for millions of people to share a common experience through electronic media than through connection to a particular piece of land. Today, the 'places' from which popular culture emerges are often composed of a series of electronic impulses created by clever marketing departments eager to prey on people's inherent insecurities. Popular culture, rather than a creation of the masses, is increasingly being given to them.

Bates and Plog's (1990) identification of culture as a system of interacting parts with an adaptive capacity that ultimately enables survival is perhaps most resonant with biocentric complexity as it presupposes that culture, including popular culture, is always capable of change. The dynamic nature of culture is well articulated in the artistic expressions of Lalla Essaydi (2006), an artist whose work aims to present the 'true complexity' of her culture. In her paintings Essaydi attempts to represent her cultural identity "as a woman, as an Arab woman living in the West, mediating between worlds, as an artist. It is not a fixed identity, but one that is changing as the world changes and as my life changes" (p. B15). Her culture, your culture, and the popular cultures that we are exposed to and co-create are complex systems of embodied experience, constantly evolving processes of learning.

Understanding Evolution

As an item of current social controversy, an explanation of humanity's supremacy on the planet, and a caution against human arrogance, the processes of evolution by natural selection that Charles Darwin (1859) first formulated in *On The Origin of Species* have run well beyond the confines of the geological and biological implications that he envisioned. In 1973, geneticist and evolutionary biologist Theodosius Dobzhansky proclaimed that, "nothing in biology makes sense except in the light of evolution" (p. 125). Evolutionary theory has fundamentally altered scientific inquiry and has also been applied (and misapplied) as an explanatory framework for numerous social, technological and cultural phenomena (e.g., Frank, 1998; Wallace, 2006).

While the exact processes of evolution are, in many instances, poorly understood, the basic principle of evolution is that change is inevitable and survival is impossible without it. The fitness or survival of an entity depends on it's ability to survive and reproduce in contexts that are synchronously competitive, cooperative, and prone to change. Adaptability, redundancy, and diversity are key components to successful survival of individual genomes, species, and ecosystems. Through the lens of complexity thinking, however, Dobzhansky's (1973) famed statement embraces an array of phenomena well outside the typical confines of biological inquiry, and might be rephrased as 'nothing makes sense in the darkness of stagnancy'. We live in a complex, ever changing world in which our chances of survival are invariably tied to the ability to adapt to these dynamic contexts.

Evolution has broad explanatory power—it presents a narrative framework for how we have arrived to the present, and encourages us to look forward to future survival. It also provides a scaffold that demonstrates the connectedness of all forms of life. In a special issue on the teaching and learning of biological evolution in the *Journal of Research in Science Teaching* the editors entitled their introduction, "Evolution: Biological Education's under-researched unifying theme" (Cummins, Demastes & Hafner, 1994). In this short piece, the authors

describe how the ongoing debate over the teaching of intelligent design and evolution in science classrooms, though important, has removed focus from students learning about the interconnectedness of living forms that is a corollary of evolutionary theory.

While most people are aware of the apparent controversy surrounding evolution, few people are aware of their common evolutionary past. As Rutherford and Ahlgren (1990) have stated, "the modern concept of evolution provides a unifying principle for understanding the history of life on earth, relationships among all living things, and the dependence of life on the physical environment" (p. 63). Evidence obtained by genomic sequencing of human mitochondrial DNA indicates that humanity's most recent common ancestor likely lived only 100-150 thousand years ago (Mace, 2005). In relation to a human lifetime this represents a separation of thousands of generations but from an evolutionary perspective encompassing the nearly four billion year history of life on Earth it demonstrates a very recent unity of the human family.

This evolutionary narrative yields a potential starting point for overcoming intercultural conflicts, and yet its positive message has been undermined by controversy and suspicion. The perception of evolution as a controversial idea globally has been greatly exaggerated by the media dominance of the United States, where resistance to biological evolution is strongest. In a recent study of data from thirty-four countries on the public acceptance of evolution it was found that only in Turkey do fewer adults consider evolution a plausible an explanation for the diversity of life on Earth (Miller, Scott & Okamoto, 2006). The authors of the study drew on relevant academic literature and previous studies to attribute Americans' denial of evolutionary theory primarily to common acceptance of literal interpretations of Genesis, widespread genetic illiteracy and the politicization of science, each of which is uniquely prevalent in the United States.

In both the United States and Turkey, inconsistencies between evolutionary theory and religious (Christian and Islamic) beliefs likely generate much of the resistance to evolutionary narratives. In these and other contexts, resistance may also be attributed to some common perceptions of the nature of

science. For those who hold the conventional 'standard account' of science (Erickson, 2005), science is an oppressive legislator of truth. As developed in Chapter Three, this perspective, though common, is inconsistent with most contemporary philosophies of science and presents an important challenge for science educators.

There are many ways to conceptualize science, but the view adopted in this research is consistent with an instrumentalist perspective, where science is only one of many valuable means of coming to know. As Capra (1982) has stated, while there is an appreciation of evidence in science, "scientists do not deal with truth; they deal with limited and approximate descriptions of reality" (p. 48). Thus science, rather than scribing cold descriptions of an objective world, is but one means of investigating the ineffable nature of the universe. Science education should contribute to, rather than diminish, a sense of mystery and wonder at the miracle of our own existence.

Biocultural Evolution

The adaptive capacity of culture has prompted much discussion of human 'biocultural evolution' (Csikszentmihalyi, 1993; Ehrlich, 2000; Lopreato, 1984), which recognizes the dynamic relationship between genetic and cultural aspects of human evolution as crucial for past and future human survival. Lumsden and Wilson (1981) refer to this interplay as 'gene-culture coevolution', "a complicated, fascinating interaction in which culture is generated and shaped by biological imperatives while biological traits are simultaneously altered by genetic evolution in response to cultural innovation" (p. 1). The concept of biocultural evolution is consistent with the complexivist observation that learning (i.e. adaptation) occurs at multiple levels of a complex system

As Davis and Sumara (2006) have alluded, "both the biological history of the species and the social history of the culture are carried in the physical structure of the individual" (p. 126). This notion is also echoed in Ehrlich's (2000) assertion that, "all of our natures are a product of our histories, biological and cultural" (p. 270). We have evolved from physical, biological and cultural

webs, and perpetuate them through our individual and collective existence. Our biological history is recorded in the information contained in genes. Culture, which Ehrlich defines as the sum of an individual's nongenetic information, while not embodied as discretely as genetic information, is equally capable of evolution through a Darwinian dynamic of competition and cooperation.

The terms *meme* (Dawkins, 1976/2006), *culturgen* (Lumsden & Wilson, 1981) and *seme* (Hewlett, De Silvestri & Guglielmino, 2002) have all been used to refer to cultural 'genes', varied conceptual entities ranging from individual beliefs to socially shared norms (Mace, 2005). Of these variants, Dawkins' meme has become most prominently used. It has recently been included in the *American Heritage Dictionary*, where it is defined as "a unit of cultural information, such as a cultural practice or idea, that is transmitted verbally or by repeated action from one mind to another". The term was first introduced in Dawkins' influential text *The Selfish Gene*, and was inspired by the Greek *mimesis* for imitation, and the French *même* for memory. Dawkins listed "tunes, ideas, catch-phrases, clothes, fashions, ways of making pots or of building arches" (p. 192) as examples of these cultural units of information that can be spread through imitation and committed to memory. In Dawkin's terminology, biocentric complexity thinking can be considered a 'co-adapted meme complex' (p. 199), a complementary system of concepts and ideas.

Reading the definitions above, most people would readily recognize memes that they have acquired throughout their lives. Ironically, however, acceptance of the idea of cultural evolution through memes has been limited by disagreement over exactly what a meme is. Anthropologist Ruth Mace (2005) attributes this in part to debate over the question of whether or not memes are faithfully replicating cultural units. She draws on the work of Mesoudi, Whiten, and Laland (2004) to point out that:

> Darwin did not know the answer to any of these questions when he put forward his theory of evolution by natural selection, because genes were unknown at that time...[therefore] questions of

definition are not essential to making the case for an evolutionary process of cultural adaptation. (p. 3)

For a complexivist, patterns observed at one level of a complex system can be used to describe and understand emergent behavior of other nested levels of the system. Memes, then, as units of cultural evolution, are only metaphorically related to their genetic counterparts. As Dawkins (1976/2006) has acknowledged, the term meme is "an analogy, nothing more" (p. 191). Yet, emerging to the level of group (and potentially global) culture, memetic change is pervasive in the globalized world.

The relative difficulty of defining memes is due primarily to the nature of the system in which they are formed. Chromosomes and DNA, though complex, are predictable on the physiochemical plane in a way that the complexities of human cognition simply are not. Reflecting the traditional brain-based view of cognition, Dawkins has commented that, "we know far less about brains than about genes" (p. 323). We know even less about the processes of embodied cognition supported by complexivists. Memetic theory cannot be expected to correlate directly with genetic theory, nor can we expect memes to be defined to the same degree as genes. Despite the lack of clear definition, memes can and clearly have evolved through Darwinian natural selection, achieving "differential reproductive success, with heritable favorable traits [i.e. memes] bestowing a survival advantage on those individuals that possess them" (Lewin & Foley, 2004, p. 21).

Csikszentmihalyi (1993) describes memes as "patterns of behavior, values, languages, and technologies" (p. 87). Like Dawkins, Csikszentmihalyi has noted an important difference between genetic and memetic replication; "the information contained in memes is not passed on through chemical instructions on chromosomes, but through imitation and *learning* [italics added]" (p. 87). Cultural evolution therefore constitutes a potential form of 'conscious' evolution because memes are capable of being shaped and replicated through human intent. Despite the recent emergence of techniques and technologies of genetic modification, humanity possesses a much greater capacity for successfully influencing the

knowledge and subsequent behavior reproduced in society through education than through influencing the reproduction of information contained in human genes.

In the terminology of cultural evolution formal education can be viewed as a process of socially mandated memetic reproduction—a process that is also capable of undergoing and prompting memetic mutation. Mutation, despite the term's negative social connotations, is the creative force behind the diversity required for evolution. In part, the negativity associated with mutation may be attributed to their predominantly detrimental effects on living organisms. As Bohannan (1992) has pointed out, in genetic systems "most mutations are not beneficial and the creature who bears them usually does not live to pass them on. A few mutations are neutral. A very few mutations may be advantageous" (p. 267). Despite the rarity of beneficial mutations in genes, these alterations are imperative to generating the diversity required for adaptability in changing environmental circumstances.

In contrast to the random mutations that occur during genetic replication, memetic mutations can be deliberately chosen for their potential survival advantage. Although the complexivist acknowledgement of uncertainty limits the ability to accurately predict the long-term effects of the introduction of any particular meme or meme complex, this is merely cause for ongoing attentiveness to the impacts of memetically inspired actions, rather than cause for abandoning the conscious manipulation of memes. It is precisely this attentiveness to the impact of dominant habits of thought that has led an identification of the deleterious effects of the modern linear-reductionist worldview and prompted consideration of biocentric complexity thinking as an alternative co-adapted meme complex.

Cultural Diversity and Redundancy

Parallels between biological and cultural evolution allow insights gleaned through investigations of biological systems to be extrapolated metaphorically to the examination of cultural systems. The concepts of diversity and redundancy (i.e. commonality) are central to understanding biological systems and are of particular

relevance for the framework for conscious cultural evolution being developed here. Diversity allows living systems to respond to changes in their physical environments, while redundancy facilitates reproduction (by allowing the genes of different organisms within the same species to combine and develop into a new organism) and compensates for errors in genetic replication during mitosis (Ridley, 2003).

Cultural Diversity

Most important drugs in modern medicine were gained through study of plants previously unknown to Western science but commonly known to local indigenous groups. Botanist Wade Davis (1996) has described the rainforest as a potential pharmacy for the future of mankind—a resource that must be protected in all its diversity for the value that its unique species have for the survival of humanity. Likewise, cultural evolutionists envision the global cultural meme pool or 'ethnosphere' (1996) as a resource, not to be homogenized, but to be protected, to maximize humanity's adaptive capabilities in this era of rapid global change. For ecologist and anthropologist Fikret Berkes, (1988) cultural diversity is "the very stuff of cultural evolution" (p. 7).

Cultural diversity can be likened to biological diversity, providing tangible support for what are often simply rhetorical appreciations of diversity in many multicultural policy documents. At the ecological level, species diversity is an important attribute of the system's adaptive capacity, making ecosystems more robust in the face of ongoing change (Balvanera et al., 2006; Resetarits & Chalcraft, 2007). Natural scientists are in debate about which levels of diversity are most important, how best to measure biological diversity, and how to identify critical levels of reduced biodiversity (e.g., Roberts, Donald & Green, 2007; Larrere & Larrere, 2007). They are in agreement however, that the benefit of diversity is enhanced survival and, accordingly, pivotal to continued biological and ecological evolution.

The deep globalization of neoliberal consumer culture represents a homogenizing reduction of cultural diversity on a global scale, with

corresponding degradation of ecological and biological diversity. "As a small number of cultural groups have achieved economic and political domination in the modern era, the extinction of species, languages and cultures proceeds at an unprecedented pace" (Mace, 2005, p. 8). As discussed in Chapter Two, the impact of the actions of humanity on global biodiversity is an unprecedented event in the history of life on Earth. Like biodiversity, cultural diversity has experienced prior reductions as populations have migrated through political and economic expansion. Like biodiversity again, however, present rates of cultural diversity loss are unprecedented (Maffi, 2001).

According to a study by Kraus (1992), up to ninety percent of the worlds' languages could be lost by the end of the twenty-first century. With the death of each of these languages comes the end of a memetic system of communicating cultural knowledge. Cultural diversity loss is inextricably connected with economic expansion. Colonization and neoliberal forms of globalization have undermined the continuity of cultural transmission through genocide, disease (e.g., smallpox, HIV/AIDS), and, in the case of many contemporary indigenous groups, the establishment of a disconnection between youth and elders who embody these societies' traditional knowledge (e.g., Bonny, 2007).

Within complex systems, diversity acts as a source of creative possibilities necessary for continued evolution in dynamic environments: "one cannot specify in advance what sorts of variation will be necessary for appropriately intelligent action, hence the need to ensure and maintain diversity in the current system" (Davis & Sumara, 2006, p. 138). Unlike the desire for control and domination that has resulted from the belief that the world can be known with certainty (i.e. that there is one 'right' way of doing things), the complexivist acknowledgment of uncertainty provides further impetus for embracing diversity. As Ehrlich (2000) puts it, "quite likely, there will always be limits to knowledge, and therefore we'll always need to be eclectic in choosing ways of 'knowing'" (p. 319). This, of course, requires the existence of diverse knowledge systems to choose from.

Cultural Redundancy

Redundancy is another important concept in biological evolution. Defined as commonality or repetition, redundancy exists at many levels, from repeated gene sequences to the shared behaviors and ecosystem roles of diverse plants and animals. In biological systems, redundancy is valuable because when a gene is damaged or a species driven to extinction, redundant genes or species may compensate for its absence, allowing the organism or ecosystem to survive. The true value of redundant memes for cultural evolution, however, is that they provide a common ground for cooperation and symbiotic cultural coevolution. As Davis and Sumara (2006) have pointed out, redundancy is required in complex systems to enable interactions among agents that are necessary for the system's coherence (p. 139). Indeed, it is the very redundancy of memes (e.g., language, beliefs, values) that bonds cultural groups together. In this sense, somewhat paradoxically, the ultimate objective of biocentric education is to make biocentric complexity thinking redundant.

Complexity theorists recognize the necessity for both redundancy and diversity in the agents that make up complex systems. Ecological educators Smith and Williams (1999) have also acknowledged this in their discussion of potential approaches to resolving global crises:

> A multiplicity of responses will be required. Underlying these responses, however, may be a common set of principles that point to our fundamental interdependence with natural systems and our need for one another. (p. 6)

Acknowledging the value of a dynamic balance between diversity and redundancy is a key aspect of conceptualizing education as a process of conscious cultural evolution. In the case of biocentric education, the co-adapted meme complex of biocentric complexity thinking is not intended to homogenize cultural knowledge systems but to simply facilitate the emergence of widely redundant memes.

Evolutionary Misconceptions

Public resistance to evolutionary theory, which is present in both non-academic and academic realms of society, may impede attempts to apply the metaphor of cultural evolution to educational discourse. In addition to the reasons for opposition to evolution that have already been discussed, resistance is also strongly tied to prominent misconceptions about the mechanisms and ends of evolution (Crawford, Zembal-Saul, Munford & Friedrichsen, 2005; Dagher & BouJaoude, 1997, 2005; Settlage, 1994). These misconceptions include ideas around genetic determinism, evolution as linear progress, and an overemphasis on the role of conflict in maintaining the fitness necessary for survival, and present yet another important challenge for today's science educators.

Genetic Determinism

The concept and problem of genetic determinism is well expressed by Ehrlich (2000) in *Human Natures*, where he draws on recent developments in genetics to argue that our natures are neither genetically determined nor products of 'blank slates' (Ridley, 2003; Pinker, 2002).

> 'Human nature' as a singular concept embodies the erroneous notion that people possess a common set of rigid, genetically specified behavioral predilections that are unlikely to be altered by circumstances... The notion that there is one such nature to change allows us to be painted in the popular mind as instinctively aggressive, greedy, selfish, duplicitous, sex-crazed, cruel, and generally brutish creatures with only a veneer of social responsibility. (p. ix)

Rather than a singular genetically determined human nature, Ehrlich asserts that there are pluralities of dynamic human natures that have emerged through processes of genetic and cultural coevolution.

The idea that humans are somehow captives of tiny replicating strands of DNA, while common (Crawford et al., 2005), has been shown to be erroneous. The recent mapping of the human genome has provided almost incontrovertible

evidence against the possibility of genetic determinism (Ehrlich, 2000). It had been estimated that the human genome would be composed of roughly 100,000 genes, so the discovery of only 30,000 genes (roughly twice as many as a worm) was therefore somewhat of a shock to the scientific establishment (Ridley, 2003). Ehrlich refers to this as the 'gene shortage problem' and uses it as evidence that human behaviors and ethics could not possibly be encoded in our genes.

As Ehrlich (2000) acknowledges, although genes to not determine human behaviors, they do exert some influence on the matrix of biocultural evolution. In *Nature via Nurture* (2003), geneticist Matt Ridley provides several examples of how genes influence the proclivity for organisms to learn instinctual behaviors. For instance, he provides a lengthy description of research into how young orangutans learn an instinctual fear of snakes (through a similar process they were also made to learn a fear of colorful flowers) (p. 156). Genes do influence our behavior but the gene shortage problem limits the degree of their potential influence; "how we experience the world is limited and structured—but not determined—by the chemical instructions encoded in the genes" (Csikszentmihalyi, 1993, p. 64).

Not only do genes contain insufficient information to determine culture and behavior, there is also a degree of plasticity between the genotype (i.e. the genetic code) and phenotype (i.e. physical structure) of any organism. For example, the changes in the size and shape of the finches' beaks that Darwin (1859) drew upon as evidence for his theory of natural selection have been shown to be changes in phenotype in response to changing environmental conditions rather than changes in the genetic code (Wells, 2000). Surely culture, which is arguably capable of greater fluidity than the physical structure of our bodies, possesses the capacity for even greater variation. The fact that groups of genetically similar humans have evolved into a plethora of diverse cultures is further support for this position.

Debunking the myth of genetic determinism is of great importance in today's context as it dismisses potential excuses for failure to alter humanity's ego and anthropocentric behaviors: 'How can we be anything but selfish when we are

the embodiment of selfish genes'? As Ehrlich (2000), however, has commented, "it would make as much or as little sense to call genes cooperative as to describe them as selfish, and it is much less misleading to avoid such analogies altogether" (p. 23), a point which Dawkins (2006) acknowledges in the introduction to the 30th anniversary edition of *The Selfish Gene*. Clearly, we can change, and we must if we desire to alter the present trajectory of the planet's living systems.

Teleological Evolution

The notion that evolution proceeds through stages in a linear progression is a widely held belief among both students and teachers (Crawford et al., 2005; Settlage, 1994). Taylor (1981) used the term *telos* in his biocentric philosophy to refer to the 'goals' of survival and reproduction that all organisms share. Thus, the notion of *teleological evolution* portrays evolution as a 'goal-oriented' process. With respect to cultural evolution, the conventionality of this evolutionary misconception in society is reflected in the ideas of 'high' culture and the 'cultured' person. These, of course, are simply euphemisms for 'upper-class' culture, which includes the 'fine arts', and represents the supposed 'ultimate' stage of cultural development.

Although, in a sense, evolution does proceed toward the 'goals' of survival and reproduction, through the lens of complexity thinking it is not the case that organisms or cultures can be described through the linear conceptions of being 'more' or 'less' evolved. As Davis and Sumara (2006) explain,

> whereas it makes sense to think about mechanical operations in terms of *optimum* efficiency, complex systems obey a logic of *adequacy*. Indeed, it makes little sense to think in terms of 'best' for systems that are constantly changing. (p. 138)

From this complexivist perspective, all existing systems are equally viable alternatives for surviving with their respective environments.

An important implication of the unpredictability of complex systems is that evolutionary success can only be assessed in hindsight. All organisms and all cultures can therefore be considered equally successful (from an evolutionary

perspective) due to the simple fact that they have successfully reproduced and survived to the present, thus refuting notions of evolutionary superiority based on the teleological misconception. As anthropologist and ecologist Feit (1988) has concluded, "all human systems of knowledge incorporate significant information and warrant thoughtful study and practical respect" (p. 78).

The complexivist dysteleological perspective of evolution also provides a unique view on the concept of cultural relativism. Although it mirrors the relativist perspective by identifying all cultures as equally successful and rendering cross-cultural judgments problematic, it departs from the relativist perspective of cultures as static, isolated singularities. Cultural groups, especially in a globalized world, are neither isolated nor static. A strictly relativist interpretation of culture denies the potential for mutual adaptation or change to occur due to the exclusiveness of cultural differences. Implying that we should maintain a separation of distinct cultural groups is pragmatically untenable and becomes even more problematic when that isolation negates the possibility of the intercultural collaboration that is needed to address crises of global extent.

Competition as Fitness

Davis and Sumara (2006) define an intelligent unity as "one that generates a diversity of possibilities and that has a mechanism for critically debating the merits of those possibilities" (p. 85-86). For survival through natural selection, however, it is commonly believed that there is only one possibility—competition (Crawford et al., 2005; Dagher & BouJaoude, 1997). As Mace (2005) has pointed out, however, natural selection simply "refers to the differential survival of certain forms due to their ability to out-live or out-reproduce others" (p. 2). Although the ability to survive and reproduce can be attained through competition, it can also be achieved through cooperation and most often occurs through a combination of both.

The overly competitive interpretation of 'survival of the fittest,' combined with the belief in evolutionary superiority, is at the root of some of the most oppressive ideologies and practices witnessed in humanity's brief existence.

Social Darwinism (exemplified in Nazi Germany), eugenics and neoliberalism have all drawn on ideas of evolutionary superiority and competition in an attempt to justify the exploitation of others. Cooperation, in contrast to competition, requires an openness to change from all agents involved and is therefore rejected as an option for those convinced of their own superiority. Although both Nazi Germany and the eugenics movement achieved a degree of power and prominence, they are both prime examples of Leopold's (1947) observation that 'the conqueror role is self-defeating'. It is likely that neoliberalism, though globally pervasive at present, will eventually suffer the same fate. For the sake of global cultural and biological diversity, one can only hope that it will be sooner rather than later.

Evolutionary Hangovers

In Richard Heinberg's (2005), *The Party's Over: Oil, War and the Fate of Industrial Societies*, he describes in detail a newly emergent global crisis, the energy crisis. Although the harnessing of various fuels for energy has brought humanity from the Stone Age, through the various ages of metals and fully into the nuclear age, this 'progress' has not come without its costs. Denuded forests, the destruction of entire ecosystems for strip mining, climate change and the threat of nuclear catastrophe are all examples of the consequences of humanity's reliance on energy. While it cannot be denied that the ability to use energy has aided in the survival of our species, our increasing use of rapidly depleting resources is now cause for global concern.

The title of Heinberg's (2005) text contains a particularly relevant metaphor. One might imagine the lavish 'parties' thrown by the globally powerful, funded by the wealth extracted through the highly exploitative but profitable pursuits of colonization, industrialization and neoliberal globalization. These parties that have left the planet, both its systems and its inhabitants, with an incredible hangover; the worst part is that those with the worst hangovers (the global poor, women and indigenous peoples) weren't even invited. In a similar vein, Ehrlich (2000) uses the term 'evolutionary hangover' to refer to "structures

or behaviors that once were adaptive but whose positive influence on reproductive performance has declined or disappeared" (p. 34). Due to the complex feedbacks of coevolutionary processes, "many of the greatest dangers on the path to the future are the result of previous adaptive successes" (Csikszentmihalyi, 1993, p. 119). As explained by evolutionary biologists Lewin and Foley (2004), although favorable traits provide a survival advantage for those that possess them "such traits will remain favored only if prevailing conditions remain the same" (p. 21). The use of natural resources for energy, while generally regarded as an adaptive success, has changed planetary conditions to the degree that the crises of overpopulation, climate change and peak oil are now globally relevant issues.

The human propensity for "quick reflexes" focused on short-term threats (i.e. the appearance of a lion or a rival) has also been identified as an evolutionary hangover—one that limits our recognition of long-term threats such as climate change, biodiversity loss, and the proliferation of nuclear weapons (Ehrlich, 2000; Ornstein & Ehrlich, 1989). Sexism, racism, ageism (and many other 'isms') can also be considered evolutionary hangovers. While these discriminatory ways of thinking and acting (based again on notions of superiority) justify exploitative practices in the minds of oppressors, the deny cooperation toward the shared goal of global survival. Following the system of thinking developed in this thesis, the dominance of mechanistic metaphors and their associated linear-reductive mode of thought, including its conception of life, can also be considered an evolutionary hangover. This is consistent with Ehrlich's connection of evolutionary hangovers with the origins of numerous contemporary global problems.

Rates of Cultural and Genetic Evolution

Although both genes and cultures are examples of complex systems, there are important differences between these two coevolutionary partners. Cultural evolution occurs at a much faster pace than genetic evolution because memes can be learned and, consequently, transferred both vertically (from generation to generation) and horizontally (among all people). In contrast, in most organisms genes can only be recombined and passed on vertically, at the agonizingly slow

rate of once per generation (or more depending on the number of children or offspring one has).

Ehrlich (2000) articulates the predicament arising from these mismatched evolutionary rates; "the incredible speed with which cultural evolution has altered the human environment, especially in the past century or two, has not allowed biological evolution enough time to make changes that could adapt us genetically to the new conditions" (p. 280–281). Ehrlich also identifies an equally problematic mismatch between technological and ethical aspects of cultural evolution—our capacity to *do* has far exceeded our ability to *understand* the ramifications of our actions.

The Evolution of Culture

A brief discussion of the evolutionary origins of culture provides some perspective on the importance of understanding the rapid rates at which cultural changes are presently occurring. Culture, as an emergent aspect of human cognition, is closely tied to the evolution of human cognitive abilities, and has been traced primarily through archeological evidence of the tools and art left by our ancestors. As Dawkins (2006) puts it, "The old gene-selected evolution, by making brains, provided the soup' in which the first memes arose" (p. 194).

The first evidence of hominid use of stone tools dates back roughly 2.5 million years (Lewin & Foley, 2004). Perhaps the starkest contrast to today's rapidly evolving cultures and technologies is found in the Odowan and Acheulean traditions, where our ancestors used simple stone tools for nearly two million years. Physical traces of art first appear roughly 40,000 years ago, and coincide with increased geographical variation in the design of tools. It was not until roughly 10,000 years ago that there is clear evidence of agricultural practices and the first permanent human settlements. Ehrlich (2000) believes that it was in these settlements, where large numbers of people first began to live alongside one another, that the conditions for increased cultural exchange (and rates of cultural evolution) became prevalent, eventually leading to the production of new technologies in the bronze and iron ages (p. 310).

Over a period of time, increasingly rapid rates of cultural evolution eclipsed those of genetic evolution. Humanity began changing environments faster than we were able physically adapt to them. Although our genes embody the biological history of our species' experience through countless ice ages and other changes, they have never before been faced with such rapidly changing contexts. For example, our genes are helpless in the face of drastic resource depletion and have yet to find a way to adapt to the carcinogenic agents that have been added to our environments through our own activity.

Culture as an Evolutionary Hangover

The amazing rate at which culture and cultural practices have evolved and impacted the world (e.g., climate change, biodiversity loss etc.) warrant some consideration of culture itself as an evolutionary hangover. The emergence of human 'intense consciousness', a term that Ehrlich (2000) uses to differentiate human cognitive abilities from those of other organisms, in effect has established a separation of our 'selves' from both the surrounding world and each other. Our unique individual identities arise from the intensity with which we experience the world. The centralization of these experiences in our individual bodies, however, has also impeded our ability to perceive our inherent interconnectedness.

Anthropologists have broadly recognized this notion. Mace (2005), for example, has plainly stated that, "our capacity for culture...clearly separates us from other species" (p. 4). Bohannan (1992) has also warned that, "by language and culture we are bonded with our own group, and (here is the trap) we are estranged from others" (p. 26). Hall (1976) has even gone so far as to suggest that resolving the global problems that arise from cultural conflicts will require nothing less than moving 'beyond' our cultures; somehow denying the cultural worldviews through which we enact the world.

It is not necessarily the case, however, that culture must continue to separate humans from each other, other species, or the world at large. It is also not the case that we must (or even can) move beyond our cultures. By consciously attempting to imbue our cultural worldviews with the underlying connectedness

that is foundational to both indigenous worldviews and biocentric complexity thinking, it is possible that we may learn to embody the knowledge of our inextricable interconnectedness to each other and the universe. The adaptation of an ethic of biocentric complexity through conscious cultural evolution is one potential path toward embedding new ways of acting in the social fabric that binds human groups together.

Remediation of Cultural Evolutionary Hangovers

The intentional manipulation of memes has been suggested as a potential means for 'curing' evolutionary hangovers (Ehrlich, 2000; Ehrlich & Ornstein, 1989). Rather than a 'cure', however, the term 'remediation' may be a more apt term for describing the application of conscious cultural evolution to problems stemming from evolutionary hangovers. Remediation has two related meanings, referring to both 'attending to learning difficulties' and 'curing or relieving symptoms of illness'. The crises described in Chapter Two can be considered symptomatic of a global illness, an illness that is directly related to the inability to learn (i.e. adapt) new ways of thinking and acting the world. In addition, it is unlikely that conscious cultural evolution will result in a final 'cure' for these issues. Evolutionary hangovers will require ongoing recursive cultural mediation as humanity continues to co-adapt and co-evolve with a changing universe.

As described above, many evolutionary hangovers are the result of the incredible speed with which culture can evolve via horizontal meme transfer. Rapid changes in human lifestyles through cultural evolution have resulted in stress-related diseases, obesity, and our desire to consume, all of which are thus examples of modern problems stemming from evolutionary hangovers (Ehrlich, 2000). The speed with which culture is able to evolve, however, can also be used to address these problems and may present our best hope for ameliorating cultural conflicts and working together toward the common goal of global survival. The proverbial 'hair of the dog' hypothesis may have some truth to it.

Bacteria represent a unique example of the impact of horizontal gene transfer in living organisms. In bacteria, genetic mutations that arise in one

organism can be passed to other organisms without vertical (parent to offspring) reproduction. Evidence of the extreme adaptability enabled through this form of gene exchange in microorganisms has recently been discovered. In *The Future of Life* (2002), E. O. Wilson describes some of the remarkable environments in which microbial life has adapted and thrived. The thermophilic bacterium *Pyrolobus fumarii* reproduces at 235°F, thrives at 221°F, and freezes to death at 194°F (p. 5). Another organism, *Deinococcus radiodurans*, has evolved the capacity to survive in environments of extreme radiation. While a human exposed to 1,000 rads of radioactive energy will die within a few days, this bacterium can survive doses of up to 3,000,000 rads (p. 6).

Horizontal gene transfer speeds up rates of genetic adaptation, facilitating the emergence of unique species that can survive in what can only be described as extreme conditions (thus they are collectively referred to as extremophiles). Horizontal meme transfer is also capable of creating unique cultural forms but is of greater importance in its capacity for establishing widespread cultural redundancy. Popular culture is perhaps the best example of the potential for the occurrence of widely redundant memes, again reflecting the dominance of consumer culture. Brands and symbols such as the Nike 'swoosh' and McDonald's 'golden arches' may be the most commonly shared memes in human history.

While a bacterium has little choice regarding the genetic material it receives from its partners, humans have a degree of influence over the memes that become part of their cultural knowledge systems. Although the media barrage that controls popular culture is difficult for most to resist or evade, there are those that are able to do so. Through my own observations, I would estimate that the numbers of those resisting and even challenging consumer driven media are growing, partially in response to media awareness courses in public schools, providing some evidence of the effectiveness of conscious cultural evolution. Following this example, biocentric education aims initiate similar actions by spreading the memes of biocentric complexity. Through the lens of biocentric complexity resistance to popular consumer culture, rather than being futile, may

be fertile.

The achievement of broad redundancy of biocentric complexity would influence the ethical know-how of those accepting this co-adapted meme complex. As Leopold (1949) has commented, ethical consideration "has its origin in the tendency of interdependent individuals or groups to evolve modes of co-operation. The ecologist calls these symbioses" (p. 238). Biocentric education can be likened to an attempt to achieve a form of cultural symbiosis through horizontal meme exchange. The aim here is to facilitate intercultural cooperation, not cultural homogenization. Achieving widespread cultural symbiosis will require coadaptation by all cultures, as it is all of our contexts that are changing. The problems we are faced with will be most easily ameliorated if there is collaboration and cooperation from the level of the individual on the street to those who occupy powerful positions in national governments and multi-national corporations. Although this is admittedly a utopian vision, as Hugo (1862) reminds us, 'there is nothing like a dream to create the future'.

The example of Kerala, India, where religio-cutlural groups of Buddhists, Jains, Jews, Christians and Muslims have managed to peacefully coexist and thrive, is an instructive example of the potential for cultural symbiosis. These diverse groups "grew with the active patronage and assistance of orthodox Hindu chieftains and kings. They retained their separate identity. There was no confrontation or conflict with Hinduism but there was no fusion either" (Narayanan, 1972, p. vi). In this case, mutual, redundant respect for a commonly understood importance of religion overcame potential conflicts between the specific doctrines. "This relationship was symbiotic not parasitic, since it was an agreement for mutual advantage" (p. vii).

Whether we like it or not, with a growing global population and easier access to international transportation, diverse cultural groups will come into contact, and possibly conflict, with increasing frequency. If these contacts are to be peaceful opportunities for meme exchange, rather than violent blows to cultural diversity, we must be conscious of our human redundancy. That is, we must identify our mutual embeddedness in living systems as a common ground

from which cultural conflicts can be addressed. Biocentric education would attempt to establish a degree of redundancy by introducing the co-adapted meme complexes of biocentric complexity thinking through conscious cultural evolution—a mode of thinking in which both diversity and commonality are pivotal to maintaining the integrity and survival of nested cultural knowledge systems.

Chapter Six: Conclusion

Education for Global Survival

What is education for? In today's globalized and globalizing world, educational aims must be responsive to the needs of both the local and global contexts in which schools are situated. In Chapter Two I provided substantial evidence that our contemporary global context (as well as many local contexts) is characterized by interconnected humanitarian and ecological crises. Global survival, as 'acceptable, long-term survival' (Potter & Potter, 1995), has become a critical educational aim that is responsive to the global context shared by all educational institutions.

Acknowledging a state of crisis provides both impetus and opportunity for change. It prompts consideration of the effectiveness of dominant neoliberal 'business models' of education and exploration of alternatives. The narrow economic focus of today's educational systems has been widely critiqued as an ill suited response to the systemic crises we face (e.g., Capra, 1996; Stewart-Harawira, 2005). To Orr (2004),

> The fact that we see [these crises] as disconnected events, or fail to see them at all is, I believe, evidence of a considerable failure that we have yet to acknowledge as an educational failure. It is a failure to educate people to think broadly, to perceive systems and patterns, and to live as whole persons. (p. 2)

From the perspective of biocentric complexity developed in this thesis, it is a failure to educate people to understand their embeddedness in a living system.

In *Global Survival* (2006), co-editor Peter Seidel laments the lack of voices emanating from education in Survival Research and states his belief that "people know a lot of things that have nothing to do with survival, and are ignorant of many things that are essential for it" (p. xi). Despite the absence of direct educational perspectives in *Global Survival*, a great deal of educational research and practice is consistent with the aims of acceptable, long-term survival. Global Education (Mitchell, Grin & Sobel, 1977; Mundy, Manion, Masemann, &

Haggerty, 2005; Pike & Selby, 1988), Education for Global Citizenship (Dower, 2003, 2004; Dower & Williams, 2002) and Education for Sustainable Development (Rausch, 2002), while not explicitly aligned with Survival Research, all focus on the achievement of the interrelated goals of social, ecological and economic justice. These are only a few examples of survival-oriented work in education that directly address the crises that threaten humanity's survival. With biocentric education I have attempted to contribute another educational perspective, presenting the need for formal education to facilitate the development of a systems perspective of life.

Biocentric Education

Biocentric education, with the broad goal of global survival as its fundamental aim, provides a conceptual framework applicable to many of the indirectly survival-oriented educational initiatives described above. Each of these educational movements uses a particular approach (e.g., global citizenship or sustainability) to attend to an important set of issues and problems shared by humanity. Biocentric education, rather than focusing attention on a particular area of concern, attempts to create more fundamental change by identifying and alleviating a common thread that links them. The linear-reductionist view of life appears to be one 'pattern that connects' these divergent crises.

Capra's (1996) identification of global crises as "just different facets of one single crisis, which is largely a crisis of perception" (p. 4) reflects the importance of formal education in the conscious shaping of students' perceptions. For example:

> A trained musician clearly perceives Beethoven's Third Symphony differently from someone whose exposure to classical music is casual. Biology students must be trained to see properly through a microscope. Good detectives and good scientists can be trained to build complex perceptions from scattered, subtle clues. (Ornstein & Ehrlich, 1989, p. 202)

Education, then, might also be effective in 'training' students to see life as a multi-layered set of interwoven complex systems. Rather than a form of pedagogical 'training', however, biocentric education aims to provide a set of concepts and ideas that students can apply as needed to make sense of their lives and the world they live in. Biocentric education is not to be pursued as the introduction of a new set of dogma but rather as an opening for discussion and dialogue on possibilities for alleviating global crises.

Orr (2004) has advocated for "a general rethinking of the process and substance of education at all levels, beginning with the admission that much of what has gone wrong with the world is the result of education that alienates us from life in the name of human domination [and] fragments instead of unifies" (p. 17). Biocentric education is an attempt to contribute to Orr's vision by fostering a wider appreciation of the miracle of life, an awareness of the systemic nature of global crises, and an understanding of life as a complex system as an adaptation to our cultural worldviews. Biocentric education, as a process of conscious cultural evolution, aims to reconnect students with the living system from which we have emerged.

The utility of complexity thinking for issues of survival has been recognized for some time. Vogt's (1948) *Road to Survival* was written in response to projected global food shortages. Early on in the text he concedes that, "we must accept change, and adjust our lives to it, if we are to survive. To do this, we must look for the order, the principles within the seeming chaos" (p. xiii). More recently, complexivist ideas have gained prominence in education, driven by an increasing recognition of the non-linear, decentralized nature of cognitive processes (Maturana & Varela, 1980; 1987) and the shortcomings of linearly based 'banking' models of education (Friere, 1970). In this work I have attempted to combine these approaches, using complexivist insights to explore a potential contribution of formal education to global survival.

As Radford (2006) has pointed out, the structures and behaviors observed in biological systems form around a central attractor in the need to survive, and "although there may be a strong survival interest among many individuals who

are party to a particular [school] this may not necessarily be a common one" (p. 188). Radford's statement accurately describes the present educational status quo, where the neoliberal model of education that has come to prominence in recent years attenuates the efforts of many concerned teachers and administrators. Biocentric education constitutes an intentional effort to challenge the dominance of economic concerns in educational institutions and society at large. The complexivist concepts of emergence and nestedness reflect the inherent interconnectedness of life and the universe, and contribute to a perception of economics as an aspect of a larger living system, rather than vice versa.

Perhaps equally important for our present context, through the lens of complexity thinking, learning is understood as the embodiment of a complex system's history of adaptation.

> Since the world now changes more in a decade than it once did in millennia, the most important concept to get across in schools is that much of *whatever* is taught will soon probably become obsolete. That rate of change is, if anything, increasing; therefore *adapting to change must be the center of any new kind of teaching.* (Ornstein & Ehrlich, 1989, p. 217)

From this perspective, learning is a process of adaptation, rather than the construction of a body of objective pieces of knowledge. At the emergent level of human consciousness the history of our adaptations, of our experiences in the world, is embodied in our cultural worldview.

Culture is thus the dynamic medium through which humanity is cognitively nested with the world, a medium in which adaptations are constantly occurring. Recognition of human dependence on the dynamic interplay of nested living systems is confounded by the fact that human enactive cognition is experienced primarily at the level of the individual. We are not conscious of our genes, cells, organs, communities, societies or ecosystems in the same way that we are conscious of our bodies. Human 'intense consciousness' (Ehrlich, 2000) emerged as an evolutionary adaptation that enabled humanity to attain its present apparent position of dominance. The situatedness of human consciousness at the

level of the individual has also contributed to a relative neglect of other emergent levels of living systems, passively advancing their deterioration.

The ability to embody cultural knowledge evolved as a biological adaptation that promoted survival. Although popular culture now promotes consumption over survival, formal education constitutes an important social domain that may potentially redirect cultural evolution to its original role. When learning is envisioned as a form of memetic mutation that impacts the diversity required for cultural evolution, formal education becomes a process of socially mandated enculturation that can take up the challenge of addressing problems arising from evolutionary hangovers through conscious cultural evolution. Within formal education lies the potential to facilitate the embodiment of knowledge of living complex systems as an adaptation to students' cultural worldviews. As these knowledge systems encompass an individual's ethical know-how, the knowledge embodied through students' experiences within schools inevitably has a significant impact on their actions.

While professing that formal education should (or can) be used to facilitate an ontological paradigm shift to biocentric complexity may seem extreme, global crises are equally extreme and complex; their resolution necessitates that such ideas are explored. As stated by Bookchin (1981),

> Our world will either undergo revolutionary changes, so far-reaching in character that humanity will totally transform its social relations and its very conception of life, or it will suffer an apocalypse that may well end humanity's tenure on the planet. (p. 15)

For Bookchin, in our present context biocentric education is clearly warranted. It is a crucial aspect of educating for global survival.

Toward Consilient Narratives of Life

This research has been presented as a form of scientific narrative, 'retelling the story of life through complexity thinking'. Stories and narratives, though not typically associated with science, are of extreme importance as frames through

which people make sense of the world. As Tomas King (2003) puts it, "the truth about stories is that that's all we are" (p. 2). Different stories are needed for different times, and in today's global context of crisis a new story is badly needed. In order for people to make new meanings for themselves outside the confines of materialism and greed they require an alternate narrative in which to envision their future. It is my belief that a narrative that reunites humanity with the world and relates the sacredness of life may inspire hopeful action toward the creation of a more just and sustainable future.

Attempting to change peoples' perceptions of life will undoubtedly involve the resolution of conflicting cultural views. Biocentric education and biocentric complexity, while attempting to supplement the significant limitations of linear-reductionist thought, remain firmly rooted in Western discourse and present only one possible framework for thinking about life and education. They have, however, been developed with the explicit intention of being flexible, adaptable and open to dialogue with and critique from alternative frameworks and systems of thought. Although Davis and Sumara (2006) are careful to state that "it is not the case that *complexity* looks for common ground among belief systems [italics added]" (p. 4), in this thesis I have made a concerted effort to do just that, drawing on complexity thinking to relate the importance of understanding the interconnectedness of life.

The interconnectedness and interdependence implicit in complexivist thinking must not simply be dismissed as a 'nice' idea emanating from utopian delusions. First, biocentric complexity is not utopian as both competition and co-operation are inherent within complex systems—conflicts will inevitably arise in contexts of diversity. The use of violence (i.e. action against life), to resolve conflicts should be limited to a last resort, rather than eliminated. Peace is not synonymous with pacifism. Second, as I have attempted to develop in this thesis, there are good reasons for believing that life is 'differentiated oneness', the commonalities among the emerging sciences of complexity and other more ancient cultural knowledge systems being just one. Although complexity may present 'new' ideas to traditional science, the underlying ontological implications

of complexity have been recognized since time immemorial. In many ways complexity thinking seems to be stating the obvious, especially from many Indigenous and Eastern worldviews.

The concept of biocentric complexity, derived here primarily from Western science, mirrors the perceptions of a living planet and universe shared widely among indigenous peoples. Stewart-Harawira (2005), for example, cites Métis scholar Carl Urion's (1999) understanding that "Traditional knowledge is living knowledge... indigenous knowledge is an expression of life itself, of how to live, and of the connection between all living things" (p. 35). Tewa Indian and Professor of Education Gregory Cajete (2000) also shares this view; in his words, "for Native people, *seeking life* was the all-encompassing task" (p. 2). For Cajete, humanity is an important part of a dynamic and living planet; "we are the Earth becoming conscious of itself" (p. 55).

Indigenous worldviews, though diverse, are also often nonlinear in their use of circular and cyclical patterns of thought, and reflect nestedness and emergence in their holistic perspective that places importance on relationships and the interdependence of all things (Cajete, 2000; Fixico, 2003; Stewart-Harawira, 2005). Fixico's concept of 'inclusive kinship', as opposed to Western 'exclusive kinship', is also reflected in Berkes (1988) observation that, "unlike people of Western cultures, the self-identity of the Cree is *not* distinct from the world around them" (p. 18). Indigenous people are as much a part of the natural living world as they are parts of their own socio-cultural groups and alliances. In one further point of congruence (among many others) the common respect for Elders found in indigenous cultures can be understood as an acknowledgment of the importance of the active 'embodiment' of cultural wisdom in Elders' knowledge of traditional teachings.

Biocentric complexity thinking is also similar to Eastern perspectives regarding the unity of humanity and nature (Morgan & Lawton, 1996). For example, Schweitzer's (1923) 'Reverence for Life' resembles some expressions of Eastern spirituality (e.g., Hinduism and Buddhism) though it lacks the idea of reincarnation of souls (Pojman, 1994). Schweitzer's view of ethics beginning

"where the use of words stops" (p. 260) also parallels Varela's (1999) ethical know-how, which is based on an embodied view of cognition. As Varela, Thompson and Rosch (1991) explain, the nonunity of the cognizing subject is a central aspect of Buddhist meditative practices. The Buddhist method of examining experience called 'mindfulness meditation' includes the doctrines of 'no-self' (i.e. no little person between your ears) and 'nondualism' (i.e. that one's experience of the world arises through enactive cognition) (p. 21-22).

The imperialism, colonization and genocide that characterize the recent history of humanity compel me to note here that it is not my intent to use complexity thinking to 'validate' other cultural knowledge systems nor vice versa. As equally successful ways of knowing (i.e. systems of thought that have survived and reproduced to the present) they can be considered as mutually validating. They are an example of what Wilson (1998) refers to as consilience or 'the unity of knowledge'. This unity (i.e. redundancy) is strengthened by the presence of knowledge rooted in diverse cultural systems of thought.

Although it is important to avoid the appropriation of cultural knowledge, I feel that it is equally important to make these cultural connections. A variety of cultural and disciplinary knowledge systems will be needed to address and resolve the many global problems of our day. Establishing a healthy dialogue among diverse systems of knowledge is an important aspect of working toward global survival. From this dialogue, shared, or consilient, narratives of life may emerge upon which humanity may build a more equitable and sustainable future.

Implications of Biocentric Education

The conceptual framework developed in this thesis provides a nascent lens through which current educational practices may be assessed. Education in and of itself is no guarantee of decency. As Orr (2004) has pointed out, many of humanity's most horrific atrocities, including many of the crises we face today, have resulted from the work of highly educated people (p. 8). This may not be surprising, considering that the goals of our contemporary educational institutions are centered on enabling students as economic, rather than biocentric, actors. The

desire for and generation of financial wealth clearly contributes to the ongoing degradation of the biosphere and the exploitation of a significant portion of humanity.

Biocentric education will hinge on addressing Csikszentmihalyi's (1993) challenge: "the most urgent task facing us is to create a new educational curriculum that will make each child aware, from the first grade on, that life in the universe is interdependent" (p. 275). Ornstein and Ehrlich (1989) have forwarded a similar challenge, stating that education should be recentered on "understanding the nature of humanity itself: our nervous system; our physiology; our evolutionary, as well as our recorded, history; our relationships with the environment; our society; our moral judgments; our possibilities" (p. 199). While it is beyond the scope of this thesis to prescribe specific curricular and pedagogical changes that might be consistent with biocentric education, some broad suggestions for education have been identified.

A clear and necessary aim of biocentric education is the development of 'crisis awareness'. As Ornstein and Ehrlich (1989) suggest, "starting from junior high, students should continuously be exposed to the real dilemmas facing society" (p. 227). Although the age at which these issues should be introduced as well as the depth to which they are introduced are debatable, being aware of a problem is an obvious prerequisite for appropriate action. The introduction of 'socially conscious' content in formal education programs has already established a measure of success. For example, with increasing educational emphasis on raising awareness of the HIV/AIDS pandemic, public pressure on pharmaceutical companies to provide antiretroviral drugs at a reasonable cost has resulted in a tripling of the number of people receiving retroviral treatment in low-middle income countries (UNAIDS, 2006).

Improved, culturally responsive presentation of human evolution would also be a great benefit to achieving the aims of biocentric education. In addition to establishing a degree of common ground through understanding humanity's (and all living organisms') common origins, "understanding more about our biological and cultural evolution will enable people to more readily see through and refute

racist and sexist arguments based on evolutionary misapprehensions" (Ehrlich, 2000, pp. 290-291). Accurate portrayal of 'science' as a human-driven endeavor, subject to the prejudices, values and beliefs of both scientists and funding agencies, will also be important to prevent cultural imperialism in science classrooms—a goal which would be facilitated by inclusion of alternate understandings of not only the contentious issue of human origins, but of human interconnectedness with other living systems.

Biocentric education is also inherently interdisciplinary. Ehrlich (2000) has identified classical education's division "into static, antique disciplines" as an outdated systems "that actively work[s] against badly needed interdisciplinary approaches to the most serious human problems" (p. 325). As Seymour (2004) has also indicated, "teaching subjects separately, without showing their relationship, reinforces a disconnected view of the world" (p. 11). Increasing specialization reduces students' capacity to understand and appreciate the connections and relationships that can only be perceived through a lens with a broader focus.

In addition to the introduction of more interdisciplinary approaches in formal education, biocentric education also requires attention to 'inter-temporality'. Global survival as 'acceptable *long-term*' survival reflects the need to extend the dominant 'short-term' perspective and consider the issues we face from multiple temporal perspectives. As Ehrlich (2000) has suggested, "if, instead of thinking in terms of decades, centuries or even the millennia of recorded history, we contemplated our history for many *millions* of years, then the problems we now face would take on a vastly different perspective" (Ornstein & Ehrlich, 1989, p. 200). An individual's 'Reverence for Life' is strengthened when they "expand their view of landscape, from parish to nation and beyond, and their sweep of time from their own life spans to multiple generations and finally to the extended future history of humankind" (Wilson, 2002, p. 155).

Achieving the aims of biocentric education will also require rethinking today's neoliberal-oriented educational policies. As Davis and Sumara (2006) have stated, "for a teaching species in a complex world, it is ridiculous to

conceive of education in terms of top-down, ends-driven structures" (p. 135). The current trend toward increasingly standardized, performance-oriented evaluation techniques reduces the diversity of local knowledge taught in classrooms, constraining possibilities for students to make needed, personally relevant connections between their local and global contexts. Standardized testing requires standardization of classroom content and activities. In essence, standardization is a practice of cultural homogenization or 'eumemics'—an attempt to control and limit memetic reproduction.

Davis and Sumara (2006) have recognized the logical flaw of imposing norms on agents of a complex system; "In a system made up of differentiated beings and where those differences are necessary to the systems viability...a truly normal agent would be truly *abnormal*" (p. 123). While similarity of content, or redundancy, is necessary to maintain the cohesion of our complex educational and social systems, too much redundancy limits the capacity for these systems to adapt to the changing situational needs of the students and citizens that schools aim to serve. Educational systems are complex, and thus do not lend themselves to linear 'educational improvement' discourses but are "more appropriately described in terms of survival, with successful adaptations in a continuously changing environment" (Radford, 2006, p. 182).

Linearly structured curricula imposed by centrally controlled education systems also inevitably fail to reflect the varied degrees of diversity in today's classrooms and communities. Doll and Alcazar (1998) have proposed an alternative to such curricula in their theoretical treatment of curriculum and complexity theories, initiating a shift from 'curricular structures of control' to 'flexible curricular systems'. A non-linear flexible curricular framework, where curricula emerge from the systemic integration of the diversity of the school, community and the formal education system, is capable of more easily responding to diverse needs.

Examples of recent educational initiatives based on emergent curricula include Common Roots (Kiefer & Kemple, 1999) and the Alaska Rural Systemic Initiative (AKRSI) (Barnhardt & Kawagley, 2004; 2005). Common Roots is a

comprehensive school development process being implemented in Vermont that is "designed to reconnect public elementary schools with the traditional knowledge and natural heritage of their local communities" (1999, p. 21). AKRSI is also focused on establishing reconnections, in this case "between two functionally interdependent but largely disconnected systems—the indigenous knowledge systems rooted in the Native cultures that inhabit rural Alaska, and the formal education systems that have been imported to serve the rural Native communities" (2004, p. 60).

Although these educational programs were designed to facilitate reconnections of different systems at different scales, it is interesting to note that in both cases place-based education is a central pedagogical strategy. Place-based education dissolves the boundaries between schools and their environs and engages students' with local cultural, political, ecological and economic concerns. Through place-based education, "inquiry into local concerns and problem-solving shape teaching and learning activities more than a standardized curriculum" (Smith, 2007, p. 190). From this perspective "educational components can be tailored to fit the particular cultural context in which they are situated" (Barnhardt & Kawagley, 2004, p. 60).

As Seymour (2004) has noted, place-based education is a means to "connect first with self and, through that, connect to others, the natural world, and to something larger that gives life it's meaning" (p. 7). Place-based education is a first step toward reconnecting to the larger world—the Earth, after all, is a 'place' that is common to everyone. It will be difficult for students to truly connect with people and places oceans away, however, if they are not first connected with the people and places of their own communities. Place-based education is increasingly being recognized as an effective pedagogical strategy and constitutes a significant area for future research.

Engaging in dialogue on global survival as an aim of education challenges the presently dominant notions of 'gold-standard' educational research based on a narrow conception of scientific causality that informs present theories and practices of educational standardization and accountability. While achievement

and efficiency are laudable goals within educational institutions, it is my contention that formal education must also be situated within a wider context that is often uncertain and always complex. Assessing the impact of formal education on biospheric health is a challenge that requires moving beyond the narrow confines of linear-reductionist causal analyses. By expanding the realm(s) within which educational endeavors are considered, I hope that this thesis can both challenge and complement dominant educational discourses by exploring the broader purposes that education might serve.

Concluding Thoughts

An emerging appreciation for the magnitude of contemporary global crises has fueled my desire to explore and develop the educational response contained in these pages. As such, this thesis represents the initiation of an ongoing work in progress. My thoughts and perceptions about life, education, and my own identity, have evolved considerably during the writing of these chapters and therefore providing a 'conclusive' finale to this discourse is difficult. Learning is an ongoing process of adaptation rather than a means to a particular end. As Dewey (1929) asserted, education "is a process of living" (p. 292).

Of the ideas introduced in this thesis, the complexivist acceptance of uncertainty is perhaps of greatest importance for today's context. Uncertainty entails a shift from dominance and control based on a belief that certain, complete knowledge is attainable, toward a mentality of coexisting, coadapting and coevolving through an imperfect knowledge of a dynamic and evolving universe.

> The learning of the inevitable letting go of certainty, letting go of solid fixation on self and national boundaries, is, in my eyes, the most needed antidote for our times, and the quickest path to survival altogether. (Varela, 1988, p. 216)

In a very real sense, the survival of our species depends on humanity's ability to learn, evolve, and adapt to greater symbiosis with other agents of the living system in which we are enmeshed. Learning, evolving and adapting each require the capacity for change, a capacity that is limited by belief in certainty.

As a critical example of this, learning to expand the modern 'solid fixation on self' to include one's interconnectedness with other systems is impeded by the certainty with which believe that we exist only as individuals. This belief is learned by most from infancy through the totality of life experience and thus limits consideration of what O'Sullivan (1999) refers to as the 'ecological self'; "a process of identification" (p. 229) with the web of life, from other organisms to the universe itself. In today's context, claims of a 'decentered self' that places value on the natural world as an integral aspect of one's own identity would likely be diagnosed as a mental disorder. Indeed, in the American Psychiatric Association's 1994 *Diagnostic and Statistical Manual* the category of 'Religious or Spiritual Problem' was introduced to enable an official diagnosis of such beliefs during times of 'post-traumatic stress' as mental illness (Valliant, 2005).

The categorical inclusion of an ecological identity as a mental disorder is indicative of the crisis that exists in the way that life is perceived in the Western world. Through the lens of biocentric complexity thinking, "perhaps a truer indication of mental illness (or, at least, psychospiritual disconnection) can be found in the far more common tendency to passively accept the abuse of the very systems that keep us alive" (Valliant, 2005, p. 174). Biocentric education encourages us to engage with the mystery of our own existence, expand our consciousness to include the complex dynamics of life, and act accordingly. It implores us to remember, at least from time to time, that we are alive, and that life, all life, is a miracle.

Literature Cited

Agar, N. (1997). Biocentrism and the concept of life. *Ethics*, *108*(1), 147-168.

Agar, N. (2001). *Life's intrinsic value: Science, ethics and nature*. New York: Columbia University Press.

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, *27*, 1-52.

Aikenhead, G. S. (2001). Students' ease in crossing cultural borders into school science. *Science Education*, *85*, 180-188.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th Ed.). Washington, DC: Author.

Anderson, P. W. (1972). More is different. *Science*, *177*(4047), 393-396.

Apple, M. W. (2004). *Ideology and curriculum* (3rd Ed.). New York: Routledge.

Attfield, R.A. (1999). *The ethics of the global environment*. Edinburgh: Edinburgh University Press.

Ayer, A. J. (1971). *Language, truth and logic*. Harmondsworth: Penguin.

Axelrod, P. (2002). Ideology and Policy. In *Values in conflict: The university, the marketplace, and the trials of liberal education* (pp. 86-118). Montreal: McGill-Queens University Press.

Baker, J. J. (in press). Biocentric education: A complexivist perspective on sustainability. *Proceedings of Trails to Sustainability: An Environmental Education Conference. Kananaskis, AB.*

Balvanera, P., Pfisterer, A. B., Buchmann, N., He, J. S., Nakashizuka, T., Raffaelli, D. et al. (2007). Quantifiying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters*, *9*(10), pp. 1146-1156.

Barabási, A. L. (2002). *Linked: The new science of networks*. Cambridge: Perseus Publishing.

Barker, C. (2002). *Making sense of cultural studies: Central problems and critical debates*. London: Sage Publications.

Barnhardt, R., & Kawagley, A. O. (2004). Culture, chaos and complexity: Catalysts for change in Indigenous education. *Cultural Survival Quarterly, 27*(4), 59–64.

Barnhardt, R., & Kawagley, A. O. (2005). Indigenous knowledge systems and Alaska Native ways of knowing. *Anthropology and Education Quarterly, 36*(1), 8–23.

Barr, J. (2002). Universities after postmodernism. *International Journal of Lifelong Education, 21*, pp. 321-333.

Bates, D. G., & Plog, F. (1990). *Cultural Anthropology* (3rd ed.). New York: McGraw-Hill.

Bateson, G. (1979). *Mind and nature: A necessary unity*. New York: E. P. Dutton.

Becker, T. (1996). The epistemology of qualitative research. In R. Jessor, A. Colby, & R. A. Shweder (Eds.), *Ethnography and human development: Context and meaning in social inquiry* (pp. 53-71). Chicago: University of Chicago Press.

Berkes, F. (1988). Environmental philosophy of the Chisasibi Cree people of James Bay. In M. M. R. Freeman and L. N. Carbyn (Eds.), *Traditional knowledge and renewable resource management in northern regions* (pp. 7-21). Alberta: The University of Alberta Press.

Berkes, F., & Jolly, D. (2002). Adapting to climate change: Social-ecological resilience in a Canadian Western Arctic community. *Conservation Ecology. 5*(2), pp. 18-33.

Bertalanffy, L. von (1968). *Perspectives on general systems theory: Scientific-philosophical studies*. New York: G. Braziller.

Bloom, H. (2000). *Global brain: The evolution of mass mind from the big bang to the 21st century*. New York: John Wiley & Sons, Inc.

Bochner, S., & Parkes, L. (1998). *The physiological effects of the timber industry in the Eden region of New South Wales: A critical review of social impact studies conducted between 1991-1995*. Report prepared for the NSW Forest Products Association, Sydney, NSW.

Bocock, R. (1992). The cultural formations of modern society. In S. Hall & B. Geiben (Eds.), *Formations of modernity: Understanding modern societies* (pp. 229-274). Cambridge, UK: Polity Press.

Bohannan, P. (1992). *We the alien: An introduction to cultural anthropology.* Prospect Heights, IL: Waveland Press.

Bonny, E. A. (2007). *Inuit Qaujimajatuqangit and knowledge transmission in a modern Inuit community: Perceptions and experiences of Mittimatalingmiut women.* Unpublished Masters thesis, Natural Resources Institute, University of Manitoba.

Bookchin, M. (1981). The concept of social ecology. *Coevolution Journal. 32*, pp. 14-22.

Brown, A. D. (2003). *Feed Or Feedback.* Utrecht, Netherlands: International Books.

Bruner, J. (1996). *The culture of education.* London: Harvard University Press.

Byrne, D. (1998). *Complexity theory and the social sciences: An introduction.* London: Routledge.

Cajete, G. (2000). *Native science: Natural laws of interdependence.* Santa Fe, NM: Clear Light Publishers.

Capra, F. (1975). *The Tao of physics: An exploration of the parallels between modern physics and Eastern mysticism.* New York: Shambhala.

Capra, F. (1982). *The turning point: Science, society and the rising culture.* New York: Simon and Schuster.

Capra, F. (1996). *The web of life: A new scientific understanding of living systems.* New York: Anchor Books.

Capra, F. (2002). *The hidden connections: A science for sustainable living.* New York: Random House.

Casti. J. L. (1994). *Complexification: Explaining a paradoxical world through the science of surprise.* New York: HarperCollins Publishers.

Center for a Postmodern World (1990). *Position paper on postmodernism.* Claremont, CA: Claremont Graduate School of Theology.

Chase-Dunn, C. (1999). Globalization: A world systems perspective. *Journal of World Systems Research, 2*, pp. 187-215.

Cobern, W. W. (1994). World view, culture, and science education. *Science Education International, 5*(4), 5-8.

Coffield, F., & B. Williamson (1997). The challenges facing higher education. In F. Coffield & B. Williamson (Eds.), *Repositioning higher education* (pp. 1-26). Buckingham: Open University Press.

Cohen, J. & Stewart, I. (1994). *The collapse of chaos: Discovering simplicity in a complex world.* New York: Viking.

Collins, H. & Pinch, T. (1998). *The Golem: What you should know about science* (2nd Ed.). Cambridge: Cambridge University Press.

Collins English Dictionary (4th Ed.). (1998). Glasgow: Harper Collins Publishers.

Costa, V. B. (1995). When science is 'another world': Relationships between worlds of family, friends, school, and science. *Science Education, 3*, 313-333.

Crawford, B. A., Zembal-Saul, C., Munford, D., & Friedrichsen, P. (2005). Confronting prospective teachers' ideas of evolution and scientific inquiry using technology and inquiry-based tasks. *Journal of Research in Science Teaching, 42*(6), pp. 613-637.

Csikszentmihalyi, M. (1993). *The evolving self: A psychology for the third millennium.* New York: HarperCollins.

Cummins, C. L., Demastes, S. S., & Hafner, M. S. (1994). Evolution: Biological education's under-researched unifying theme. *Journal of Research in Science Teaching, 31*(5), pp. 445-448.

Cvetkovich, A. (2001). Don't stop the music: Roundtable discussion with workers from the Michigan Womyn's Music Festival. *GLQ: A Journal of Lesbian and Gay Studies, 7*(1), 131-151.

Dagher, Z. R., & BouJaoude, S. (1997). Scientific views and religious beliefs of college students: The case of biological evolution. *Journal of Research in Science Teaching, 34*(5), 429-445.

Dagher, Z. R., & BouJaoude, S. (2005). Student's perceptions of the nature of evolutionary theory. *Science Education, 89*(3), 378-391.

Darwin, C. R., (1859). *On the origins of species by means of natural selection, or the preservation of favoured races in the struggle for life*. London: John Murray.

Davis, B. (2004). *Inventions of teaching: A genealogy*. London: Lawrence Erlbaum Associates.

Davis, B., & Sumara, D. (2006). *Complexity and education: Inquiries into learning, teaching and research*. London: Lawrence Earlbaum Associated.

Davis, B., Sumara, D., & Luce-Kapler, R. (2008). *Engaging minds: Changing teaching in complex times*. New York: Routledge.

Davis, W. (1993). The global importance of biodiversity. In M. A. Fenger, E. H. Miller, J. F. Johnson and E. J. R. Williams (Eds.). *Our living legacy: Proceedings of a symposium on biological diversity*. (pp. 23-46). Victoria, BC: Royal British Columbia Museum.

Davis, W. (1996). *One river: Explorations and discoveries in the Amazon rain forest*. New York: Simon & Schuster.

Dawkins, R. (2006). *The selfish gene*. (30th anniversary Ed.). Oxford: Oxford University Press.

Denzin, N. K., & Lincoln, Y.S. (2003). The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (2nd Ed.). (pp. 1-45). London: Sage Publications.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: MacMillan.

Dewey, J. (1929). My pedagogic creed. *Journal of the National Education Association, 18*(9), 291-295.

Dobzhansky, T. (1973). Nothing in biology makes sense except in the light of evolution. *The American Biology Teacher, 34*, 125-129.

Doll, W. E. Jr., (1993). *A post-modern perspective on curriculum*. New York: Teachers College Press.

Doll, W. E. Jr., & Alcazar, A. (1998). Curriculum and concepts of control. In W. Pinar (Ed.), *Curriculum: Toward new identities* (pp. 295-324). New York: Garland.

Doll, W. E. Jr., Fleener, M. J., Trueit, D., & St. Julien, J. (Eds.) (2005). *Chaos, complexity, curriculum and culture: A conversation.* New York: Peter Lang.

Dower, N., & Williams, J. (Eds.). (2002). *Global citizenship: A critical introduction.* New York: Routledge.

Dower, N. (2003). *An introduction to global citizenship.* Edinburgh: Edinburgh University Press.

Dower, N. (2004). Keynote Speaker: Are we all global citizens or only some of us global citizens? At *Educating for human rights and global citizenship conference*. University of Alberta, Nov. 11-13.

Ehrlich, P. (2000). *Human natures: Genes, cultures and the human prospect.* Washington, D.C.: Island Press.

Erickson, M. (2005). *Science, culture and society: Understanding science in the 21st century.* Cambridge, U.K.: Polity Press.

Essaydi, L. (2006). True complexity. *The Chronicle of Higher Education, 52*(25), p. B15.

Etzkowitz, H., & Leydoesdorff, L. (1997). Universities and the global knowledge economy: A triple helix of university-industry-government relations. In J. de la Mothe (Series Ed.) *Science, technology and the international political economy*. London: Cassell.

Feinberg, W., & McDonough, K. (2003). Introduction: Liberalism and the dilemma of public education in multicultural societies. In K. McDonough & W. Feinberg (Eds.), *Education and citizenship in liberal-democratic societies: Teaching for cosmopolitan values and collective identities* (pp. 1-19). Oxford: Oxford University Press.

Feit, H. A. (1988). Self-management and state-management: Forms of knowing and managing northern wildlife. In Freeman, M. M. R., and Carbyn, L. N., (Eds.). *Traditional knowledge and renewable resource management in northern regions*. Edmonton: IUCN Commission on Ecology and the Boreal Institute for Northern Studies. 72–91.

Feyerabend, P. (1993). *Against Method* (3rd Ed.). London: Verso Books.

Fixico, D. L. (2003). *The American Indian mind in a linear world: American Indian studies and traditional knowledge*. New York: Routledge.

Fleck, L. (1979). *Genesis and development of a scientific fact*. Chicago: University of Chicago Press. (Originally published 1935).

Foucault, M. (1979). *Discipline and punish*. New York: Vintage Books.

Frank, S. A. (1998). *Foundations of social evolution*. Princeton, NJ: Princeton University Press.

Friere, P. (1970). *Pedagogy of the oppressed*. New York: Continuum International.

Gleick, J. (1988). *Chaos: Making a new science*. New York: Penguin.

Gould, S. J. (1989). *Wonderful life: The Burgess Shale and the nature of history*. New York: Norton.

Griffin, D. R. (1988). *The reenchantment of science: Postmodern proposals*. Albany: State University of New York Press.

Gutek, G. L. (1995). *A history of the Western educational experience* (2nd ed.). Prospect Heights, IL: Waveland Press.

Habermas, J. (1981). *Theory of communicative action*. (T. McCarthy, Trans.). Frankfurt: Suhrkamp.

Hall, E.T. (1976). *Beyond culture*. New York: Anchor Press.

Hall, S. (1988). The toad in the garden: Thatcherism among the theorists. In L. Grossberg & C. Nelson (Eds.), *Marxism and the interpretation of culture* (pp. 35-57). Chicago, IL: University of Illinois Press.

Hanson, W. (1884). The ethics of protection and free trade. In *The fallacies in progress and poverty* (pp. 115-143). New York: Fowler and Wells.

Hawken, P. (1993). *The ecology of commerce: A declaration of sustainability.* New York: Harper Business.

Heinberg, R. (2005). *The party's over: Oil, war and the fate of industrial societies*. East Sussex, UK: Clairview Books.

Herz, J. H. (2003). On human survival: Reflections on survival research and survival policies. *World Futures: The Journal of General Evolution. 59*(3), pp. 135-143.

Hewlett, B. S., De Silvestri, A., & Guglielmino, C. R. (2002). Semes and genes in Africa. *Current Anthropology, 43*,(2), pp. 313-321.

Hitz, S., & Smith, J. (2004). Estimating global impacts from climate change. *Global Environmental Change, 14*, 201-218.

Holland, M. M., & Bitz, C. M. (2003). Polar amplification of climate change in coupled models. *Climate Dynamics, 21*, 221-232.

Hubbard, B. (1998). *Conscious evolution: Awakening the power of our social potential*. Novato, CA: New World Library.

Hughes, T. P., Baird, A. H., Bellwood, D. R., Card, M., Connolly, S. R., Folke, C. et al. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science, 301*(5635), pp. 929-933.

Hugo, V. (1862). *Les Miserables* (Trans. C. E. Wilbour). New York: Random House.

Intergovernmental Panel on Climate Change (IPCC). (2001). *Climate change 2001: The scientific basis*. Contribution to Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change.

Intergovernmental Panel on Climate Change (IPCC). (2007). *Climate Change 2007: The physical science basis: Summary for policymakers.* Contribution to Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Jameson, F. (2001). Notes on globalization as a philosophical issue. In F. Jameson & M. Miyoshi (Eds.), *The cultures of globalization* (pp. 54-77). Durham, NC: Duke University Press.

Johnson, S. (2001). *Emergence: The connected lives of ants, brains, cities, and software*. New York: Simon & Schuster.

Joint United Nations Program on HIV/AIDS (UNAIDS). (2006). *2006 Report on the global AIDS epidemic: UNAIDS 10th anniversary special edition.* UNAIDS.

Kapur, G. (2001). Globalization and culture: Navigating the void. In F. Jameson & M. Miyoshi (Eds.), *The cultures of globalization* (pp. 191-217). Durham, NC: Duke University Press.

Kates, R. W. (2000). Cautionary tales: Adaptation and the global poor. *Climactic Change, 45*, 5-17.

Katz, M. B. (1976). The origins of public education: A reassessment. *History of Education Quarterly, 16*(4), pp. 381-408.

Kauffman, S. (1995). *At home in the universe: The search for the laws of self-organization and complexity*. Oxford, UK: Oxford University Press.

Keifer, J., & Kemple, M. (1999). Stories from our common roots: Strategies for building an ecologically sustainable way of living. In G. A. Smith & D. R. Williams (Eds.), *Ecological education in action: On weaving education, culture and the environment* (p. 21-46). New York: State University of New York Press.

Kellner, D. (2002). Theorizing globalization. *Sociological Theory, 20*(3), 285-306.

Kenway, J. & Kraack, A. (2004). Reordering work and destabilizing masculinity. In N. Dolby, G. Dimitriadis & P. Willis (Eds.). *Learning to labor in new times* (pp. 95-109). New York: RoutledgeFalmer.

Keohane, N. O. (1994). The mission of the research university. In J. R. Cole, E. G. Barber & S. R. Graubard (Eds.), *The research university in a time of discontent* (pp. 153-177). London: The Johns Hopkins University Press.

Kerr, R. A. (1998). Requiem for life on Mars? Support for microbes fades. *Science, 282*, 1398-1400.

Khor, M. (2001). *Rethinking Globalization.* London: Zed Books Limited.

Kincheloe, J. L., & McLaren, P. (2005). Rethinking critical theory and qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage Handbook of Qualitative Research* (3rd Ed.). (pp. 303-342). London: Sage Publications.

King, T. (2003). *The truth about stories: A native narrative*. Toronto: Anansi Press Inc.

Klein, N. (2000). *No logo: Taking aim at the brand bullies*. New York: Picador.

Kliebard, H. M. (1975). The rise of scientific curriculum-making at its aftermath. *Curriculum Theory Network*, *5*(1), 27-38.

Knudson, P., & Suzuki, D. (2006). *Wisdom of the elders: Native and scientific ways of knowing about nature*. Vancouver, BC: Greystone Books.

Koestler, A. (1967). *The ghost in the machine*. New York: Hutchinson & Co. Publishers.

Krauss, M. (1992). The world's languages in crisis. *Language*, *68*(1), pp. 4-10.

Kuhn, T. (1980). *The structure of scientific revolutions* (2nd Ed.). Chicago, IL: University of Chicago Press.

Kump, L. R., Kasting, J. F., & Crane, R. G. (2004). *The earth system*, New Jersey: Pearson Education.

Küng, H. (2001). Basic trust as the foundation for a global ethic. *International Review of Psychiatry*, *13*, 94-100.

Labaree, D. (1997). *How to succeed in school without really learning: The credentials race in American education*, New Haven, CT: Yale University Press.

Larrere, R., & Larrere, C. (2007). Should nature be respected? *Social Science Information*, *46*(1), pp. 9-34.

Laszlo, E. (Ed.). (1993). *The multi-cultural planet: The report of a UNESCO international expert group*. Oxford: Oneworld Publications.

Laszlo, E. (2006). Introduction. In E. Laszlo & P. Seidel (Eds.), *Global survival: The challenge and implications for thinking and acting* (pp. i-vii). New York: SelectBooks Inc.

Laszlo, E., & Seidel, P. (Eds.). (2006). *Global survival: The challenge and implications for thinking and acting.* New York: SelectBooks Inc.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Leakey, R., & Lewin, R. (1995). *The sixth extinction.* New York: Doubleday.

Leopold, A. (1949). *A sand county almanac.* Oxford: Oxford University Press.

Lewin, R. (1999). *Complexity: Life at the edge of chaos* (2nd Ed.). Chicago, IL: University of Chicago Press.

Lewin, R., & Foley, R. A. (2004). *Principles of human evolution* (2nd Ed.). Oxford: Blackwell Publishing.

life. (n.d.). Dictionary.com Unabridged (v 1.1). Retrieved October 25, 2007, from Dictionary.com website: http://dictionary.reference.com/browse/life

Loomis, J. B. (2002). *Integrated public lands management: Principles and applications to national forests, parks, wildlife refuges, and BLM lands.* New York: Columbia University Press.

Lopreato, J. (1984). *Human nature and biocultural evolution.* London: Allen and Unwin.

Lovelock, J. E. (1988). *The ages of Gaia: A biography of our living Earth.* New York: Norton.

Lovelock, J. E. (2000). *Gaia: A new look at life on Earth.* Oxford: Oxford University Press. [First published in 1979]

Lumsden, C. J. & Wilson, E. O. (1981). *Genes, mind, and culture: The coevolutionary process.* Harvard: Harvard University Press.

Lyotard, J. F. (1984). *The postmodern condition: A report on knowledge.* Manchester: Manchester University Press.

Mace, R. (2005). Introduction: A phylogenetic approach to the evolution of cultural diversity. In R. Mace, C. J. Holden & S. Shennan (Eds.), *The evolution of cultural diversity: A phylogenetic approach* (pp. 1-10). London: UCL Press.

MacIntyre, A. (1998). *A short history of ethics.* (p. 1-13). Notre Dame: University of Notre Dame Press.

Maffi, L. (Ed.). (2001). *On biocultural diversity: Linking language, knowledge and the environment*. London: Smithsonian Institution Press.

Marginson, S. (1993). *Education and public policy in Australia*. Melbourne: Cambridge University Press.

Maturana, H. R., & Varela, F. J. (1980). *Autopoiesis and cognition*. Dordrecht, Holland: Reidel.

Maturana, H. R., & Varela, F. J. (1987). *The tree of knowledge: The biological roots of human understanding*. London: Shambhala.

McQuaig, L. (2001). *All you can eat: Greed lust and the new capitalism*. London: Penguin Books.

meme. (n.d.). The American Heritage Dictionary of the English Language, Fourth Edition. Retrieved September 10, 2007, from Dictionary.com website: http://dictionary.reference.com/browse/meme

Merchant, C. (2005). *Radical ecology: The search for a livable world* (2nd ed.). New York: Routledge.

Mesoudi, A., Whiten, A., & Laland, K. N. (2004). Is human cultural evolution Darwinian? Evidence reviewed from the perspective of The Origin of Species. *Evolution, 58*, 1–11.

Mignolo, W. D. (2001). Globalization, civilization processes, and the relocation of languages and cultures. In F. Jameson & M. Miyoshi (Eds.), *The cultures of globalization* (pp. 32-53). Durham, NC: Duke University Press.

Millennium Ecosystem Assessment (MEA) (2005). *Ecosystems and human well-being: Biodiversity synthesis*. Washington, D.C.: World Resources Institute, Island Press.

Miller, J. D., Scott, E. C., & Okamoto, S. (2006, August 11). Public acceptance of evolution. *Science, 313*, 766-777.

Milner, A. & Browitt, J. (2002). *Contemporary Cultural Theory*(3rd ed.). London: Routledge.

Mitchell, M. R., Grin, S. S., & Sobel, B. (1977). *World education: An emerging concept*. Washington, D.C.: University Press of America.

Mundy, K., Manion, C. Masemann, V., & Haggerty, M. (2005). *Global education in Canada.* Toronto: Ontario Institute for Studies in Education/UNICEF.

Morgan, P., & Lawton, C. (Eds.). (1996). *Ethical Issues in Six Religious Traditions*. Edinburgh: Edinburgh University Press.

Naess, A. (1973). The shallow and the deep, long-range ecology movement. A summary. *Inquiry, 16*, pp. 129-158.

Narayanan, M. G. S. (1972). *Cultural symbiosis in Kerala.* Calicut, India: Mathrubhumi Press.

Nash, R. (1989). *The rights of nature: A history of environmental ethics.* Wisconsin: The University of Wisconsin Press.

Natural Sciences and Engineering Research Council of Canada (2005). *Research means business: A directory of companies built upon NSERC-supported university research.* (Cat No. NS3-22/2005E). Ottawa: Author.

Nef, J., & Robles, W. (2000). Globalization, neoliberalism, and the state of underdevelopment in the new periphery. *Journal of Developing Societies, 16*(1), 27-47.

Nelson, L. (1993). *Who knows: From Quine to a feminist epistemology.* Philadelphia: Temple University Press.

Nissani, M. (1997). Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. *Social Science Journal, 34*(2), pp. 201-216.

Noddings, N. (1984). *Caring: A feminine approach to ethics and moral education.* Berkeley: University of California Press.

Olssen, M., Codd, J., & O'Neill, A. (2004). *Education policy: globalization, citizenship and democracy.* London and New Delhi: Sage.

Osborne, K. (1999). *Education: A guide to the Canadian school debate.* Toronto: Penguin Books.

O'Sullivan, E. (1999). *Transformative education: Educational vision for the 21st century*. New York: Zed Books.

Ornstein, R., & Ehrlich, P. (1989). *New world, new mind: Moving toward conscious evolution.* New York: Touchstone.

Orr, D. (2004). *Earth in mind: On education, environment and the human prospect*. London: Island Press.

Peters, R. T. (2004). *In search of the good life: The ethics of globalization*. New York: Continuum.

Phillips, L. M., & Norris, S. P. (1999). Interpreting popular media reports of science: What happens when the reader's world meets the world on paper? *International Journal of Science Education, 21*, 317-327.

Pike, G., & Selby, D. (1988). *Global teacher, global learner*. London: Hodder and Stoughton.

Pinch, T. J. (1986). *Confronting nature: The sociology of solar-neutrino detection*. Dordrecht: D. Reidel Publishing Company.

Pinker, S. 2002. *The blank slate: The modern denial of human nature*. New York: Viking.

Pojman, L. P. (Ed.). (1994). *Environmental ethics: Readings in theory and application*. Sudbury, MA: Jones and Bartlett Publishers.

Potter, V. R. (1971). *Bioethics: Bridge to the Future*. Englewood Cliffs, N.J.: Prentice-Hall.

Potter, V. R. (1988). *Global Bioethics: Building on the Leopold Legacy*. East Lansing: Michigan State University Press.

Potter, V. R., & Potter, L. (1995). Global bioethics: Converting sustainable development to global survival. *Medicine and Global Survival. 2*(3), pp. 185-191.

Prigogine, I., & Stengers, I. (1984). *Order out of chaos: Man's new dialogue with nature*. New York: Bantam Books.

Radford, M. (2006). Researching classrooms: Complexity and chaos. *British Educational Research Journal, 32*(2), 177-190.

Radford, M. (2007). Prediction, control and the challenge to complexity science. *Proceedings of the 2007 Complexity Science and Education Conference* (pp. 209-216). Vancouver, BC.

Rankin, K. (2004). Gender, development and globalization: Economics as if people mattered. *Journal of American Planning, 70*(4), 493-494.

Rausch, F. (2002). The potential for sustainable development for reform in schools. *Environmental Education Research, 8*(1), pp. 43-51.

Resetarits, W. J., & Chalcraft, D. R. (2007). Functional diversity within a morphologically conservative genus of predators: Implications for functional equivalence and redundancy in ecological communities. *Functional Ecology, 21*(4), pp. 793-804.

Richardson, K. A., & Cillers, P. (2001). What is complexity science? A view from different directions. *Emergence, 3*(1), pp. 5-22.

Ridley, M. (2003). *Nature via nurture: Genes, experience and what makes us human.* Toronto: Harper Collins Press.

Rizvi, F. (2004). The "lads" and the cultural topography of race. In N. Dolby, G. Dimitriadis & P. Willis (Eds.), *Learning to labor in new times* (pp. 83-92). New York: RoutledgeFalmer

Roberts, R. L., Donald, P. F., & Green, R. E. (2007). Using simple species lists to monitor trends in animal populations: New methods and a comparison with independent data. *Animal Conservation, 10*(3), pp. 332-339.

Ruddiman, W. F. (2003). The Anthropogenic greenhouse era began thousands of years ago. *Climactic Change, 61*, pp. 261-293.

Russell, P. (1995). *The global brain awakens: Our next evolutionary leap* (2nd Ed.). Palo Alto, CA: Global Brain.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans*. New York: University Press.

Sagan, C., & Drake, F. (1975). The search for extraterrestrial intelligence. *Scientific American, 275*, 80-89.

Schweitzer, A. (1923). *Civilization and ethics* (Trans. J. Naish). London: A. & C. Black.

Schrödinger, E. (1944). *What is life? The physical aspect of the living cell.* Cambridge: The University Press.

Seidel, P. (2006). Introduction: A sensible way to think and act. In E. Laszlo & P. Seidel (Eds.), *Global survival: The challenge and implications for thinking and acting.* (pp. ix-xii). New York: SelectBooks Inc.

Settlage, A. Jr. (1994). Conceptions of natural selection: A snapshot of the sense-making process. *Journal of Research in Science Teaching, 31*(5), 449-457.

Seymour, M. (Ed.) (2004). *Educating for humanity: Rethinking the purposes of education.* London: Paradigm Publishers.

Skyttner, L. (2001). *General systems theory: Ideas and applications.* Singapore: World Scientific Publishing Company.

Slattery, P. (2006). *Curriculum development in the postmodern era* (2nd Ed.). New York: Routledge.

Slaughter S., & Leslie, L. (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university.* Baltimore: Johns Hopkins.

Slaughter S., & Rhoades, G. (2004). *Academic capitalism and the new economy: Markets, state and higher education.* Baltimore: Johns Hopkins.

Sleep, N. H. (2001). Oxygenating the atmosphere. *Nature, 410,* 317-319.

Small, C., & Nicholls, R. J. (2002). A global analysis of human settlement in coastal zones. *Journal of Coastal Research, 19*(3). 584-599.

Smith, G. A. (2007). Place-based education: Breaking through the constraining regularities of public school. *Environmental Education Research, 13*(2), 198-207.

Smith, G. A., & Williams, D.R. (1999). Introduction. In G. A. Smith & D. R. Williams (Eds.). *Ecological education in action: On weaving education, culture and the environment* (p. 1-18). New York: State University of New York Press.

Snow, C. P. (1959). *The two cultures.* Cambridge: Cambridge University Press.

Sowell, T. (2003). *Applied economics: Thinking beyond stage one.* New York: Basic Books.

Spariousu, M. I. (2004). *Global intelligence and human development: Toward an ecology of global learning.* Cambridge, MA: MIT Press.

Steinbock, B. (Ed.) (2007). *The Oxford handbook of bioethics.* Oxford: Oxford University Press.

Stewart-Harawira, M. (2005). *The new imperial order: Indigenous responses to globalization.* New York: Zed Books.

Stewart-Harawira, M. (2007). Globalisation, work and indigenous knowledge in the global marketplace: The New Zealand experience. In L. Farrell & T. Fenwick (Eds.). *Educating the global workforce*. Oxon, UK: Routledge.

Taylor, P. W. (1981). The ethics of respect for nature. *Environmental Ethics. 3*, pp. 197-218.

Thelin, J. R. (2004). Higher education and the public trough: A historical perspective. In E. P. St. John & M. D. Parsons (Eds.), *Public funding of higher education: Changing contexts and new rationales* (pp. 21-39). Baltimore, MA: Johns Hopkins University Press.

Tibbets, J. (2004). The state of the oceans, Part 2: Delving deeper into the seas bounty. *Environmental Health Perspectives*, *112*(8), pp. 65- 74.

Tol, R. S. J, Downing, T. E., Kuik, O. J., & Smith, J. B. (2004). Distributional aspects of climate change impacts. *Global Environmental Change*, *14*, pp. 259-272.

Tyler, R. (1949). *Basic principles of curriculum and instruction.* Chicago: University of Chicago Press.

United Nations Human Development Report (UNHDR) (2006). *Beyond scarcity: Power, poverty and the global water crisis*. New York: Palgrave Macmillan.

Urion, C. (1999). *Recording first nations traditional knowledge.* Unpublished paper, U'mista Cultural Society.

Valliant, J. (2005). *The golden spruce: A true story of myth, madness and greed.* New York: W. W. Norton.

Varela, F. J. (1988). Laying down a path in the walking: A biologist's look at a new biology and its ethics. In Grof, S. & Valier, M. L. (Eds.), *Human survival and consciousness evolution* (pp. 204-217). Albany, NY: State University of New York Press.

Varela, F. J. (1999). *Ethical know-how: Action, wisdom and cognition.* Stanford, CA: Stanford University Press.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience.* MIT Press: London.

Vickers, D. (1997). Economics and ethics: An introduction to theory, institutions and policy. London: Praeger.

The Vienna Circle (1973). *The scientific conception of the world: The Vienna Circle*. London: D. Reidel Publishing Company. (Originally published 1929)

Vittachi, A. (1989). *Earth conference one: Sharing a vision for our planet.* Boston: Shambhala Press.

Vogt, W. (1948). *Road to survival.* New York: William Sloane Associates.

Volk, T. (1995). *Metapatterns: Across space, time and mind.* New York: Columbia University Press.

Waldrop, M. M. (1992). *Complexity: The emerging science at the edge of order and chaos.* New York: Simon & Schuster.

Wallace, W. M. (2006). *Techno-cultural evolution: Cycles of creation and conflict.* Washington, D.C.: Potomac Books.

Ward, P. D., & Brownlee, D. (2000). *Rare Earth: Why complex life is uncommon in the universe.* New York: Copernicus Books.

Warren, K. J. (1994). The power and promise of ecological feminism. In L. P. Pojman (Ed.), *Environmental Ethics* (pp. 124-134). Boston: Jones and Bartlett Publishers

Waters, M. (1995). *Globalization.* London: Routledge

Weaver, W. (1948). Science and complexity. *American Scientist, 36,* pp. 536-544.

Weiner, N. (1946). *Cybernetics: Control and communication in the animal and machine* (2nd Ed.). Cambridge, MA: M.I.T. Press.

Wells, J. (2000). *Icons of evolution: Science or myth? Why much of what we teach about evolution is wrong.* Washington, DC: Regnery Publishers.

Wilkinson, C. (Ed.) (2002). *Status of coral reefs of the world.* Perth: Australian Institute of Marine Science.

Williams, R. (1981). *Culture.* Glasgow: Fontana Paperbacks.

Willis, P. (2004). Twenty-five years on: Old books, new times. In N. Dolby, G. Dimitriadis & P. Willis (Eds.), *Learning to labor in new times* (pp. 167-196). New York: RoutledgeFalmer.

Wilson, E. O. (1998). *Consilience: The unity of knowledge*. New York: Alfred A. Knopf Inc.

Wilson, E. O. (2002). *The future of life*. New York: Vintage Books.

World Commission on Environment and Development. (1987). *Our Common Future*. Oxford: Oxford University Press.

Yudhoyono, S. B. (2005). Keynote Speaker: Natural disasters and global responsibility. At *APEC CEO Summit*. Busan, South Korea, November 17.

Zimmerman, M. E. (1994). *Contesting earth's future: Radical ecology and postmodernity*. London: University of California.