

Waking Up in the Anthropocene: Big History and the Biosphere

by

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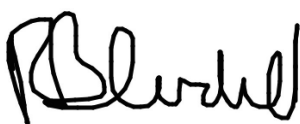
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December 30, 2015

R. Blundell

Date

Waking Up In The Anthropocene: Big History and the Biosphere

To the bluefin tuna of Stellwagen Bank

and the oak trees of Red Hill

With gratitude

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Dissertation Summary

As humanity enters an uncertain time known as the Anthropocene, proponents of an emerging subject called Big History claim it provides a promising educational framework capable of eliciting transformative learning. Yet no one has empirically examined the cognitive elements of that transformation or articulated how it may propagate systemically into broader domains of culture, society or the biosphere; which are issues central to the Anthropocene. This thesis takes a highly reflexive approach to explore how Big History education and the Anthropocene may be meaningfully linked and how such linkages may inform better pedagogical and cultural communication of Big History in the Anthropocene.

Much of this research is built on a centrally positioned and empirical qualitative study that revealed several cognitive elements of Big History transformative learning. These included *narrative awareness and disruption, urgency and amelioration, reflexivity, causal thinking, empowerment and participation, gratitude and appreciation, transcalar-fractal thinking, and emergent-future thinking*. A secondary analysis then revealed how these experiential elements correlate with fundamental perceptual and behavioral changes that experts suggest may form an appropriate response to the Anthropocene. These data and the concepts that emerged over the research were constructed into a general framework that integrates: *phenomenology, narrative, tacit knowledge, transformative learning, emergence, transcalar-fractals, enactivism, cybernetics, and systemic reflexivity*. This framework may be the first such attempt to explain, with sufficiently broad reflexivity, how the naturalized cosmology of Big History can propagate systemically from personal experience to culture and the biosphere and thus suggest how Big History education can provide an appropriately foundational (i.e. cognitive) response to the Anthropocene.

Preface

This dissertation investigates the proposal that the Anthropocene and Big History may be more than merely coincidental; that there could instead be deeper, systemic, and complex dynamical relationships at play. Such a subject, and research agenda, has required an investigation that crosses a necessarily wide and inclusive intellectual landscape. Yet, I am not a historian, nor a philosopher, a physicist, mathematician, sociologist, psychologist, nor a cultural theorist (I am a geologist by training, a naturalist, and a science educator). While such interdisciplinarity is probably a requisite to any endeavor that claims to fall under the very large umbrella of Big History, the primary fields to which this thesis seeks to make a contribution are the overlapping subjects of Big History education and communication. Secondarily, the research may also be useful to the emerging fields of Anthropocene Studies and methodology in Creative Practice research.

The research is divided into nine chapters across multiple phases of research as they unfolded iteratively over the course of the dissertation. Chapter 1 (CONTEXT) introduces the problem of the Anthropocene and proposes the potential of Big History education as an opportunity to address it. The literature review is an attempt to draw out specific dimensions within each of these subjects that might reflect one within the other in order to reveal any potentially meaningful connections.¹ Based on the contexts and findings of Chapter 1, Chapter 2 (DESIGN) develops a dissertation structure designed to facilitate the larger, complex-systems and cultural-level research agenda. Chapter 3 (EMPIRICAL) generates qualitative data on the cognitive transformative learning aspects of engaging with Big History. Chapter 4 (CORRELATION) then draws conceptual connections between those cognitive shifts and the currently degraded biosphere. Chapter

¹ This exercise in critical reflection between subjects is the essential capacity of *reflexivity*. In a general sense, reflexivity refers to bidirectional and transactional relationships between, objects and subjects, causes and effects. A reflexive relationship is necessarily circular with both the cause and the effect affecting one another in a relationship in which neither is independent of the other. A capacity for self-system reflexivity will itself become an important finding of the research overall.

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5 bolsters the research findings by re-examining a number of established learning and communication theories and integrating them into a general framework for Big History transformative learning. Chapter 6 (PRAXIS) transitions the thesis from theory to practice by developing a metaphorical model of communication practice that I call *Cosmosis*. Chapters 7 (PRACTICE 1) and 8 (PRACTICE 2) present detailed explanations on how the creative projects implement the findings of the previous thesis research in practice. Chapter 9 (CONCLUSION) summarizes my proposal of the overall research outcomes and contributions.

Chapter 1

CONTEXT

One of the noblest characteristics which distinguish modern civilization from that of remoter times is, that it has enlarged the mass of our conceptions, rendered us more capable of perceiving the connection between the physical and intellectual world.

-- Alexander von Humboldt (1851)

In the past two decades a diverse and growing cadre of scholars and educators has been developing a new subject with the colloquial and rather catchy name of “Big History.” Big Historians view history on a cosmic scale, claiming that the Big History perspective can yield important new insights about humans in the universe. Big History educators have also suggested that it offers a pedagogical framework capable of eliciting profoundly transformative ways of thinking about one’s self, society, the global environment and beyond. Yet, despite the optimistic claims and growing enthusiasm for Big History, no one has yet rigorously explored the specific means by which Big History education might transform at its most fundamental level, that is, to change the way learners think. Also, in a time of serious concerns about the declining integrity of the planet’s biosphere, an epoch known as the *Anthropocene*, no one has meaningfully articulated the potentially broader impacts of Big History as a form of environmental education.

Perhaps not merely coincidentally, the optimistic claims of Big History education have emerged at about the same time as the concept of the Anthropocene epoch. Despite some scientific uncertainty, if the Anthropocene presents an even partially valid picture of the state of the biosphere, humanity may want to formulate a response. This would be wise regardless of its composite causes, but probably wiser if we aimed to shape that response

with reference to the problem itself. Therefore, this study sought to better understand these two issues with a tentative openness to the possibility that they may be linked in some systemic way. Stated alternatively, if the Anthropocene is the biosphere's response to humans, what might be an appropriate human response to the Anthropocene? This thesis explores that question by assessing *whether or not Big History education can play a substantial role in shaping an appropriate human response to the Anthropocene and if so, how?*

The Big Claims of Big History

According to The Big History Institute at Macquarie University,

Big History is the attempt to understand, **in a unified and interdisciplinary way**, the history of the Cosmos, Earth, Life and Humanity. Big History is ambitious ... it seeks understanding by bringing together and linking the knowledge available in many different scholarly disciplines...

Big History surveys the past at all possible time scales, from those of cosmology to those of human history. In its search for understanding, Big History explores fields such as astronomy, physics, geology, biology, climatology and archeology. ("About Big History - Macquarie University," 2015 emphasis in original)

Whereas this scholarly description emanates from a primarily historical disciplinary setting,² Big History is not the first attempt to understand, articulate, or teach a modern, scientifically informed, cosmology that includes humans. Other allied forms take names such as "Cosmic Education" (Montessori, 1912), "Universal History" (e.g., Stern, 1973), the "New Story" (Berry, 1978), "The Universe Story" (Swimme & Berry, 1994), "Cosmic Evolution" (e.g., Chaisson, 2002), the "Epic of Evolution" (e.g., Taylor, 2008), and "Deep History" (Shryock & Smail, 2011). Three of these--Big History, Deep History, and

² This is largely because the Big History Institute is largely the brainchild of the modern historian, David Christian, who coined the term "Big History" in a 1991 *Journal of World History* article (see below).

Cosmic Evolution--also have formal academic origins, and each aims to maintain a research agenda.

Regardless of the label, the central idea running through the subject of all these monikers is the narrative of a changing cosmos from which humans have emerged. Also common to the various genres is an interdisciplinary enthusiasm that frequently manifests in big claims. For example, the molecular biologist, Ursula Goodenough writes of the cosmic narrative,

The Big Bang, the formation of stars and planets the origin and evolution of life on this planet, the advent of human consciousness and the resultant evolution of cultures – this is the story, the one story, that has the potential to unite us, because it happens to be true (1998, p. xvi).

And from what is typically considered a very different discipline, the economist and social theorist Graeme Snooks claims,

Big history provides the basis for developing ‘big theory’... The pay-off is that we can ease our great journey through time by providing glimpses of what lies ahead and, thereby, preventing avoidable societal crises. (Snooks, 2005, p. 5)

From a seemingly even more disparate pair of disciplines, mathematical cosmology and theology, the pedagogical value of “The Universe Story” is proposed to offer “a new unity to the educational process from its earliest beginnings through the highest level” (Swimme and Berry 1994, p. 5). This is a claim echoed by the geographer, archaeologist and Big History educator, Barry Rodrigue, who replaced his university’s Western Civilization course with a Big History version. Rodrigue (2010) justifies this transition based largely on the anecdotal accounts of his students which suggest the Big History perspective “transcends national boundaries, political and religious disputes, and economic systems. It serves as a new, unifying reference point for the way we understand our world and our place in it” (p. 142). The historian David Christian, who coined the

term Big History and has probably done more than anyone else to develop its academic position, also suggests a further, cultural role by saying, “Big history provides context for our lives ... a replacement for creation myths ... intellectual coherence, and insights and perspectives” (2005a, p. 29). Referring to Christian’s field-defining tome on Big History, *Maps of Time* (2005c), renowned historian William H. McNeill assessed it to be,

... a great achievement analogous to the way in which Isaac Newton in the seventeenth century united the heavens and the earth under universal laws of motion; it is even more closely comparable to Darwin’s nineteenth-century achievement of uniting the human species and other forms of life within a single evolutionary process (McNeil quoted in Christian, 2005c, p. xv)

Such praise for Big History has prompted calls for further extending the Big History perspective into formal educational contexts: a trend documented as a growing number of tertiary-level Big History courses and high school curricula (B. Rodrigue & Stasko, 2009). For example, with support from the philanthropist Bill Gates, Christian’s version of Big History is now used as the curriculum for a massive online open course (MOOC) called “The Big History Project.” As of April 2015, David Christian reports that The Big History Project is used by over 600 schools in the US and over 200 in Australia. Big History is also being taught in South Korea, the Netherlands, Japan, the UK, New Zealand and will soon be being taught in Hong Kong and India. His estimates suggest that Big History in some form is being taught in 1500 schools in different parts of the world (email correspondence with the author dated April, 2015). Such development and large-scale investments suggest that Big-History education is continuing to gain momentum.³

While these broadly interdisciplinary voices embed rather large claims about the power of the cosmic story in secondary and tertiary pedagogical contexts, formal, academic research definitions of Big History are equally grand in scope and ambition. According to

³ All of this is despite a persistent lack of any formal or systematically derived empirical data.

the Big History Institute, which has emerged as the premier scholarly organization devoted to the subject,

Big History offers us the possibility to understand our universe, our world, and our humanity in a new way. Big History is a field of vast scope, innovative research, and compelling promise, and may well provide **key knowledge to unlock some of the critical challenges of our future**. (“What is Big History” 2015, emphasis in original)

Descriptions of Big History such as this reflect the desire among some of its proponents to establish Big History as a full-fledged academic field or, at least, a component of interdisciplinary scholarly research.⁴ Accordingly, those who wish to conduct Big History as research are currently working to define a suitable research paradigm, demarcate its epistemological boundaries, agree on proper disciplinary conventions, and design appropriate research methodologies (e.g., Voros, 2013).

There is also a budding association of Big History with environmental education. A 2008 Yale University conference on environmental values and sustainability reported that a comprehensive cosmology, such as that presented by Big History, can place human beings within the grand narrative of the universe and “fundamentally challenge our traditional understandings of what it means to be human in relation to the natural world” (Leiserowitz & Fernandez, 2008, p. 47). The conference attendees then lamented on how such an,

emerging awe-inspiring story has yet to be adequately translated from the natural sciences into the humanities or into the culture at large, where it could help transform our deepest conceptions, values, and worldviews. (2008 p. 47)

⁴ An excellent primer on the evolution of Big History as a field of research can be found in the 2011 issue of *World History Connected*. This online forum includes a collection of essays from the field’s early proponents.

And more broadly still, according to physical cosmologist Eric Chaisson (2014), “Earth is now in the balance. Our planet harbors a precarious collection of ... complex systems ... [that] will likely require a broad evolutionary outlook, for only with awareness and appreciation of the bigger picture can we perhaps survive long enough to continue (p. 36).

Clearly for some, the enthusiasm for Big History as a form of transformative education is high. But in order for such claims to attain an equally robust evidential basis, both philosophical and empirical work still needs to be done. As a starting point, a formal analysis that can lead to better articulation of the precise elements of Big History education, and perhaps their impacts across the cognitive, academic and cultural contexts announced above, is needed. However, before providing that more detailed analysis, which is one part of the work of this dissertation, I would first like to situate this research more specifically within the subject of the Yale conference above: the context of the planetary biosphere.

The Anthropocene as Biospheric Context

As outlined above, advocates of Big History and its allied forms are making big claims about its potential to transform across a wide spectrum of pedagogical, social and environmental domains. Yet, this thesis focuses its research primarily as an effort to address the Earth’s accumulating environmental problems. To do this, I will hereinafter invoke the concept of the Anthropocene as an all-encompassing term for *human-induced* environmental problems.

The term *Anthropocene* was proposed in 2000 by Crutzen and Stoermer and has been gaining currency as a way to denote the current time period, beginning about 200 years ago, in which humans began affecting the Earth’s geologic and biospheric systems at planetary scales. The term has been widely used by Crutzen and others (Crutzen, 2002;

Steffen et al., 2015; Steffen, Crutzen, & McNeil, 2007; Zalasiewicz et al., 2008). At present, the term Anthropocene is being considered for designation as a new geological epoch by the International Commission on Stratigraphy. This designation, if adopted, would elevate the Anthropocene to the same hierarchical level as the Pleistocene and Holocene geological epochs. In such a case, Holocene sedimentary deposition will officially be seen as having terminated, and a new, human, planetary epoch will be said to have begun. An implication of this new epoch is that geologists millions of years from now, if there are any left, will be able to identify the planetary presence of humans by geologic-scale signs of our activity embedded within the global fossil record.

While scientists still debate the precise “start date” of the Anthropocene, the evidence for global-scale anthropogenic change has been mounting for decades, if not centuries (Steffen, Grinevald, Crutzen, & McNeill, 2011). Ever since The Enlightenment, commentators began to suggest a need for vast expansions in our conceptions of geological time. Perhaps not surprisingly, it has often been the geologists, who, by tending to study landscapes from a first-person point of view, were among the first to notice and report on large-scale anthropogenic change. For example, in his 1922 book *Man as a Geological Agent: An Account of his Action on Inanimate Nature*, the British surveyor Robert Sherlock observed that “Man’s geologic activities are primarily as an agent of denudation; in which capacity ... he is probably more effective than even the sea itself” (Sherlock, 1922, p. 14). As Sherlock had observed by the beginning of the 20th century, the planet was already showing signs of human impact beyond local and ephemeral scales, even though the term “Anthropocene” had not yet been coined.

Today, the possibility of a geologic-scale human epoch has attracted the attention of an international and interdisciplinary group of scientists, who propose to define the Anthropocene in terms of nine global-scale natural systems. Each of these systems is also associated with a specific set of critical boundaries within which humanity would likely need to stay in order to avoid serious consequences for present civilization. These

boundaries are described in the Planetary Boundaries Framework (PBF) which proposes an overall “safe operating space” in which human societies can develop and thrive within the boundaries of Earth System’s resilience (Rockström et al., 2009). The PBF has also undergone continuing updates in response to substantial scientific scrutiny since its inception (Steffen et al., 2015). What follows is a summary of the PBF’s nine planetary boundaries including acceptable ranges and current measures for each:

1. *Climate change*. Considered a “core boundary,” the most overwhelming climate change problem is global warming. Long-term climate stability requires no more than 350 parts per million (ppm) of carbon dioxide in the atmosphere; as of December, 2015 we are at 401.85 ppm.⁵
2. *Changes in biosphere integrity*. Considered a “core boundary,” this element refers to the loss of systemic resilience that comes from high genetic biodiversity. A loss of biodiversity reduces every form of ecological resilience. In terms of species numbers only, the boundary is 10 species going extinct per million per year. Currently, we lose over 100 species per million per year. Further, the biosphere integrity index is now also informed by the Biodiversity Intactness Index (a measure of ecosystem degradation based on change in population abundance caused by anthropogenic impacts since the start of the industrial era).
3. *Stratospheric ozone depletion*. The ozone layer protects the Earth from ultraviolet radiation. Prior to the widespread use of chlorofluorocarbons in the 1960s, the level was 290 DU (Dobson Units); after the widespread adoption of chlorofluorocarbons in manufacturing, it fell to 276. We have largely eliminated CFCs from industrial manufacturing and reduced the level to 283 DU today, but the ozone layer is still significantly diminished, especially over Antarctica.

⁵ According the the Earth Systems Research Laboratory at the National Oceanic and Atmospheric Administration (NOAA).

4. *Ocean acidification.* Excess atmospheric carbon is acidifying the world's oceans, which could become potentially lethal to ocean life such as coral reefs. The Calcium carbonate saturation level prior to the industrial revolution was 3.44. The safe planetary limit is defined as 2.75, and we are already down to 2.90. This corresponds to a 30% change, while the boundary limit is set at 80%.
5. *Biogeochemical flows.* With the manufacture of nitrogen and phosphorous-rich fertilizers from a century ago, we doubled the terrestrial nitrogen cycle. We currently fix 121 million tons, and this needs to be reduced to 35 million tons. New measures have been designed to account for local/regional and freshwater/saltwater differences.
6. *Land-system change.* Every acre of natural habitat that is lost threatens ecosystem services like clean water, clean air, and atmospheric carbon balance. Humans have already fragmented or affected 85% of Earth's ice-free land. The updated measure takes into account that those land-use changes particularly affect biogeochemical processes. The danger point is 15% of land being used for industrial agriculture; we are currently at 12%.
7. *Freshwater use.* Increasing droughts from global warming compound the effects in all the other systems. There are currently 800,000 dams, with two new ones being completed every day. The numeric limit is thought to be 4,000 cubic kilometers of runoff water consumed per year; the current amount is 2,600.
8. *Atmospheric aerosol loading.* This limit refers to microscopic particles in the atmosphere that affect climate and living organisms. Airborne dust and smoke kill hundreds of thousands of people annually, and when the dark soot settles on polar ice, it further increases heating, causing the ice to melt faster, compounding sea-level rise. The new

measure of aerosol optical depth (AOD) is now linked to the South Asian monsoon system, and the boundary is set at .025 AOD; it varies regionally between .015 and 0.4 in that region, with an annual mean of 0.3 AOD.

9. *Introduction of novel entities*. Refers to organic pollutants, radioactive materials, nanomaterials, micro-plastics, and modified life forms. Such harmful toxins are showing up in every niche globally. Coal-fired power plants are one of the worst offenders in this category, but many new synthetic forms are now being measured. (Steffen et al., 2015)

This list presents the current, materialistic assessment of the anthropogenic impacts on the component systems making up the global biosphere. Overall it illustrates the nature and extent of the anthropogenic environmental changes denoted by the concept of the Anthropocene.

In order to better visualize the quantitative values in the list above as real, planetary-scale issues, Steffen et al., (2015) have presented the following graphic (Figure 1):

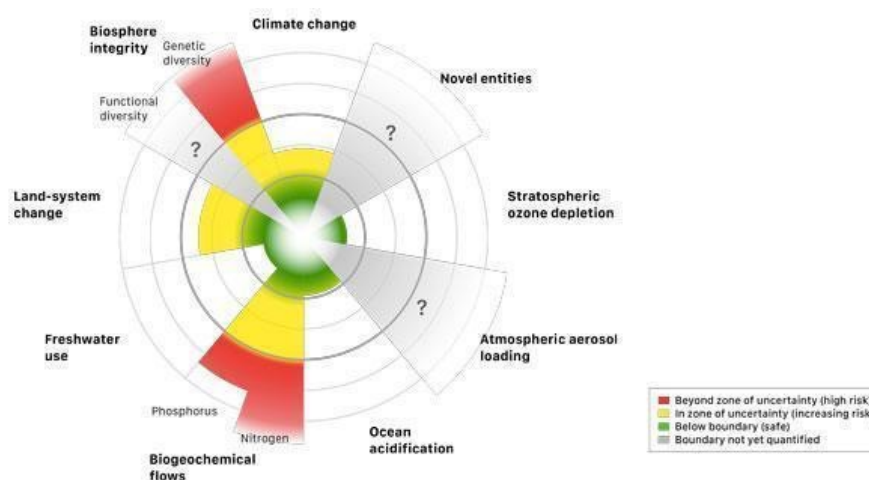


Figure 1: The Planetary Boundaries Framework.
Used by permission The Stockholm Resilience Center

The Planetary Boundaries Framework presented by Rockström, Steffen, and others (2009; 2015) is based on the most widely accepted, credible and comprehensive science. As such, it constitutes the most realistic description of the Anthropocene and provides an objective, quantitative rationale for considering the issues of relevance. The PBF represents our best scientific knowledge about the material causes of the Anthropocene and is considered well established. While this dissertation is not dismissive of the materialistic causes of and responses to the Anthropocene, it also accepts the need to apply the full force of such objective knowledge in understanding and practice. Thus, in addition to the causes commonly understood as “material,” it also seeks to understand a broader spectrum of the causes and responses to the Anthropocene by exploring some of the non-material precursors that logically lead to these material conditions. Such a research stance mandates a closer look at ideological phenomenon of humans that have, at least in part, led to the Anthropocene. This is not meant to be a denial or exclusion of the material causes and responses of the Anthropocene. Instead, it is an attempt to develop a more balanced, holistic, and therefore more viable response. Such a robust and long-term human response to the Anthropocene, it is presumed, will require understanding the deeper and therefore fuller range of dynamics that are inherently associated with the namesake of the Anthropocene: the *Anthropos*.⁶

Being largely the result of Earth Systems science, the Planetary Boundaries Framework is also systems-based model for describing how the global ecosystem has changed since the end of the Holocene. As a genuine systems framework, it captures the fact that interactions occur both within and between the nine systems indicated above. However, to more fully adopt the “systems thinking” behind the Planetary Boundaries Framework, an appropriate response is also obliged to consider the role of systemic interactions across the multiple components of the planetary system. In other words, to extend systems

⁶ This philosophical stance, which will be later understood as “reflexivity,” will also emerge as an finding of the thesis research (see Chapters 3 and 5).

thinking on a more comprehensive scale, we would be wise to consider the impact of all forms of *systemic feedback* between and within the major systems involved.

A key *systems* concept is the feedback loop. Feedback is about the transfer of information (and energy) between and across systems and feedback loops denote that such transfers can sometimes effect both of the systems involved. Feed back loops come in both negative and positive varieties and understanding the distinction between the two is critical. Negative feedback loops are generally benign because they tend to move a system toward equilibrium. The classic example of a negative feedback loop is a domestic thermostat designed to keep ambient temperature within a desired range. In this case, the system is kept within a predetermined range by constantly moving toward equilibrium. Negative feedback loops are relatively easy to design, engineer and predict.

By contrast, positive feedback loops create the potential for drastic swings in systemic conditions because the inputs that result from changes tend to push the system further away from established equilibrium, and usually at an exponentially accelerating pace. According to the environmental scientist Donella Meadows, “Positive feedback loops are sources of growth, explosion, erosion, and collapse in systems. A system with an unchecked positive loop ultimately will destroy itself. That’s why there are so few of them” (1999, p. 11). Positive feedback loops may be relatively rare in nature for this reason, but they are also what may make the Anthropocene an unstable epoch and a potentially grave biospheric state.

Another systemic characteristic of feedback loops, negative or positive, is that they exhibit transcalarity. That is, they occur across a range of scales from the molecular (e.g., an exothermic reaction causing a runaway heat event and explosion in a test tube) to the social scale (e.g., a bank run or collapse of a Ponzi scheme). Whereas the extent of a given negative feedback loop is determined by its internal limiting factors, such as the depletion of a chemical agent or the exhaustion of bank funds, if a positive feedback loop

is initiated, however, and such a limiting factor is not present, the result could be irreversible systemic collapse.

The reality of planetary biospheric positive feedback loops, especially between the systems of the Planetary Boundaries Framework raise the stakes of humans' decisions about whether to change current global-scale consumption, ecological degradation and pollution. These feedback loops represent largely hidden thresholds that, if crossed, could trigger potentially catastrophic runaway situations that may be impossible to recover from after the fact. A well-known example of a potential positive feedback loop that may arise as a result of global warming, based on the concept of albedo, is when glaciers melt to expose darker surface areas. Because darker surfaces retain a higher proportion of solar radiation, greater dark surfaces on the planet thereby increase the retention of solar heat, resulting in more melting, more heat, and so on. The result is a runaway greenhouse effect that could alter environmental conditions so drastically as to make the planet unlivable (at least by current standards of civilized life). Regardless of the actual living conditions that this kind of drastic climatological swing might create, it is the combination of extremely high, global-scale risk coupled with scientific uncertainty that makes the Anthropocene such a potentially pernicious time. On living in the Anthropocene, Andrew Revkin writes,

We no longer have the luxury of ignorance. We're essentially in a race between our potency, our awareness of the expressed and potential ramifications of our actions and our growing awareness of the deeply embedded perceptual and behavioral traits that shape how we do, or don't, address certain kinds of risks (2011).

The primary aim of the Planetary Boundaries Framework is to present an objective, comprehensive, science-based assessment of global ecological health. As the authors of the framework make clear, the modern, energy-intensive, human societies which are presumed to be the largest contributor to the conditions of the Anthropocene, "came of

age” entirely within the modern era. This statement is based on the conventional definition of “Modern” as having emerged in the post-Enlightenment Era. Rockström et al., (2009) state that the relatively stable climate of the Holocene as “the current interglacial period that began about 10,000 years ago, allowed agriculture and complex societies, including the present, to develop and flourish” (p. 2). In other words, the Holocene has provided a relatively constant 11,700-year period of global atmospheric conditions, albeit with annual and seasonal fluctuations. The climatic conditions of the Holocene are thus identified as the only conditions under which modern human civilization is known to exist. Therefore, taking a highly cautionary stance is warranted, and it would seem unwise to alter the global atmospheric system into an unknown, relatively unpredictable and potentially highly erratic state.

It should be noted, although the Anthropocene is a formal designation that attempts to capture and describe the cumulative anthropogenic changes currently playing out on a planetary scale, the term “Anthropocene” is not synonymous with any one of the particular systems or environmental problems that are included in the Planetary Boundaries Framework (i.e., climate change, ocean acidification, etc.). Thus, throughout this dissertation, the term Anthropocene is used to denote the planetary-scale systemic processes, including those that are said, by most scientists, to have reached problem status. Yet, the Anthropocene is not the “research problem” of this thesis. That is, it is not the intention of this thesis to address the Anthropocene directly through policy, environmental, or other “material” intervention. The dissertation does, however, aim to understand the ways of thinking that have, based on the scientific evidence, led us to the Anthropocene. However, context matters. This is not meant to be a prosecution of historical thinking. My intent is not to blame the predicament of today on the thinking of yesterday. The question is, rather, how might the transformative learning associated with Big History education adjust historical thinking, persisting today, based on contemporary contexts. Having arrived at the Anthropocene, what can we learn from it? How can the Anthropocene, as depicted in the complex processes expressed in the PBF, inform our educational systems and interventions? How can the potential of the Anthropocene help

shape an educational response? What does the Anthropocene tell us about us? What might be some of the cultural-level drivers, and cultural-level responses to the Anthropocene? To more precisely explore these questions, an adequately comprehensive (i.e., reflexive) cognitive-to-cultural-to-biosphere framework is needed.

To summarize, the PBF is important to this thesis for two primary reasons. First, it implicates collective human activity as the primary source of deterioration in the planet's ecological integrity (hence, I accept the legitimacy of the "Anthro" prefix). Second, because it presents a *complex-systems* way of depicting planetary-scale processes, it highlights that cumulative anthropogenic change is a *systemic* phenomenon. With these links between "human activity" and "systems" now hopefully established, a way of more succinctly problematizing the human dimensions of the Anthropocene is still required.

Anthropocene as a Wicked Problem

A useful model for understanding large complex issues is the idea of a "wicked problem." Rittel and Webber (1973) initially formulated the idea of wicked problems for use in the realm of social policy to describe political, economic, and environmental issues. They defined a wicked problem as having several primary qualifying characteristics including: no definitive formulation; no similar problems to which they could be compared; no opportunity to learn by trial and error; no stopping rule (which means simply running out of resources is not a viable option); stakeholders who have radically different worldviews and different frames for understanding the problem; and constraints and resource requirements that change over time (a "moving target" effect). An important additional consideration is that every wicked problem can be considered to be a symptom of another problem, rather than a problem in itself.

Given just these preliminary criteria, the Anthropocene (and the constituent systems of the PBF) may be seen to qualify as a wicked problem. But there is more. Later scholars

expanded the wicked problem model by adding three additional characteristics: the near-impossibility of coming to a complete solution (Conklin, 2005); no immediate and ultimate test for potential solutions (Ritchey, 2011); and the solutions are not true or false but rather good or bad (or better or worse). In other words, the “solution,” if that term applies, depends on how the issue is framed, and vice versa (i.e., the problem definition depends on the solution, and the problem is never solved definitively). The salient insight here is that when both the problem and the “solution” are ill-defined and moving targets, on-the-fly adaptability, creativity, and innovation, become the key capacities.

That wicked problems require unconventional approaches is echoed by Leiserowitz and Fernandez (2008) when they observe that,

...within the policy community there is insufficient systemic perspective or holistic thinking and an over-reliance on old tools and approaches (e.g., government regulation). We need new ideas “outside the box” to get broad ownership of the problem and participation in the effort to solve our shared environmental challenges (p. 29).

While Rittel and Weber (1973) and others provide an excellent starting point and vocabulary for beginning to understand the nature of wicked problems, the model was formulated in the early days of complex systems thinking and thus still retains a rather top-down engineer’s or “first-order” perspective. Further, early versions of the wicked problem framework had been developed in a time before the rapid onset and systemic-scale environmental problems that have now been documented by Earth systems science. Recently, Levin, Cashore, Auld, and Bernstein (2012) addressed this shortcoming, and brought the wicked problems into the 21st century by developing a new category that they termed “super wicked problems.” The authors defined super wicked problems as having the original aspects, plus the additional following characteristics; an urgent time-frame (time is running out); a lack of central authority; aspects wherein those seeking to solve the problem are also causing it; plans that adequately acknowledge future

irrationality (discounting); and the possibility that different solutions can create other problems. Thus, according to Levin et al., (2012), climate change is a “super wicked problem” because of the added level of urgency and because it has even more demanding characteristics that were not an issue when the term was first created. Further, Levin et al., (2012) also effectively shift the focus of strategic thinking from a symptom level to an underlying problem level. That is, while Rittel and Weber (1973) defined a wicked problem as being related to the problem itself, the items that now define a super wicked problem relate to the agent(s) trying to solve the problem. Levin et al., (2012) also acknowledge the important conundrum inherent to a super wicked problem: that those who seek to find a solution are also often those who create conditions on a local scale that allow the problem to persist.⁷ This seemingly benign, if not convoluted, idea highlights how the problems of proximal concern to a collective of agents in a larger system, can blind those agents to their own contribution to a super wicked problem, and thus inhibit their ability (or willingness) to adequately, and creatively, respond. This will become a critical issue for the current research.

Also common to many scholars who work on wicked problems is the acknowledgment that such problems are best solved through collective action. Indeed, a wicked problem is a problem whose solution *requires the response of a great number of people*. Because of this, super wicked problem “solutions” tend to encourage broad stakeholder participation. Rittel and Weber advocated for a collaborative approach to solving wicked problems and attempted “to make those people who are being affected into *participants* of the planning process” (1973 p. 46).⁸

⁷ This dynamic is akin to incommensurability in Kuhnian paradigm shifts and will be explored in Chapter 6 using the concept of self-system reflexivity. However, one continuing limitation is the retention of the continuing top-down perspectives of policy makers.

⁸ The present research contains collaborative communication components (i.e., the creative practices discussed in Chapters 6, 7, and 8) precisely because I recognize that wicked problems can only be solved through the collective action of stakeholders--in this case, Earthlings.

In addition to requiring interdisciplinary collaboration, the solutions to wicked problems should be thought of as psychological in nature. That is, the solution requires not merely collaborative action from a large number of stakeholders, but a very specific kind of action—linked to a change in mindset, or cognition. This cognitive-cultural dimension of wicked problems is crucial, though little discussed. In some ways wicked problems can be construed as problems of culturally induced human cognition because cultural structures are often reflective of cognitive structures. Levin et al., (2012) hinted at this aspect of wicked problems by touching on the irrationality that underlies wicked problems. That is, the fact that even groups of people seeking to solve the problem are very often those whose mindsets are also either causing the problem, or impeding attempts to redress it, make a wicked problem like the Anthropocene even more intractable.

Perhaps a more immediately practical reason for identifying the Anthropocene as a super wicked problem is that it enables a researcher to logically presume that human activity, policies, institutions and social structures arise directly or indirectly out of cognition contextualized to the environment (culture) in which it has arisen. After all, a policy must be thought up before it can be written, passed, and enforced. Institutions (such as higher education) are then built to enact those policies, and the larger social structure then reflects the priorities of those institutions. The system, of course, is self-circular and cognition appears to be a common component to all of these phenomena. This psycho-social and planetary sentiment is captured by the geologist Robert Sherlock, cited above, who also said “Perhaps the most difficult, and at the same time the most interesting, problem that arises in connection with our subject is the relation between Man’s psychology and his geological activities” (1922 p. 343).

The intuitive understanding behind Sherlock’s logic is now formally known as the “social-ecological systems model” (Berkes et al., 2003; Norberg and Cumming, 2008). In the social-ecological systems model, interactions within and across complex dynamical

systems matter because each domain is understood to be connected to other domains in various ways. Through systemic, socio-ecological processes the effects of changes in one domain can propagate through the system and out into other domains in the world, thereby inducing changes of various degrees on all scales. Further, “those effects might eventually travel back and lead to the disappearance of the original domain or transform its dynamics” (Chu et al., 2003). Taking a social-ecological system approach and inserting the domains cited by Sherlock above as the components (“Man’s psychology and geological activities”) in the system of interest (the planetary biosphere), provides the basic methodological philosophy applied in this thesis. Taking the social-ecological systems model seriously should allow a more holistic understanding of how the teaching and learning of Big History can propagate into the biosphere and then “travel back” to transform the original cognitive domain. This is the essence of self-system reflexivity, as applied, in the case of this thesis, to the socio-ecological relationship between human cognition and the biosphere. Of course, the intended systemic process here would preferably be a negative feedback mechanism (as opposed to positive) because of its equilibrating action.⁹

Finally, if the Anthropocene meets all the criteria developed by researchers such as Rayner (2006), Camillus (2008), and Levin et al., (2012), to qualify it as a super wicked problem, then it will not have a solely scientific or technological solution.¹⁰ Similarly, Kellert and Speth (2009) have concluded, “no degree of legal or regulatory requirement, technological advance, scientific insight, or shift in economic thinking could by itself achieve the needed remedial response to our environmental and social challenge. What is needed as well is a basic alteration in the *perception* of our place in the natural world” (p. 1, emphasis added). The need for such a large-scale shift in perception, or cognition, among the human race is what pushes many Big Historians to consider the broader potentials of Big History education. This dissertation is an exploration of the way Big

⁹ As an element of design-based research, this logic will resurface and lead to the justification of cultural-level communication as discussed in Chapters 6 and 7.

¹⁰ However, technology and science are sure to be important parts of any appropriate response to the Anthropocene.

History education, as an inherently transcalar narrative of complex dynamic systems, might be able to transform the way people think.

This thesis presumes that the Anthropocene represents an increasingly irrational state of human affairs and the concept of the “wicked problem” helps to explain and address the complex, psycho-social and cultural nature of the Anthropocene. Further, I argue that the environmental issues that make up the Anthropocene constitute a super wicked problem in the strictest sense because: they are urgent; embed invisible, unpredictable, potentially existential, and irreversible consequences; and finally, they involve a great number of stakeholders who both simultaneously contribute to and must collaborate to solve the problem.

As I have shown in the preceding discussion, the systems level interactions that make up the Anthropocene may be among the most difficult that the human mind can conceive: the component environmental problems of the Anthropocene are urgent; they include all people on planet Earth as its stakeholders; and they are rooted in human cognition, including the political, economic, and academic structures that are built upon such thinking. The real-world risks that arise from a serious issue like climate change--both practical and potentially existential--despite being widely supported by empirical evidence, yet still fail to elicit an appropriately urgent and unified human response. This apparent lapse of rationality (assuming that self-preservation is rational) suggests that the problems of the Anthropocene may be saying something more about past and present states of human psychology than it does about any particular biospheric component that may be at stake. That is to say, whatever the important role material processes play in creating the environmental changes denoted in the term *Anthropocene*, it is the *Anthropos*’ perceptions of and responses to those processes that are the particular focus of this thesis. What these cognitive states are, and what they should perhaps rather be, will

therefore be part of this research's investigation.¹¹ But for now, what the potential role of Big History education might be still needs to be explored. For this it will be useful to more closely examine some of Big History's formative ideas.

Discourse on the Ideas and Faculties of Big History

As indicated at the beginning of this chapter, many Big Historians claim that, in addition to being a research perspective, it can also be a pedagogical approach. This two-part agenda of research and teaching is captured in the titles chosen by the International Big History Association (IBHA) for the first three of their bi-annual scholarly conferences. They are as follows:

Teaching and Researching Big History: Exploring a New Scholarly Field (2012)

Teaching and Researching Big History: Big Questions, Big Picture and Big Questions (2014)

Building Big History: Research and Teaching (2016) (source: IBHA website ibhanet.org)

By equally highlighting research *and* teaching in each of their conference titles, the members of the IBHA acknowledge the legitimacy of both these overlapping facets of Big History. But it also means that they distinguish between the *doing* of Big History and the *teaching* of Big History.¹²

So what does it mean to *do* Big History? An answer to this question, I propose, may be found by asking what unique intellectual faculties are required to do it. This may also, in

¹¹ These questions are explored through an analysis of diverse expert opinions in Chapter 4 and then applied in Chapter 5.

¹² The research and analysis of this dissertation focus primarily on Big History education in tertiary (i.e. undergraduate) contexts.

turn, help illuminate what good Big History teaching practice is. Some related questions are: What are some of the key concepts emerging out of Big History content and the cosmic narrative? And, how can these insights be reflected back into Big History teaching and communication practice? To answer these questions, and draw these links, I will now examine the relevant Big History literature with an eye toward useful concepts embedded within the discourse.¹³

Being a relatively new subject, Big History is just beginning to accumulate a body of literature and the discourse within that literature naturally reflects the specialized backgrounds of its major proponents. Originally this meant historians and world historians, but there are now an increasing number of academics, representing other fields, that see the value of the Big History perspective. These include astronomers (e.g., Chaisson), anthropologists (e.g., Spier), geographers (e.g., Rodrigue), geologists (e.g., Alvarez), and political scientists (e.g., Gustafsson), among others (eg., Aunger, 2007).

Yet, such interdisciplinarity presents challenges not only to conventional historians, but also to the many disciplines that currently fragment the landscape of academia into silos of specialization: an increasingly problematic situation in the face of complex and wicked problems. To the question of whether the conventions of timescale and disciplines can be broken with impunity, at least one prominent Big Historian responds, “I am sure that they can; I believe that they are indeed little more than conventions and that breaching them can only be healthy” (Christian, 1991 p. 225). Still, at the outset of this research I was not prepared to merely adopt such a stance as a received wisdom. Instead, I thought it more prudent to formally develop the rationale for the necessary boundary-traversing in this research. To now do this with sufficient reflexivity, I will reference the concepts embedded within the Big History discourse itself. The presumption here is that ideas of potential value to my thesis are likely to be inherent, ultimately, to the natural processes that Big History seeks to understand. In particular, I suspected that concepts such as

¹³ This too is what it means to exercise reflexivity.

interdisciplinarity, transcalarity (i.e., the willingness and ability to consider phenomena across scales), complexity and change within systems, would have key functional roles to play in this research.

Because the concepts above emanate from within the Big History narrative itself, their development can also be traced through its literature. For example, the historian David Christian, who has been teaching Big History at a tertiary-level, and thinking about it as a research genre since 1989, initiated an important discourse on interdisciplinarity in his essay titled *The Case for Big History* (1991). In this originating text he suggested that one of the virtues of Big History is that it encourages historians to ask big questions, which in turn encourages them to “become more familiar with the models, techniques, habits of thinking, and types of evidence used in other disciplines” (p. 5). As an exemplar of interdisciplinarity, Christian imagines the potentially new insights that an economist might glean if they were to also draw on the disciplinary knowledge of traditional historians. This would entail interdisciplinarity between economics and history and indeed, we do have a field called economic history. But in the process, Christian then demonstrates how such interdisciplinarity can also blend seamlessly into another aspect of Big History: transcalarity. Christian proposes that considering economic forces not just across the decades or centuries of economic history, but also across the scales of thousands, hundreds of thousands, and even millions of years of human history (and beyond), can raise a host of “new and really interesting research questions” (p. 6). And his logic continues that whatever the implications of such transcalarity may be for economic theory, we can also imagine for any other discipline as well. There can be, of course, objections based on the drawbacks of overgeneralizing, but the finer point Christian makes is that there are also drawbacks from hyper-specialization, and these may be the tendencies that a Big History perspective can serve to counter. His larger point, however, is that transcalarity should be considered a tool available for use across disciplines which, if used appropriately, can yield raise novel questions and insights. Thus *transcalarity* is considered an intellectual faculty of doing Big History.

Another key feature of Christian's (1991) case for Big History is an early, albeit informal, recognition of some complex systems principles that researchers encounter in a Big History perspective. For example, he characterized the universal system as "winding down," thus adopting the language of energy regimes and the inevitable thermodynamic principles to which all systems must conform. Notwithstanding the Second Law of Thermodynamics on a universal scale, Christian acknowledges that some systems exhibit creativity, or spontaneous ordering, that can "swim upstream" against the forces of entropy, at least on local scales. Christian's invocation of such complexity principles, or at least the vocabulary, has become foundational in much of the Big History discourse to the present day.

A related concept of complexity that Christian (1991) invokes, and that has since entered the parlance of some Big Historians, is equilibrium. Among the phenomena he includes as expressing equilibrium dynamics (at least temporarily) are galaxies, stars, the earth, the biosphere (referring to what James Lovelock has called '*Gaia*'), as well as "social structures of various kinds, living things, and human beings" (p. 10). Equilibrium in this particular systems context can be thought of as the way that energy moves through systems and in this sense serves as way of bridging the social and natural worlds. But while considering the forces of equilibration across a broad spectrum of scales, Christian (1991) stops short of considering them across the more proximal complex *systems* that may be manifesting at the scale of the lecture hall. That is, he declines to speculate in any detail about what equilibrating forces might be acting inside the heads of the "human beings" in his classroom (his students), or how the sociocultural forces that shape them, and will be shaped by them, may ultimately impinge on the world more broadly.

However, Christian does offer a preview of Big History's potential educational impacts by discussing efforts to convene the team-taught Big History course he began offering at Macquarie University three years earlier. In the description of its curriculum, that closes the essay, he finds it sufficient to say that the educational value of asking fundamental questions about one's origins and place in larger contexts is "self-evident." He then posits

that this is precisely what creation myths often do, and that this could be a primary “payoff” for teaching history at the scale of Big History.

After fourteen years of teaching that Big History course in tertiary and public settings, Christian returns to the issue of Big History education in 2005 to assess the state of a field he now temporarily refers to as “macrohistory.” In *Macrohistory: The Play of Scales* (2005b), he speculates on how the field might further evolve as both a research area and an approach to teaching. To do this, Christian (2005b) revisits transcalarity by posing the question of how Big History research may manifest across three different time scales: Human, (100,000-10 million years) Planetary, (4.5 billion years) and Cosmological scales (which would include the presently understood 13.8 billion-year history of the universe). As initially explored in 1991, Christian had been suspecting that surveys of the deep past conducted from perspectives based within specialized fields could provide a good starting point for launching new, interesting, and significant research agendas within those fields. He adds that in some cases, even a familiar question may appear in a new light. This, Christian proposes, “may constitute the new research agenda” (email correspondence with the author, Oct. 2015). Here, as well as in his earlier discourse (1991), one can clearly discern an intellectual evolution toward more refined transcalar thinking, at least with regard to timescales. But how these forces manifest not only across timescales but broader political, cultural and ecological systems still has yet to be articulated¹⁴

Christian (2005b) more explicitly than Christian (1991), considers Big History education as a phenomenon that can elicit profound and personal cognitive transformation. He does this by devoting some space to considering what teachers can “expect to gain by teaching history through these many different time-frames” (p. 30). Here Christian further develops the issue of Big History’s impact on personal identity, noting that “identity is a central theme in all history teaching” (p. 31), but macrohistory, he argues, can offer new, and potentially transformative answers to the question, “*who am I?*” This assertion is built on the intuitive understanding that “there is a profound connection between history,

¹⁴ The relevance of this expansion; from traversing timescales to traversing systems, will be further developed and applied in the “communication” phases of Chapters 6-8.

memory and the sense of identity” (p. 32). He then connects individual identity to social identity by pointing out, “Where similar identities are shared by many people they shape collective behaviour, which is why collective identities can be such potent historical and political forces” (pg. 32). In other words, Christian is implying that individual identity is transcalar from the individual to the collective. As a teaching field, then, Christian (2005b) proposes that macrohistory could have cognitive impacts that enrich students' sense of their own identities and situate themselves in the larger scheme of things.

As an example of how Big History education can foster transcalar thinking, Christian (2005b) suggests how teachers of macrohistory can help students explore different types of identities across seven different time scales: the microhistorical (the level of individual and particular); the conventional scales of modern historiography (such as ethnic and national); the Global History Scale (such as the 500 years of modernity, cultural zones, and ‘the west’); the World History scale (5,000 years of civilization); the Human History Scale (100,000–4 million years of human beings’ existence as a species); the Planetary Scale (4.6 billion years of life in the biosphere); and the Big History Scale (13 billion years, taken to be the totality). Christian remarks that even though these broader scales “can be humbling,” they can “also induce a certain realism about the place of human beings in the universe, and about the nature of human history” (p. 35). He concludes,

By looking at issues of identity through many different time-frames, we can convey a sense of both the richness and the coherence of the many different identities that shape us all. Doing this ought to be a powerful antidote to the narrower and more rigid sense of identity that is still taught overtly or covertly in many modern history syllabi. And what is true of issues of identity is true of our understanding of the past in general. Taught well, macrohistory can also convey the sense that, beneath this bewildering complexity, there may be an underlying coherence to the past. The past is complex; but it is not meaningless. (2005b p. 34)

Further, observing that human action has caused so much species extinction around the planet, Christian (2005b) acknowledges that human history is “a phenomenon of planetary significance” (p. 43). Extending this argument to what could be considered a source of human action; thinking (which one might also reasonably expect to have some relation to human history), means that human cognition too has planetary significance. This fact is not without visible evidence. Indeed, many aspects of the human psyche are readily observable in various manifestations across the surface of the planet. Perhaps the reification of human thinking as culture is a banal point, but Christian’s articulation of human thinking on civilizational and planetary scales is significant because it shows that Christian may be willing to make some tentative claims, albeit indirectly, about the potential impact of Big History education on the biosphere. Although Christian does not have empirical evidence of Big History fostering transcalar thinking, there is anecdotal data accumulating from his own students and those of his colleagues (e.g., Spier, Rodrigue, Benjamin, Brown and others). Correlating empirical evidence of the Big History educational experience to the anthropogenic causes of the Anthropocene is the goal of this thesis.¹⁵

In *What’s the Use of Big History?* (Christian 2005d), a presentation originally given at the World History AP exam reading in June 2005, Christian continues to develop ideas on the cognitive dimensions of Big History education. In particular, he discusses three “habits of mind” that are cultivated by the doing and teaching of Big History. He summarizes them as:

Perspective. “Seeing global patterns over time and space while also acquiring the ability to connect local developments to global ones and to move through levels of generalizations from the global to the particular.”

Comparisons. “Developing the ability to compare within and among societies, including comparing societies’ reactions to global processes.”

Framing. “Developing the ability to assess claims of universal standards yet remaining aware of human commonalities and differences; putting

¹⁵ Of course, this correlation could be negative or positive. In other words, it may just as efficiently suggest that a Big History education promotes the cognitive anthropogenic causes of the Anthropocene, or counteracts them. This correlational analysis is the work of Chapter 4.

culturally diverse ideas and values in historical context, not suspending judgment but developing understanding.” (Christian, 2005d para. 18)

Interestingly, Christian then considers how these three cognitive capacities may matter in the world by invoking the themes of social complexity, intellectual networks, and humanity’s increasing control of the world’s energy and resources.¹⁶ Although Christian (2005d) here gets another step closer to considering Big History as a cognitive component of a complex dynamical system that can span culture and the biosphere, a genuinely cogent framework has yet to be developed, and there is still a lack of empirical evidence to support these claims.

Christian (2010) again took up the subject of Big History education, or as he was then calling it, “Universal History.” In *The Return of Universal History* (2010), he reports on the growing acceptance of Big History, including the prominent support of renowned scholars like the historian William McNeill. Two decades after Christian first defined Big History, he now predicts it that it will be widely taught in high schools, among other places. The effects on historical scholarship of this possible “return to universal history in a new, scientific, guise” will be three-fold. First, reiterating many of his arguments made across the decades, in general education, he claims that “it will help students grasp the underlying unity of modern knowledge ... [and] help overcome this [modern] sense of fragmentation by providing maps through the vast ocean of modern knowledge” (p. 16). Second, he again argues for interdisciplinarity by writing that “It should be possible to teach about the past in ways that help students understand that history and literature and biology and cosmology are not separate intellectual islands, but parts of a single, global and interdisciplinary attempt to explain our world” (p. 16). Third, Christian asserts that we must look “at the scales of universal history” in order “to grasp the underlying unity of humanity as a whole” (p. 16). He highlights a key reason “for welcoming the prospect of a return to universal history” as “the possibility that it may provide the framework

¹⁶ Intellectual networks will be relevant to the cybernetics principles discussed in Chapters 5 and 6.

within which we can create histories that can generate a sense of human solidarity or global citizenship as powerfully as the great national histories had once created multiple national solidarities” (p. 16). But the most relevant (to this thesis) additional argument that Christian now makes is that Big History’s “coherent vision of the past ... should help people in many different walks of life to understand better the complex relationship between our own species and the biosphere” (p. 16). Big History is very much a subject about complex dynamical systems across not just time scales but physical, social, and ecological domains of contemporary reality.

An independent yet consilient instance of linking interdisciplinarity and transcalarity across systems is picked up in the literature of Big History’s allied (but different) academic field of “deep history.”¹⁷ As in Big History, deep historians Shryock and Smail (2011) argue that disassociating natural history from human history “leaves no room for contingency, no room for change, no way to understand the path-dependent nature of variation within systems” (2011, p. 12). For them, this means that cosmologies that exclude natural history from human history create, in effect, ahistorical worldviews that render deeper self-reflection out of range. One of their efforts, then, is to urge scholars across disciplines to overcome their training-ensconced reluctance to delve deeper into the past for novel insights. Similar to Christian’s logic, the argument that follows from this dilemma, according to Shryock and Smail (2011) is one that promotes a substantial deepening of historical inquiry so that long-obscured insights can become visible to historian.

In their edited volume, *Deep History: The Architecture of Past and Present* (2011), they apply an interdisciplinary and transcalar perspective to consider domains that are traditionally beyond the purview of historians. What is relevant to Big History education, and this dissertation, is that the co-authors in Shryock and Smail (2011) collectively

¹⁷ For a more detailed discussion of the differences between Big History and deep history see Blundell (2012).

imagine “a set of tools—patterns, frames, metaphors—for the *telling* of deep histories” (p. xi emphasis added).¹⁸ In the process they initiate new speculations about concepts such as “fractal replication, exchange, hospitality, networks, trees, extensions, scalar integration and spiraling patterns of feedback intrinsic to all co-evolutionary processes” (p. xi). The tools they propose are a series of “orientations and base metaphors” (p. 15) to be added to the repertoire of concepts that Deep Historians should be considering, such as the human body, energy and ecosystems, language, food, kinship, migration, goods, and scale. These concepts, they argue, are made available to the historian because each of them can be reasonably expected to persist across human timescales.¹⁹ As a specific example, the authors offer an analysis of how kinship is an idea that “travels well through space and time” (p. 30). By tracing Deep History ideas through *material space*, as well as time, Shryock and Smail (2011) provide an intellectual precursor for the current research, which, in a similar way, aims to trace Big History insights through the domains of cognition, material culture, social structures and ecosystems. By speculating about the “shift[s] in sensibilities” associated with the *doing* of deep history, Shryock and Smail are also exploring them for the *teaching* of Big History. Although they do not say it explicitly, deep historians and Big Historians alike are invoking the principles of complex dynamic systems theory in research practice.²⁰ This is an instance of consilience worth noting.

The concepts of complexity, dynamism and transcalarity are also rooted in the natural sciences. Therefore, Big Historians such as Christian (2005) and Spier (2010), and Deep Historians Shryock and Smail (2011) have found a welcome ally in the work of astronomer and physical cosmologist, Eric Chaisson, a natural scientist whose concept of increasing complexity has become a central organizing principle for Big History

¹⁸ To understand why this text is critical to the thesis, see Chapter 6 where metaphor, in particular, will be explored for its use in Big History communication praxis.

¹⁹ As it turns out, some of these concepts emerged as elements of a Big History transformative experience as revealed in the empirical study of Chapter 3 and are further explored in Chapters 4-8.

²⁰ Complex Dynamical Systems is an idea that will be further developed and applied in relation to Big History in Chapters 4, 5 and 6.

(Chaisson, 2002; 2006). Chaisson has worked to quantify how energy flows dynamically through what he calls “thresholds of increasing complexity” in cosmic evolution (2006). In so doing, he has developed a framework for increasing complexification in cosmic evolution and the Big History narrative as well. Chaisson’s definition of complexity, derived from the context of physical cosmology, includes multiple interacting components resulting in cumulative change.²¹ This leads him to surmise that “All complex systems—alive or not— ...[w]hether stars, species or societies, a unifying trend seems to link (and rank) all such ordered systems in a consistent, uniform manner” (Chaisson, 2014, pg. 90). According to Chaisson, “That is the true forte of cosmic evolution: demonstrating quantitatively how everything is related to everything else even within a messy, imperfect universe” (Chaisson, 2014, p. 90).²² Chaisson goes further to assert his view,

If we are to articulate a unified worldview for all complex systems observed throughout Nature, then we must objectively and consistently model each of them identically. To restate once more for clarifying emphasis, complex systems likely differ fundamentally not in kind, but only in degree, that is, degree of complexity manifesting *ontological continuity*. (2014, p. 34 emphasis added)

Like Christian with temporal transcalarity, and Shryock and Smail with conceptual transdisciplinarity, Chaisson too helps to advance a natural theoretical framework that can support the current research; he does this by quantitatively charting the movement of energy through (and across) the whole of time and space. This is valuable because such a view presumably includes all systems and domains from the particulate, stellar and

²¹ Later I will adopt a single definition of complexity drawing on complex dynamical systems theory that is (a) composed of many components; (b) ever-changing; and (c) interconnected.

²² It should be noted, Chaisson’s work focuses exclusively on energy flows, not, as this thesis will, on information flows. The current research will consider what it means to take Chaisson’s “ontological continuity” seriously not just for energy, but for information as well. If the universe is indeed a complex dynamical system comprising all the many ever-changing, interacting components that these authors have heretofore been theorizing about for the content narrative of Big History, how do these dynamics translate into cognitive functions that are ontologically continuous with that universe?

galactic, to the individual, cultural, and planetary. Thus, change in one domain (e.g., human cognition) will have effects in other domains (e.g., culture or biosphere). This is simply a consequence of Chaisson's "ontological continuity" (2014, P. 34), which will be exploited in the practical application of the findings of the current thesis.

The central narrative of Big History is scientific insofar as it is built upon the data of the natural sciences, and complex because cosmic evolution is driven by complex dynamical processes. Therefore, the Big History research perspective naturally embeds (or reflects) complex dynamical principles. What is relevant here is how the recognition of the universe's increasing complexity has become an important concept in the research perspective informed by Big History. Thus, present in the discourse of Christian (1991; 2005b; 2005d), continuing through Shryock and Smail (2011), and finding conceptual support in the work of the natural sciences such as Chaisson (2002; 2014) there is a line of intellectual faculties and concepts that can now be extended into the current thesis.²³

Previous Work in Big History Education

Because the Big History perspective and education draw heavily on science and the fruits of contemporary scholarship, it is rooted in the modern, Western, academic tradition. As such, it is also a product of that legacy's long and shifting educational priorities.

Normative pedagogical philosophies throughout the 17th and 18th centuries were overly didactic (i.e., focused on rote learning) and aimed at developing industrial progress.

However, beginning in the 19th and through the 20th centuries, educational philosophers like John Dewey (1859-1952) in America and Jean Piaget (1896-1980) in Europe had begun to articulate a radical, new educational paradigm based on the philosophy of constructivism. Constructivist thinkers believed that people build their own understandings and knowledge of the world through their experiences and by reflecting

²³ This lineage toward transcalarity and ideas of complexity will have important methodological relevance in the next chapter (2).

on those experiences. Constructivist theories of learning which questioned perennial methods of rote learning then led to large-scale educational reforms that prioritized much richer and more experiential pedagogies. These constructivist models considered a fuller range of human subjective experience and they also formalized the connections between a society's educational philosophy and the quality of its social life.²⁴

Building on the ideas of Dewey, Maria Montessori (1870-1952) articulated a prescient foundation for Big History pedagogy that was based on ever-expanding spheres of causality. She famously wrote “Since it has been seen to be necessary to give so much to the child, let us give him a vision of the whole universe... for all things are a part of the universe, and are connected with each other to form one whole unity” (1948/1989 pp. 6-7). She would later call this way of learning “Cosmic Education” because it suggested an approach to learning, and a curriculum, that could, in principle, encompass the entire cosmos.

Montessori’s commitment to expansive and interconnected knowledge is analogous to that which surfaced four decades later with the historian David Christian. Christian (1991) described a similar revelation that to understand any particular historical event, one would need to also understand the myriad preconditions from which that event sprang. Like Montessori, following this logic to its full extent, Christian surmised that one would eventually come to know, in some measure, the whole universe. In Christian's historical framing, he would need to consider history all the way back to the beginning of time - to the Big Bang. This, he claims, led to his first tertiary-level Big History course in the late 1980's (Christian, 1991).

Although what could be considered the corpus of Big History now spans at least three decades and many disciplines, there are only a handful of published accounts devoted

²⁴ A fuller historiography and philosophical explication of transformative learning, including transformative learning in Big History, is provided in Chapter 3

specifically to Big History teaching. One of the earliest (Harris & Hamilton, 2009), reports on two early-career educators attempts to teach an inaugural, tertiary-level Big History-themed course called *Zoom: A history of Everything* which was developed by Professor Douglas Northrop and used Christian's *Maps of Time* (2005c) as a course text. A notable outcome of this study was student reaction to the course. Harris and Hamilton (2009) conclude that many of their students "came away with a deeply environmentalist understanding of humanity's role in the universe, and a sense that the primary way their generation would influence the universe would be through its choices regarding conservation and ecology" (p. 4). Also pertinent was their observation students reached this new understanding "not through direct lecturing on the subject but rather through their enhanced understanding throughout the semester of the ways that seemingly unrelated factors influenced each other, such that social actions had biological repercussions, and vice versa." (p. 4). The work of Harris and Hamilton (2009) reflects on the challenges faced by both students and teachers though an early, Big History-themed undergraduate-level course. Their report hints at the potential for transformation across scales and domains. For example, they cite,

challenges to the standard narratives and inherited mythologies [and students'] ... enhanced understanding ... of the ways that seemingly unrelated factors influenced each other, such that social actions had biological repercussions, and vice versa [as substantive parts of their] journey. (pp. 1-2)

Harris and Hamilton go on to suggest how they and their students acquired an expanded capacity for "future-thinking" as they considered "the current path of humanity and our possible role and actions in the immediate future" (p. 4). While their essay effectively touches on several of the key themes generally believed to be at the heart of a Big History transformative experience, the project is essentially anecdotal from the educators' perspective and no quantitative or rigorous qualitative analyses were attempted.

The most comprehensive work yet published on Big History education, specifically in a higher education context, is an edited volume called *Teaching Big History* (Simon, Behmand, & Burke, 2014). The account arose from the work of a group of professors working to design and implement a new first-year Big History curriculum, “which they called the Big History First-Year Experience,” at their university. Significantly, it is the first such study to include a small empirical component, which was based on a Big History research and assessment tool developed by the author of the present dissertation. The instrument, which was developed as part of this dissertation (see Chapter 3), offers a way of measuring transformative experience according to the characteristics of such experience defined by Kevin J. Pugh, whose work was based on John Dewey. The site of Simon et al.’s (2014) study was Dominican University, a small liberal arts college where the entire faculty was committed to offering an experimental Big History course to all first-year students. Their rationale was the strong feeling “that Big History, used as the core of a general education, prepares students for the challenges humanity faces in the twenty-first century” (pp. 18-19). Of the 89 student respondents, 80 percent said they had “thought or talked about the content of the course outside of class”; 72 percent said that “their Big History experience had changed the way they saw or understood aspects of the world”; and 48 percent said that “Big History had changed the way they saw their role in the world” (p. 81).

The team contributing to *Teaching Big History* (2014) synthesized the following student learning outcomes:

- critical and creative thinking in a manner that awakens curiosity, enhances openness to multiple perspectives, and increases willingness to challenge one’s own assumptions;
- recognition of the personal, communal, and political implications of the Big History story, including insight into the interdependence between humans and the environment, and modes of positive empowerment to effect change; and
- development of reading, thinking, and research skills, enhancing one’s ability to evaluate and articulate one’s understanding of one’s place in the unfolding universe. (pp. 561-2)

These outcomes listed in *Teaching Big History* (2014) make an excellent introduction to Big History education in a college-level context. They also provide a substantive starting point for more detailed investigations on the Big History education. However, with respect to the overall priorities of the current thesis, which deals with the transformative learning aspects of Big History education and the Anthropocene, the most significant outcome of the project at Dominican University, is the overall criteria by which the educators judged the value of Big History education; “that the Big History program is successful if students taking a Big History course see their own self reflected in the course,” (p. 84).²⁵

Whereas Simon, Behmand, and Burke, (2014) provides the most recent and detailed account of Big History education in a tertiary setting, a single, but more directly relevant, data point is provided by Rodrigue (2010). Rodrigue, who has been teaching a 13-week Big History course, concludes the essay by citing a passage from one of his student’s final essays, who wrote,

When I was first asked to consider my role in the universe four months ago...I do not think I fully realized there was even a living community around me, never mind an Earth full of other humans and an entire universe beyond...But after this long, incredible voyage of exploration...I have a newfound sense of what the universe is. I have learned...that we are all part of the Global Future, and I can make a difference in my life as well as the lives of others. I feel honored to have been a part of the big history movement...I know that I am a better, more wholesome being because of this experience. My role is now to change my ways and respect this beautiful planet that granted us life, and to get others to join me. (p.142)

In what is otherwise a critique of the “Western-Civ” model still employed in U.S. higher education, this lengthy quote of a student’s first-person reflection, suggests a richly

²⁵ This Big History-Self reflexivity will become a crucial element of Big History transformative learning and will be explored in detail in Chapters 3 and 4.

complex, nuanced but profound process. (2010). It exemplifies a methodological approach for understanding the Big History educational experience. This experiential, subjective, self-reflective (constructivist), and first-person, (phenomenological) approach to inquiry is sufficient to capture the nuanced understandings that the current thesis will later develop and implement.²⁶

While the handful of accounts above may form an initial basis for more research, overall they are too teacher-centered, anecdotal, theoretical, or their discourse adopts a political stance centered on institutional change, to adequately support the claims and current investments in Big History education.

Summary and Call to Action

This chapter has situated the dissertation by contextualizing the emergence of Big History education within several contemporary issues. A review of interdisciplinary literature traced a lineage within Big History that suggests its potential as a catalyst for transformative learning. Next, a biospheric systems context was developed using the Planetary Boundaries Framework. I also framed the Anthropocene as a “super wicked problem” in order to establish its complexity and intractability. A literature review then highlighted the concepts of transcalarity, complexity and systems principles within Big History, in order to develop its unique intellectual challenges and potential virtues. This literary lineage then led me to speculate on the potential cognitive-level interconnections between the Big History narrative and the Anthropocene. In other words, framing Big History education in terms of complex and dynamical systems has been presented as an opportunity to explore its potential as transformative learning across the cognitive, sociocultural, and biospheric domains of the Anthropocene. Although empirical evidence from Earth Systems Sciences has established the environmental problems of the

²⁶ A detailed discussion of phenomenology and phenomenological research methods is provided in Chapter 3.

Anthropocene, no similarly empirical study has yet confirmed the transformative elements of Big History education. Nor has any research attempted to rigorously correlate them in a sufficiently broad, systems-based framework that could tell us something useful about how Big History might relate to the causes of the Anthropocene already in train. For these reasons, both an empirical and correlational study is warranted.

Accordingly, the research conducted in this dissertation will explore the question, If Big History has the capacity to shape a human response to the Anthropocene through the propagation of its educational impact, then what, precisely, are the components of the cognitive shifts intrinsic to Big History education? And how might these cognitive shifts correlate to our systems-based understandings of what has led to the environmental problems of the Anthropocene? Further, if there are connections between Big History and the biosphere, how can they be best integrated into educational practice? If super wicked problems such as the Anthropocene require innovative, pragmatic, far-ranging, creative and complex interventions, what forms might such interventions take? This exploration has been summarized by the following composite question: *Can Big History education can play a substantial role in shaping an appropriate human response to the Anthropocene and if so, how?*

Chapter 2

DESIGN

People should think things out fresh and not just accept conventional terms and the conventional way of doing things. I look for what needs to be done. After all, that's how the universe designs itself.

-- R. Buckminster Fuller

A designer is an emerging synthesis of artist, inventor, mechanic, objective economist and evolutionary strategist.

-- R. Buckminster Fuller

The crises of our time, it becomes increasingly clear, are the necessary impetus for the revolution now under way. And once we understand nature's transformative powers, we see that it is our powerful ally, not a force to feared or subdued.

-- Thomas Kuhn

Purpose of this Chapter

Chapter 1 presented an interdisciplinary set of contextualizing issues and concepts that were deemed to require an equally interdisciplinary (and perhaps unorthodox) research approach formally known as “Doctoral Dissertation with Creative Component.” Because some readers may not readily know this “Creative Practice” form of scholarship, this chapter aims to help clarify how the overall dissertation structure was designed to accommodate such an interdisciplinary and boundary-crossing endeavor. The work of this chapter is *design*. Thus, the goal of this chapter is to explain the design of a dissertation structure that addresses the following contexts and concepts:

1. Claims of Transformative learning in Big History (prompts Empirical survey)
2. The Anthropocene as Biospheric Context (prompts Correlational analysis)
3. Complex systems in Big History (prompts framework Integration)
4. The Anthropocene as “Wicked Problem” (prompts Creative Practice model)

This interdisciplinary set of contextualizing issues calls for a closer examination of the philosophical and methodological concepts used to ground the overall thesis.²⁷

The Learning Sciences and Design-based Methodologies

Design-based research which blends empirical educational research with the theory-driven design of learning environments, is an important methodology for understanding how, when, and why educational innovations work in practice. Design-based innovations... help us understand the relationships among educational theory, designed artifact, and practice. Design is central in efforts to foster learning, create usable knowledge, and advance theories of learning and teaching in complex settings. Design-based research also may contribute to the growth of human capacity for subsequent educational reform.

-- The Designed Based Research Collective (2003)

The overall goal of this dissertation to facilitate improved teaching practice of Big History places this research partly under the umbrella of the “learning sciences.”²⁸ The learning sciences is an interdisciplinary field that, according to Barab and Squire (2004), “draw[s] on multiple theoretical perspectives and research paradigms so as to build understandings of the nature and conditions of learning, cognition and development” (p. 1). Researchers within the learning sciences investigate cognition specifically in order to produce evidence-based knowledge about how people learn.²⁹ Learning sciences research often results in the development of theory, learning technologies, and curricula that can shed light on the elements of learning. The learning sciences, and their commitment to designing “bespoke” methodologies have been increasingly accepted in diverse

²⁷ The overall creative-practice approach of this dissertation is integral to the research activity. Therefore it is considered a critical part of the research (not merely preliminary or background philosophy). However, if the reader finds it preferable to advance straight to the data collection, they may skim or skip this chapter.

²⁸ The plural form of “learning sciences” is adopted as a convention to distinguish its use as a descriptive noun for a variety of “sciences” as opposed to a verb, as in, to “learn” science.

²⁹ It should be noted, the author holds an advanced degree (Ed.M.) in Science Education with an emphasis on public communication.

educational research settings since the 1970s (Brown, 1992; Wang & Hannafin, 2005; Anderson & Shattuck, 2012; Bell, Hoadley, & Linn, 2013).

Research in the learning sciences not only seeks to understand and articulate, but also, as does this dissertation, *to change and improve educational practice and opportunity* (Barab & Squire, 2004). This commitment to addressing real-world problems, through better practice, aligns learning sciences with action research. Action Research refers to scholarly research that is conducted with the explicit aim of improving the pre-existing practices of the researcher as well as the extended community of practitioners (McNiff and Whitehead, 2002). Therefore, learning sciences research produces not only knowledge about the problems addressed, but also original methodological knowledge that can be of value to other researchers. The body of methodological knowledge produced in the learning sciences is often preserved and disseminated through what its researchers call design-based research methodologies. In other words, a design-based methodology produced through the learning sciences can be considered a research outcome in itself as long as it is adequately grounded in theory, described in enough detail to allow replication by other researchers, and is based on sound design-based principles.

What are design-based research principles? A fundamental aspect of design-based research, and the one that makes it exceptionally useful to the current thesis, is provided by Brown (1992) who argued that design-based methodologies allow for the study of “rich, complex and constantly changing” (p. 144) systems with emergent properties (including properties that emerge from the researcher’s own interaction with the subject). Wang and Hannafin (2005) later expressed this critical characteristic in educational research by describing the design-based approach as,

a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on

collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories (p. 6)

Barab and Squire (2004) further defined design-based research as new and creative "approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings" (p. 2). This means that design-based research implies a pragmatic philosophical underpinning, one in which the value of a research outcome lies in its ability to produce changes in the world (p. 6).

The fruitfulness of design-based methodologies led Wang and Hannafin (2005) to propose five defining characteristics of design-based research as: "Pragmatic, Grounded, Interactive, iterative and flexible, Integrative, and Contextual" (p. 7). All of these features are reflected in the design of this dissertation's methodology. First, the "pragmatic" aspect is implicit in its aim to address contemporary problems through the development and implementation of novel educational interventions. (Design-Based Research Collective, 2003). Second, the "grounded" criterion is reached because the methodology systematically grounds the research in real-world contexts, concepts and theories (e.g., claims of Big Historians, systems theory, the Anthropocene). Third, the "interactive" characteristic is embodied within the entire research process as iterative of cycles of collaborative, critical reflection in order to respond to its own research findings as they emerge, and then integrate them into subsequent research (this required much flexibility during the entire process). Fourth, as I will show momentarily, the research is "integrative" because it draws on a variety of research methods and approaches from both qualitative and quantitative research paradigms, and depending on the needs of the research, it is willing to adjust them (as in post-positivism below). Finally, the structure of the entire dissertation is "contextualized" because the research results are "connected with both the design process through which results are generated and the setting where the research is conducted" (Wang & Hannafin, 2005, p. 11). This is exemplified by the decision to employ an academic creative practice model in response to what is framed to

be, at least partially, a cultural-level research problem in education. The design-based integration of all of these characteristics will become clearer as the research progresses through the nine chapters.

Underpinnings in Educational Philosophy

Voros (2008) has pointed out, “it is impossible to separate methodological considerations from the associated underpinning philosophical foundations” (p. 191). This is true overall and the design of this methodological approach drew particularly heavily on the educational philosophy of John Dewey. These include Dewey’s conceptions of pragmatism, transformative learning, aesthetics, and social constructivism, (wherein individual actors participate collectively in the creation of the social world).

In his treatise on how we learn, entitled *Art as Experience*, Dewey also made the case for the learner as a living creature of nature who navigated the tensions of conflict and resolution of enculturation largely through aesthetic experience (1934). Coupled to this view of the world, I have adopted Dewey’s conception of “transformative learning” to refer to a holistic constellation of cognitive and affective responses to a learning experience. Transformative learning is the deep learning that a transformative experience elicits.³⁰

Both social constructivism and educational pragmatism emerged during the American Progressive Era: a period of social activism and political reform that flourished from the 1890s to the 1920s, largely in response to the abstract intellectualism of European philosophy and the lingering absolutism of Enlightenment Era modernism. Menand (2002) highlights the practical connection between these two concepts when he points out that William James, C.S. Peirce, and John Dewey all believed that

³⁰ Deweyan educational philosophy and specifically his ideas on aesthetic and experiential transformative learning are discussed in depth in Chapter 3.

ideas are not things ‘out there’ waiting to be discovered but are tools people invent--like knives and forks and microchips--to make their way in the world. They thought that ideas are produced not by individuals, but by groups of individuals--that ideas are social. They do not develop according to some inner logic of their own but are entirely dependent--like germs--on their human carriers and environment. And they thought that the survival of any idea depends not on its immutability but on its adaptability. (Menand, 2002)

The dual-faceted philosophy captured in the passage above acknowledges the constructivist view that human knowledge is embodied and thus can manifest in the physical world, but avoids slipping into any extreme or “strong form” relativist ontologies (Helm 2001). Rather, it prompts a more conformist version that accepts the tenets of the social constructivism in much the same spirit as Kuhn’s (1977) account of the social consensus aspects of science. This philosophy accommodates the view taken in this thesis that the contemporary world is shaped as much by social forces (as the collective expression of cognitive structures), as it is by physical processes.³¹ And because these cognitive structures are experientially derived, as Dewey has argued, they can be surfaced and described by research. The pragmatic inclination then accepts that the products of such experiences, the transformations in cognition, manifest through expression of human understandings and their meanings in feedback with the physical world. But the pragmatism also maintains that the physical world still arbitrates the evolutionary fitness, through survival or extinction, of those constructed understandings and meanings.³² Accepting this Deweyan pragmatic philosophy in the context of the Anthropocene acknowledges that human extinction is possible, if not likely, in the near term and on its current trajectory. But also, by considering the anthropogenic nature of the problem, whatever that means, we may also be able to exercise some form of anthropogenic response. In the case of this dissertation, I have decided to focus on what I deem to be a fundamental area of potential anthropogenic change; the way we think, and in particular, by learning Big History, aligning the way we think as contiguous with the

³¹ This statement is essentially a constructivist description of the Anthropocene: that anthropogenic impacts are global-scale manifestations of human thought in action. Therefore, constructivist problems may call for constructivist solutions.

³² Historically speaking and at least for the time being.

“natural” world as described by the natural cosmic narrative. Aligning a response to a problem based on the problem is seen as both reflexive and fundamentally pragmatic.

The transactional view of knowledge above is of high relevance to the design of this dissertation because it assumes that we cannot separate ourselves from what we have experienced and learned. This means the investigator and the object of investigation are linked such that who we are, and how we understand the world, is a central part of how we understand others, the material world and ourselves. Therefore, this research adopts a stance that can be considered empirical first, but interpretivist foremost. I hold this to be the essence of a post-positivist paradigm (as opposed to a naive positivist view). In other words, while I adopt a post-positivist (objectivist) outlook with respect to the scientific content of Big History, this philosophical stance affords an ability to capitalize on the success of humanistic (subjectivist) principles with respect to understanding how people make meaning of that knowledge. In light of this, the research adopts a philosophical position wherein meaning is interpreted from scientific knowledge. It is a perspective that maintains a commitment to the post-positivist findings of science, but also emphasizes the complex ways in which humans can interpret such knowledge.³³ In short, the meanings people construct, through their interpretations, matter. How we interpret the scientific content cosmic narrative matters, but its not all that matters. A sufficiently accurate rendering of humans in the universe requires both the sciences and the humanities.

Considering Dewey’s views collectively, this research accepts that the lived experience of engaging with the scientific cosmic narrative (or any narrative, but in this research I am focusing on a “natural” Big History narrative), can change learners and manifest in social reality. This stance accepts that individual experiences are inherently subjective and always interpreted (constructivist). Nonetheless, as discussed above, this research

³³ In the integrational work of Chapter 5, I provide more detail using the concept of complex dynamical systems theory, to speculate on how such interpretive knowledge can materialize in the world.

subscribes to the post-positivist view that there is a real world and that we can know it scientifically, albeit partially and probabilistically. This research paradigm is post-positivist in that it privileges the explanatory power of science, while it is social-constructivist in that it simultaneously acknowledges the limits of the inductive and hypothetico-deductive (scientific) method.³⁴

Creative Practice as Doctoral Research

This dissertation has been accepted by Macquarie University as “Creative Practice Research.” That is to say, it has been formally submitted as “A Doctoral Dissertation with a Creative Component.”³⁵ Of course, good scholarly research invariably requires some degree of creativity, if not art. But not all research incorporates the design of “artistic” outputs. Since the mid-1990s, the Australian Research Council (ARC) has recognized the validity of, and has supported, such practice-based creative research (2012b). Creative Practice research in this usage refers to research that is either based on artistic practice, or leads to improvement in any practice that integrate artistic creativity. This relatively new development of practical artistry is visible in a shifting preoccupation in arts research toward “problem-solving” as opposed to the former criteria of originality (AHRC 2012). Indeed, the AHRC indicates, “language used to describe some arts research has become effectively indistinguishable from that used to describe other forms of research” (2012). According to Macquarie University, the goal of doctoral dissertations with creative components is in “discovering and disseminating knowledge through new ways of thinking, seeing and hearing” (2015, para. 3). The university stipulates that all higher degree creative practice research projects must include a creative component as well as a written dissertation and that both components are considered to be equal and examined holistically.

³⁴ I have previously made the argument for post-positivist scientific knowledge communicated through the humanities in a social constructivist reality in Blundell (2009, unpublished thesis).

³⁵ Macquarie University is an Australian leader in acknowledging the utility and validity of Creative Practice research (also known as *practice-led* or *practice-based* research).

The written component of a creative practice dissertation can be theoretical, conceptual or analytical and it must stand in a specific relation to the creative component. This convention has implications for the way doctoral dissertations (including this one) are designed because creative outputs are not presented as evidence in support of any particular argument made in the thesis. Instead creative practices should be judged insofar as they *demonstrate* the findings discovered through the inquiry of the thesis. In short they are artistic outputs (or “artefacts”) of findings (outputs), not evidential bases for argument (which would instead be considered inputs).³⁶ In this rendering, inputs (evidence) are the literature and empirical data, whereas outputs (artefacts) are the creative practices themselves.³⁷

According to Macquarie University rules, in a Ph.D. with creative practice, the size of the creative component is not specified, and it can vary according to the candidate's area and medium. They state this could mean a written musical score, a compositional folio containing a number of pieces; which might be in different forms such as software, video or audio recordings. Or, in the genre of writing, for example, the creative component could take the form of a novel, biography, collection of shorter pieces, or a volume of poems. Candidates may otherwise elect to integrate the creative and the critical components, as e.g. in a ficto-critical writing, essays or films. In the case of this thesis, the creative components consist of a multimedia public lecture and an augmented reality smartphone app.³⁸ Each of these “creative components” (the creative practice outputs) have been converted into digital video with links to online versions. The goal of these creative practices is to demonstrate the cumulative findings of the research as a form of “cultural communication” (i.e., informal public education). That is, the thesis exploits the

³⁶ This “exegesis” form is a convention of creative practice research and is the work of the exegetical tables in Chapters 7 and 8.

³⁷ Further guidance on how to engage with the creative practices is provided in Chapter 6.

³⁸ This project, documented in Chapter 7, was funded through a competitive, university organized, “Innovative Scholarship Program” grant awarded to the author.

semiotic model of communication articulated by William H. McNeill (2011) who, after a lifetime of teaching world history, came to believe that such “webs of communication” had an “almost magical power of ... to define how human groups affected one another and the environments in which they live” (pg. 47). The communicative power that McNeill is referring to also ties the creative practices to the complex-systems concepts discussed in Chapter 1. In other words, the creative practices are proposed as cultural communication efforts, the impacts of which, may propagate through the “webs of communication” to impart a systemic equilibrium dynamic in the complex, wicked problem of the Anthropocene. In McNeill’s terms, the creative practices are proposed as cultural communication projects that can impact how people affect one another and their environment systemically.³⁹ This process assumes that it is not only energy that moves through complex dynamical systems, but information as well. The creative practices are designed to impart their impact through complex systems dynamics as information in a negative feedback loop.

Research Paradigm

As a doctoral project, the onus is on the student to describe the paradigm within which this research has been conducted. The structure of this dissertation arises organically from the real-world contexts and questions that motivate the research. Alas, it is necessarily complex, interdisciplinary, and may be seen as unorthodox (to some). To address this complexity, Voros (2008) proposes that a researcher needs to adopt what he calls a “meta-paradigmatic meta-perspective.” Also referred to as “Integral Inquiry,” this approach can recognize and value the contributions of all paradigms so as to be both inside and outside of any one in particular. Or as Voros explains,

An integral meta-perspective can range across a variety of different perspectives, drop into them where needed, use them for as long as is necessary, and move out of them again when their utility for the current

³⁹ See Chapter 6 for McNeill’s concept in practice.

aspect of inquiry is exhausted. In other words, an integral (meta-)perspective is one that is, as it were, 'freely floating' and not bound to any particular singular paradigm-based perspective. (2008 p. 198)

Therefore, an Integral Inquiry framework (Voros, 2008) is appropriate here because it allows for the selection of elements from various research paradigms and weaves them into a coherent “meta-paradigm” that can effectively address the integral research problem. Integral Inquiry also suits the study of Big History because the field Voros (2008) developed it for; Futures Studies, and Big History can be essentially seen as two sides of the same coin.⁴⁰ The difference is merely one of directionality. Whereas Big History uses narrative structure to explore the past, Futures Studies uses narrative scenarios to describe potential conditions in the future (Staley, 2009).

To organize an Integral Inquiry’s myriad paradigms and their associated methodological approaches, Voros (2008) developed a tabular typology. The typology presents the philosophical stances of four “inquiry paradigms” based on their intrinsic ontology, epistemology, methodology and axiology.⁴¹ Each of these components engender its own set of commitments and assumptions that become constitutive of the form of inquiry and thus define the criteria for what are appropriate as valid knowledge claims or research outcomes.

While there may be overlaps and gradations across various paradigmatic forms, the table below summarizes several paradigms by describing their ontological, epistemological, axiological, and methodological “Stances.”

⁴⁰ Voros’s (2008) views on Integral Inquiry as methodology were formulated as part of his work on the emerging field of “Futures Studies,” which he is helping to pioneer.

⁴¹ *Ontology* refers to the basic nature of reality; *epistemology* concerns the validity of knowledge; *methodology* deals with issues of validity in acquiring that knowledge; and *axiology* concerns the underpinning values that ground the research (including those held by the researcher).

Descriptors of “ <i>Stances</i> ” used by Voros (2008)	Resultant Paradigms in this Dissertation
Post-positivist and <i>critical realist</i>; there is a “real” reality but only imperfectly and probabilistically apprehendable <i>Historical realism</i>; a virtual reality shaped by social, political, cultural, economic, ethnic, and gender values that can become crystallized over time. Experience of reality is <i>local, specific and often co-constructed</i>, subjective-objective reality can be co-created by mind and given cosmos.	Ontology: Post-positivist Criticalist, Constructivist Participatory.
<i>Transactional and modified dualist</i>, knowledge can be subjective in <i>participatory transaction with cosmos</i>, experiential, presentational, propositional and practical.	Epistemology: Post-positivist, Constructivist Participatory
Empirically <i>qualitative, hermeneutical, political participation in collaborative action inquiry, primacy of the practical use of language grounded in shared experiential context.</i>	Methodology: Post-positivist, Constructivist Participatory
<i>Practical knowing how to flourish with a balance of autonomy, cooperation, and hierarchy in a culture is an end in itself and is intrinsically valuable.</i>	Axiology: Participatory

In addition to explicating his paradigm of “integrated inquiry,” Voros (2008) further identified six broadly accepted “paradigm positions” that help to define a given integrated research paradigm: inquiry aim, inquirer posture, nature of knowledge invoked, knowledge accumulation, values, and goodness/quality criteria. The following table shows the current research as defined by Voros’s (2008) typology of such “positions.”

Descriptors of “ <i>Positions</i> ” used by Voros (2008)	Resultant Paradigms in this Dissertation
In terms of <i>inquiry aim</i>, the current research is mostly <i>descriptive, slightly explanatory and critical</i>, and leading toward human flourishing.	Post-positivist Participatory

In terms of <i>inquirer posture</i> , the current research is conducted by a <i>passionate participant as facilitator</i> , whose voice is manifest through self-reflective action with secondary voices illuminating theory, narrative, and other presentational forms.	<i>Constructivist</i> <i>Participatory</i>
In terms of <i>nature of knowledge</i> , the current research invokes historical insights, as well as individual and collective reconstructions sometimes coalescing around consensus within an extended epistemology that includes the primacy of practical knowing, critical subjectivity and living knowledge.	<i>Criticalist</i> , <i>Constructivist</i> <i>Participatory</i>
In terms of <i>knowledge accumulation</i> , the current research places it within communities of inquiry embedded in communities of practice.	<i>Participatory</i> <i>Post/positivist</i>
In terms of research <i>values</i> , the current research considers them to be included and formative to inquiry.	<i>Criticalist</i> <i>Constructivist</i> <i>Participatory</i>
In terms of <i>goodness or quality criteria</i> , this research rests on internal and external validity and reliability, historical situatedness, and the congruence of experiential, presentational, propositional and practical knowing, leading to action to transform the world in the service of human flourishing.	<i>Post/positivist</i> , <i>Criticalist</i> , <i>Constructivist</i> , <i>Participatory</i>

This thorough survey of what may seem above to be merely confounding terminology is required to adequately describe how this research was conducted. An Integral Inquiry paradigm is appropriate here because it allows for the necessary plurality of outlooks and approaches. This research requires such a perspective because it crosses many ontological subdivisions (later referred to as domains of reality). This is summarily indicated by the high number and degree of variability of paradigms listed in the right hand column of both tables above. Listed in their order of prevalence the Paradigm is: Participatory (10), Constructivist (7), Post/Positivist (6) and Criticalist (4).⁴² Such a plurality of capacities is deemed required in order to fulfill the larger research agenda of the present study and also precisely what an Integral Inquiry paradigm allows. This progression also makes

⁴² Parenthetical values refer to the number of times the paradigm was invoked in both tables.

suggestions for how the dissertation can be most fully engaged with and understood. In other words, this means reading the thesis from a participatory paradigm will likely be the most productive, whereas reading it from a strictly criticalist paradigm, for example, is likely to be least productive. However, for a most appropriate, and fully holistic understanding, Voros's (2008) integral inquiry paradigm is indicated.

Dissertation Methodological Structure

The research is divided into nine integral and iterative chapters across multiple phases of research as they unfolded over the course of the dissertation (see Figure 2 below).

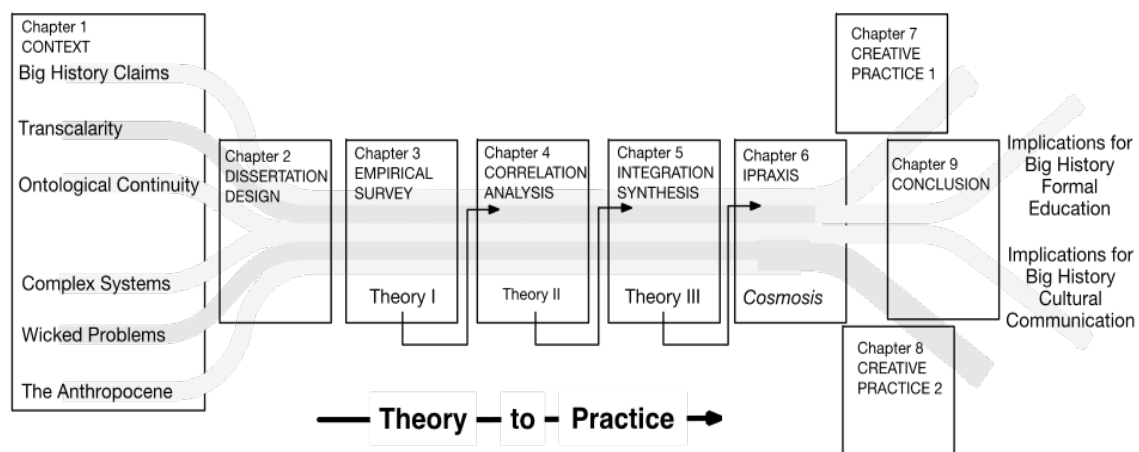


Figure 2: *Dissertation Methodological Structure by Chapter*

Following the dissertation methodological structure depicted in Figure 2 above: Chapter 1 (CONTEXT) introduced the problem of the Anthropocene and the potential role of Big History education as an opportunity to address it. The literature review of Chapter 1 is an attempt to mine both of these subjects for insights that might reveal meaningfully practical connections. This Chapter 2 (DESIGN) developed a dissertation structure designed to facilitate the larger, complex-systems and cultural-level research agenda. Chapter 3 (EMPIRICAL) will generate qualitative data on the cognitive transformative

learning aspects of engaging with Big History and propose the first part of a three-part grounded theory. Chapter 4 (CORRELATION) will reveal conceptual connections between those cognitive shifts and the currently degraded biosphere in order to develop part 2 of the grounded theory. Chapter 5 will bolster the research findings by re-examining a number of established learning and communication theories and propose the final part of the three-part grounded theory. This cumulative theory will then be integrated into a general framework for Big History transformative learning. Chapter 6 (PRAXIS) will transition the thesis from theory to practice by developing the conceptual and aesthetic philosophy behind a metaphorical model I call *Cosmosis*. Chapters 7 (PRACTICE 1) and 8 (PRACTICE 2) constitute exegetical discussions for the dissertation's creative practice components. I describe the development and presentation of these two cultural communication practices based on the *Cosmosis* model. Chapter 9 (CONCLUSION) will summarize the overall research outcomes, conclusions, and suggestions for future research.

Chapter 3

EMPIRICAL

It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.

-- Sherlock Holmes, in Arthur Conan Doyle's
A Scandal in Bohemia (1891)

Purpose of this Chapter

As a reminder, recall that the literature review of Chapter 1 established the rather bold and wide-ranging claims of Big Historians coupled to a paucity of empirical data to support those claims. The work of this chapter, then, is to generate that empirical data, surface any patterns that emerge, and organize them into a form that can serve subsequent research and practice.

As the dissertation design of Chapter 2 specified, the overall dissertation will advance chapter-by-chapter as the work integrates and builds on the cumulative findings of previous chapters (see Figure 2). Therefore, this chapter will establish the first part of a three-part running grounded theory as follows:

1. **What are the specific cognitive elements of transformative learning in Big History?** (This Chapter 3).⁴³
2. Forthcoming (Chapter 4).
3. Forthcoming (Chapter 5).

⁴³ As a convention in this dissertation, this three-part running theory will present its constituent part as a research question at the beginning of each of the three chapters, and then as a resultant theory at the end of each relevant chapter.

Background

Despite the enthusiastic claims and anecdotal evidence of Big History as transformative learning across multiple and far ranging domains, (Alvarez 2009; Benjamin 2009; Christian 1991, 2005a, 2005b, 2010; Markley 2009; Spier 2005, 2008; Stokes Brown, 2010), very little has been done to examine Big History learning at the level of individual cognition. What is needed is a systematic investigation into the Big History transformative experience on the personal level. With this knowledge, an appropriate pedagogical framework could be built and put into practice both in education and in wider cultural communication.⁴⁴ Thus, the rationale for this empirical component is to survey and explore the transformative experience of Big History, when it happens, in the context of a Big History educational setting. In particular, I explore the habits of mind cultivated through that transformation by investigating the following general question:

*What are the cognitive elements of Big History transformative learning?*⁴⁵

Before proceeding, it will also be instructive to recall the following passage from Chapter 1 wherein a student of Big History reflects on her experience at length

When I was first asked to consider my role in the universe four months ago ... I do not think I fully realized there was even a living community around me, never mind an Earth full of other humans and an entire universe beyond. ... But after this long, incredible voyage of exploration ... I have a newfound sense of what the universe is. I have learned ... that we are all part of the Global Future, and I can make a difference in my life as well as the lives of others. ... I know that I am a better, more wholesome being because of this experience. My role is now to change my ways and respect this beautiful planet that granted us life, and to get others to join me. (Rodrigue, 2010, p. 142)

⁴⁴ This is the work of Chapters 4-6.

⁴⁵ In this context “cognitive elements” refers to the general ways people think or “thoughts.”

This personal and subjective reflection exemplifies many of the profound but nuanced elements of a transformative learning experience. Clark (1993) describes transformative learning as a process of "perspective transformation" which consists of psychological (cognitive), convictional (values and beliefs), and behavioral (lifestyle and action). Elias (1997) goes on to refine transformative learning as, the expansion of consciousness through the transformation of basic worldview and specific capacities of the self. Either way, transformative learning is considered deep learning. It is learning that changes the learner in profound inward and outward ways. Because this study is more detailed, systematic and empirical than any similar previous research, it should be of original value to Big History educators.

Lessons from William James

As this study attempts to make scholarly use of people's subjective, transformative experiences, I sought to find precedence in the work of others. In addition, because the outcomes of this research aimed at young adult and public audiences, studies that examined adults were necessary.⁴⁶

A good, albeit outdated, model for such a study is William James' (1842-1910) late 19th century investigation into the transformative experiences of adult subjects.⁴⁷ James had attempted a daring project, which he reported in the prestigious Gifford lecture Series of 1901. In his lecture entitled *The Varieties of Religious Experience: a Study in Human Nature*, he analyzed the anecdotes of people who had undergone religious conversions in moments of profound personal revelation. His lecture marked an important departure

⁴⁶ Because transformative learning is taken to mean a significant shift in previously held cognitive narratives, learning in the very young, where narrative structures have not yet been established is considered a fundamentally different kind of learning. This kind of "primary" developmental learning is not the subject of this dissertation.

⁴⁷ The psychological theories of James would deeply influence philosophers, theologians, scientists, novelists, cultural critics, and poets. Visionaries such as Carl Jung, Aldous Huxley, Emile Durkheim, Edmund Husserl, Bertrand Russell, and Ludwig Wittgenstein, among others, all profited from his ideas (Goodman, 2013).

from previous studies in religion, which had typically focused on religious texts, structures, institutions, and doctrine. Instead, James wanted to advance a new kind of understanding of religious experience by examining the mechanisms of personal transformation from the inside out, as opposed to outside in.

Why was his Gifford Lecture, a “daring project”? Because James was well aware of what he called *scientificism*, that is, the tendency for intellectuals of the day to adopt a strong aversion for anything that seemed to depart from positivistic science. Yet, James believed that such a myopic stance would blind researchers to more holistic investigations into complexities of human experience and the lived realities they could produce (Woelfel, 2013). He believed that such a narrow view, ironically, could “induce a sort of religious dogma” of its own (1902/2009). By shifting the focus of inquiry from some outer divine decree to an inner personal experience, James knew he was taking some risks. But he also initiated a new strand of investigation.

His research agenda was to understand scientifically the psychological basis of transformative religious experience. For this purpose, James crafted a pragmatic definition of religion as “The feelings, acts, and experiences of individual men in their solitude so far as they apprehend themselves to stand in relation to whatever they may consider the divine (1902/2009, p. 27).” This framing of religion is not wholly reductionist; it thoughtfully balances methodological rigor with humanistic sensibilities. It is broad enough to be inclusive, but also narrow enough to distinguish it from clinical science. While his aim was scholarly, his vocabulary also allows a sensitivity to religion’s internal, subjective, and often, idiosyncratic qualities.

It is James’ precise and deliberately pragmatic word selection in defining the transformative experience of religious conversion that make his investigations particularly interesting and useful to this dissertation. His definition captures religion as an affective response (i.e. *feelings*), to phenomenological modes of inquiry (i.e. *experiences*), which lead to practical consequences (i.e. *acts*) that ultimately shape the

world we live in. In the inaugural year of the 20th century, James was acknowledging that human feelings, experiences, and the acts they impel, could be treated as matters with material consequences.

Through his analysis of varied accounts of religious experience, James (1902) ultimately advanced a pluralistic theoretical framework. He asserted that "the divine can mean no single quality, it must mean a group of qualities, by being champions of which in alternation, different men may all find worthy missions" (p. 487). In this way, he also enacted his pragmatic philosophy by clearly linking how personal experiences, regardless of how interior or subjective they may be, manifest in complex ways to have impacts in people's lives. James's investigation was concerned with how his subjects, not just his theories, converted into the world. The analysis that James reported in "The Varieties" was founded upon self-reported accounts of adults who had undergone profound religious conversions. His research was to assemble self-descriptive accounts of others' experiences, identify any patterns and themes, and organize them into a framework useful for understanding the elements of transformative experiences. This model applies aptly to the current research. If, as James believed, the transformative power of a religious experience is at least partially amenable to reductive understanding, regardless of the dogma or validity of its content, then perhaps, so too is a Big History experience. While the content of Big History is scientific, natural, and materialist, the "lived-experience" methodology that William James developed is closely aligned with the philosophical commitment of phenomenology and can probably apply in any non-religious transformative experience as well.

Phenomenology as philosophical commitment

This section explicates the invocation of phenomenology as a philosophical concept (as opposed to its use as a method, which is described in the methods section below). In this sense, phenomenology is rooted in the German philosophical tradition that sought to understand basic phenomena by focusing on the lived-experience of the inquirer.

Traditionally this meant that the philosopher would engage in a systematic analysis of

their own experience in order to better understand a particular phenomenon (Marton and Booth, 1997).

Phenomenology, as founded by Edmund Husserl (1859-1938), was primarily a philosophical approach to the study of the structures of reality (phenomena) as they appear in consciousness. It was a response to the modern estrangement of experience from reality. Husserl drew upon Hegel to reunite the sensuous world with the natural world and in the process recovered and elevated experience by casting the body as the locus for consciousness. His aim was to provide a preliminary, experiential base from which science could then be launched. This was a break from the previous, Cartesian way of seeing the material world as discrete objects that exist and interact separate from our perceptions of them. To do this, phenomenology involves a systematic study of qualitative data.

Later developments in phenomenology were also important to the current thesis. For example, Husserl's ideas were further refined by Maurice Merleau-Ponty (1908-1961) to include the constitution of meaning in human consciousness. Merleau-Ponty was the first to make a sustained argument for the preliminary, if not foundational, role that experience can play in making meaning of the world, as well as engaging with it. Thus, it is with Merleau-Ponty that we arrive at the core of the current research, which is to explore lived-experience and the potentially transformative experience of Big History. Merleau-Ponty's phenomenology provides a means of realistically committing to the primacy of experience, and it supports how Big History can be truly transformative across the domains of reality, not just in the minds of learners.

In its original sense, phenomenology aimed to be a wholly new kind of science. While this form of philosophical phenomenology has lost much of its explanatory power today, it has since re-emerged as an especially apt and thorough way of framing the *lived-experience* as a viable subject of study. As the assumptions of naïve positivist and modern paradigms have given way to more relativist, post-modern worldviews, phenomenology

has found a new role. In qualitative research, phenomenology has gained viability that it lacked as it was originally conceived (Smith, Flowers & Larkin, 2009). It is this function of privileging the human lived-experience that makes it philosophically important to the current study in two primary ways. First, it underscores the substantial role of experience, as just described, but it also provides a link between experience, a manifestation of perception, and individual agency. That is to say, phenomenology provides cogency between the subjective ways a phenomenon (like Big History) can be experienced, and how that experience can manifest through the subsequent outlook and actions of the experiencer. Phenomenology in this sense highlights the cyclical relationship between a subjectively lived-experience and the objective world that results from the collective expression of individual agencies.

As a method of scientific inquiry, phenomenology studies topics usually regarded as subjective, such as consciousness and its contents (i.e. judgments, perceptions, and emotions). Although phenomenology seeks to be objective about subjective topics, it is not wholly reductionist and thus does not attempt to study consciousness from, for example, the perspectives of clinical psychology or neuroscience. Instead, the form of phenomenology adopted here applies systematic reflection to determine the essential properties and structures of experience.

One technicality needing to be addressed is my choice to retain the term phenomenology despite the possibility of it also being appropriately described as phenomenography. This latter terminology is in response to a recent shift from the first-person experience of the researcher to the third-person experience of the research subjects (Smith et al., 2009). The difference is on the subject of investigation. While phenomenology was originally interested in the *phenomena* or “the thing itself” (Kant 1781/2012), some usages of the term phenomenography have appeared in the literature to focus on the experiences of others as subjects. Like the current study, those also sought qualitative descriptions, and better understandings of the *relationship* between phenomena and human experiencer, not

solely the phenomena itself. However, these distinctions have not been fully adopted in the literature. Thus, despite these developments, I retain the phenomenology designation.

In this dissertation, then, the pragmatic value of phenomenology as a concept refers to a vigorous preoccupation with the human *lived-experience*. This takes the emphasis off epistemology without needing to abandon objectivity, reason or positivism (if this were a methodologically scientific study, of course, this shift in focus would be inappropriate). In this assumption, experience matters because it is seen to fundamentally shape subjective knowledge. This constitutes a shift from a solely epistemological approach toward an applied phenomenological one.

Narrative

Another concept that will become critical to understanding the theoretical as well as practical outcomes of the current study is narrative. This is because narrative has been established in recent years as an especially powerful way of understanding a variety of human experiences and phenomena. Haidt (2013) summarizes the cognitive function of narrative when he states, “The human mind is a story processor, not a logic processor” (p. 328). Thus, on a human-dominated planet (i.e. in the Anthropocene), narrative should be seen as an integral component of human-biospheric systems. In support of such a view, one that links narrative to identity, culture and the experience of transformation, Gardner (2006) suggests that one way to capture the attention of a disparate population is:

by creating a compelling story, embodying that story in one's own life, and presenting the story in many different formats so that it can eventually topple the counterstories in one's culture. (p. 62)

McAdams (2008) affirms the centrality of narrative at the level of culture, by providing a nationalistic example wherein:

Americans have sought to narrate their lives as redemptive tales of atonement, emancipation, recovery, self-fulfillment, and upward social mobility. The stories speak of heroic individual protagonists-the chosen people whose manifest destiny is make a positive to difference in a dangerous world, even when the world does not wish to be redeemed. The stories translate a deep and abiding script of American exceptionalism (quoted in Navarez and Lapsley, 2009, p. 22).

In America, as in all nations and social, human populations, cultural level and personal level narratives tend to be deeply connected. As an example, for many in western industrialized societies, consumerism has become a common basis of self-identity. Big History itself rests on a narrative foundation. In fact, perhaps despite its epistemological ambitions, Big History is at least partly a culture-bound narrative. Either way, narrative has become a founding theory in psychology and will thus be a useful tool for better understanding the human condition.

Transformative Learning

A third theory needing to be preliminarily identified for its contribution to the current study is transformative learning. This study adopts the view that a transformative experience is generally synonymous with transformative learning.⁴⁸ Before the term “transformative learning” existed, educational philosophers such as Dewey (1933, 1958) and Piaget (1976) were already considering the deep psychological and structural changes that occur as one gains new knowledge. Dewey essentially argues that a fulfilling life is about having rich, meaningful learning experiences and how these experiences prepare us, and create an enlarged capacity for, future learning and experience. This, he thought, was the meaning of life (Dewey, 1933). Dewey also applied an intuitive understanding about the power of aesthetic experiences with art and nature to illustrate this claim and made direct connections to the educational endeavor (1934, 1998). For example, he often talks about the difference between learning concepts (as static knowledge to be acquired) and ideas (as opportunities to consummate potentials) (1934/2005). Dewey argued that when we think in terms of *ideas*, we open ourselves up to whole new ways of relating to

⁴⁸ Or at least the possibility that one can lead to the other in either direction.

the material to be learned. In other words, Dewey framed education as potentially imbued with opportunities for meaningful experiences to be lived, not merely concepts to be absorbed. In this way, according to Pugh (2011), Dewey distinguishes between experience and “*AN experience*” with the latter being a richer opportunity and having the potential to profoundly change the way we perceive and interact with the world.

Mezirow (1981) further refined a concept of transformative learning by showing that the object of transformative learning is the transformation of the learner’s perspective. He defined this transformation of perspective as an emancipatory process of:

...becoming critically aware of how and why the structure of psycho-cultural assumptions has come to constrain the way we see ourselves and our relationships, reconstituting this structure to permit a more inclusive and discrimination integration of experience and acting upon these new understandings. It is the learning process by which adults come to recognize their culturally induced dependency roles and relationships and the reasons for them and take to overcome them (1981 pg. 7-8, emphasis in original).

Mezirow’s (1981) refinement was considered less prescriptive than earlier theories because he sought to focus squarely on the transformative outcomes of an educational experience. But his preoccupation with “change” resulted in the first true model, or framework, of transformative education. One way he did this was by highlighting the differences between pedagogy (teaching children) and andragogy (teaching adults). Dewey’s linking of what is learned with what is experienced would later become the understanding that personal, social, and cultural development are *de facto* targets of liberal education in Western contexts.

By the mid 20th century, this lineage of transformative learning theory had become overshadowed by formal, academic educational research, which was by then aiming to standardize educational goals and systems. Bloom (1956), for example, generated a substantive framework (that he called a taxonomy) of how learners learn. Learning

frameworks such as Bloom's, with its plurality of components, showed signs that educational philosophers were beginning to see the value in broader, more complex, and nuanced views of learning. Krathwohl, Bloom and Masia (1956) for example, adapted Bloom's Taxonomy in order to more fully address the affective domains of learning. This extension also led to a discourse that included richer, qualitative descriptions of the educational experience. These too have become relevant to this dissertation.

Recently, commentators have begun to articulate the specific mechanisms of transformative learning. Cranton (2006) defined transformative learning as "the development of revised assumptions, premises, ways of interpreting experience, or perspectives on the world by means of critical self-reflection" (p. xii). In more recent research, educational psychologists Pugh, Schmidt, Bergstrom, and Heddy (2012) developed and evaluated the Teaching for Transformative Experience in Science Model (TTES). This model further operationalized Deweyan principles into measurable transformative experiences by defining them in terms of three composite constructs: Motivated Use, Expansion of Perception, and Experiential Value (Pugh et. al., 2012 p. 112). These three aspects form the basic initial measure of a transformative experience adopted in this study.

The current, empirical study understands the transformative experience both as a potential dimension of formal learning and informal learning through aesthetically designed cultural communications. As Jackson (2000) showed, Dewey seems to have presciently understood the elegant relationship between learning and culture. Dewey had cast the learner as a living creature of nature that navigated through the tensions of conflict and resolution of enculturation through aesthetic experience. These nuanced, almost postmodern understandings of the emergent and evolving complexities of life seem to best underpin the principles of this dissertation. However, what Dewey and his contemporaries could not have anticipated in their age was the Anthropocene. This dissertation, then, aims to elucidate a more precise, current and relevant application of the transformative experience. To meet the ultimate aims of responding appropriately to the

Anthropocene, a situation that may require fundamental changes to the small and large-scale patterns of human thought and action that have brought about the problem in the first place, I have adopted transformative learning as the holistic constellation of cognitive and affective responses to a learning experience.

In summary, these three interrelated subjects, phenomenology, narrative theory, and transformative learning, have informed and guided the entire research process, including the overall methodology, instrument design, methods, analysis, interpretation, and as will become clear throughout the remainder of the dissertation, the application of the results in practice.

Research Question

Recall that this research is couched in broader efforts by the author to develop cultural communication practices. Thus, the results are meant to provision appropriate aesthetic phenomenological dimensions that can inform the design of cultural communication practice as well as formal pedagogical curricula. Either way, it has been argued (through the Deweyan insights discussed below) that pedagogical practice designed with personal experience (phenomenology) in mind, will tend to provide a richer experience that can in turn transmit the ostensibly transformative power of Big History more effectively into social and cultural domains. The refined research question thus became:

What are the qualitative elements of transformation cited by students who report having had a transformative experience from engaging with Big History in a tertiary setting?

An important consideration to acknowledge is that this study sought to surface and describe transformative experience only *when it had already happened* in a particular educational setting. This slightly distinguishes the project from the conventional questions asked in educational research. For example, I did not seek to assess the effectiveness of any particular intervention (independent variable) on any particular

cognitive learning goal (dependent variable). That means that this research is not so much conventional educational research as it is an inquiry into describing the qualitative nature of transformative experience in an educational setting. I sought only to elucidate the transformative experience of students who already reported them as having happened. Nonetheless, it is assumed that more engaging learning, no matter what the subject or particular audience, will result in improved understanding.

Methods

Qualitative Research Approach

Qualitative research is a systematic approach for gaining a better understanding of a particular human experience. By contrast, quantitative research seeks causal explanations by controlling variables and converting results to measurable quantities. The results of qualitative research are typically reported in words as opposed to numbers because language is capable of expressing the nuances and richness of human experience. Because of this, results are usually descriptive and presented in an extended narrative or summarized into textual graphics such as tables or matrices (Fraenkel & Wallen, 1990; Creswell, 2009; Merriam, 1988).

Qualitative researchers are typically interested in describing how things happen and therefore investigate both the processes and their outcomes (Fraenkel & Wallen, 1990; Merriam, 1988). Subjects amenable to qualitative methods include social situations, educational interventions, events, and individual or group interaction. The aim is to make sense of the phenomena from the perspective of the human participants. Given the spectrum and complexity of human experience, clarity usually only emerges very gradually from social situations.

Qualitative research suits this project for several reasons. First, such research takes place in natural, real world settings. This was convenient because for ethical and other

administrative reasons, there was no ability to control the academic setting. Qualitative research design also tends to be context-sensitive and emergent. That is, the methodology allows for adaptation in research activities as data becomes available. Outcomes tend to be negotiated out of the data provided by participants (Lincoln & Guba, 1985). Rigor in qualitative research is established through both validation and reliability efforts. These may share some aspects with quantitative research (such as in triangulation, when data from multiple sources can be used to strengthen a particular observation or claim) but will differ in others. Qualitative research gains credibility primarily through the thorough description of contexts, limitations, and procedures; logical coherence of the design; utility of the outcomes; and robust crosschecking of researcher interpretations through inter-rater agreement schemes (Lincoln & Guba 1985). All of these strategies are employed in this study and fully described below.

Researcher Role and Subjectivity (Axiology)

Because the qualitative researcher is considered instrumental in study design, data collection, analysis, and interpretation, substantial care must be taken to contextualize and describe the role and potential biases of researchers through a measure axiological description.⁴⁹ If this is done adequately, the experience and insights of the researcher can be seen as an asset to the credibility of the research, not a liability (Locke et al. 1987). The researcher is an active Big History educator who acknowledges the significant potential of researcher bias and takes steps to mitigate these potential threats to validity through a detailed and transparent description of research paradigm in Chapter 2 of this dissertation.

Survey Instrument Design

The survey instrument for this study had two components. Each potential participant was

⁴⁹ Axiology refers to the constellation of values of the researcher that may introduce bias in the research methodology.

given three yes-or-no questions to determine whether the participant had had a transformative experience in studying Big History. If the participant answered “yes” to all three of the questions, he or she was considered to have passed the threshold for inclusion and was then given the three open-ended questions.

The focus of analysis is transformative experience as self-reported and described by students enrolled in tertiary (undergraduate) level Big History courses. This phenomenological study aims to reveal the subjective underlying mechanics of a transformative experience, when it happens. The analytic focus is transformative experience, which is operationally defined as affirmative, self-reported responses to two (out of three) yes-or-no survey questions based on the following pre-established constructs. Transformative experience refers to a holistic constellation of cognitive and affective responses that result in motivated use, expansion of perception, and experiential value (Pugh et al., 2012). Pugh et al., (2002; 2010; 2011; 2012) operationalized these constructs of transformative experience in order to facilitate its measurement by describing them as follows.

- **Motivated Use** refers to student’s application of ideas presented in the course to situations outside the course. It records a type of “transfer” to contexts that are not required and are therefore self-motivated (Pugh & Bergin, 2006). This process of “bringing” a learned concept into a new setting indicates that a change, or transformation, has taken place. This construct is also particularly useful because it places particular emphasis on engagement that extends beyond the classroom (i.e. into culture).
- **Expansion of Perception** refers to new ways of seeing and understanding the world. The emphasis is on novel cognitive aspects of motivated use with respect to objects, phenomena, issues, others, or the self. In Big History this invariably involves an expanded sense of perception, and therefore a transformation has taken place.
- **Experiential Value** refers to the valuing of content for its usefulness in immediate, everyday experience. It is a subjective measure of value that overlaps with and extends the intrinsic and utility aspects of value (Pugh, 2010). This is also a direct measure of how the learner values the new knowledge. The teaching strategy of fostering an appreciation of content (Brophy, 2008) is based on this construct.

To capture these constructs, the following questions were asked in an online survey (See Appendix A for full survey):

1. Do you ever think about what you've learned in your Big History course, or talk about it with others outside of class (in everyday life)? Yes or no?
If yes, how much do you think/talk about Big History and what do you think/talk about?
2. Has your Big History experience changed the way you see or understand aspects of the world? Yes or no?
If yes, how has your Big History experience changed your perspective?
3. Do you think taking a Big History experience was valuable? Yes or no?
If yes, what was the value in your Big History experience?

An affirmative answer to any of the above “yes-or-no” questions elicited further response by revealing its associated “If yes” open-ended question. In this way, the open-ended questions were also designed to correspond to Pugh’s three constructs for transformative learning.

Using existing post-course evaluation materials from established Big History courses was also considered as a source for data on student experience; however, it was found that they were not readily available; had not usually been systematically administered; and did not specifically seek to document transformative experiences. Thus, at the time of this writing I had been unable to find any formal empirical data investigating the claims that students enrolled specifically in Big History courses undergo transformative experiences.

Primary Academic Settings

The large majority of survey responses originated from Macquarie University in Sydney Australia, Dominican University in San Rafael, California USA, and Villanova University in PA USA respectively. These three despite being dispersed on opposite sides of the globe, share many other demographic qualities. Macquarie University is a mid-sized private institution that enrolls about 27,471 full-time undergraduate students annually with an average tuition rate of \$29,680 AUD per annum (MQU website, 2015).

It is located in a suburban setting of Sydney, NSW with an ethnically mixed student population and in 67th in the world for Arts and Humanities (5th in Australia), according to the 2015 Times Higher Education rankings ranks. Dominican University is a small, private institution enrolls about 1,628 full-time undergraduate students annually with an average tuition rate of \$40,600 USD per annum. It is located in a suburban setting of San Francisco, CA with an ethnically mixed student population and typically accepts 80% of applicants (Dominican University website, 2014). Villanova University enrolls about 10,735 full-time undergraduate students annually with an average tuition rate of \$46,966 USD per annum. It is located in a suburban setting of Philadelphia, PA with an ethnically mixed student population and typically accepts 49% of applicants (Villanova University website, 2014)

Overall, the three primary sources of academic survey submission originated from suburban, affluent, and ethnically mixed student populations in universities with typical Western, liberal, scholastic orientations.⁵⁰

Sampling & Sample

A preliminary technique for filtering “background noise” data was to set the high inclusion threshold described above. But I still wanted to cast the sampling net broadly. A campaign was initiated to invite participation across an international range of ongoing undergraduate Big History courses. This effort consisted of emails with links to the online surveys, sent to several (5) educators with active and ongoing tertiary-level Big History courses. While a range of populations in various educational contexts were given the opportunity to take part in this survey, in no case was it made mandatory. Therefore, only those inclined, for whatever reason, tended to participate. This likely had the effect of further creating a self-selected sample. This sampling-level selection effect likely occurred due to the fact that the total student population that was invited to participate

⁵⁰ One interesting exception is the historically religious affiliation of Dominican University.

was told that the study was interested in documenting their experience with Big History. This may have disproportionately encouraged those who felt that they had had a transformative or meaningful experience, simply because they would be more motivated than those who did not feel this way. Those who did not consider their Big History engagement transformative may have been less enthusiastic and less inclined to participate. While this would have been considered a design flaw in a quantitative experiment or in a study that aimed to assess a particular dependent variable, I feel it did not present a threat to validity given the research questions (i.e. how a transformative experience happens, *when it happens only*). Further, while these sampling-level effects would have been a problem for a study aiming at a truly random sample, it was, in fact, a benefit for this study that aimed to isolate and describe the elements of a particular kind of experience. In other words, this filtering of the total sample, prior to collection, effectively improved the data's signal-to-noise ratio, thereby adding a degree of precision to the analysis.

Appropriately, the results are not able to indicate any proportional quantitative claims as to the total students who experienced a transformative experience from the Big History program, nor does it posit any conceptual changes, as these would have been outside the explanatory scope of the project. Instead, the study sought to describe, qualitatively, the *lived-experience* of the study's subjects. Thus, research questions were best served by a self-selected, purposeful sample of students willing to provide qualitative descriptions of their experience. In this context, many of the customary concerns of education research become irrelevant and this will explain to readers why there are no *p*-values or correlational coefficients reported.

Data Collection

Data collection occurred over a three-year period coinciding with the academic calendars of the participating universities. In general this meant for semester 1 (2011, 2012, 2013) at Macquarie University and (2012, 2013) at Dominican University. A smaller effort to

distribute the surveys at Villanova University also yielded a small number of online survey submission (n=5). However, responses from Villanova and other sources were not tracked by date. The majority of respondents were self-selected from Macquarie University's Big History course (MHIS115 – An Introduction to Big History) which was convened by a seasoned Big History professor (David Christian) using a tutorial structure wherein three tutors, who were either full-time faculty of Arts, or graduate students (the author was one of these tutors) tutored sections of approximately 15-30 students for 45-minutes once per week. Twice-weekly lectures (in a large lecture hall) were encouraged but not required, but tutorials were mandatory. The tutorials were conducted in small classroom settings and incorporated both lecture and group discussion exercises. These sessions may or may not have included multimedia presentations (all of the author's classes included substantial multimedia enhancements). The Dominican respondents were student enrollees in a first year (freshman) Big History Experience program that were team-taught by core faculty. Macquarie (and other) students were invited to participate in an online survey of their experience, while Dominican students participated in a post-course survey administered by a staff educational researcher.

Because the survey instrument asked multiple but optional questions, not all respondents provided the same number of responses. Some respondents provided more than one response per question. To account for this variability, each text box from the survey was treated as a single response. Still, some responses contained more than one utterance and thus could contain multiple codes. To simplify reporting, statistics are based on the response (a single text box) as the basis or unit of calculation. Therefore, percentages refer to responses and not necessarily to respondents. There were a total of 86 respondents. The data paring and conditioning described above then yielded 62 respondents. These respondents were then distributed into the 179 total discrete responses available for qualitative analysis (See Appendix B for full student responses)

Validity and Reliability

This study adopts Creswell's criteria of "trustworthiness" in order to establish rigor (Golafshani, 2003). Three components of rigor were established through the following primary means:

1. **Internal Validity:** included an internal triangulation procedure wherein the quantitative data generated by the Pugh criteria, after setting a threshold for inclusion, were then compared with the textual responses. If there was a significant mismatch between what was reported in the Pugh responses and the free-language text (for example, if the Pugh responses were positive and the text was incoherent) then the respondent was removed from the data set. This applied in only four instances.
2. **Reliability:** Cross check coding *concepts* and *categories* with multiple (3) independent raters (inter-rater reliability 80.4% See Inter-rater reliability worksheets in Appendix C and Appendix D).
3. **Verification:** Sufficiently detailed description of sampling methodology and procedures to allow future independent investigations to replicate all activities of the research.

Constraints and Limitations

In preparing this study, several constraints needed to be accounted for ahead of time through careful research design. Some of these constraints are inherent due to the novelty of the subject and the sheer complexity of subjective human experience. Adequately describing how people respond personally to new insights and information is as complicated and varied as there are personal responses. However, that does not mean that asking questions about the process must necessarily fail to provide fruitful data, especially for developing improved teaching strategies and directions for future research.

Given this narrow scope of inquiry, and the limitations presented by the particular circumstances (graduate research conducted with the confines of an ongoing undergraduate program), a full-fledged experimental design with elements such as mandatory participation, controlled and randomized sampling, pretest-posttest administration etc., was not possible or warranted.

Other limitations were more externally imposed and arose from the fact that this research needed to take place during active, ongoing academic sessions. These units were part of existing course structures, in different university settings, across departmental conventions and priorities, and on different continents. Thus, each setting came with its own preexisting conditions that could not be interfered with. For example, the population of students taught by the author, as a tutor, was only one part of a larger lecture cohort. The entire course population was taught by a seasoned course convener (a full professor) whereas other graduate students or faculty tutored the other two sections. This created a myriad of confounding variables beyond researcher control.

Given these constraints, it became clear that it would be impossible to isolate out the usual variables typically relevant to educational research. Specifically, these limitations made it impossible to distinguish between transformative experiences due, for example, to the quality of instruction, teaching styles, or specific curricular content. In response, the only options were to refer back to the research questions to ensure that only answerable questions were asked, and to further refine the study design so that it would demonstrate sufficient rigor while also allowing the most compelling data to surface. These considerations were critically considered and brought to bear on the work. They are reflected both in the empirical study and overall dissertation design.

One limitation that arose, which is common to many studies of university students, is the fact that students are usually already overburdened with coursework and the many surveys administered as part of their course evaluations and other various on-campus research. As the current survey was a voluntary additional survey, I had to make design compromises so that students would be more willing and inclined to complete it. One such compromise was to make the survey extremely short by having the open-ended follow questions only appear if the initial response to the yes-or-no question was answered in the affirmative. The problem that this design may have created was that respondents might have learned that only a “yes” response would trigger the follow up

question. Thus, any respondents who did not want to answer these extra questions may have been encouraged to answer “no” (especially to the later two questions) in order to avoid the third question’s open-ended text response. To resolve this potential problem, I later decided that only those responses with three affirmative answers would be included in the survey. Fortunately, this further sample-limiting solution would ultimately have the effect of further conditioning the sample in a beneficial way (because it would result in fewer non-transformed respondents). Exact ratios of total student population available relative to number of respondents were impossible to calculate given that total student population across all universities was unknown. However, again, this figure is not relevant given the adjusted research questions.

Other, externally imposed limitations arose due to standard ethical protocols and obligations. For example, because this study could only occur in actual academic settings, it was impossible to implement a controlled experimental design. An internal review board considered that this would have created an unethical treatment wherein one part of the student body would have received an experimental treatment (regardless of whether it was considered beneficial or detrimental). This limitation fortunately did not matter considering the refined research questions. Another limitation was created due to the need to maintain respondent anonymity. Without any means of identifying respondents either pre and post study, or across the respondent pools from the different universities, many of the data (approximately 30%) could not be matched to any particular survey response.⁵¹ Thus, without the ability to contact students individually (which would have required identifying them), neither pre- post-study, longitudinal, or follow-up designs could be utilized.

Finally, as a qualitative research project, this study may well be considered a preliminary, or pilot, study. While efforts have been made to bring this survey into conformity with established qualitative research protocols (by implementing validity and inter-rater

⁵¹ This was an unavoidable problem arising from the fact that I could not exercise any control over how the data was collected, stored, or recorded at the participating universities.

reliability measures, for example), the external factors discussed above did impinge upon its scope and rigor as a conventional qualitative research effort. In summary, although there were many constraints imposed on this research, fortunately none of them posed any significant threats to validity or reliability. This is especially apparent in light of the overall research agenda and the chosen research questions.

Analysis

Recall that all (100%) of the respondents included in this dataset had already crossed a “transformative experience threshold” according to the Pugh (2011) criteria, by self-reporting a personally transformative experience with Big History. The goal here was not to *quantify* the numbers of students who had undergone a transformative experience (because this is effectively 100% of the sample). Because the research questions instead concern the *quality* of a transformative experience that has already happened, the study adopted a standard qualitative research methodology. The aim here is to explore the data in a way that elucidates the prominent experiential themes that emerge. The data consists of all free-language text supplied by respondents that describes the details of their experience in the Big History course. The data was processed after Creswell’s (2009) procedures for qualitative research in the following steps:

1) Organize and prepare data for analysis:

- a) Collected all online survey submissions (86) and then removed any that were errant, incomplete, or irrelevant (24 including test submissions) leaving (62) respondents.
- b) Isolated and removed any respondents that did not meet the minimum threshold for transformative experience (i.e. two out of three affirmative responses to Pugh’s 3 criteria). This removed 4 respondents out of 62, leaving (58). This step also serves as a triangulation check on internal validity for online survey data (see note above).
- c) Combined online survey submissions and data provided by Dominican University (58 respondents + 29 respondents), which resulted in a total of (87 respondents)
- d) Each respondent’s free language text responses were allocated to a single data cell in order to conform to the different format provided by Dominican University. This allowed me to adapt the online survey data wherein some respondents

provided multiple responses. This conversion from “respondent” to “responses” as the base unit datum yielded a total of (179 responses), each one now fully conditioned for coding analysis.

- 2) **Preliminary coding:** Read each response, highlighting key words or phrases that anchored, signified, and pointed to key research questions in order to generate primary *codes*. This included several weeks of ruminating through cycles of critical reflection.
- 3) **Coding round 1:** After some days, returned to coding process, each time attempting organize and delimit the codes into broader, more inclusive, groupings or *concepts*.
- 4) **Coding round 2:** Returned to the data with lists of concepts, trying to best fit, expand, or distill concepts and relevant definitions. In each case, referred back to research questions for guidance.
- 5) **Coding round 3:** Converted appropriate groups of concepts into *categories* based on research questions.
- 6) **Coding round 4:** Used text-to-speech software that allowed the computer to read results of round 2 codes while I tallied each code into its best-fit category. This number is thus taken to represent a relative measure of each code and became what I termed the category’s *relevance factor*.
- 7) **Establish inter-coder reliability:** Distribute text samples along with defined codes and categories to three volunteer code-checkers. Calculate inter-rater reliability coefficient of .804 which corresponds to agreement with other coders 80.4% of the time.
- 8) **Analysis:** Reorganize categories into “best-fit” description of overall phenomena and re-labeled as “Elements of Transformation” and report as results (below).
- 9) **Theory generation:** In a discussion narrative, the Elements of Transformation are prioritized based on cumulative occurrences and reasoned relevance to research questions; this allowed a theory of Big History as transformative experience to emerge.

Reflected in this coding protocol is an effort to address the fact that many responses were blended, by the respondents, into mixed constellations of ideas. Therefore some of the original textual responses required being parsed into discrete utterances.

Results

The results of the qualitative analysis of survey data indicate that students who had transformative experiences from engaging with Big History described the cognitive elements of that transformation in the following order of relevance.

Table 1: The Cognitive Elements of Big History Transformative Learning

Cognitive Element of Transformation (relevance factor)	Example Utterances (dataset response #)
Narrative Awareness and Disruption (181) <i>Narrative awareness</i> refers to respondents' enhanced ability to recognize the cultural and personal stories they have adopted and created. From this narrative awareness often arises <i>narrative disruption</i> . To disrupt a personal-level narrative is to elicit a substantial reorganization of the base structures of thought and root cognitive metaphors.	<i>I definitely feel like I see the big picture. I've often found myself thinking about our modern world very differently... I'm questioning our modern lifeway more, instead of taking it for granted. (34)</i>
a) Personal (50) acknowledged at the individual or personal level	<i>I found learning about these concepts caused me to question all of the stories upon which I base my identity as a human. (112)</i>
b) Undefined (43) acknowledged but not at a specific level	<i>The best was just having so many pre-existing ideas shattered. (32)</i> <i>It completely changed my way of thinking in nearly every aspect of life. (106)</i>
c) Cultural/Social (40) acknowledged at a social or cultural level	<i>Better understanding my cultural background has broken down a lot of prejudice I felt towards different cultures and understanding a bigger picture of history has helped to understand how cultural differences have arisen and also how little these mean in a big picture. (143)</i>
d) Planetary (38) acknowledged at a planetary or biospheric level	<i>I know that I need to keep recycling and conserving water. These may be small things, but they all add up. (118)</i>
e) Cosmic (10) acknowledged at a cosmic level	<i>I see myself as tiny in comparison to billions of years of the past, the universe, and the future; but I also see the large effect one species can have on the world. (169)</i>
Urgency and Amelioration (70) The two-part <i>Urgency and Amelioration</i> capacity refers to (a) a student's sense that the Anthropocene is a fundamental problem and (b) that it requires an immediate response.	<i>It made me open my eyes more to the damage that we, as a species, are doing to the planet and ways to stop it. (121)</i>
a) Acknowledgment of a problem (30)	<i>Maybe things that are too complex are dysfunctional. Maybe we need to resort to a simpler life and simpler way of thinking about things to ensure the survival of our species. (116)</i>
b) Expressed a sense of urgency (23)	<i>We are killing it. (158).</i>
c) Expressed need for amelioration (17)	<i>I feel that I should do more to try and save and protect the world because it will benefit the generations to come. (127)</i>

Waking Up In The Anthropocene: Big History and the Biosphere

Reflexivity (62) Reflexivity refers to individuals' capacity to recognize their place within social/cultural/biological systems and manage their interactions beneficially according to systemic forces.	<i>Knowing more about the whole story makes me really think about the ways that everything in the universe is linked. (57)</i>
Causal Thinking (44) Causal thinking refers to a learner's ability to see how contemporary issues and structures are rooted in events that might otherwise seem distant in time and space and therefore disconnected.	<i>I think everyone should do Big History. I think if we are going to make well-informed decisions about our future we need to know how we've gotten to where we are now. (67)</i>
Empowerment and Participation (42) <i>Empowerment and Participation</i> is a two-part capacity referring to an emancipatory quality of the experience that can lead to a newfound desire to act or participate.	<i>The amazing thing about Big History is that it can make you feel insignificant; but, if you stick with it, it can also empower you. That feeling of empowerment has stuck with me. (48)</i> <i>I need to take a bigger role in saving the biosphere. (145)</i> <i>I talk about the empowerment to seek change that this perspective has provided. (65)</i>
Gratitude and Appreciation (34) utterances of new gratitude and appreciation	<i>Just like the astronauts saw earth as one beautiful whole i saw what they saw- perhaps everyone needs to take a trip out of earth to reflect and appreciate just how extraordinary lucky we are to exist on it. (105)</i> <i>Will treat the world with more respect, nature is all we have and we don't need to abuse it. (159)</i>
Transcalar-Fractal Thinking (27) refers to instances when a student recognizes drastically new temporal and spatial scales often accompanied with a recognition of how a phenomenon at one scale has counterparts in another. This "fractal" thinking enables an individual to perceive and experience parallels across the micro, meso, and macro scales.	<i>It gave me a better lens to understand the connections... Big History invites one to take a step back from our microscopic perspective and examine a system as whole, how it interacts with other systems, and notice patterns. (71)</i>
Emergent-Future Thinking (18) is a two-part complement of emergence and future thinking. It is an imaginative way of thinking wherein the individual is aware of the radical dynamism of the universe and contemplates the radical change of the past as an indicator of the future.	<i>It makes you think about not only yourself but about the world and universe as a whole. How things are connected and how wide open possibilities are. (70)</i>
Other (33) Of least significance were students combined expressions of feelings of:	<i>In terms of scale, I see I'm very small and very brief. Humbling, I guess. But also a little awed by the precariousness of this world. It makes it harder to take things for granted. (134)</i>
a) Insignificance & significance combined (16)	<i>It has shown me how small but also how important humans are to the story of the universe. (95)</i>

b) Insignificance (7)	<i>It has made me understand the vastness (if that is a word) of our universe and the history of the universe in terms of how I see myself and how insignificant I am in relation to everything. (69)</i>
c) Emergence (7)	<i>Understanding of more than just human history. Able to see big patterns that emerge throughout time, and on universal scales and microscopic [sic] scales. This gives you an appreciation that ... we are just the process of billions of years of emergence. (30)</i>
d) Significance (3)	<i>Made me realize that my life has an impact on the future of this planet. (155)</i>

Table 1: The Cognitive Elements of Big History Transformative Learning: The left column provides a brief description of each element's meaning and the right column provides exemplary participant utterances from the raw survey data.⁵²

Discussion

Qualitative research presumes that any effort to reduce real-world phenomena down to discrete descriptive components is an exercise in making the phenomena manageable and understandable. Any attempt to do so, especially in the realm of complex, subjective human thinking will unavoidably result in some loss of connection, precision, and authenticity to the original phenomena. The particular arrangement of elements of transformation presented above is but one interpretation. However, Salomon (1995) proposes that the development of “composites” can be applied at the level of the individual in a particular context. While I have experimented with various groupings that arrive at slightly different orderings, the basic themes and ordering of transformative elements remained essentially the same. Therefore, the “constellations” that make up each element of transformation are determined to be the “best fit” to the data based on all of the variables, both conformational and confounding, discussed in the text.

Significant Findings

⁵² These elements of cognitive transformation will be correlated to aspects of ecological identity and the biosphere in Chapter 4; further explicated with educational theory and integrated into a formal pedagogical framework in Chapter 5; and synthesized into cultural communication praxis in Chapter 6.

Making sense of qualitative data is typically accomplished by identifying and describing patterns and themes emerging from qualitative data in order to make sense of a particular phenomenon (Agar, 1996; Creswell, 2009). The analysis of the student survey data suggests that the transformative learning experiences associated with Big History contain the following eight qualities:⁵³

1. Narrative Awareness and Disruption: how stories change in response to engaging with Big History across personal to cultural domains
2. Urgency of Amelioration: the recognition that the Anthropocene requires immediate attention
3. Reflexivity: the capacity to recognize one's agency within a system and act toward system benefit
4. Causal Thinking: the capacity to see how contemporary issues and structures are rooted in events that might otherwise seem distant in time and space and therefore disconnected
5. Empowerment and Participation: the sense that one can and should participate (exercise agency)
6. Appreciation and Gratitude: subjective components that motivate lasting changes in thought and behavior
7. Fractal Thinking: the ability to recognize experiences across scales from personal to cosmic levels
8. Emergent-Future Thinking: an imaginative way of thinking in which the individual can project the past radical creativity of the universe into the future.

Grounded Theory Part I

This chapter's findings constitute the following theory and initiate the first of a three-part running theory as follows:

1. **Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners (This Chapter 3)**
2. Forthcoming (Chapter 4)
3. Forthcoming (Chapter 4)

The research pursued here suggests that there are some rather compound benefits and novel pedagogical opportunities afforded by the Big History curriculum. These benefits

⁵³ These findings are described in detail, and further developed in Chapter 5.

are thought to go beyond cognitive and intellectual understanding, and able to manifest as a transformative experience - in some cases causing deep identity shifts. It is argued that these impacts, if they can be better understood and articulated, may extend into other domains of experience such as culture, and outward still into the biosphere (i.e., the life-world).

These data are preliminary and descriptive. As yet, there is no grand explanatory theory offered, suffice that the Big History transformative learning embed these particular cognitive elements. Yet, even these preliminary empirical findings may be of value to those who teach Big History. In this regard, the Cognitive Elements of Big History Transformative Learning above constitutes a contribution of knowledge to the field of Big History education and it goes some way toward validating the claims of Big History educators raised in Chapter 1. Later in this dissertation, Chapter 5 will build substantially on these findings by marshaling a number of established educational theories to bear on the development of a more general Big History educational framework. However, before launching that phase of research, one of the other contexts raised in Chapter 1, the wicked problem of the Anthropocene compels first correlating this empirical data into more specific connections with the environment. This will now require an additional analysis of the original survey data, only this time with the specific aim of correlating the same student utterances to the biosphere. How these cognitive shifts map onto environmental problems may provide additional insight into the potentially systemic relationship between Big History and the Anthropocene.

Chapter 4

CORRELATION

Little can be done in conservation without creating a new kind of people.

-- Aldo Leopold

The major problems in the world are the result of the difference between how nature works and the way people think.

-- Gregory Bateson

Purpose of this Chapter

This chapter seeks to append the second part of a three-part running grounded theory as follows:

4. Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners (Chapter 3).
5. **How do the cognitive elements of Big History transformative learning correspond to changes thought necessary by relevant experts to constitute an appropriate response to the Anthropocene?** (This Chapter 4).
6. Forthcoming (Chapter 5)

Building on the empirical findings from the previous chapter, this chapter seeks to understand how the elements of Big History transformative learning compare to the causes believed to have led to the Anthropocene. The goal of this chapter, then, is to reveal any correlations (which could be either positive or negative) between *The Cognitive elements of Big History Transformative Learning* (Chapter 3, Table 1) and the environmental problems of the Anthropocene. To determine this, an analysis maps exemplary utterances of Big History students onto the insights of experts in the fields of environmental science, education, philosophy, and cultural studies. It then reports the results in a correlational table. This analysis explores precisely how the Big History transformative experience can impinge on the changes in attitudes and values believed

necessary to respond appropriately to the Anthropocene. While the empirical survey revealed what the elements of transformation associated with Big History are, this chapter discusses how they can be linked to the environmental problems that make up the Anthropocene.

Introduction

Despite some scientific uncertainty, if the Anthropocene presents an even partially valid picture of the state of the planet, humanity may want to formulate a specific response. This would be wise regardless of the Anthropocene's composite causes, but probably wiser if we aimed to shape that response with specific reference to the problem itself. More specifically, the question is, "What can the environmental problems created by human activity over the past two centuries, and particularly since the discovery of how to exploit fossil fuels, teach us about how our actions, may be putting biospheric systems into unpredictable and potentially dangerous states of disequilibrium?" While answering this question has certainly called for an examination of the Anthropocene, it will now require a further examination of the *anthropos*. This investigation of the anthropogenic component of the Anthropocene requires a deeper, more reflexive investigation of the particular components of human thinking (cognition) that are presumably behind the ways we act. In other words, choosing to focus this analysis on root causes, not symptoms, will require asking questions of the material causes, human actions, and deeper still, the cumulative human cognitive dimension that have led to the Anthropocene.⁵⁴

As discussed theoretically in the literature review of Chapter 1, and then documented empirically in the qualitative survey of Chapter 3, Big History has emerged with the

⁵⁴ Again, this examination is considered both a process of *self-system reflexivity* and a finding of the empirical research. Not only does it entail an examination of the "self" in the problem of the Anthropocene, it also entails an application of self-generated and self-reported data. Solutions to systemic problems in an ontologically continuous system can be revealed by a process of self-system reflection.

potential to elicit transformative learning. Transformative learning in Big History, like learning generally, is a cognitive phenomenon. By now also framing the Anthropocene in terms of its cognitive dimensions, the analysis should, in-effect, allow for a more useful comparison based on the “least common denominator” of cognition and thus a better understanding how the two may be linked. In other words, asking equivalent questions about Big History transformative learning (as were asked in Chapter 3) as are asked now regarding human activity in the Anthropocene, may shed light on the role Big History education might play in formulating an adequately systemic response to the Anthropocene.

The specific analysis in this chapter compares what experts in relevant fields (e.g., ecology, environmental education, cultural studies etc.) believe are the cognitive-level contributors to environmental degradation with the acquired new ways of thinking reported by students on the Big History transformative experience survey. The question of interest in this analysis can be stated as:

How do the particular qualities of a Big History transformative experience correlate to ecologically sustainable values as described by relevant experts?

The discussion that follows integrates quotes from the student data. Utterances are presented verbatim from the final dataset in Appendix B and are indicated by parenthetical references to the survey response immediately following the quoted text. A self-description of a transformative experience can often contain multiple elements of transformation in a single utterance. For example, the following excerpt taken from the survey data contains aspects of 1, 3, 4, 7, and 9 above:

Understanding of more than just human history. [I am] Able to see big patterns that emerge throughout time, and on universal scales and microscopic [sic] scales. This gives you an appreciation that everything is related, that we as humans aren't 'amazing' and 'important' in any real sense, that we are just the process of billions of years of emergence. (30).

Many of the expert quotes that follow derive from a report entitled *New Consciousness: Values to Sustain Human and Natural Communities* (2008), which was published by the Yale School of Forestry and Environmental Studies. The report is particularly useful because it documents the proceedings of an esteemed group of leaders from diverse disciplines, including the natural sciences, social sciences, philosophy, communications, education, religion, ethics, public policy, business, philanthropy, history, the creative arts, and the humanities. These leaders set out to describe what they saw as the most pressing environmental issues of our time and to begin the search for solutions. Their report is taken to represent a credible, critical, and expert consensus on how modern society can address the root causes of, and potential solutions to the many varied facets of the degradation of ecological integrity.

If the various cognitive transformations suggested by the previous empirical survey can somehow map onto the worldview, attitudes, values, or lifestyles as constituents of a response to the Anthropocene, then this will show that Big History education may potentially play a significant role. Further, if it can be shown that these qualities can transform individuals toward this effect, then an application on a cultural level should also be able to extend these effects culturally.⁵⁵

Analysis

The following discussion links back to and extends the following *Cognitive Elements of Transformative Learning in Big History* (Chapter 3, Table 1).

Narrative Awareness and Disruption

The most common cognitive-level change reported by survey respondents was a shift in awareness of narrative structures at both the cultural (acquired) and personal

⁵⁵ This implementation as cultural communication will be attempted through the creative practice components described in Chapters 8 and 9 of this dissertation.

(constructed) levels. I have termed these cognitive changes *narrative awareness* and *narrative disruption*. *Narrative awareness* refers to respondents' enhanced ability to see not only the stories that they have adopted culturally, but also the narrative structures that they themselves construct in order to make sense of their world. From this new narrative awareness can arise *narrative disruption*, a term that refers to an acknowledgment of how some previously unexamined cognitive narratives may need to be modified, sometimes drastically, in order to correspond to new knowledge about the world. To disrupt a personal-level narrative is to elicit a substantial reorganization of the base structures of thought or root cognitive metaphors (See Mezirow 1981).

Experts from a diversity of psychological and social sciences uphold the central role of narrative in human affairs. McAdams (2008), referring to Giddens (1991), argued for the importance of the “formulation of an integrative narrative identity.” Such an integrative narrative identity rests on what has been encoded as “Narrative Awareness” in Table 1. This refers to an understanding of the stories one has constructed to make sense of the social and cultural context in which one is embedded. McAdams explained that the development of narrative awareness is a major challenge for people living in modern societies, who must “seek personal integration within an ever-changing, contradictory, and multifaceted social world that offers no clear guidelines, no consensus on how to live and what life means” (pg. 244). The Historian David Christian (1991; 2005; 2010) has also argued for decades that the scientific narrative at the heart of the Big History curriculum represents just such a guiding narrative; in effect a “new” modern origin story currently, and continually, under construction.

The experts who convened in the 2008 Yale School of Forestry and Environmental Studies suggest that we can restore a cosmological context by creating narratives that embed the human story in “a deeper understanding of the human relationship to nature – the Universe Story” (Leiserowitz & Fernandez, 2008 p. 39). The report they compiled characterized their consensus that,

A deep understanding of modern cosmology places human beings within the grand narrative of the universe – from the Big Bang, to the formation of galaxies, the coalescing of Earth and the solar system, and the origins and evolution of life. This narrative reminds us that human beings are not separate from nature and its processes – we emerged from it, we are the descendants of a vast, complex, terrifying, and beautiful universe, inhabitants of an incredibly precious planetary home, and kin, literally, genetically, to all other life on Earth. These ideas and this story fundamentally challenge our traditional understandings of what it means to be human in relation to the natural world. (p. 39)

As this synthesis of expert consensus suggests, an appropriate response to the Anthropocene may depend upon people becoming aware of the narratives they have been using to make sense of reality, and then having those narratives, which make up “our deepest conceptions, values, and worldviews” (p. 39), disrupted by the discovery of how they do not align with reality.

To do what the Yale conference participants see as necessary, Gardner (2006) suggests that one can “capture the attention of a disparate population” by “creating a compelling story, embodying that story in one’s own life, and presenting the story in many different formats so that it can eventually topple the counterstories in one’s culture (p. 62)” Gardner added that, “[T]he story must be simple, easy to identify with, emotionally resonant, and evocative of positive experiences” (pg. 69).

These observations and recommendations from leading experts suggest that improving environmental values will require fundamental shifts in the narratives by which people live and shape their internal and external worlds. Experts’ conceptions of the function of narrative also provide a basis for evaluating the significance of how students experienced their engagement with the big History curriculum. The student responses indicate that they did indeed experience awareness and disruption of their narratives as a result of participating in the Big History course.

For example, one student wrote that the best part of the Big History experience was,

I found learning about these concepts caused me to question all of the stories upon which I base my identity as a human. (112)

Other student responses included the following:

Before, I suppose I saw myself in the world as just a human, now I see myself more as a compilation of years and years of history. In the first lectures I remember being told that matter can never be destroyed meaning that when we die, it is really only our subconscious that dies.. i found that really interesting. And it has really made me ask, what is the point of everything? (83)

Its [sic] really helped me to make sense of other elements of history, science and astronomy that I learned in high school, but I didn't realise that they all linked in such a complex way and created a huge story. (87)

Seeing history taught as a whole instead of separate narrowed accounts has made me much more aware of our past as a whole and where the story is going. (93)

Narrative awareness and disruption in Big History refers to how stories can change in response to engagement with the content of Big History across personal to cultural domains and was also one of the most prevalent themes to emerge in the student responses. This correlation suggests that cultivation of this capacity for narrative awareness and disruption will be an important part of responding to the Anthropocene because according to the experts, outmoded narratives largely cause the environmental problems of the Anthropocene.⁵⁶

Urgency and Amelioration

⁵⁶ It should be noted that these description by respondents of their own becoming aware of narratives and having them disrupted are perfectly in line with Mezirow's theory of transformative learning (although he doesn't always use term narrative). The essence of Mezirow's theory is about how individuals become aware of their narratives in order to critically evaluate them.

The two-part *Urgency and Amelioration* capacity refers to (a) a student's sense that the environmental degradation is a fundamental problem and (b) that it requires immediate attention. Experts on environmentalism also call for a sense of urgency and the need for amelioration. For example, Kellert, Speth and Rose (2009) stated,

As we begin to glimpse how deeply embedded we are in complex ecosystems and dependent on other life forms, we see we are destroying the very basis of our continuity as a species. As biology demonstrates a fuller picture of the unfolding of diverse species in evolution and the distinctive niche of species in ecosystems, we are questioning our own niche in the evolutionary process. As the size and scale of the environmental crisis is more widely grasped, we are seeing our own connection to this destruction. We have become a planetary presence that is not always benign (p. 429).

Another assertion of the need for awareness of the urgency and amelioration, as well as a hint of how it may be addressed, is provided by Hörl (2013) who observes that,

...the explosion of human and non-human, animate and inanimate agencies as a result of unabashed technization forces us today... to rethink our mindset and the rationality at the core of the Anthropocene. And this maybe even by punishment of the decline of our species. The very first thing the Anthropocene forces us to do is a radical critique of Anthropocentrism. Today, we must think on a level of non-trivial, complex environmentality, to reorganize our thinking profoundly according to the environment. And this doesn't only concern the establishment of a theory, but also the institutions, politics, ethics, or even pragmatics (pg. 59).

The systems thinker Gregory Bateson, who was motivated by what he saw as the deeply misguided epistemology in modern ecology, expressed a sense of urgency about the Anthropocene problem as early as 1972. He pointed to the "massive aggregation of threats to man and ecological systems" which "arises out of errors of thought" (1987, p. 463). He later referred to "conventional (but wrong) ideas about the nature of man and his relation to the environment" (Bateson, 1987 p. 511 parentheses in original).

In the present study, students who engaged with Big History came to recognize, as the experts do, that ecological degradation of the biosphere is an urgent issue. One student

wrote that the worst thing about the Big History learning experience was “the realization of how dire consequences could be if current unsustainable current growth rates are continued (a scary thought)” (27, parentheses in original). Other examples of students’ survey responses included the following:

I understand our species more, and our past, and just how drastic the human impact has been on the Earth. (11)

It made me open my eyes more to the damage that we, as a species, are doing to the planet and ways to stop it. (121)

This correlation between expert opinion and student responses suggests that engaging with Big History can elicit in a learner, a sense of urgency about the Anthropocene and other large-scale wicked problems. This urgency may be reasonably expected to encourage individuals to formulate an appropriate response to the Anthropocene.

Reflexivity

Reflexivity is a concept well understood in social psychology that refers to an individuals’ capacity to recognize their place within a social system and manage their interactions beneficially according to systemic forces. In other words, in a social system, it is the understanding that is what is good for the system is also good for the self. According to Krippendorff (2008), reflexivity is an epistemology of participation in social systems that are under continuous reconstruction (re-articulation and redesign) by their human constituents, who are able and willing to hold each other accountable for what they contribute, say, and do, and how they move through discourses and networks of conversations among them.

Rose (2009) brings reflexivity into environmental domains by asserting that a transformation of our relationship to ecology will draw strength from,

a reflective process to enable us to see the interdependence of life on earth, [and] inspired leadership ... to give us a sense of what is possible ... [and] lead to a change in our worldview, which leads to a transformation of the ways that we think, that we act, and how we communicate with others. We

are just at the beginning of framing what this transformational ecology might be. But it is clear, it has a tremendous potential to make the human impact on life on earth a bit more environmentally responsible. (p. 84)

Plumwood (2002) further attributes the degradation of the earth's ecosystems as being a result of western culture's dualistic conception of reality. She believed the cause of the current, modern reflexivity is because,

We human beings situate ourselves not only outside, but also above nature. Thus, we have developed conceptions of ourselves as 'belonging to a superior sphere apart, a rational sphere of exclusively "human" ethics, technology and culture dissociated from nature and ecology.' (p. 100)

Plumwood claimed that this self-image has made humans vulnerable to illusions of autonomy, utility and control, adding that societies take entirely for granted the functioning of the ecological systems that support them; they only deserve attention when they fail to perform as expected. Plumwood suggests that the ecological irrationality of human-nature dualism presents a threat to our survival.

Survey respondents indicated that their experiences with Big History did prompt them to develop self-system reflexivity. One student wrote, "I have learnt [sic] about myself and humans in relation to the rest of the universe" (43). Another wrote, "I gained a feeling of connection to all who have come before and all who will follow"(52). Other responses included the following:

It has extended my view of history to the beginning of time and made me understand the inter-relation of all aspects of humanity, the environment and universe. (29)

It has changed my perspective, my view of my responsibility as a global citizen and an understanding that there is a reaction/consequence to all decisions we make for future generations. Time seems far more cyclical than linear now. (63)

I am far more aware of the fact that decisions made in our and other parts of the world affect all of us. There is no individuality in the global

community. The formation of "civilisations" and the creation of power has made me criticise the way society is today. (64)

That there should not be distinction between human and environment but humans are also part of the environment and that we should cooperate as one global citizen. (66)

As these responses suggest that students who participated in the Big History course came to a deeper understanding of their place within a larger system and their responsibility to act according to the good of the system as a whole. This indicates a high degree of correlation with respect to the cognitive element of *reflexivity* associated with transformative learning in Big History and what the experts believe constitutes an appropriate response to the Anthropocene.

Causal Thinking

Causal thinking refers to a learner's ability to see how contemporary issues and structures can be rooted in events that might otherwise seem distant in time and space and therefore disconnected. Experts have indicated that a cosmic narrative, such as the account of Big History, has a particular ability to reveal these causal connections across massive time and spatial scales. The Yale Conference participants promote such large-scale engagements because “[t]hese subjects help students understand the often invisible threads of culture, economics, politics, material flows, environmental and social impacts that link disparate people and places in this increasingly globalized and interconnected world” (Leiserowitz & Fernandez, 2008, p. 54).

Students in this study who engaged with Big History and completed the survey expressed an acquisition of enhanced causal thinking skills. One student reported having gained “more awareness of how we came to be where we are today” (48). Other comments included the following:

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Now when I see new things i [sic] think about what they could have evolved from and how long this certain species has existed. I have become more scientific. (52)

It ... makes things more clear about why things are today. (38)

Gives more meaning to thing [sic] because I know where everything has come from and what has happened in the past to get to the present day. (42)

As these comments indicate, the students who participated in the Big History course and completed the survey experienced enhanced causal thinking. That is, they improved their ability to see the common roots of apparently disconnected contemporary issues and structures. The Yale experts and others cited in this research have indicated that Big History has a particular ability to show these causal connections across massive temporal and spatial scales. Such an understanding of large-scale causality is seen as a crucial part of an appropriate response to the Anthropocene because the problem itself is rooted in the deeply interconnected nature of the world's cultures, economies, politics, products, and natural resources.

Empowerment and Participation

Empowerment and Participation was shown to be an important component of Big History transformative learning. This two-part capacity refers to an emancipatory quality of the experience that can lead to a newfound desire to participate. As Leiserowitz and Fernandez (2008) report in the proceedings of the Yale conference, attendees argued that, among individuals who are “detach[ed] from the greater cosmological context there is a pervasive failure to understand human beings as inextricably part of, and emergent from, nature and natural processes, with attendant moral duties, responsibilities, and obligations” (p. 27). To gain a sense of one's “moral duties, responsibilities, and obligations” is to be empowered to participate in ameliorating the Anthropocene. These experts recognized that a sense of one's duty and capacity to cultivate an appropriate response to the Anthropocene was an important precursor to attempting to do so.

As an indicator of this new sense of empowerment, one student's response was that the engagement with Big History "[m]ade me realize that my life has an impact on the future of this planet" (155). Other similar student responses included the following:

The amazing thing about Big History is that it can make you feel insignificant; but, if you stick with it, it can also empower you. That feeling of empowerment has stuck with me. (48)

Makes you feel insignificant at the start - but at the same time alerts you to the problems we face today and how it has been humans that have created these problems. So it was kind of a motivation to make a positive change! (75)

I see myself as more important. I'm the culmination of 13.7 billion years of history, all leading to the most complexity to have ever occurred [sic]. The similarities between ancient civilisations and our modern ones. We have not progressed as far as we think. (104)

Though I feel less significant in the grand scheme of things, I realise that I do matter, as one person, while not being significant in themselves, can radically alter the course of history. (122)

These representative responses show how the students' transformative engagement with Big History often empowered them with the sense that they should, and could, participate in an appropriate response to the Anthropocene.

Appreciation and Gratitude

The sixth element of the Big History transformative experience, as indicated in student utterances, was the elicitation of *appreciation and gratitude*. Correspondingly, experts on Big History have also stated that this is a crucial component of Big History education. At the dawn of the conservation movement, Aldo Leopold wrote that, in order for any movement to take hold, it must be driven by "some force ... more universal than profit, less awkward than government, less ephemeral than sport; something that reaches into all times and places, where men live on land, something that brackets everything from rivers

to raindrops, from whales to hummingbirds, from land estates to window boxes” (1922). In a letter to a friend he later wrote that he could “see only one such force: ... a sense of love and obligation to that great biota” (Leopold, 1944). Today, with even greater environmental challenges looming, the forces of love, appreciation, and gratitude may be even more crucial motivators for stewardship of the planet. Indeed, student responses indicated that participants experienced an increase in their sense of appreciation and gratitude through participation in the Big History course. Notably, several students reported,

i [sic] found myself spending time looking up things like the role the moon plays in everyday life. I think the main thing that has changed in my perspective is appreciation. i appreciate things i probably wouldn't have so much before. The idea of our earth being one whole rather than your country/ my. Just like the astronauts saw earth as one beautiful whole i saw what [sic] they saw- perhaps everyone needs to take a trip out of earth to reflect and appreciate just how extraordinary lucky we are to exist on it. (105)

I have a greater appreciation for the miracle it is that we're here in the first place and that how incredible it is that our universe has got so incredibly complex and continues to do so at an ever increasing rate. The persistency of life and the precursors before it and how rare and infirm our world is. (13)

It opened my eyes to the things that have always been in my surrounding which I have never appreciated. (47)

The way in which I view the world lets me appreciate where I am and where we are as a race so much more. (73)

Such appreciation and gratitude seem to be important elements to the Big History transformative experience because they provide an emotional component that may serve to motivate lasting changes of habit.

Fractal Thinking

The term fractal refers to a pattern or sequence that persists across scales. I adopt the term to describe instances when a student recognizes how a process encountered on one scale, or at one time in the cosmic narrative of Big History, also appears in another. *Fractal Thinking*, then, enables an individual to perceive parallels in their experience and natural phenomena across the micro (personal), meso (cultural), and macro (natural) scales. Deming (2009) provides an example of fractal thinking when she metaphorically likens organism-level biological processes to social processes at the level of culture. Culture, she writes; “is an organism that follows the same imperatives to survive as an individual creature does. Given half a chance it will thrive despite the threat of decline and will pass on what life-enhancing skills it has accrued” (pg. 270). Although this is a metaphor, as I have and will continue to argue, even metaphorical thinking can have impacts in physical domains. In Big History, there are ample opportunities to teach about both local and global environmental change and the connections between these scales. Carried into the lived-experience, there are then opportunities to observe global change at the local level and to examine local contributions to global problems.

However, this process of seeing dynamics happening across scales is most compelling when it serves to connect the personal level and the natural level. Tucker and Swimme (2009) have stated that we need to “step back to assimilate our cosmological context. If scientific cosmology gives us an understanding of the origins and unfolding of the universe, philosophical reflection on scientific cosmology gives us a sense of our place in the universe” (pp. 429-430). Similarly, Voros (2001) wrote that because humans employ perceptual filters “[W]e tend to see what we expect to see,” thus, we benefit from “any framework which helps to expand our perceptions” and thereby “help[s] us to become more attuned to more of the world out there” (pg. 20). Thomashow (2008) also argued for the creation of an “integrated cognitive framework for teaching environmental change,” which would be an educational curricula designed to cultivate “pattern-based environmental learning,” that is, recognition of the patterns that “transcend scale, that emerge in a variety of landscapes and milieus, that link atmospheric, oceanic, terrestrial, and organismic phenomena, and that show the relationship between spatial and temporal

variation” (Thomashow, 2008 p. 242). According to Thomashow, learning to detect and recognize such patterns is “the conceptual foundation for understanding how to cope with complexity and irregularity” (p. 410). This way of thinking, “serves to empower students to assess and propose solutions for problems of planetary significance” (p. 410).

In the context of this study, fractal thinking is exemplified by the linking of student experiences across scales from the cosmic level to the level of personal identity. Student responses evincing the development of fractal thinking included the following:

It gave me a better lens to understand the connections I was already seeing. Big History invites one to take a step back from our microscopic perspective and examine a system as whole, how it interacts with other systems, and notice patterns. Learning about the Big Bang and the specifics behind that was particularly impacting on me as I had previously avoided the subject as I don't consider myself a particularly science-y person so studying content with a science base was a fruitful challenge for me. (71)

Another student recalled,

It shaped the way I look at it more than how interact with it, [sic] I'm still the same person but my view towards the world by how its changed and maybe the direction its [sic] headed by looking towards the past. The sense of large repeated patterns. (22)

The development of fractal thinking is crucial to an appropriate response to the Anthropocene because such thinking represents an awareness of how processes that occur on one scale, or at one time in the cosmic narrative of Big History, can also appear in another. In particular, fractal thinking enables a person to see the connections between personal, local, and global environmental changes even though these changes occur on vastly different scales. In this sense, the abstract mathematical concept of fractals becomes a metaphor that describes the real bridge between self and other.

Emergent-Future Thinking

Conventional history cultivates a contemplation of the past and the future, although it does not typically compel a questioning of fundamental assumptions, nor does it normally contextualize the human narrative within the natural world. Big History, by operating on a much larger scale, traverses the boundary between human (humanities) and natural (science) paradigms, and thus provides a unique opportunity to cultivate a new transcalar capacity that I have termed *Emergent-Future thinking*. This way of thinking, the eighth cognitive capacity identified in this study, is a two-part complement of emergence and future thinking. In this imaginative way of thinking, the individual is aware of the radical creativity of the universe and can contemplate the past as a window on the future. Emergent-Future thinking, then, may have the power to crack previously perceived constraints on possible futures. It is a response to the “lack-of-imagination” complaint frequently levied by researchers of solutions to seemingly intractable, super wicked problems. The claim being made here centers on the possibility that when we encounter the history of radical emergences that drive the Big History narrative, we may find a new openness to imagining equally radical emergent futures, and such futures, then, will likely depend on equally radical emergent solutions. Futurists Hayward and Voros (2006) also acknowledge the “systems” value of encouraging this kind of thinking in students, specifically by using experiential learning approaches that “allow students to see the world differently; to see themselves as actors in that world; and to see learning from the past going forward into the creation of alternative futures” (p. 712).

Many scholars emphasize the importance of attending not just to the past, but also to the future that may emerge from the present. Speth (2009) argued that we should “move from discounting the future, focusing severely on the near term, to empowering future generations economically, politically and environmentally and recognizing duties to yet unborn human and natural communities well into the future” (p. 10). Similarly, Raskin (2009) stated, “Foresight and intention—the essence of free will—when exercised collectively broaden the frontier of social possibility. Now more than ever we need people who imagine other worlds and, in so doing, make them attainable” (p. 140). Further, Leiserowitz and Fernandez (2008), synthesizing a wide expert consensus, stated,

Most people are so caught up in the activity of the present that it is very difficult to imagine where current global trends and trajectories might be leading. These scenarios should describe both the potential futures that we desire and those that we do not, extrapolating from both current trends and trajectories, and the key decisions that individuals, governments, companies, and civil society will be making over the next several decades (p. 44).

Student participants who completed the survey for this study indicated that the Big History course did encourage the kind of cognitive capacities that I have termed Emergent-Future thinking. Representative responses included the following:

I think its really important to know the history of the world because then we can have more knowledge when it comes to facing future problems that humanity and the earth are set to face. (88)

It makes you think about not only yourself but about the world and universe as a whole. How things are connected and how wide open possibilities are. (70)

I think about Big History everyday. With the world below my feet, seeing how things have changed get my mind wondering about what it could be if somethings never happened. Starting with the big bang and how society is shaped or formed today, with one little detail missing, it astonishes me with how different this place we call home could really be. (45)

[I am] more accepting of the inevitability of change, and the illusory idea of cultures "always being this way." (123)

Conclusion

This chapter extended a correlational analysis between the *Cognitive Elements of Big History Transformative Learning* (Chapter 3, Table 1) that were surfaced empirically in the qualitative survey, and the insights of a diverse selection of relevant experts. The purpose of this exercise was to show how each of the transformative elements elicited by engaging with Big History have a correlate in experts' recommendations for addressing the Anthropocene problem.

Much the same as in the empirical survey, wherein students' responses often contained multiple utterances on a constellation of transformative elements, each of these pairings, the expert assertions and the relevant student responses, are simplifications, of course.

Any one of the core elements of a Big History transformative experience would not necessarily constitute a fully appropriate response to the Anthropocene on its own.

Indeed, it is also acknowledged that even a full complement of the content and conceptual understandings inherent to knowing the Big History story would not constitute a full complement of human competencies.

For some people, engaging with Big History means asking who we are, as humans, and to then be able to reasonably speculate about who we want to be in the universe. This is a question that first needs to be asked on the personal level, then culturally, then as a planetary species, and then beyond. I have come to believe that a Big History education that includes these crucial ingredients has the chemistry not only to slow Anthropogenic impacts, but also to put humanity on a much longer-term, more prosperous and perhaps humane trajectory through the cosmos.

Grounded Theory Part II

The research of this Chapter (4) appends the second part of the three-part running theory of Big History transformative learning as follows:

1. Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners (Chapter 3).
2. **The cognitive elements of Big History transformative learning correspond particularly well to several changes thought necessary by relevant experts to constitute an appropriate response to the Anthropocene** (This Chapter 4).
3. Forthcoming (Chapter 5).

The task now is to return again to the *Cognitive Elements of Transformative Learning in Big History* (Chapter 3, Table 1), to better see if and how they may align with established educational and communication theories, and then, later, integrate the cumulative

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findings into a formal, Big History pedagogical framework that is also suitable for cultural communication practices.

Chapter 5

INTEGRATION

We need to change society's worldview that leads to ecological destruction. To do so, we need a model of transformation. And the environmental movement does not have a clear model of transformation.

-- Mary Evelyn Tucker

Purpose of this Chapter

This chapter intends to append part 3 to the three-part, running grounded theory as follows:

1. Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners (Chapter 3).
2. The cognitive elements of Big History transformative learning correspond particularly well to several changes thought necessary by relevant experts to constitute an appropriate response to the Anthropocene (Chapter 4).
3. **Can the cognitive elements of Big History transformative learning be linked (reflexively) to concepts engaged within the Big History narrative itself? And are there any established educational and communication theories that can be particularly useful to include in a general framework for pedagogy and communication of Big History transformative learning?** (This Chapter 5).

Introduction

The research of this chapter builds on the cumulative findings of previous chapters by extending an analysis toward established theories and concepts. This task can be alternatively summarized by the question: *What unique educational and communication concepts can support a mode of action through which Big History transformative*

learning can manifest across cognitive, cultural, and biospheric scales? The final step of this integration will be to synthesize a general framework for Big History pedagogy and communication.

The interdisciplinary scholars cited in the correlational analysis (Chapter 4) presented a consensus view that an appropriate response to the Anthropocene will likely require a multifaceted framework that includes cognitive, and cultural level impacts. For example, Raskin (2009) claims, “We urgently need a synthesis of theory, values, and practice that blends an understanding of the historic moment, a commitment to planetary solidarity, and a true global citizen’s movement” (p. 143). All of these concepts have been touched upon in the current research thus far. For example, Chapter 1 discussed the planetary context as the biosphere, the urgency of wicked problems, and the impact of shared history on identity and values. Chapter 3 then presented empirical data on the phenomenological aspects of Big History transformative learning and Chapter 4 then showed how such learning correlates (inversely) to the cognitive structures believed by experts, to be root causes of many environmental problems. In this chapter, I curate a selection of theories and concepts from relevant literature, integrate them into the findings thus far, and then synthesize the cumulative insights into a general pedagogical framework for communicating transformative learning in Big History.

Analysis

The question of interest in this analysis is how the myriad concepts discussed thus far can function to facilitate and manifest transformation. The point of this more detailed and theoretically grounded analysis is to shed new light on any overlooked significances and interconnections. While this effort may, at times, seem to meander, or explicate the obvious, it does so by necessity and only to the extent that the ideas that emerged over the course of the investigation do. The complexity rightly reflects how complex problems often require equally complex analysis. Further, the range of subjects marshaled in the effort, also reflects my intent to generate a comprehensive and unbroken line of reasoning

between Big History transformative learning and appropriate pedagogical and sociocultural responses to the Anthropocene. Because the resultant framework for understanding is intended to be genuine integrative of human lived-experience, the analysis thus begins with a return to phenomenology.

Phenomenology

Let us then suppose the mind to be, as we say, white paper, void of all characters, without any ideas: How comes it to be furnished? Whence comes it by that vast store which the busy and boundless fancy of man has painted on it with an almost endless variety? Whence has it all the materials of reason and knowledge? To this I answer, in one word, from EXPERIENCE.

—John Locke 1690

When John Locke penned the above proposal in *An Essay Concerning Human Understanding*, Enlightenment science was still in an early formative stage. His proclamation that experience should be the root of knowledge production was intended to be a founding principle for science.⁵⁷ There are, of course, multiple ways of knowing. But how much do we, the researchers, teachers, and writers of Big History, actually *live* the familiar and inherent concepts of physical, biological, social, and cerebral emergence that drive the Big History curriculum? Does it matter?

Phenomenology is “the study of structures of consciousness as experienced from the first-person point of view” (Smith, 2013 p.1). Therefore, I adopted the methods and language of phenomenology. The phenomenon of interest to this thesis is the lived-experience of students who engage with a Big History curriculum. Phenomenologists distinguish between pre-reflective and post-reflective experience by calling the former *experience*, and the latter *lived-experience*. The difference between experience and lived-experience is that the lived-experience is thought have an added structural durability in consciousness. This is because the experience has been reflected upon. That is the essence of phenomenology.

⁵⁷ As opposed to received philosophical wisdom or religious doctrine.

Traditionally, phenomenology meant that the philosopher would engage in a systematic analysis of his or her own experience in order to better understand a particular phenomenon (Marton & Booth, 1997). In this original sense, phenomenology aimed to be a kind of science. While this early form of philosophical phenomenology has lost much of its reductionist, explanatory rigor today, it has since re-emerged as an especially apt way of thinking about the lived-experience to describe qualitative aspects of reality. As the assumptions of positivist and modern paradigms have given way to more relativist, post-modern worldviews, phenomenology has found a new role. In some ways it has gained a viability that it lacked as originally conceived. Validating or even privileging the human lived-experience is the function that phenomenology can bring to a general pedagogical framework.

Phenomenology makes this contribution in two primary ways. First, it underscores the primal nature of human experience as just described, but it also provides a link between experience and perceptions of individual agency. That is to say, it provides cogency between the necessarily subjective way phenomena (like Big History) can be experienced, and how such experiences manifest in the outlook and actions of the experiencer. Phenomenology in this sense validates the relationship between subjectively lived-experience and an objective world to then be lived in. As the poet David Whyte puts it: “We shape our self to fit this world and by the world are shaped again” (Whyte, 1996). By revitalizing such a privileged position for the lived-experience of natural phenomena, a framework can effectively recommit to Locke’s call for “EXPERIENCE” as the foundation of valid knowledge. Does this mean that an irrational person’s perceptual experience of the world is a valid description of the world? Not necessarily, because context matters. For example, what may have been rational in the Holocene (or during the industrial age) may come to seem irrational in the Anthropocene. This thesis addresses the issue by considering that the Anthropocene may be the result of certain cultural narratives that have become unsustainable, outmoded, and indeed irrational.

The implication of phenomenology for Big History educators, then, is that they should be aware of the value in deep, self-reflective examination of learner's experiences, as well as their own. This awareness provides a motivation for seeking out, facilitating, and creating lived experiences not just for learners, but also for the self. It is an argument for the lived-experience of Big History's content and not just conceptual knowledge.⁵⁸ This is not, of course, an argument against conceptual knowledge. Indeed conceptual, or content knowledge too is crucial to a holistic understanding of Big History. But specifically, the next section will explore how that conceptual knowledge interfuses with experiential knowledge through the narrative structure of cognition.

Narrative

The concept of narrative has featured prominently in the both empirical data and the literary discourse of previous chapters. Therefore, a logical next step toward understanding how transformative learning in Big History can manifest in culture and beyond, is to consider the more fundamental role of *narrative* in human affairs, and naturally, human cognition.

Narrative theory refers to the constellation of understandings by which humans lead storied lives, both individually and socially (Bell, 1997; Connelly & Clandinin 1990; 2006, Craig, 2003, Kitchen, et al. 2011; Smith et al. 2009; van Manen, 1990). Evolutionarily speaking, humans are obligate "meaning-makers" and narrative approaches to cognition understand that meaning to be made through narrative structures. As Haidt (2013) understands it, "The human mind is a story processor, not a logic processor" (p. 328) and this understanding is now the basis of *narrative psychology*. The power of narrative approaches for understanding human cognition is expressed by social psychologist Dan McAdams (2008) who claims that narrative psychology "has moved to the center of the discipline" (p. 242). We now also have *narrative consciousness theories*

⁵⁸ This understanding will become particularly relevant in the forthcoming discussion on the role of tacit knowledge.

of human development as articulated by neuroscientist and neurobiologist Damasio (2000) who wrote, “Consciousness begins when brains acquire the power, the simple power, I must add, of telling a story” (p. 10). Further, *narrative identity theory* draws explanatory power from the idea that human beings function according to an “internalized, evolving, and integrative story of the self” (McAdams, 2008 p. 243). In other words, stories can change who *we* are.

Narrative structures may be what provide the durability that makes the difference between an experience and a lived-experience. Cognitively speaking, narrative structure also makes a lived-experience portable. This means that the personal narratives that we craft to define ourselves are reflected collectively in the cultures we inhabit. Narrative is how we make meaning of our personal experience, ourselves and the world. Narrative cognition and culture, then, are integral and transcalar. The highly personal, identity-defining and uniquely human capacity for narrative makes story an exceptionally good lens through which to understand human cognition and culture (Niles, 1999).

Transformative experiences stand out because they change cognitive, narrative structures: the greater the disruption, the greater the transformation. Thus narrative inquiry can also provide valuable insights for understanding experiences of personal transformation (McAdams, 2001). Narrative inquiry is a qualitative method that holds story as “a portal through which a person enters the world and by which his or her experience of the world is interpreted and made personally meaningful” (Connelly & Clandinin, 2006 p. 477). Methodologies of narrative inquiry are a way for making sense of human experience in terms of first-hand personal accounts. This is the rationale for the qualitative inquiry method used in thesis. If one is going to make a fully formed argument about the impact of personally transformative experience, it is appropriate, indeed required, to use first-hand accounts.

Narrative is an accepted and especially powerful way of understanding the human experience. Recall that Gardner (2006) links transformative personal narratives, identity, and culture by suggesting that,

...one way to capture the attention of a disparate population: [is] by creating a compelling story, embodying that story in one's own life, and presenting the story in many different formats so that it can eventually topple the counterstories in one's culture. (p. 62)

While pre-reflective experiences are ephemeral, narrative brings a structural integrity to these experiences. Once our experiences are lodged as narratives, they then crystallize in identity. Thus, beyond its role in basic communication and ability to serve as the foundations as an “origin story,” on a deeper level, narrative provides a cognitive, structural durability to the causal sequences revealed through the Big History curriculum. Given this understanding of the narrative nature of cognition, and its relation to culture, we can invert the relation to become more aware of our own culturally acquired and potentially unexamined narratives. In other words, cultural narratives can be understood as personal narratives, writ large, collectively and systemically, and therefore subject to the dynamics of complex dynamical systems (for example, as components of feedback loops). Thus systemic transformation can be understood, most basically, as a transformation of narratives, whether at the personal or cultural level. Neuroscience now enables us to see that self-knowledge is narrative awareness (See discussion Chapter 3, p. 69-70). There is also something undeniably resonant with the fact that Big History itself, rests on a narrative foundation. In fact, Big History is a narrative.

Practitioners are themselves transformed by teaching Big History. For example, William McNeil in “Leaving Western Civ Behind” described the transformation he experienced upon engaging with the Big History of David Christian (McNeil, 2011). For McNeil, that transformation was “the central intellectual transformation of the twentieth century” (2011, p. 47). The implications are that Big History educators need to be aware of the power and ubiquity of narrative in human meaning making, including their own.

They also need to be mindful of the many narratives embedded with the Big History curriculum and especially how they may disrupt unexamined narratives held by learners. Narrative can be key component of transformative learning.

Transformative Learning

Any kind of learning implies some form of cognitive change. However, *Transformative Learning* in this thesis refers to a specific kind of learning that includes the disrupting and reconstructing of preconceptions, misconceptions, and narratives (Mezirow, 1997). The experience of transformative learning is big, memorable and durable enough to carry forward and shape subsequent learning and experience. This reciprocal nature of transformative learning and experience is fundamentally a constructivist process and the ideal of the educational philosopher John Dewey. He, and others, had long argued that education should ultimately be about cultivating a fulfilling life, which, in turn, sets us up for future erudition and experience (Dewey, 1958; 1998, Jackson, 2000). Thus, a truly transformative educational experience can usually be recollected to a specific phase of learning, or even a moment, that marks a substantial shift in the way one sees, relates to and comes to be in the world. The empirical data of Chapter 3 has shown that Big History has the potential to elicit these self-reflective understandings. The challenge here is to understand how a transformative experience of Big History becomes structurally embedded in cognitive identity structures, and thus part of the everyday narrative of one's lived-experience.

Dewey (1934/2005) also applied an intuitive understanding about the power of aesthetic experiences with art and nature to illustrate this claim and made direct connections to the educational endeavor. For example, Dewey talks about the difference between learning concepts (as static knowledge to be acquired) and ideas (as opportunities to consummate potentials). He argued that when we think in terms of *ideas*, we open up whole new ways of relating to the material to be learned. In other words, he is framing educational opportunities as experiences to be had, as opposed to concepts to be merely learned. In

this way, he also distinguishes between experience and what he termed “*AN experience*” (the latter being richer and more of an opportunity) as having the potential to change the way we perceive and interact with the world.

Teaching and communicating Big History, therefore, can be more than the transfer of conceptual knowledge. As a potentially transformative experience, learners will undergo a range of potentially exciting, threatening, and fulfilling learning phases. Transformative learning theories serve as a template for how Big History can disrupt learners’ cognitive repertoires. These theories can also help Big History educators know what to expect, in terms of the sequence of challenges and opportunities inherent to transformative learning, and thereby better facilitate student engagement. The implication is that Big History educators should be aware of the sometimes difficult and delayed process of narrative disruption and seek to thoughtfully and empathetically engage with students through the process. This enhanced awareness can provide access to learning dynamics that may have otherwise remained concealed due to the fact that they are hard for learners to put into words.

Tacit Knowledge

“I have learnt so much about the workings of the Earth and its history. It’s hard to put into words” (Big History Student, 43). This seemingly mundane utterance of a Big History student may actually underscore a key element of Big History transformative learning. The phrase “hard to put into words” has become common in the educational discourse on Tacit Knowledge, usually expressed as “hard to articulate.” The physicist-turned-philosopher Michael Polanyi proposed the concept of tacit knowledge in 1958 (1966; 2012). He wrote that tacit knowledge is intrinsically “hard to formalize and therefore difficult to communicate to others ... deeply rooted in action and in an individual’s commitment to a specific context,” and that it “consists partly of technical skills [and partly] of mental models, beliefs and perspectives so ingrained that we take them for granted and cannot easily articulate them” (2009, pg. 98).

Polanyi's philosophy of tacit knowledge is intrinsically linked to phenomenology because it points to a way of knowing that is rooted in lived-experience. In other words, to acquire tacit knowledge, one must *experience* something first-hand. Further, the inherent relationship between personal experience and tacit knowledge led Polanyi to focus on the personal processes of discovery that one must engage with, in order to acquire tacit knowledge. He wrote,

To hold such knowledge is an act deeply committed to the conviction that there is something there to be discovered. It is personal, in the sense of involving the personality of him who holds it, and also in the sense of being, as a rule, solitary; but there is no trace in it of self-indulgence. The discoverer is filled with a compelling sense of responsibility for the pursuit of a hidden truth, which demands his services for revealing it. His act of knowing exercises a personal judgment in relating evidence to an external reality, an aspect of which he is seeking to apprehend. (2009, pg. 24)

Here, Polanyi is acknowledging the recursive power with which a tacit understanding can become entwined with self-identity and inspire one to learn more. He believed that such tacit knowledge becomes most useful and most powerful when it is *indwelt*, as opposed to being remembered as explicit knowledge. This is how Polanyi thought tacit knowledge manifests itself within the learner. He wrote: "To interiorize is to identify ourselves with the teachings in question, by making them function as the proximal term of a tacit moral knowledge, as applied in practice" (2009, pg. 18). Thus, he implies, that when knowledge is tacit, it is lived. Therefore, tacit knowledge is personal and because it resides closer to the *self*, it can activate a moral component that is apt to be expressed through character and action. In other words, we are more inclined to act morally (whatever that morality happens to be) based on tacit knowledge than we are on conceptual knowledge. By linking knowledge to context, tacit knowledge can play a critical part in connecting the transformative learning of Big History to outward ethical action. In this way, tacit knowledge may have elements of ethos and agency that explicit knowledge lacks.

Writers in the field of knowledge management later refined the notion of tacit knowledge to be “personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective and value system” (Nonaka & Takeuchi, 1995, vii.). A recent empirical study identified three primary facets of tacit knowledge as “mastery of the big picture; expert networks; and social skills” (Puusa & Eerikäinen, 2010). Most teachers of Big History should be able to appreciate the value of a big-picture, context-dependent, networked, perspective-oriented concept. All of these capacities are important to Big History knowledge. But what is often overlooked, or even avoided by more quantitatively-oriented and standards-based educational interventions are the many other vital human parts of tacit knowledge: the personal, subjective, constructed, values-laden, culture-bound and experiential ways of knowing Big History.⁵⁹

In summary, tacit knowledge provides a composite way of understanding, and a vocabulary for anticipating, the sometimes-ineffable nature of Big History transformative learning. Tacit knowledge is more than the practical knowledge of how to ride a bicycle; a common but limited conception of tacit learning. Learning tacit knowledge is learning tied to personal identity in ways more profound than simply practical knowledge. Understanding this helps Big History educators accept the responsibility of teaching for moral action and encourages them to think about the impact of previous learner experiences in creating new learning opportunities. Practitioners of Big History should be aware that much of the personal transformation that comes from engaging with Big History can be hard for learners to articulate. But they should also be aware that the tacit knowledge they impart on their learners exerts a significant impact on their values, attitudes, and actions. Given the experiential dimension of tacit learning, practitioners should also try to provide students with opportunities for meaningful lived-experiences. Finally, because tacit knowledge links context and agency, it underscores that transactions occur between the domains of thought and action; cognition and world. In this way, it can

⁵⁹ My own professional pedagogical practice is open to developing these qualities precisely because, I believe, if we do not appropriately engage these powerful capacities within the human spectrum of knowing, then we are probably failing to deliver on the full promise of Big History education.

be thought of a “systems” phenomena capable of generating new, “emergent” properties across these domains.

Emergence

Emergence is a phenomenon of Complex Adaptive Systems.⁶⁰ A system is complex if "a great many independent agents are interacting with each other in a great many ways" (Waldrop, 1992, p. 11). Emergence happens under certain systemic conditions in unpredictable ways. Emergence can be a very slippery slope, however, because it largely inexplicable (by definition, we do not have a reductionist understanding of emergence). And yet, it happens all the time. Indeed, the narrative of Big History is very much a narrative of emergences. However, a theory of emergence is not the goal of this thesis. Instead, the research is primarily interested in how the concept of emergence impinges on cognition and transformative learning in Big History. What's relevant in this regard is how emergence, in one sense, is a driver of change. Without emergence, nothing changes, and there can be no narrative, no ecology, if nothing changes. But emergence can be distinguished from Darwinian evolution because evolution acts on and within the constraints the previously emergent properties. Because the products of emergence become available for natural selection and Darwinian evolution, emergence can thus be thought of as a more fundamental phenomenon. The diversity stemming from Darwinian evolution can be predicted; the products of emergence cannot. There is something still mysterious about emergence but there is evidence for it. Evolution itself is an emergent property.⁶¹

The empirical data show that the concept of emergence can play a significant role in Big History transformative learning. This is likely because the narrative of Big History is essentially a credible account of emergence within one big, cosmic, complex adaptive

⁶⁰ Complex Adaptive Systems (CAS) is used synonymously with the previously used term Complex Dynamical Systems (CDS) based on the particular source cited in the current discussion.

⁶¹ As far as I can discern, so is everything else.

system. Whether we are considering the emergence of fundamental forces at the beginning of the universe, or the emergence of elements from atoms, or the complex behaviors that emerge from organismic relations in ecosystems, or even the emergence of unpredictable new ideas that occur when old ideas collide in the classroom (or in the mind), emergence places a premium on relationships. Emergence is therefore a fundamentally ecological principle. Students of Big History are invited to participate in an ecosystem that traverses personal identity, a college campus, a country, a planet and a cosmos.

Finally, if emergence is seen as the fundamental natural process by which novelty arises in the universe, Big History, in essence, is the story of the many emergent events that together have created the complex reality that currently exists. Looking back at the historical thresholds of emergent complexity in the narrative of Big History reveals a universe that changes in fundamental and drastic ways. Using that same intellectual faculty for viewing the past to instead speculate about the future opens the potential for equally drastic changes. Thus, emergence, as the central driving process of Big History, is a concept capable of widening the imaginable the range of possible futures. Big History educators should understand this higher-order function of emergence because its impact is capable of traversing multiple scales of time and space. Considered among the whole constellation of cognitive elements of transformative learning reported by students of Big History, the concept of emergence can provide a counter balance for failing to solve problems based on “failures of imagination.” The lived-experience of emergence can provide a similarly transformative effect in perceptions of the self. How such transformations can manifest across scales of experience can be perceived as a matter of fractals.

Transcalar and Fractal Thinking

Transcality is a concept arising in the Big History literature and touted as a component of transformative learning. Cognitive disruption due to transcality is probably inevitable

due the vast ranges of temporal-spatial scales in Big History. While the transformative potential of grappling with these cosmic scales has already been discussed and documented, I wish to explain why I have coupled it with a fractal component. I believe this highlights an as of yet unrecognized cognitive faculty that is cultivated through Big History transformation learning. Fractals are a phenomenon of transcalar repeating patterns observed in Nature that can be described mathematically (Mandelbrot, 1983). The association between these two concepts, transcalar thinking and fractal thinking, is captured in the following student response: “Big History invites one to take a step back from our microscopic perspective and examine a system as whole, how it interacts with other systems, and notice patterns” (71). This quotation reveals both the transcalar (microscopic-whole) and fractal (patterns) thinking inherent in a Big History transformative learning experience.

The Big History narrative provides many opportunities to engage with fractals. After repeated engagement with fractal phenomena, a student can develop a familiarity or perceptual skill in recognizing them (see Table 2 below for examples). Fractal thinking, then, refers to an acquired cognitive capacity for pattern recognition across scales. It is expressed when a student verbalizes how a process encountered on one scale, or at one time, also manifests in others.

The significance of transcalar-fractal thinking for Big History is that it enables an individual to perceive and experience parallels across the micro, meso, and macro scales. This way of thinking can provide a metaphorical bridge between the learner and the content of Big History. This link also highlights a relational capacity can be especially compelling when it links some aspect of the learner’s personal identity and the physical cosmos. This has the effect of making the content personally meaningful. Fractals, especially when they are highlighted in the Big History curriculum, provide a way of linking personal narratives across scales to the narratives of Big History. Big History educators should understand the fractal nature of what they teach as a way of personally

connecting the content to the learner. Fractals encountered in the Big History narrative can link the knowledge to the knower.

Embodied Cognition and Enactivism

Embodied cognition theories propose that what we know is inextricably related to our physical, biological, and physiological selves (Gibbs, 2005). Our consciousness and cognition are products of natural, biological processes. What we know and how we can know is contained within the natural constraints and capacities of the human brain and body (Barsalou, 2008). Enactivism effectively extends embodied cognition back out into the world. According to Varela, Thomson and Rosch (1992), enactivism,

is a term that recognizes the growing conviction that cognition is not the representation of a pregiven world by a pregiven mind but is rather the enactment of a world and a mind on the basis of the variety of actions a being in the world performs. The enactive approach takes seriously, then, the philosophical critique of the idea that the mind is a mirror of nature but goes further by addressing this issue from within the heartland of science (p. 9).

Enaction, then, refers to the manifestation of embodied knowledge in the world through physical action. Because we act in the world based on natural cognitive processes, enactivism makes the link between our actions and nature --because our thoughts are natural phenomena. Enactivism also implies that what we think and know is reflected in how we act (Froese 2011). This also links enactivism to tacit knowledge, emergence, systems and complexity theory because enactivism implies an ongoing systemic interaction between what is known and what is acted (Maturana & Varela, 1992). Together these cognitive elements constitute a psycho-sociological concept that describes how knowledge becomes embodied and systemic (i.e., enters into the wider, containing structural systems).

Varela and colleagues build on phenomenological and cognitive concepts to develop a model of cognition as "embodied action" (Varela et al., 1991/2: xx). They call this combination of embodied understandings and resultant outward action "the enactive

approach.” Varela presents this as the "fundamental insight" of enactivism, through which he claims that the mind is embodied and therefore "not in the head" (Varela, 1999, p. 72; quoted in Watson, 2000). The implication here is a mind not just in the head, is perhaps outside as well. If so, this may support the idea of deep integral connections between our thoughts and the “outside” natural world. These ideas will have profound implications to any appropriate response to an issue such as the Anthropocene: not because of what we think about the environment but because of what we thinking about ourselves.

Enactivist principles provide a basis for anticipating how what a learner knows, and can subsequently come to know through engaging with Big History, will become embodied within the learner. It also provides a rationale for considering the learning environment as a setting for situated learning. According to Varela et al., (1991) enactivism is important because it extends the concept of embodied cognition to include the wider "biological, psychological, and cultural context" (p. 173). All of these capacities: “the known mind and world, stand in relation to each other through mutual specification or dependent co-origination” (p. 150). Big History educators should understand that whatever they teach will be embodied by learners and enacted in the world.

Cybernetics

The previous sections have discussed several cognitive elements of transformative learning reported by students of Big History. How these transformations in thinking can be transmitted to manifest in the world may also be worthy of understanding by Big History educators. One concept for such transmission, or propagation, is cybernetics.⁶²The term *cybernetic* dates back to Plato’s κυβερνήτης (kybernētēs): meaning the art of navigation, which he used to compare the steering of a ship with the

⁶² It is also important to note that cybernetics (like transclarity, complexity, etc.), although not usually invoked by name, is also a prominent driver of change in the Big History narrative itself.

governing of a society.⁶³ Cybernetics today is a communication theory for explaining how information can carry agency across disparate domains. I invoke cybernetic principles to depict how such cross-domain transmission of Big History can occur.

During the rapid technological advancements surrounding World War II, American mathematician and philosopher Norbert Wiener (1894–1964) developed algorithms in order to understand and predict the trajectories of aircraft. In a 1948 book entitled *Cybernetics: Or the Control and Communication in the Animal and the Machine*, he developed the math and models that would optimize estimations of aircraft positions in order to shoot them down (Wiener, 1948).

What made Wiener’s formulations revolutionary was how they effectively bridged the animal-machine boundary. By accounting for pilots’ decision-making (animal), in relationship to aircraft (machine), he established information as being the lingua franca of organisms and machines. This work opened new understandings of how component biological and mechanical systems could interact in ways that maintained control of larger systems. Later cyberneticists developed an even more transdisciplinary scope and the *Systems Theory* that emerged has since been applied to understand, model and design systems of any kind: physical, technological, biological, ecological, psychological and social, or any combination of these (Heylighen & Joslyn, 2001).

Cybernetics focuses on how *information* flows in complex systems. Although many of the recent theories and understandings emerging from Complex Systems Science are also integral to this work, the limited scope of cybernetics allowed me to better address the specific question of how the ideas (as information embedded within a Big History curriculum) can have ameliorative impact in the Anthropocene: in other words, to make the journey across the disparate domains of immaterial and material mentioned above.

⁶³ The steering metaphor is apt considering that one of my basic aims through this work is explore how planetary-scale system dynamics might “steer” humanity toward a more appropriate response to the Anthropocene.

The challenge here is to find a way of transferring Big History personal experience, ostensibly as tacit knowledge, so that it can be managed and transmitted as information from the interior domain of psychology to the material domain of culture. I have chosen the word “transmitted” here carefully to distinguish it from “communicated” because as we will see, tacit knowledge is known for being difficult to communicate. This is what can make our experience “matter” in the world—literally as well as metaphorically.

Cybernetics then offers a way of understanding how information travels across systems of seemingly disparate components. Given the scope and subject matter of my research on transformative experience, a subjective phenomenon, I am primarily interested in the qualitative, as opposed to quantitative, aspects of cybernetics. My analysis concerns how information, as opposed to energy, which is a commonly invoked driver of change (for example, see Christian 2005; Chaisson, 2011; Spier, 2005), moves through a system and how that information, or tacit knowledge, functions to influence or steer actions toward system-level goals—specifically, as a response to the Anthropocene.

Ecologist and philosopher Gregory Bateson (1904–1980) did much to advance cybernetic understanding between psychology and the biosphere. In *Steps to an Ecology of Mind* (1972/1987), he wrote, “After all, the subject matter of cybernetics is not events and objects but the *information* ‘carried’ by events and objects” (1987 pg. 407). Bateson extended basic cybernetic principles to make more useful connections among cognitive, cultural, and natural domains. In March 1970 he testified before the State Senate of Hawaii (SB 1132):

That all of the many current threats to man's survival are traceable to three root causes: technological progress, population increase, and certain errors in the thinking and attitudes of Occidental culture. Our "values" are wrong. We believe that all three of these fundamental factors are necessary conditions for the destruction of our world... we note that every solution which we can imagine is made difficult or impossible by the thinking and attitudes of Occidental culture. (Bateson, 1987, p. 511)

Bateson was motivated by what he saw as a deeply misguided epistemology in the early field of ecology. Bateson expressed this view, and the connection between cognition and the biosphere, by pointing to the “massive aggregation of threats to man and ecological systems which arise[s] out of errors of thought” (1987, p. 463). He later refers to “conventional (but wrong) ideas about the nature of man and his relation to the environment” (p. 511, parenthetical comment in original).

This account of the universal nature of cybernetic principles may seem obvious to those who think deeply and ecologically, regardless of their specialization. But I highlight the concept of cybernetics nonetheless because I feel it helps provide not only a more comprehensive account of history, but also a new a critical line of reason with which to reconsider Big History in cultural communication practice. Taking cybernetics seriously, especially in light of the Anthropocene, can bring new relevance and significance to both formal, pedagogical and informal, cultural communication practices.⁶⁴

As a fundamental notion of communication, cybernetics tends to bleed into various domains and developed independently across multiple disciplines. An example of such consilience can be seen in the work of the celebrated historian William McNeill (b. 1917), who I also quote in Chapters 1 and 6. McNeill (2011), despite having never used the term “cybernetics,” arrived at cybernetic understandings after decades of contemplation about human history. He intimates a cybernetic hypothesis when he surmises that the “least material of these equilibria—the semiotic—had an almost magical power to alter the others.” He concludes that “reliance on webs of communication to define how human groups affected one another and the environments in which they lived ... has the virtue of emphasizing the semiotic equilibrium that I believe plays such a commanding role in provoking historical change” (pg. 47). By identifying the flow of semiotic information as the primary agent of historical change across disparate domains

⁶⁴ This argument for cultural communication of Big History as praxis is formally developed in Chapter 6.

of human affairs, McNeil is enlisting cybernetics, and cultural communication, in principles even if not in names.

While the sequence for extrapolating personal experience to the world at large may be intuitive, even obvious, it is extremely difficult to research through reductionist and specialist methods of scholarship. So, in order to pursue the thesis that personal experience can come to matter in the world and ultimately shape a response to the Anthropocene, a cybernetic system with sufficient scope to span the gap between personal experience and the biosphere was needed. Because the subject matter of Big History covers the entire universe, it also needed to extend the system to include the cosmos. Such a model is proposed as follows:

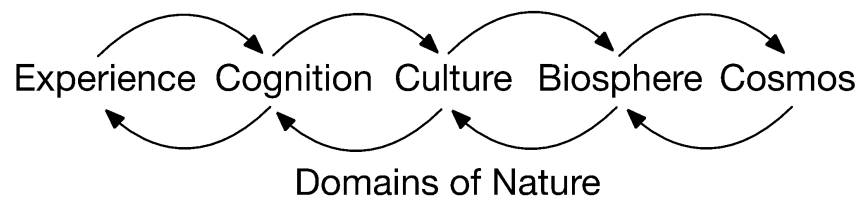


Figure 3: A Cybernetic Framework for Big History Communication:
Showing the universe as a Complex Adaptive System (or Complex
Dynamic System) that includes individual experience.

This diagram represents a simple cybernetic framework for visualizing cybernetics as a conduit specifically for the transformative learning experiences of Big History. This is the path by which the elements of Big History transformation can move across domains. Each domain in this model represents an overlapping milieu of semiotic-exchange, the transmission through which is not solely of energy, but of *information*.

The overall system is an emergent manifestation of nature. Within nature, from left to right, and in accordance with Locke's axiom for "EXPERIENCE," the system begins in the personal experience of Big History. Personal experience then shapes the cognitive structures of the experiencer and effectively moves the tacit knowledge one step right, into the overlapping domain of *Cognition*. *Culture*, as the emergent collective expression

of individual psychologies, then has Anthropogenic impact in the *Biosphere*. To complete the cybernetic system, the domain of *Cosmos* refers to the holistic, universal ordering of energy and information into universal patterns. The dual arrows indicate that all transactions between the domains are two-way exchanges. Because each domain represents a systemic component with its own range of internal complexity overlapping with the complexities of the all-encompassing natural system, information can circulate within each domain, as well as through the system as a whole. This stepwise progression is capable of supporting communication (transfer) across all the domains of relevance to my thesis, from personal experience to culture and beyond.

This model is, of course, a simplification. There are manifold ways to present a conceptual system that spans all of nature. This model was devised to suit the current research by placing the relevant domains in close enough proximity to see how they might exchange information. This configuration allows mapping a pathway of propagation through which the teachings of Big History can migrate across the domains of cognition, culture and biosphere. There are myriad influences and emergent feedbacks playing out within and across the cells of circularity. Similarly, the step-wise progression suggested by this graphic is a compromise, for the sake of clarity. Complex cybernetic systems need not, and surely would not, adhere to such a linear and orderly sequence. Nevertheless, this configuration allows me to map a pathway through which the personal and cognitive impacts of Big History can propagate from the domain of personal experience to culture and beyond.

It should be noted that this system is essentially an expression of *Philosophical Naturalism* (Papineau, 2009), which sees the whole system as a manifestation of natural, emergent complexity. Taken as a worldview, this stance sees Nature not as a category but *the* category. In such a worldview even something as potentially problematic as human imagination can be “validated” as a kind of reality because such phenomena arise from natural, neural networks. Thus, although supernatural phenomena themselves are incommensurable with this system, instead, what one might have labeled as

“supernatural” can simply be subsumed as “natural,” as an expression of a natural (or naturalized) human imagination.⁶⁵

Finally, this detailed account of cybernetics is also pursued because it leads to a potentially new understanding of what I think of as a critical component of an appropriate response to the Anthropocene. This has to do with the lingering and pernicious oversimplification of the object and subject. The rendition of a cybernetic system above conforms to what cyberneticians call a *second-order* cybernetic system (Froese, 2011; Pask, 1970; Von Foerster, 2003). This highlights that a researcher is obliged to include himself as both an observer and an agent, in any system considered. Further, a second-order cybernetic system assumes that humans play an autonomous part in the function, goals and directions of the local system, and therefore the entire system. As von Foerster describes,

In a “second-order stipulation” the observer enters the system by stipulating *his own* purpose. ... From this it appears to be clear that social cybernetics must be a second-order cybernetics—a *cybernetics of cybernetics*—in order that the observer who enters the system shall be allowed to stipulate his own purpose: he is autonomous. (2003, p. 286)

The second-order cybernetics described by von Foerster (2003) is one of the early arguments away from prevailing preoccupations with absolute systemic control. Pask (quoted in Tofts, Jonson & Cavallaro, 2004) extends this argument further by emphasizing the differences between first and second-order cybernetics as shifts,

... from information to coupling; from the reproduction of “order-from-order” to the generation of “order-from-noise”; from transmission of data to conversation; from stability to

⁶⁵ I include this commentary in order to explain my commitment to a secular, philosophical naturalism and help justify why I did not adopt something like Pierre Teilhard de Chardin’s (1881–1955) notion of the *noosphere* (the realm of thought), which is generally regarded as a religious concept. However, I do accept that de Chardin’s idea is, by default, part of the cybernetic system of nature and a powerful notion with many functional similarities.

organizational closure; from external to participant observation. (p. 61)

This means that despite how it usually appears, there are *no detached outside observers* in a second-order cybernetic paradigm (Froese, 2011). However, a conundrum arises if one asks to see an example of a first-order cybernetic system. How can there be a cybernetic system that does not include a human observer? A temporary resolution is to understand that any “comprehensive” view is provisional. This cybernetic realization of a self, as nested, enfolded and unified systems within systems can be referred to as self-system reflexivity (see below). Reflexivity refers to an epistemological awakening wherein the cognitive component of the system adopts its agency within the system. In the case of Big History and the biosphere, reflexivity underscores how a student (an experiencer) embodies ecological, economic, and cultural influences. Much like how emergence can link the knower to the known, cybernetics can link the experiencer to the experience.

In summary, a *second-order* cybernetic systems view understands humans as obliged to play a part in the functions, goals, and directions of more encompassing systems. Thus, cybernetic principles offer an important concept for both Big History practitioners and learners because they help conceptualize how information embedded in cognitive structures can traverse domain boundaries⁶⁶. Practitioners should be aware that what they are teaching enters into larger complex adaptive systems capable of carrying their impact across the domains of nature. Second-order Cybernetics in particular also helps the learner see that actions in proximal domains have impacts in distal domains, indeed all domains. The implication of relevance to the current thesis is that what we do to the biosphere, we do to ourselves. Such “self-system reflexivity” is the subject of the next section.

Systemic Reflexivity

⁶⁶ Again, this reference to “traversing boundaries” will become relevant in the development of Big History communication praxis discussed in Chapter 6.

In order to understand what is meant by *systemic reflexivity* in the context of this thesis, it will be helpful to scaffold the concept upon a similar concept from sociology: social reflexivity. According to Hayles (1999) “Reflexivity is the movement whereby that which has been used to generate a system is made, through a changed perspective, to become part of the system it generates” (p. 8). This means an individual with a high degree of social reflexivity participates effectively, both socially and economically, in all aspects of a society. Social reflexivity means having access to opportunities to make life choices and to make the most of those opportunities. It means being able to thrive in social contexts. By contrast, “social exclusion” refers to being alienated from social systems and communities with all the attendant problems this normally entails.

The concept of social reflexivity is used to define, by analogy, what may be called *natural reflexivity*.⁶⁷ As in social reflexivity, natural reflexivity means a particular state of a component within a natural system (the biosphere) that is aware of its agency within the system and can thus modify its actions and impact according to desired individual and/or natural systemic outcomes. Systemic reflexivity, which in a paradigm of philosophical naturalism (i.e., ontological continuity), is natural systemic reflexivity, equips the learner who encounters Big History to assess the impact of one value, attitude, belief, or action over another based on system-self well-being. The need for better-naturalized systemic reflexivity is an important insight of this dissertation research. A person with natural systemic reflexivity lives in an awareness and acknowledgement of the power of relationships. Practitioners concerned with the Anthropocene should be aware that Big History as an educational intervention is an opportunity to cultivate not just social reflexivity but also natural systemic reflexivity.

Results

⁶⁷ I use this term as a matter of convention and fully acknowledge that even social phenomena are by-default natural phenomena according to the earlier commitment to philosophical naturalism.

A General Framework for Big History Transformative Learning

The following proposed framework is based on the cumulative contexts, empirical findings, concepts and theory (the nine concepts just discussed through literary discourse), and practical experience of the author. The purpose of this framework is to improve the teaching and public communication of transformative learning by providing insights on how Big History transformative learning happens and how that transformation can then propagate across personal, cultural, and biospheric domains.

Phenomenology: Mindful awareness and analysis of the human lived experience. A deliberate preoccupation with the structures and experiences of consciousness.	
Function/Significance: Acute awareness of the particularities of lived experience reveals often unexamined qualities of that experience. This, in turn, cultivates attendant sensibilities, such as empathy, which can enhance ecological identity.	Praxis: Practitioners should be aware of the value of close examination of their own and the learner's experience. This provides a motivation for facilitating and designing compelling lived experiences for learners because the lived-experience matters to how the content of Big History can be made meaningful.
Narrative Theory: A constellation of narrative-centered theories and concepts on how human beings make meaning of the world and draw on constructed knowledge. Narrative infuses human experience across scales of personal cognition to culture by providing a durable structure that can be recorded and recalled through time and space.	
Function/Significance Learners' awareness of the origins and function of narrative helps them build an awareness of their own culturally acquired and potentially unexamined narratives. Narrative also provides a cognitive structural durability to the causal sequences revealed through the Big History curriculum.	Praxis: Practitioners need to be aware of the ubiquity and power of narrative in human meaning making (including their own). They also need to be mindful of the many narratives embedded within the Big History curriculum and especially how they may disrupt unexamined narratives held by learners.
Transformative Learning: A sequential process of learning based on the disruption and reconstructing of personal narratives, including culturally acquired (learned) narratives.	
Function/Significance: Transformative learning theories serve as a template for how learning can disrupt learners' cognitive repertoires. They can also help practitioners know what to expect (in terms of the sequence of challenges and opportunities) and thereby facilitate more effective engagement.	Praxis: Practitioners should be aware of the sometimes difficult and delayed process of transformative learning and seek to carefully and empathetically engage the sequence of disruption. Big History can be particularly transformative because of the range of narratives that span cosmic evolution.
Tacit Knowledge: A mediating "hard to articulate" learning or knowledge gained through experience and entwined with ethical action.	

Waking Up In The Anthropocene: Big History and the Biosphere

Function/Significance Tacit knowledge provides an understanding and vocabulary for anticipating the sometimes-ineffable knowledge gained by engaging with Big History. It also helps practitioners understand the responsibility of teaching for moral action and encourages them to think about the impact of previous learner experiences and how to create new “indwelled” experiential opportunities.	Praxis: Practitioners should be aware that much of the personal transformation that comes from engaging with Big History can be hard for learners to articulate. But they should also be aware that the tacit knowledge they impart to their learners will exert a significant impact on their values, attitudes, and actions. The experiential dimension of tacit learning should also further encourage practitioners to provide students with opportunities for meaningful lived-experiences.
<i>Emergence and Emergent-Future Thinking:</i> Emergence is a fundamental natural process by which novelty arises in the universe. The potential for emergence increases under certain circumstances of optimum complexity. Emergences are generally unpredictable and therefore can appear mysterious.	
Function/Significance: Emergence is a central driving process in Big History and a concept capable of opening the range of possible futures.	Praxis: Practitioners should understand the higher-order function of emergence as they teach the Big History curriculum. It is about drastically expanding the range of imaginable futures.
<i>Fractal and Transcalar Thinking:</i> A natural phenomenon of complex systems wherein dynamics and attributes sustain across scales. Often these attributes exhibit notable symmetries.	
Function/Significance As a combined concept, fractals and transcalar thinking can provide a bridge between the learner’s personal identity and the content of learning. This has the effect of making the content personally meaningful.	Praxis: Fractals present in the Big History curriculum provide a way of linking personal narratives across scales to the narratives of Big History. Practitioners should understand the fractal nature of what they teach as a way of personally connecting the learner to the content.
<i>Enactivism:</i> A sociopsychological theory of mind that acknowledges how cognition arises from the interaction between the thinker and its natural environment. It is, in essence, the naturalization of thought. The theory of cognitive enactivism (as opposed to representationalism) is closely aligned with notions of social constructivism.	
Function/Significance: Enactivist principles provide a rational basis for understanding how something as ephemeral and immaterial as cognition can come into materiality as a result of ecological interactions. Learners manifest what they learn in their lived, embodied, experience through enactivist principles.	Praxis: When enactivism is considered in a Big History educational context, it can complete a coherent cosmic-to-personal narrative. Practitioners should not consider learners to be passive recipients of information but rather recognize that they will actively construct themselves and their world through Enactivist principles.
<i>Cybernetics:</i> A communication theory in which information can be seen to carry agency across disparate domains (assuming ontological continuity). Second-order cybernetics in particular acknowledges how an observer of a system is always a nested component in the system observed.	

Function/Significance: Cybernetic principles are an important step in acquiring systemic reflexivity both in the practitioner and the learner by showing how information embedded in cognitive structures can traverse (perceptions of) domain boundaries. Second-order cybernetics in particular helps the learner understand the relations among system components and that what they do to adjacent domains has effects that impact ALL domains.	Praxis: Practitioners should be aware that what they are teaching enters into a larger complex adaptive system capable of carrying their impact across the domains of nature. Also, second-order cybernetics should make all aware that ultimately no observers can be outside the planetary system. What we do to the biosphere, we do to ourselves. Big History education presents a unique opportunity to consider these dynamics across cosmic scales.
Systemic Reflexivity: A particular state of a component within a system that is simultaneously aware of its agency within the system and can thus modify its actions/impact according to a desired individual and/or systemic outcomes.	
Function/Significance: An understanding of systemic reflexivity, and in particular systemic reflexivity with the biosphere, equips the learner to assess the impact of a value, attitude, belief, or action over another based on systemic/self well-being.	Praxis: Practitioners should be aware that this is a consequence of any educational intervention. Further, if an appropriate response to the Anthropocene is a goal, then Big History presents an exceptional opportunity to cultivate a learner's systemic reflexivity within a natural biospheric system.

Table 2: A General Framework for Big History Transformative Learning

This research suggests the need for more empirical research on the transformative aspects of Big History. With the data generated by this research organized into a theoretical framework, future researchers will be able to design more broadly sampled and longitudinal studies that can further link the transformative learning experience of Big History students to social and environmental problems. Future work will also be able to focus more specifically on each of the elements of transformation, bringing a richer and perhaps more precise understanding. Another potential use of this research could be for large-scale educational programs such as the Big History Project, Chronozoom, and various Big History-themed MOOCS apply the findings of this dissertation to improve the transformative learning aspects of their programs. This would entail, for example, integrating the *Framework for Big History Transformative Learning* into their learning goals and using it to expand their teacher training curricula. They could also integrate aspects of the survey instrument designed in this thesis to analyze the transformative learning aspects of student experience.

Grounded Theory Part III

Based on the cumulative research conducted in this thesis, a three part general theory may now be fully explicated as follows:

1. Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners (Chapter 3).
2. The cognitive elements of Big History transformative learning correspond particularly well to several changes thought necessary by relevant experts to constitute an appropriate response to the Anthropocene (Chapter 4).
3. **The cognitive elements of Big History transformative learning are intrinsically linked to concepts engaged within the Big History narrative and supported, in practice, by established educational and communication theory** (This Chapter 5).

This theory generally supports the claims of Big Historians by providing empirical evidence of the unique cognitive elements of Big History transformative learning, linking them to the Anthropocene, and grounding the theory with additional, established educational and complex systems concepts.

Chapter 6

PRAXIS

If the Anthropocene is ... to be a critical concept, it must result in a discussion of a comprehensive ... ecologization of thinking and the mind, of subjectivity, desire, power, affects and so on.

-- Erich Hörl (2013)

What is demanded of us now is to change attitudes that are so deeply bound into our basic cultural patterns that they seem to us as an imperative of the very nature of our being.

-- Thomas Berry (1999, p.104)

Purpose of this Chapter

The work of this chapter is *Praxis*. Praxis means theory in practice. This is distinguished from the more general term “practice” in that praxis implies implementation of a specified theory. The specific theory put into practice in this dissertation is the three-part grounded theory developed just articulated above and the practice is cultural communication (Green et al., 2013).⁶⁸

This chapter, then, transitions the thesis from theory to practice by extending the *General Big History Transformative Learning Framework* (Chapter 5, Table 2) toward practical outputs. This work involves three sequential tasks as follows:

1. Clarify the relationship between thesis research and creative practice genre.
2. Justify and demonstrate creative practice as cultural communication.⁶⁹
3. Describe the mode of action used for cultural communication.

⁶⁸ For the purposes of this dissertation, the term “cultural communication” refers to communication designed specifically for public audiences (e.g., informal learning interventions and public lectures) as opposed to traditionally formal academic contexts.

⁶⁹ As will be developed in this chapter, an argument for creative practice is synonymous with an argument for cultural communication.

The Creative Practice Genre:

While all good research requires a degree of creativity, “Creative Practice” as a formal research genre refers specifically to scholarly research that integrates a practicable component or production. Australia has emerged as a world leader in defining the creative practice as doctoral degree research and scholars have been continually shaping, refining, and challenging its form and utility over the past two decades (Fletcher & Mann, 2004; Boyd, 2009).⁷⁰ Krauth (2011) traced the history of Creative Practice research over the past two decades and summarized its diversification from reflective, to parallel, to plaited (p. 3). The earlier “reflective” forms of creative practice prioritized the artistic practice or product, presumably as “high art,” in which the written component served as a post-practice exegesis⁷¹ revealing the creative process in hindsight.

The earlier forms of Creative Practice research later expanded to include a model in which the written component described the creative process in a continuing dialogical text. This addition to the form was considered significant because it implied a new, two-way “umbilical cord” between the theoretical research and its practical outputs.⁷² However, the originality was still largely driven by the internal genius of the researcher or creative practitioner and the exegesis merely aimed to reveal this idiosyncratic creativity.

As the scholarly debate continued into the 2000’s a new “plaited” form also emerged that allowed for a more “enfolded” relationship between the research and creative output. This shift also opened an opportunity to conduct what could be seen as more traditional, scholarly research and still integrate creative (artistic) approaches. The new transactional relationship also implied an added or alternative outcome to the research undertaken and

⁷⁰ Alternative terms used in the literature are “Practice Based Research;” “Practice-Led Research;” “Practice-as-Research;” and “Humanities & Creative Arts Research.”

⁷¹ In the context of the creative practice research genre, the term “exegesis” refers to the written, explanatory analysis of the creative output; the “artefact” of creative practice (i.e., the public lecture presented in Chapter 8).

⁷² In the parlance of creative practice research this is described as the relationship between the “exegesis” and the “artefact.”

“raised the status of the exegesis from servant-to-the-master narrative to a sort of equal, to a narrative in its own right” (Krauth, 2011 p.4). In this later variety, Krauth (2011) observed that the candidate might be seen to stop being only an artist, but also becoming a more “disengaged and critical humanities academic” (p. 3). In this sense, the creative practice genre had moved closer to a traditional research activity. By 2009 the Australian Research Council prescribed the criteria that creative practice research must provide information indicating: Research Background (field, context, and research problem), Research Contribution (innovation, new knowledge), and Research Significance (evidence of excellence) (Australian Research Council, 2009).

Academic issues notwithstanding, what strikes this researcher as most compelling about the more rigorous form of creative practice research is that it allows a more complex dynamical systems relationship between the “artefact” and its creation. It allows an even more “ecological” transaction that supports not just an “umbilical” relationship between artist and artefact, (or researcher and creative output), but a systems-based relationship between data, researcher, artist, artefact and world. It presents an opportunity not only to apply the creative energies of an individual, but also systemic input from a broader ecosystem. In this way, creative practice appears to capitalize on the “self-systemic reflexivity” so prominent in both the design and empirical findings of the thesis.

Cultural Communication and the Anthropocene

As first described in Chapter 1, and further explicated throughout the thesis, the Big History narrative embeds concepts of transcalarity, complexity, systems, and change. These concepts relate to the content of Big History education and the claims of its practitioners. They also serve to situate the thesis within the Anthropocene because the Planetary Boundaries Framework has been framed as a planetary-scale, complex dynamical system capable of including human cognition, culture, and the biosphere. The empirical survey, correlational analysis, and integration of the *Framework for Big History Transformative Learning* also generated a research context. The challenge of this section is to now justify the creative practice as cultural communication by documenting the role

of communication and in particular, the role of communication in culture with regard to the complex dynamical systems and the Anthropocene. How the theory generated through the cumulative research impinges on the design of the creative practice projects will be discussed in later sections. The following discussion will better clarify and establish the myriad links between cultural communication and these contextualizing issues.

The Role of Communication

An interdisciplinary yet very consilient commentary has arisen to describe the role of cultural communication in systems. Notably, McNeill (2011) identified three interrelated domains, or *equilibria*, of human civilization--the material and energetic, the biological, and the semiotic--and remarked that “the least material of these equilibria – the semiotic – had an almost magical power to alter the others, acting... as initiators of change within the systems as a whole” (p. 46). He continued, “[H]uman cultures ... were the most changeable aspect of reality and impinged on all around us” (p. 46). McNeill thus intuitively that human “webs of communication” are among the most important aspects in the playing-out of human history, defining how humans interact with each other and their environments. McNeill believes that these webs of communication have played “such a commanding role in provoking historical change” (p. 47) that his advice seems to be; if you want to transform humankind, transform their “webs of communication” (p. 42).⁷³ A similar view has compelled the late theologian Thomas Berry (2000), to call the formation of a new cultural story the “great work of our era” and the economic psychologist David Korten (2007) to surmise that the “[Great Turning] requires reframing the cultural stories by which we define our human nature, purpose, and possibilities (p. xlvii).

Culture as a narrative phenomenon

⁷³ This presumably includes various cultural manifestations.

Korten (2007) was prescient to invoke “cultural stories” because as the discourse of this thesis has suggested, transformative learning in Big History (and human cognition generally) is deeply dependent on narrative structures. Charlton (2008) underscored this utility when he asserted, “People will not feel comfortable and positive about the contemporary world until we can endorse and believe an evolutionary cosmology which is appropriate to modern conditions” (p. 1). McAdams (2008) then specified “appropriate” in terms of the formulation of personal, identity narratives, which he added are,

an especially salient challenge for individuals living in modern societies, who seek personal integration within an ever-changing, contradictory, and multifaceted social world that offers no clear guidelines, no consensus on how to live and what life means. (McAdams, quoted in John et al., 2008 p. 242)

The point is made explicitly by Christian (1991) that earlier societies too all lived with big stories that were widely known and widely believed, but today such a story is lacking. As argued by Christian (1991), the Big History story is an attempt to create such a story for the modern world. Therefore, especially today, the narrative structures present in the ways we think, identify, and construct modern societies make cultural communication an ideal disseminative form for teaching the transformative learning inherent to Big History.

Urgent Context

Cultural communication is also ideal on the grounds of urgency in the context of the Anthropocene. Ehrlich and Kennedy (2005) invoked this “memetic” argument when they wrote of their hope to bring about necessary cultural change that can “speed that process and encourage change in a positive direction.” More specifically, other scholars have written that research-based cultural communication practice may offer quicker responses to culturally induced environmental problems. For example, Kellert (2008) wrote that with a situation as urgent as the Anthropocene, “The goal must be forging cultural

change, not waiting on it” (p. 11), while Speth (2009) reminded us that ecological affinities can be learned “relatively quickly” (p. 26). Adopting the creative practice model for this dissertation, then, is pragmatic at least on the grounds that information can travel quickly through the complex dynamical systems that embed culture.⁷⁴

Cultural Problems call for Cultural Solutions

As I argued in Chapter 1, and was echoed in the chorus of experts in Chapter 4, the environmental problems that constitute the Anthropocene are to some degree culturally induced. An example of the link between cultural communication and its biospheric impacts may be readily visible in the contemporary world. Kasser (2009) points to the fact that existing multinational corporations already employ a powerful, well-funded, and highly sophisticated cultural communication machine and observes that

We live in a culture dominated by commercial advertising, which should be understood as the best-funded, most sophisticated propaganda campaign ever employed in human history, with millions of dollars spent yearly to pay researchers to investigate how to “press the buy button” and billions of dollars more spent to pay for-profit media corporations to deliver these messages to children, adolescents, and adults.” (p. 192)

Thus, cultural communication is justified on a more optimistic reverse logic that, if it works for commerce, it could, in principle, also work for creating countercultural forces.

An additional rationale for cultural communication, as opposed to legislation, for example, is because the Anthropocene, as a complex, bottom-up phenomenon, will tend to resist change merely imposed from above. This is underscored by Speth (2009), who predicts, “If the people in a democracy no longer care about the land, the laws that protect that land will not hold” (p. 326). Forbes (2009) too calls for “conservation grounded in an ethos of relationship” rather than “in law” (p. 326), implying that laws and policies

⁷⁴ This is essentially a memetic argument: how ideas are communicated and evolve based on Darwinian natural selection principles.

originate in collective values, and beliefs: how people think. If so, at least in a functioning democracy, cultural values tend to precede and shape laws, not so much the other way around. It seems reasonable then, that we could turn toward the aforementioned deeper drivers of culture in seeking an appropriately resilient response to the Anthropocene.

After critically assessing “the potential of contemporary social actors” such as politicians, legislators, and others who dominate public discourse, Raskin (2009) finds them too fragmented and myopic “for the task of such a transformation” (p.122). Yet, maintaining steadfast hope in “people as active agents who interpret events give cultural meaning to social reality, and construct order, norms, and authority” he suggests we turn toward “other social forces now latent in the cultural field” (p. 122). But if not marketers, lawmakers, or politicians, then who? Charlton (2008) specifically casts “creative artists, including inspired scientists, to create new means for communicating new human-cosmological ideas, images, and stories” (p. 7). Such calls resonate with the claims of Big Historians and the goals of cultural communication, both of which, further support the creative practice approach taken in this research.⁷⁵

Because Creative Practice research explicitly supports artistic as well as academic values as its *raison d'être*, it is well suited to cultivate simultaneously objective and rational as well as aesthetic and imaginative responses to the Anthropocene.

Integration of Science and Humanities

⁷⁵ Which, recall, “is all about discovering and disseminating knowledge through new ways of thinking, seeing and hearing” (Macquarie University, 2015 para. 3).

Callicott (2009) has argued that the humanities should have an important role “in creating a new consciousness in harmony with Nature,” which could be accomplished by “forg[ing] a partnership with the sciences in order to bridge the chasm” between two cultures that were “coexisting but mutually estranged” (p. 276). To bridge that chasm, he suggests, “expressing the new nature of Nature, as revealed by the sciences, in the grammar of the humanities” (p. 276). Callicott sees the “The putatively ‘value-free’ discourse of science—a mixture of mathematics, statistics, and technical jargon—is not readily or easily accessible. [whereas] The discourse of the humanities—rich with imagery, metaphor, emotion, and honest moral judgment—resonates with a much wider audience” (p. 278).

Callicott (2009) went further than calling for an integration of science and humanities. He explicitly asked for people who were capable of doing so to come forth through cultural means and “express the philosophical and humanistic essence out of contemporary scientific theories” (p. 278). He called for a radical new tradition to bring original scientifically accurate interpretations to cultural communication by saying,

[N]ot only should humanists witness and testify to these changes, driven by science and communications and information technology, I believe that humanists are one of the main channels through which a new consciousness in harmony with Nature shall flow. Not only can we humanists articulate and interpret the wonderful new natural world that the sciences are revealing, we can even steer consciousness change in positive and hopeful ways. In our collective cultural life, as in our individual personal lives, I believe in the power of optimism. (p. 295)

Thus, another justification for the use of the creative practice model is that by encompassing artistic endeavors, it invites an interpretive mode and aligning it with growing efforts to bridge the sciences and humanities.

Inherently collaborative

There is now a documented and widespread belief that an appropriate response to the Anthropocene lies in collaborative, cultural communication. This is a view expressed by the diverse experts who convened the Yale School of Forestry and Environmental Studies, reporting,

We have many sophisticated scientific and policy analyses of climate change, species loss, and other environmental issues, but our situation also requires the knowledge and wisdom of psychologists and philosophers, poets and preachers, historians and humanists to help us see and communicate hard truths and inspire individual and social change. (Leiserowitz & Fernandez, 2008, p. 21)

Along these lines Raskin (2009) commented that,

This is the revolutionary moment when conditions are in place for transformation. In the midst of systemic crisis, [overly] conventional institutions and ideas lose their sway, and political authorities lose their legitimacy, enlarging cultural and political arenas for oppositional concepts and new allegiances. (p. 129)

Innovation commensurate to the Challenge

The uncertain and potentially catastrophic nature of the Anthropocene surely calls for, “muting the risks that threaten social and ecological continuity; adjusting our values, behaviors, and institutions for a world growing more connected and fragile; [and] mobilizing cultural and political resources for fundamental social change” (Raskin, 2009 p.112). But Raskin also concluded that a foundational model for such change “has not yet been laid” (p.117). So how is this to be done?

Experiential

Experts from across the disciplines are calling for new narratives that are integrative of nature rather than disconnected from nature; rooted in science; inspiring; and experiential as well as conceptual. Leiserowitz and Fernandez (2008) further expressed the need for “new metaphors that accurately represent scientific understanding, but also engage powerful and emotionally motivating networks of associations in the human mind” (p. 40). According to Charlton (2008), in order for this narrative to fulfill its internal [psychological], and external [cultural] function, it must be poetic, symbolic, dynamic [evolutionary], and inspiring of awe” (p. 2). Leiserowitz and Fernandez (2008) made a similar call for creative arts to cultivate new, naturalized narratives. They laud the “pioneering efforts” among humanities scholars who “explore and analyze the links between the environment and literature, history, philosophy, religion, and the creative arts” (p. 42). They claim these types of endeavors warrant “further support, expansion, and integration across disciplinary boundaries, including reaching out to engage broader society in a critical evaluation and transformation of dominant cultural narratives and practices regarding human-nature relationships” (p. 43). Recognizing the value of living these relationships in the first-person phenomenological sense, Rose (2009) also calls for “models of change that we can experience” (p. 82). One model implied by the attendees of the Yale sustainability conference is that “We should tear down the conceptual walls that stand between humans and nature to view ourselves more properly as part of the natural world and vice-versa” (Leiserowitz & Fernandez, 2008, p. 56). If, as they claim, we have become walled off from natural domains by cultural boundaries, then the great work, according Forbes (2009), is “about turning hard boundaries into soft boundaries and teaching the mature skill of gracefully navigating this new terrain” (p. 235).

Transition from Grounded Theory to Creative Practice

The thesis has heretofore been building a case for transitioning from theory into practice or praxis. This is akin to Krauth's (2011) move from "disengaged and critical" (p. 3) toward Charlton's (2008) "creative and inspired" (p.7); from generating empirical data on the "shift[s] in sensibilities" associated with learning Big History, to generating "patterns, frames, [and] metaphors—for the telling of deep histories" (Shryock & Smail, 2011 p. xi).

An Osmotic Model of Cultural Communication

Building on the discourse above, I now propose a culture-bound, experiential and metaphorical cultural communication model based on permeating membranes or the "softening of boundaries" as invoked by Forbes (2009).

In the classic science-lab demonstration of molecular osmosis, a semi-permeable membrane divides a beaker vertically into two equal reservoirs of a liquid solution (solvent plus solute). After additional solute (only) is added on one side of the membrane, increasing its concentration, osmotic forces push molecules through the membrane, toward the higher concentration, in order to equilibrate system. The net movement of molecules causes the concentrations to equilibrate but the effect is also to raise the level of the solution one side of the membrane. This rise is surprising because it rises against the prevailing force of gravity.

Building metaphorically on the dynamic of physical osmosis I propose a similar, narrative-based model for the cultural diffusion of cosmic concepts, awareness and identity. I have termed the process *Cosmosis* (cosmic osmosis) in which the membrane in the molecular version above can represent any of the conceptual boundaries that humans *construct*. By this I mean the philosophically constructed divides between science and humanities, nature and culture, self and other, etc.. In this metaphorical system, if we now dissolve a mix of personal stories on "our" side of the membrane, the system again equilibrates, this time, by *cosmotic* pressure. But in this case, instead of a liquid solution

rising against the force of gravity, the shift is an increase of personal narratives dissolved in cosmic narratives. Again, perhaps still surprisingly, the level rises (the system changes), but this time against the prevailing force of culture.

If we can now also imagine that each time a narrative crosses the membrane, whether it is personal or cosmic, it effectively punches a new hole in the membrane so that, over time, it becomes increasingly permeable. The more our personal stories crossover into natural and cosmic stories (as opposed to merely cultural) the more naturalized our personal identity narratives become.⁷⁶ The same would be true in the other direction as well; the more that natural, cosmic stories enter into our personal stories, the more naturalized humans become. And because stories traveling in either direction must currently cross culture (which is the present state in the Anthropocene), culture too, thus, becomes more naturalized.

I realize that the metaphor is not perfect. So I will now present the *Cosmosis* model using a series of simplified graphics.

⁷⁶ This model, of course, has worked equally as well with stories that can just as effectively disconnect humans from cosmos and nature. Which is, presumably, a misleading state of identification that has contributed to the Anthropocene.

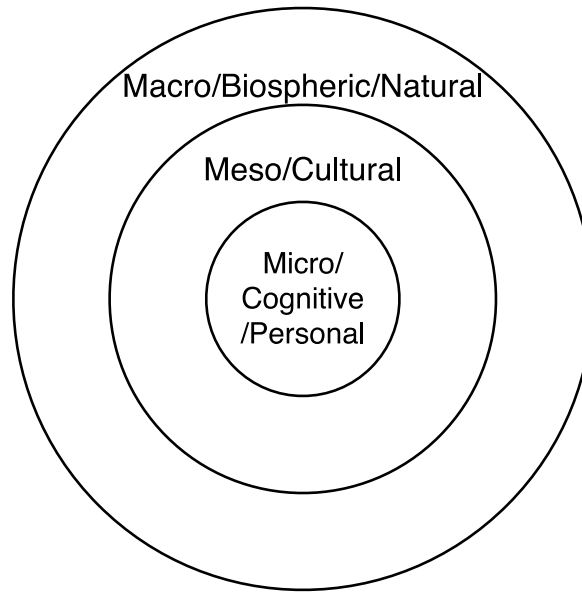


Figure 4a: The *Cosmosis* Model of Narrative Diffusion

Figure 4a above depicts the *Cosmosis* model for narrative diffusion from personal-to-cultural-natural domains. In this initial state, the three domains are separated by solid lines, or “hard boundaries” using Forbes’ (2009) language. The inner circle labeled *micro/cognitive/personal* represents the realm of cognition where personal narratives operate. The middle circle labeled *meso/cultural* represents the cultural sphere, and beyond culture is the *macro/biospheric/natural* domain, which is synonymous with Nature. In this state, the cultural domain is experienced as standing between the personal (inner) and natural (outer) domains.

Figure 4b below updates the system by showing a permeable boundary (dashed circle) between the personal-micro domain and the meso-cultural domain. This signifies that cultures created by humans generally reflect the collective beliefs, values, and thoughts of individual people, expressed human agency. Figure 4b also introduces the element of narrative to the *Cosmosis* model, and specifically the transmission of narratives across the membranes between domains (indicated by the arrows). Given the high degree of reflexivity between personal and cultural narratives, the membrane between personal and cultural narratives is easily traversed through the process of normative enculturation discussed above (represented by arrow *a*) and is thus highly permeated. In this state, our

connection to nature and cosmos is obscured and overly cultural identification is easier to see and adopt.

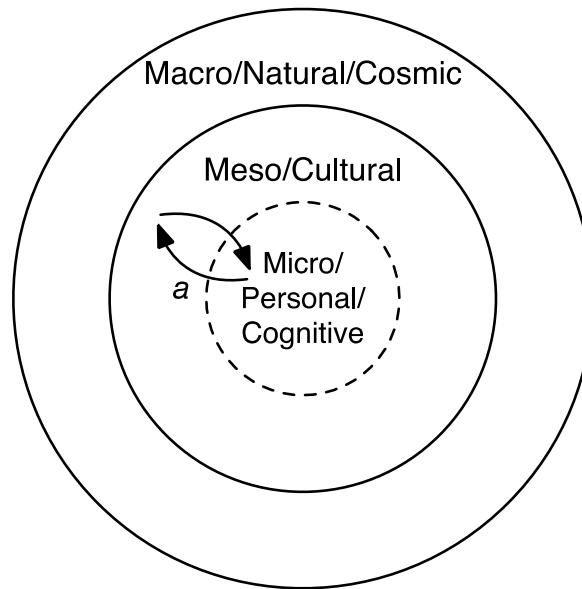


Figure 4b: The *Cosmosis* Model (Cognitive to Cultural)
Cosmosis: Cognitive to Cultural. Arrow *a* indicates a “foray” into the meso-scale narratives of culture. Forays can be either experiential or conceptual. (e.g. a walk down Main Street or through a shopping mall, a visit to an art gallery, or viewing a television commercial). As a convention, forays begin in the personal domain. They begin and end with the self and the double arrows indicate a transaction between personal identity narrative and the narratives of the domain experienced.

The arrows in the diagram can also be thought of as narrative forays. In other words, each time an individual embarks on a foray, whether it is experiential or conceptual, an experience happens. That experience takes a narrative form (see the discussion of cognitive narrative structures in Chapter 5) and is added to that individual’s repertoire of cognitive experience. That story is also appended to that individual’s identity narrative according to the narrative psychological principles previously discussed. The double arrows indicate that every experience conveys obligatory change in both the experiencer and the world. For example, when an individual engages with the cultural domain, they then *embody* that change on a personal level, and *enact* it through participation and creation of new culture; change happens. As in the previous *Cosmosis* metaphor, each transgression of a border also imparts an opening. This corresponds to transformative learning because as openings become more numerous, and larger, broader cognitive

capacities and narrative identities are able to pass through them. Not only can a personal narrative traverse the cultural realm and vice versa (i.e. one can tell our stories on YouTube, or Nike can induce one to buy sneakers), but also, a phenomenological experience in nature (say, a period of contemplation in a forest) or an intellectual engagement with Big History (as in a lecture or public talk) can create a path between the personal and cosmic realms. The more often, and further an individual embarks, the more permeable, and extended the boundaries between personal and cosmic narratives become, and the more integrated the cosmic narrative is within the individual's own identity narrative. Over time, the membrane becomes increasingly diffuse (Figure 4c below). Experiences in one domain affect the others, and to that extent, the entire system is shifted toward system *reflexivity*: self, culture, and cosmos are transformed through our personal experiential forays. The realization of the membrane permeability is the essence of what I have called self-system reflexivity. In this state, our connection to nature and cosmos becomes easier to see and identify with, thereby balancing out the present and overly-cultural self identification.

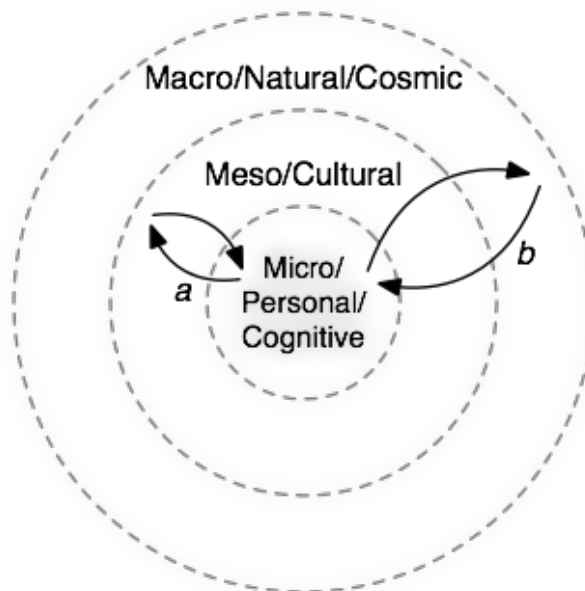


Figure 4c: The Cosmosis Model (Cognitive to Cultural and Natural)
Arrow *b* indicates a broader narrative foray into the macro-scale, natural, world, biosphere or cosmos (i.e. a walk in the woods, contemplation of a leaf, a planetarium show, or engaging with Big History). Again, narrative has the power to move through the boundaries and in each instance punch a hole that can increase permeability.

Of course, I am not proposing this as a literal description of reality. It is merely a simplified metaphorical model for visualizing how engaging with Big History, a narrative that encompasses all of the narrative domains in the model, can elicit transformative learning, propagate that transformation, and help understand *the mediating role that culture can play*. This systemic understanding becomes especially relevant in the context of the Anthropocene and should have practical implications for both the formal teaching and cultural communication of Big History because it addresses how cosmic level phenomena and understandings can impact our personal thoughts and actions. And if there are impacts, how they can then be transmitted to problematic culture. These are the basic questions addressed through the creative practices of this thesis by demonstrating this *Cosmosis* model as praxis (theory in practice).

Cosmosis occurs each time the cosmic story diffuses across the membranes to permeate the entire system. In this case, personal, cultural, natural and cosmic narratives are transformed. In this practical framework the focus is not so much on the experience of the world (as in the discussion of phenomenology), or what the stories are (as in the discussion on narrative), or how they are held in knowledge (as in the discussion of tacit knowledge) or how they are carried between the domains (as in the discussion of cybernetics), but how the boundaries between the domains become more porous and permeable. *This is the element of personal transformation* -- porous boundaries -- and the point of a *Cosmosis* praxis. The result of all this is phenomenological and ontological continuity and a key part of Big History transformative learning which hold that personally experiencing the cosmos (and by default the biosphere) matters.

Because each “foray” into a wider domain of experience, whether physical or intellectual, punches a metaphorical hole in the boundary that is traversed, a potentially measurable criterion for assessing a *Cosmosis* praxis will be the degree to which it results in a change in boundary permeability. A further and more specific measure could also be how equally

dispersed the permeability is across the boundaries between the learner and the natural world or cosmos (as compared to the boundary between self and culture).

Example of *Cosmosis* in Cultural Communication

An example of how this model could be implemented in cultural communication is provided by the Planetary Boundaries Framework (Chapter 1, Figure 1). As previously discussed, the PBF depicts nine planetary-scale systems based on scientifically quantified boundaries (in this case, “boundary” refers to system-specific measures of anthropogenic perturbation) that humanity should strive not to exceed. However, “engaging with society about the planetary boundaries” through “visualization, outreach and public engagement” is also stated as a core research theme within the PBF project. As such the PBF diagram is also meant graphically represent the interrelationship of nine planetary systems and their boundaries values. One of the main goals of the PBF is that the “earth is a single complex, integrated system” (Steffen et al., 2015, pp. 7–8). Yet, on the diagram, the lines between the nine systems are solid, rather than permeable, and straight rather than indicative of any circular, systemic feedback. The use of solid lines in the diagram of the PBF might instead suggest that these systems are discrete, which, in effect, de-emphasizes inter-system communication. To help make this point, a hypothetical adaptation of Steffen et. al. (2015) is offered in response as Figure 5 below.

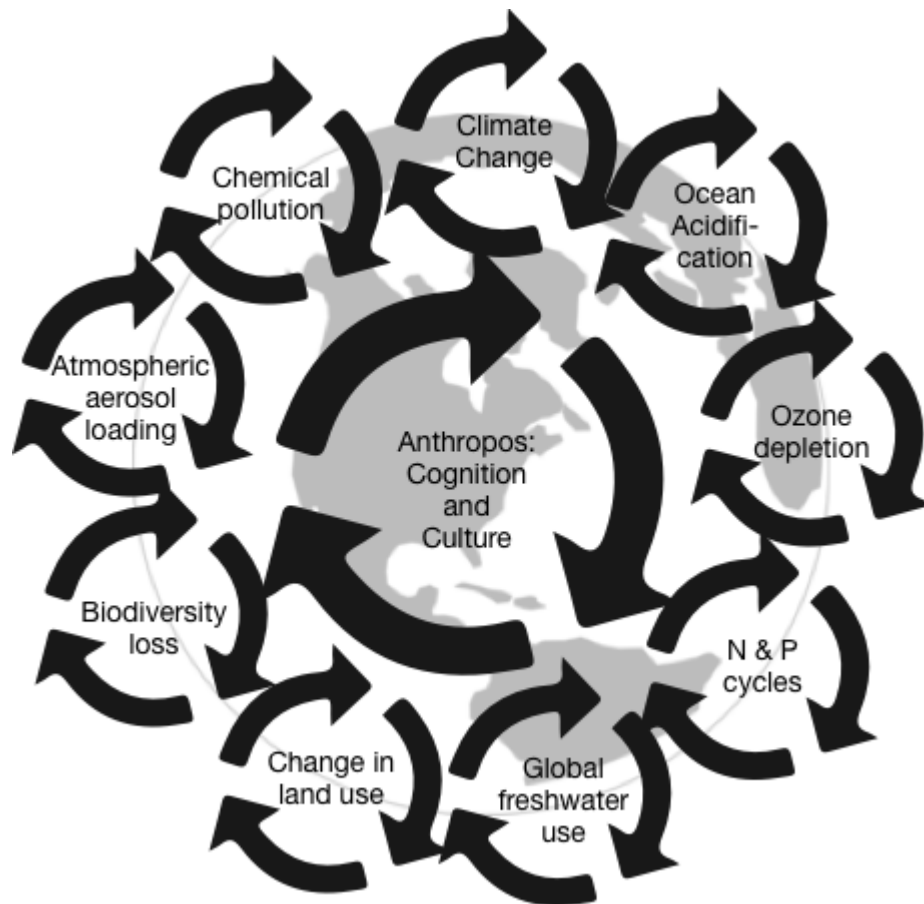


Figure 5: Hypothetical Adaptation of the Planetary Boundaries Framework
A hypothetical adaptation of the Planetary Boundaries Framework of Steffen et. al., (2015). In this rendering, the framework includes the “Anthropos” as a centrally positioned entity, touching upon all of the planetary systems and potentially measured by cognitive and cultural aspects.

To be clear, the original PBF and diagram presented by Rockström et al., (2009) is adequate for what it sets out to do, namely, to “define a safe operating space for humanity based on the intrinsic biophysical processes that regulate the stability of the Earth System” (p.1). The critique here is not of the research or the science behind the PBF but of the cultural communication implicit in the diagram. In light of the cumulative findings of this thesis it is glaring, at least to this researcher, that the quintessential anthropogenic system, culture, is not also represented as one of the “intrinsic biophysical processes” in the diagram. I acknowledge that the authors may have sought to limit the scope of the diagram in order to more simply show biospheric limits quantitatively, but it seems ironic to not indicate that humans are an integral part of the living sphere. This is especially visible given that the namesake of the proposed geological epoch, the *Anthropos*, is cast

as the responsible agent. Is it too implicit to be explicit? Or might this omission, especially in a graphic designed as tool for cultural-level communication “to engage the public,” inadvertently miss an opportunity to communicate a more unifying message? In any case, this oversight of graphical design in the PBF misses a crucial opportunity to communicate perhaps *the* key notion of biospheric systems science: that the human thinking is an integral part of anthropogenic impact and thus an important component in planetary biospheric degradation. A broader implication of this missed opportunity may provide some justification for research in a subject such as Environmental Humanities. Such research could investigate how this small, but philosophically important observation may also be reflected in the literature of Anthropocene Studies.

Implications for Creative Practices of the Dissertation

This chapter set out to clarify a number of issues relevant to Big History cultural communication in the context of the Anthropocene and with some reference to the principles of complex dynamical systems. By establishing the relation between the research and the practice I have shown how the theory generated by this research overall has been integrated into practice (praxis). How the theory is integrated into the practice is the essence of exegesis and has distinct implications for how the creative components should be engaged in this dissertation.⁷⁷

While the dissertation in its entirety effectively constitutes an exegesis, the following two chapters serve to elucidate specifically how the *General Framework for Big History Transformative Learning* (Chapter 5, Table 2) is applied as praxis to each of the two creative practice projects.

On a general level, the criteria for judging any creative practice, is reflected in the funding priorities of the Australian Humanities Research Council (2012):

⁷⁷ This approach of implementing the research in creative practice, and then also explaining how through the exegesis, are the defining conventions of the genre. As such, the exegesis *is* the explanation.

Our primary concern is to ensure that the research we fund addresses clearly articulated research questions, issues or problems, set in a clear context of other research in that area, and using appropriate research methods and/or approaches. (p. 9)

Applying these criteria specifically to the current thesis suggests asking the following questions of each creative output:

- Is it situated within the claims of Big Historians and the Anthropocene?
(see Chapter 1, Context)
- Does it fit the designed-based methodological structure?
(see Chapter 2, Dissertation Design)
- Does it draw on the empirical findings?
(see Chapter 3, Empirical)
- Does it build on the links discovered in the correlational analysis?
(see Chapter 4, Correlation)
- Is it grounded in established educational and complexity theories?
(see Chapter 5, Integration)

To put this in philosophical terms, the question is; How well does it conform to Chaisson's "ontological continuity?" Or in metaphorical terms; How much osmosis does it facilitate? That is, How often and how well does it punch holes in perceptual boundaries?

As I have now argued from numerous, integrated fronts, the decision to adopt the creative practice genre for this dissertation was highly pragmatic because, the form can directly and beneficially link the impacts of Big History transformative learning to the Anthropocene.

Chapter 7

PRACTICE 1

What seems to be a stone is a drama.

— Abraham Joshua Heschel

Purpose of this Chapter

Chapter 7 documents the design and production of *Cosmosis I*: A mobile smartphone app for *in-situ* experience of the Cosmic Background Radiation. Much of the text here reiterates Blundell (2013), *Making it Real: The Cosmic Background Radiation Explorer App*. The chapter concludes with an exegetical table that describes how the app integrates the empirical results generated in Chapter 3 (see Table 1: *The Cognitive Elements of Big History Transformative Experience*) and the *Cosmosis* praxis based on integrative research conducted in Chapter 5 and 6 (see *The Framework for Big History Transformative Learning* in Table 2).

Background

The Cosmic Background Radiation (CBR) is a keystone piece of consilient evidence in support of modern cosmology and, as such, it is critical to understanding the evolution of the universe. Indeed, much of what we know about the Big Bang and the subsequent evolution of the universe is inferred from the study of the anisotropic fluctuations in the microwave radiation as recorded in the CBR image. While the CBR is one of the most fundamental and empirically supported phenomena in all of cosmology, widespread public perception and student understanding of the CBR remains inappropriately weak.

Thus, for my first creative practice, I designed a mobile smartphone app to simulate the CBR as it would be observed if one could fine-tune his or her eyes to see in the microwave radiation. In this chapter, I argue that conventional means of educating about the CBR have largely failed to capture and convey its essential relevance to daily experience. I then propose new phenomenological approaches to teaching about abstract subjects by building conceptual understanding *on top of* real-world, phenomenological experience. The app addresses this problem by providing a simulated, geospatial, interactive, and phenomenological experience of the CBR. The following text reports on the theoretical, pedagogical, and technical aspects of the project before summarizing in an exegetical table how the app implements the *Cosmosis* praxis to cultivate cosmic level, systemic reflexivity in learners.

Technological Justification

The rationale for creating a smartphone app as a cultural communication practice is simple: handheld network-connected devices have become ubiquitous in culture and are gaining fast adoption in education. Digital communication is one of the preeminent forms of cultural communication in our time. The industrialized West is a technological culture, subject increasingly to technologically mediated experiences of the world. This trend will likely exacerbate the problem of disconnection from nature and the Anthropocene unless we endeavor to design more nature-oriented technological experiences. The scholar and cultural critic Eric Hörl, when asked how technology, art, media, ecology, and practice would relate each other, replied,

I can imagine that technology and art together will advance the process of the ecologization of Being. ... I dream of a neo-cybernetic underground which grows to be the germ cell of a general ecological practice, which does not let itself be dictated the meaning of the ecologic and of technology, neither by governments, nor by industries. ("From the Anthropocene to the Neo-Cybernetic Underground. A conversation with Erich Hörl," 2011)

Thus, I adopted a research sub-question for this Chapter as follows:

What would creative practice application of the Cosmosis Reflexivity Framework for Transformative Experience in Big History look like in a technologically mediated context?

Callicott (2009) declared that the “revolution in communications and information technology” is “more profound” than any other revolution in history, greater than the shift “from orality to literacy,” which occasioned its own “profound shift in human consciousness – from a sense of community identity to personal identity and from mythic thought to abstract philosophical and scientific thought.” Callicott declared that the current shift, the one “from literacy to Googality,” would cause “another transformation of human consciousness ... as we leave the linear world of letters and the privacy and intimacy of the one-way conversations we have with books, for the simultaneity, interconnectedness, and interactivity of the cyber world” (2009, p. 278).

Agreeing that such a revolution is indeed underway, Mitchell Thomashow (2009) discussed the “epistemological challenge” of developing “an integrated cognitive framework for teaching environmental change (p. 400).” The development of such a framework requires not only a “reconsideration of how science is taught,” but also attention to “how it serves to empower students to assess and propose solutions for problems of planetary significance.” According to Thomashow, this work depends upon the purposeful use of technology; it is “deepened and enriched with the use of computers and the Internet and the implicit scaling conceptualizations embedded in their use” (2009, p. 423).

Cosmosis1: The Cosmic Background Radiation Explorer

Any truly holistic attempt to teach what we know about the early universe, or the history of the universe in its entirety (such as in Cosmic Evolution or Big History courses), should begin, appropriately, with the beginning of our knowledge. This means starting with the physics of the Big Bang. Much of what we know about the Big Bang and

subsequent evolution of the universe is inferred from the study of the Cosmic Background Radiation (CBR). The CBR is one of the most fundamental and empirically supported phenomena in all of cosmology (Weinberg, 2008). The entire modern cosmological model rests on the CBR because everything that follows it is rooted in the primordial temperature fluctuations represented by the splotches of blue, turquoise, orange and red (See Figure 6).

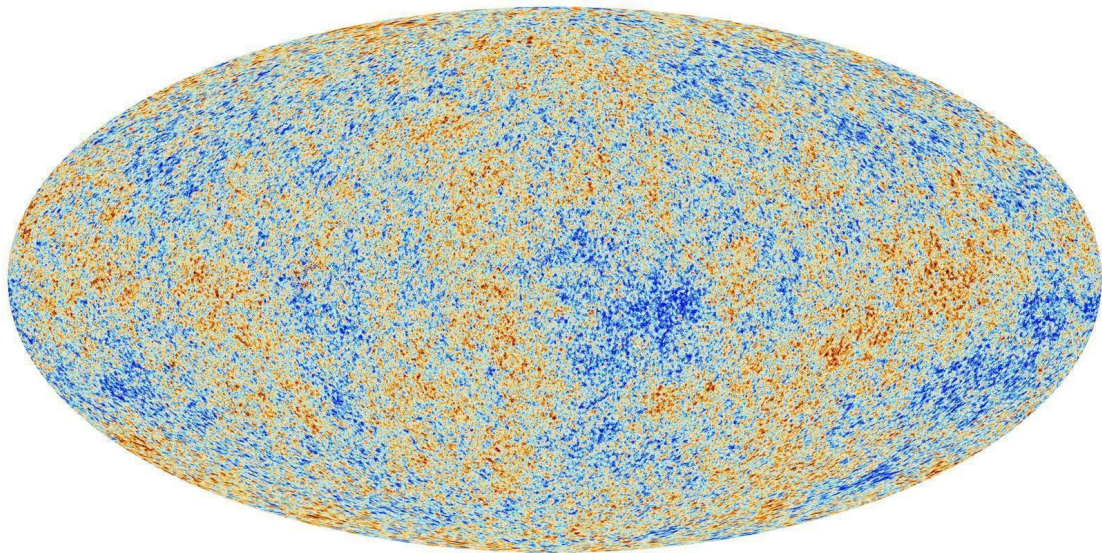


Figure 6: The Cosmic Microwave Background Radiation
Used by permission European Space Agency (2014)

But the true significance of these quantum-level perturbations is impossible to grasp unless one holds an overall understanding of how these minute temperature differences (or energy densities) have evolved into the large-scale galactic structure we see today. Subsequent topics, such as the formation of stars and galaxies, accretionary physics of planetary systems, the emergence of complexity, and the mega-scale structure of the universe, depend on integrating the physics and spatial ubiquity of the CBR.

It is common for educators to introduce the CBR by telling the wonderfully serendipitous story of how Penzias and Wilson discovered it. They include language like: “The CBR is the echo of the Big Bang,” or “The CBR is the leftover radiation from the Big Bang.”

These conversations are typically supported using images of the CBR produced by NASA and the European Space Agency (ESA, 2013). Published surveys (Fraknoi, 2004; Wallace et al., 2011) and our own teaching experience suggests that while most students can readily grasp the ideas of “echo” and “residual” radiation, they fail to be able to explain how evolution is the source for the mega-scale structure of the universe, or even locate where the CBR actually is.

While the NASA and ESA images are excellent resources for visualizing the CBR in formal learning environments and for discussing the finer points of cosmic microwave anisotropy, I argue that these images alone routinely fail to place the CBR into a real-world and thus appropriately meaningful context.

Another way that educators have tried to bring relevance the CBR is to explain to students that they can experience the CBR today by “un-tuning” an old-style television set and observing that about 10% of the static seen is caused by the CBR. While there is nothing factually incorrect in the content of these approaches, they are technologically outmoded and inadequate for communicating the immense importance of the CBR as a cornerstone idea of the Big Bang model. There are a handful of projects dealing with the conceptual understanding and visualization of the CBR (Van der Veen J., 2010; McGee et al., 2011; Dekker et al., 2011; Van der Veen et al., 2012), but all of these endeavors rely on large traditional desktop or other large-format (i.e. stationary) monitors.

Research Problems

The CBR remains under-appreciated and misunderstood relative to its importance, ubiquity, and rare exemplification of scientific consilience. While the abstract notions and the complex physics of the early universe are known contributors to this low engagement (Fraknoi, 2004; Van der Veen et al., 2012), we argue that the initial introduction of the CBR needs to be a more phenomenological encounter. If students can be introduced to

the CBR as a lived-experience first, then they will be better equipped, and more motivated, to engage with it intellectually when the material gets more sophisticated.⁷⁸

While I am arguing here in general for a more relevant, phenomenological, way of encountering the subject of the CBR, another, more specialized, problem also arises in the context of narrative-based courses that include the CBR. In courses such as Big History, where the overall structure is narratively structured, sequential, and the complexity of one chronological phase is built upon the one preceding it, the issue of keeping concepts linked in a congruent way is especially important. Because the CBR, and the cognitive disconnect associated with it, happens early in these types of courses, it can severely disrupt future learning. We have observed that once students lose their orientation, it is often very hard to regain it in a chronological, and thus logical, and thus meaningful way. By failing to communicate the genuinely critical aspects of location and relevance of the early universe, Big History educators risk losing many students from the outset. This deprives students not only of a fuller understanding of the Big Bang model, but also of the truly awe-inspiring and holistic reality of the rise of complexity in the universe – a reality of which they are a systemic part and can experience with a little technological help and imagination. In a constructivist paradigm of learning, it is illogical to expect students to successively link the phases of cosmic evolution into a logical sequence without a primary understanding of how the CBR predicts the future evolution of the universe. In a very real and debilitating way, students can get lost intellectually, and thus in more personally meaningful ways, as soon as they leave the gate.⁷⁹

The idea proposed here is that there is an under-realized way of perceiving the CBR and learners who can incorporate (indwell) this perception will undergo a sort of transformative relationship with the world. I call this basic transformation in thinking an epiphany, as in, *the usually sudden manifestation or perception of the essential nature or meaning of something* (Merriam Webster, 2012). The specific epiphanies provided by this

⁷⁸ This is an idea closely related to Polanyi's (2009) notion of tacit knowledge and the associated motivation toward new learning because it has become personal through "indwelling."

⁷⁹ Maintaining the connection between the learner and the story is critical to develop "self-system" reflexivity argued for in Chapter 5.

app are that the CBR is real, it is not only “out there” in the sky but also within the learner physically and narratively, and that the structure of the sky today is a real-world embodiment of the initial temperature fluctuations recorded in the CBR. By the rule of transitive relation, then, the user is a real-world embodiment of the cosmos. In this way, *CosmosisI* is inherently ecological (and therefore helps cultivate a broader ecological identity) because it reveals the creative power of relations in the universe. This is the transformative learning intended through the experience of the *CosmosisI* app.

The key innovation here is to provide a phenomenological base upon which more formal, in-class conceptual understandings can be later built. We do not aim to provide an in-depth examination of the science of electromagnetism or the CBR. We emphasize this limit in defining the scope of this app to the initial part of this aim. Filling in the details of concepts such as cosmic inflation, differentiation, decoupling, and the behavior of electromagnetic radiation, for example, still require formal learning efforts and environments. This limitation notwithstanding, we also hope and expect that this app may find extended application in broadly diverse, informal settings (i.e., cultural communication). In any case, this project enhances the general trend in integrating educational media and software (such as apps) in the classroom (Bonnington, 2013).

Theoretical Underpinnings

The arguments and claims of this project emerge largely from our own observations in teaching and assessing students’ understanding of the CBR. There also exists a rich body of published literature and empirical research in support of phenomenological education. What is new is the ability to implement well-crafted educational experiences through affordable technological means.

The currently emerging technological paradigm presents new opportunities to apply time-tested educational approaches. If the mark of a good idea is timelessness, then the ideas of the John Dewey most certainly qualify. Dewey, who thought deeply and wrote widely on the relationship between human experience and learning, anticipated the constructivist theory of learning in which becoming educated meant more than just one’s cognitive

accrual or rote learning. Dewey held deeply intuitive understandings of the power of personal experiences and made explicit connections to the formal educational endeavor. As early as 1909, he was writing about the importance of “organizing education to bring all its various factors together ... into organic union with everyday life” (Dewey, 2010, p. 35). Broadly speaking, this app accepts Deweyan philosophy because it aims to reconnect learning to everyday life.

Dewey also stressed the reciprocal relationship between experience and learning. Dewey’s idea is recalled by Pugh (2011) as “Just as experience is a means for enriching and expanding learning, so learning is a means for enriching and expanding experience” (p. 109). This reciprocal relationship between the lived-experience and learning constitutes the phenomenological argument for this app.

Dewey also maintained a dual commitment to the power of aesthetic experience while also remaining a staunch pragmatist. He reminded us to measure the value of things insofar as they impacted everyday life. Toward the end of his career, he displayed this pragmatism when he wrote that the value of any philosophy would rest on the answer to this question: “Does it end in conclusions which, when they are referred back to ordinary life-experiences and their predicaments, render them more significant, more luminous to us, and make our dealings with them more fruitful”? (Dewey quoted in Pugh, 2011, p.7).

Finally, Dewey (1934; 1958) offers insight into this project by making distinctions between more traditional and progressive definitions of learning. For example, he talks about the difference between learning *concepts* (as static knowledge to be acquired) and encountering *ideas* (as opportunities to consummate new potentials). Dewey argued that when we think in terms of ideas, as opposed to concepts, we open up whole new ways of relating to the material to be learned. In other words, he is framing educational opportunities as experiences to be had, as opposed to concepts to be merely learned. In this way, he distinguishes between ordinary experience and “*an*” *experience* (the latter being a richer event, imbued with opportunities for exploration) as having the potential to change the way we perceive, interact, and participate with the world. Handheld, mobile,

and multimedia technologies are providing a new platform on which to build innovative learning experiences. It is compelling that in this technological age Dewey's ideas can find new contemporary application.

***Cosmosis1* Full Script:**

What follows is the full script of the *Cosmosis1* App (timestamps in min:sec link to online video the of app). The app can be downloaded to an iPhone or iPad from Apple iTunes using this link <https://itunes.apple.com/us/app/cosmosis1-cosmic-microwave/id896359769?mt=8>. Alternatively, examiners of this dissertation wishing to try the app on an Apple© device (iPhone or iPad) may request the code for a free download from Macquarie University administrators.

Part 1 Discovery Mode

Part 1 ([link to full online video](#)) is the initial default mode of the app requiring the user to complete sequential steps in order to gain the conceptual understandings.

Step 1: [00:00-01:36](#)

Of all the questions we can ask, there are really just a few that approach the deepest mysteries of life. Where do we come from? Where does everything come from? What is the nature of the universe? What was it like at the beginning of time?

Questions like these have awed and baffled people for as long as there have been people to ask them. But perhaps the biggest question of all concerns the origins of the universe, and everything in it. Where did everything that ever was, everything that is, including you and me, and everything that will ever be, come from?

We'll be exploring this question together. My name is Rich Blundell and I will be your guide on a journey to the beginning of it all.

This app is not your typical app. We are going back in space and time to experience the birth of the universe. It will be a journey of both science and imagination.

But by the time you complete this app, you'll have an entirely new understanding of where we come from, and where we are, in this

constantly evolving universe. You will see, and experience, the world in a whole new way. To begin, just tap...

Step 2 [01:37-03:15](#):

You've probably heard of the Big Bang. It's the origins of space and time and everything in it. In a very real way, you were at the Big Bang. And so was I. So it's nice to see you again. But what would it have been like, to be really there? And how do we know what really happened?

Have you ever seen this image before? What you are now looking at is a key piece of evidence in the Big Bang theory. This is the Cosmic Background Radiation or CBR. Scientists think of it as the visible echo of the Big Bang. But it's not sound. This is a residue of primordial light of the Big Bang. It is the light of pure quantum energy. Another way to think about this pattern is as a sort of wall or a curtain. But if it is a curtain, what is it hiding? This splotchy pattern of colors is a secret message from the deep past. What does it tell us?

Before we can decipher it, there are a few things we need to know. The next section will show you how to use the app to navigate on our journey. Just tap to continue...

Step 3 [03:16-04:41](#):

Now we're about to explore to the deep past and the Cosmic Background Radiation. But before we head out, there are a couple of things you need to know in order to navigate to the edge of the observable universe. We'll be using your device's camera, science, and a little imagination, to peer back into deep space and deep time.

Remember the Cosmic Background Radiation is a phenomenon of light. Light is a radiation and radiation is a kind of wave. So we can think of both light and radiation as a wave. Like this. The quality of the light, its color and energy, for example, are related to the properties of the wave. A big wide wave, or wavelength like this, makes the light that we call, infrared light. Light with a much smaller, a more tightly spaced wave, like this, we call ultraviolet.

Now, we can't actually see either of these kinds of light with the naked eye. But we know they exist because we can experience their other effects. Heat, for example, is how we experience infrared light, and ultraviolet light leaves us with a sunburn...

Step 4 [04:42-05:46](#):

The control bar with the waveform at the bottom of the screen covers a range of wavelengths all the way from really short, on the left, to really long, on the right. So this waveform is divided into sections each one a different wavelengths light. A really short wavelength, like the x-ray section on the left, is just a few atoms across - that's incomprehensibly small. Really long wavelengths, like the microwave on the right, can be larger than the radius of the earth.

You can think of this little diagram as a kind of roadmap for getting across the different wavelengths. As we get into our exploration, you'll be able to specify which band of light you want to view the world in. When you slide your finger along the line to specify wavelength to the next, you are tuning your camera to see in that particular wavelength...

Step 5 [05:47-06:29](#):

Finally, as you work your way through this experience you'll find that finishing one wavelength will unlock the next one. So by the end of journey, you will be a pro and then be able to navigate freely, jumping back and forth, skipping these videos, and exploring with your camera.

But along the way, don't be surprised if a few new questions come to light. You'll have a chance to explore them more deeply, interact, and share your experience at the end of the ap. OK, let's make our way to the Cosmic Background Radiation...

Part 2 Explorer Mode

Part 2 ([Link to full online video](#)) is only unlocked after the user has completed the entire sequential progression.

X-ray [00:00-01:26](#):

We begin our journey back to the cosmic background radiation in the very short wavelengths. Light waves of this frequency are just a few atoms wide. A wavelength this short can easily penetrate living tissue and is therefore really useful in medical diagnosis.

You've probably either had or seen an X-Ray image. When a doctor takes an X-Ray, she shines an X-Ray light on the broken part of your body. We can't see the light, but the film or sensor is sensitive to this wavelength. X rays can shine right through your flesh and bones and the "shadow" that they cast is picked up by the sensor and lets us see what's inside.

Keep in mind this is not a real X-ray image. Not only are X rays harmful, but it would also be impossible to actually turn a little camera in your

phone into an X ray machine. That's why you can't actually see your own bones. This is a simulation of what your camera would be seeing if you could tune it to the X-Ray wavelength.

Try pointing the camera at your left hand to match up the bones. When you are through exploring in X-Ray, try the next longer wavelength by sliding your finger to the right into the ultraviolet range of the spectrum. It's best to be outside for this...

Ultraviolet [01:25-03:05](#):

Ultraviolet wavelengths range from just a few atoms wide, to a few thousand atoms wide. This means that the light wave is a little bit longer than the X-ray but still really, really, short. What's cool about this wavelength is that this is the wavelength that bees see in. So as you look through the camera you are seeing the world as a bee sees the world.

This is just a simulation, but if it were real, and you looked at a flower, you be able to see the patterns that are otherwise invisible to us humans. The patterns that bees see in the flower petals are believed to direct the bee toward the nectar and into the right position to pick up the pollen.

Seeing the world through ultraviolet reveals some hidden intricacies of nature. In this case, flowers are communicating to bees in ways that we overlook all the time. So tuning into ultraviolet light is like eavesdropping on a secret conversation between flowers and bees, and the language they are speaking is light.

It makes me wonder, what other wavelengths of light might reveal? What other hidden surprises might we might be missing everyday? Slide right, into the visible range to find out...

Visible Light [03:03-05:27](#):

So far we've explored light that we can't see because the wavelengths are too short to be sensed by human eyes. In fact, human vision is tuned to an extremely narrow part of the electromagnetic spectrum. What we call the visible range may contain all of the colors of the rainbow, but it amounts to just a tiny fraction of the whole spectrum.

You may be wondering, if there is such a broad range of wavelengths of light, from just a couple of atoms wide to as big as the earth, why is it that humans can only see across such an extraordinarily narrow band?

The answer has to do with the very special relationship between our earth and its closest star: the sun. The surface temperature of the sun is about 5900 degrees Kelvin. This temperature emits a very specific range of wavelengths, which are then filtered through the atmosphere before

reaching the surface of the earth. So the earth basks in a relatively constant glow of this very specific wavelength. While we are continually bathed in a broad range of electromagnetic radiation from various sources, the visible range is the dominant wavelength here on Earth.

So all creatures that see, evolved the ability while illuminated in the filtered light of the sun. So it only makes sense that we would be able to see in this very particular band of light. But we don't just see! Our vision is fine tuned by nature in order to make use of the particular wavelength that we evolved in. The fact that you can see the green of these trees, or the blue of the sea, or the red of a sunset, or even your own feet, depends on geologic, interplanetary, and stellar phenomena!

Look through the camera. Even though things may look, well, just like they do through your own eyes, take the opportunity to see the world with a new appreciation for vision.

Next stop, Infrared. You know what to do...

Infrared [05:25-06:36](#):

Ok, we have now entered the world of heat-light. This is how a thermal camera "sees" the world. The colors simulate different temperatures, or energy levels, emitted by the different objects.

Like bees with ultraviolet light, snakes have the ability to sense in the infrared. You can understand why this would be because snakes sometimes find their prey by the infrared heat they give off. Snakes can "see" in the dark and recreate an entire scene in their "mind's eye" but it's based not on the patterns of reflected visible light, as we do, but the patterns of thermal radiation.

Spend some time exploring the world through a snake's point of view...

Microwave [06:34-07:02](#):

The microwave experience begins with a "Calibration Sequence" after which, the user can "fine tune" their camera to the microwave spectrum. In this sequence, a real-time geospatial visualization of the CBR pattern appears in the sky behind foregrounded objects such as the plant, buildings, and clouds.

CBR Experience [07:00-12:04](#):

What you are now seeing is Cosmic Background Microwave Radiation where it really is. If necessary, you can fine-tune the sensitivity of your camera using the vertical slidebar on the left. Now move your camera

slowly along the horizon. From your current position at the center of the observable universe, you can see that you are at the center of a cosmic sphere. You can see this because the space between you and that surface is essentially transparent.

In current scientific interpretation, the CBR started almost 14 billion years ago as the while-hot visible light of the Big Bang. As the universe expanded, this light has been stretched along with space itself, into the longer, microwave wavelengths. That's why we can't see the CBR with our naked eyes, but satellites that can detect microwaves can. So just like when we imagined X-Ray, ultraviolet and infrared light, this is how the world would look if we could tune our see in the microwave part of the electromagnetic spectrum.

The CBR is picture of whole cosmos when it was just 380,000 years old. It captures the very special moment that the universe when through what physicists call a phase transition. So that surface is boundary between a hotter, denser and more energetic time just as it was cooling enough to become transparent space.

So on the other side of that phase transition, hidden from our view, is the violent and highly energetic plasma of the early universe and the Big Bang itself. But on this side of that dappled surface is the cold, quiet, and transparent space that we're all familiar with today.

If you can think about that surface as a snapshot of the early universe, it makes sense that the image is a record of an earlier time. This is the same idea that a picture taken of you as a toddler shows how you looked back then. And just like how a person's face is an expression of their genes working beneath the surface, the CBR pattern also imprints what was going on beneath its surface.

The light captured in the CBR image is almost uniform. But it is that *almost* that makes all the difference. Those variations in color from orange to blue correspond to the miniscule temperature variations imprinted on the light. The splotches record quantum fluctuations embedded in the structure of the Big Bang. But where they originate is still a deep, deep mystery.

Ok, so all of this science is cool and it gives an idea of what and where the CBR is, but why does it really matter? Why are those tiny fluctuation so important?

Because creativity depends on diversity. If the early universe had been perfectly uniform, there would have been capacity for interactions between different temperatures. If every point in space had been exactly

the same density, there would have been no opportunity for exchange, no relationships, no creativity, and the universe would have become a diffuse uniform fog.

But it isn't! All of the matter and structure of the world exists because of those little ripples of color. All of the trees and buildings you see in the foreground eventually emerged from those tiny fluctuations... But it's not just the stuff that comes from those interactions. As the universe complexified over cosmic timescales, the interactions between objects became relationships between subjects.

So in this radical interpretation, even our personal relationships are the offspring of those primordial relationships. The colors you see are the source of what has since become all of the beauty and drama and dreams of the world.

So why does the CBR matter? Because we're all intimately connected to the cosmos, and each other. The CBR can remind of this reality.

So look around this reality for a while and let that sink in. Thanks for listening.

Exegetical Discussion

This app addresses the research problems by enhancing phenomenological and conceptual understanding of the CBR. By applying accepted educational theory to emerging, technologically facilitated learning scenarios, this app addresses the lack of student engagement in and appreciation of the Cosmic Background Radiation. While the trend toward integrating apps into educational curricula is not new, *CosmosisI* is the first in a series of "Epiphany" apps that enhance the education and communication of latent ideas about cosmic-human evolution. These apps may stand alone as informal educational experiences or be used to supplement learning across a wide range of subjects. Table 3 below shows the key components of the *General Framework for Big History Transformative Learning* (Chapter 4, Table 2) in the left column and a brief discussion of select examples from the *CosmosisI* App in the right column.

Table 3: *Exegetical components of CosmosisI Cosmic Background Radiation Explorer App*

Concept	Discussion & Example from script
Narrative: A constellation of narrative-centered theories and concepts on how human beings make meaning of the world and draw on narratively constructed knowledge. Narrative infuses human experience across scales of personal cognition to culture, by providing a durable structure that can be recalled through time.	The goal of the app is to examine, and experientially disrupt, unexamined narratives about how we sense the world. The first part of the app experience is an exercise in “re-tuning” our eyes (through augmented reality techniques) to see in different wavelengths of electromagnetic energy. The second half of the experience is to then take that new capacity for visualization and re-examine the phenomenon of the Cosmic Background Radiation. The culminating narrative shift is based on the overlooked interpretation of the CBR as the primordial relationships between all that has emerged and evolved in the present-day universe including the relationships the user is embedded within in daily life. Not only are narrative elements used to communicate the science of electromagnetism and the CBR throughout the content, but the entirety of the app experience is meant to elicit a transformative narrative shift.
Phenomenology: Mindful awareness and analysis of the human lived experience. A deliberate preoccupation with the structures and experiences of human consciousness.	The app experience is founded on a new lived-experience with the natural phenomenon of electromagnetism and the CBR. This is a basic preoccupation of the app. The goal is to provide an in-situ phenomenological experience upon which conceptual understanding can be built. I have also designed the script to encourage users to “go outside” to experience the phenomenon. These techniques further the lived-experience and inherently demonstrate the value of phenomenology.
Transformative learning: The process of learning based on the disruption and reconstructing of personal narratives. A transformative learning experience implies a change in the way a learner thinks, perceives, and is valued beyond the learning context.	Transformative learning is built into the app experience by providing a scaffolding upon which the user may interpret future experience. This is exemplified in the use of commonly experienced elements within the app interface overlays (e.g. bones of the hand in the X-ray section, a flower in UV section, a mouse in the Infrared, etc.). This provides the user with a new, transformed way of experiencing these phenomena in addition to electromagnetism itself. Given the finding of the integrated research, it is also clear that the new “relational” experience of the CBR is an inherently new and thus transformative.
Tacit knowledge: A mediating “hard to articulate” learning or knowledge gained through first-person experience. Tacit knowledge is also embodied knowledge, or indwelled, and is thus entwined with an ethical dimension and enacted (see below).	The element of tacit knowledge is perhaps best demonstrated in the app section on visible light. In the first instance, shifting the user’s visual experience of electromagnetism as a co-creative result of “geologic, interplanetary and stellar phenomena” as opposed to a given, static capacity is an extraordinarily difficult thing to articulate. Secondly, the new knowledge is intrinsically tied to the experience of visible light and is thus experiential. Lastly, I have tried to convey a new sense of gratitude for the fundamental contribution of planetary processes in the experience of human vision. This new sense of gratitude and connectedness is anticipated to become part of the users worldview and thus embed an and environmental ethic. All of these elements converge to constitute just one of the tacit knowledge components of the app experience.

Enactivism: A socio-psychological theory of mind considering how cognition arises from the interaction between the thinker and its natural environment. It is, in essence, the naturalization of thought. The theory of cognitive enactivism (as opposed to representationalism) is closely aligned with the social constructivist views.	Throughout the app experience, I have endeavored to fuse new knowledge about natural phenomena to inward and outward experience of the world. Each of the wavelength visualizations ties what is typically considered an “outer world” phenomena and tied it intimately to the lived experience of the user. The script of the app often expresses this internalization of the natural phenomenon in the convention of encouraging the user to remember and apply this intimate connection to nature in everyday experience. For example, I conclude each section by saying something like “the next time you encounter this phenomenon, thinking about how you experience it.” This process should be especially apparent in the final culminating experience of the CBR through the logic that our relationships are the natural extension of the primordial relationships captured in the CBR image.
Cybernetics: A communication theory in which information can be seen to carry agency across disparate domains. Second-order cybernetics in particular acknowledges how an observer of a system is always a nested component in the system observed.	While the app itself is an instance of cybernetic communication in a technological sense (i.e. a mobile device is communicating to a biological being), the entire experience is infused with cybernetic exchange. For example in the experience of ultraviolet light, I emphasize how flowers are, in a sense, “communicating with bees” by manipulating how ultraviolet light is reflected off of their surface. This can be interpreted as a form of communication between seemingly disparate entities that integrates the natural phenomenon of electromagnetic light carrying the information between agents in a system. In this interpretation, the sun, the flower, and the bee are three nested agents in an expanding cybernetic system.
Emergence (Emergent-Future thinking): Emergence is the fundamental natural process by which novelty arises in the universe. The potential for emergence increases under certain circumstances of optimum complexity. Emergences are generally unpredictable and therefore can appear mysterious.	By emphasizing the creativity arising from the relations between the phenomena explored, and between the user and the phenomena, the app highlights the process of emergence. This is especially apparent in the culminating CBR experience, when the user realizes that the resplendent complexity of the natural universe is the result of the process of natural emergence. By highlighting a narrative lineage that extends from the present back to the CBR and the Big Bang itself, the user can now grasp the historical radical creativity of the universe. When that realization is then projected into the future, the thinking becomes emergent-future thinking, and radical creativity can extend to potential solutions of contemporary problems.
Transcalar-fractal thinking A natural phenomenon of complex systems wherein attributes are sustained across scales. Often these attributes are symmetrical. Fractals present an opportunity to forge new connections, which are a key component to reflexivity and the <i>Cosmosis</i> process.	An instance of transcalar-fractal thinking is exemplified in the <i>Cosmosis1</i> app by the scale-independent creativity of the early universe, as captured in the image of the CBR, and its symmetrical analogue, the creativity of personal relations maintained in the lived-experience. The goal of such design is to present a conceptual and experiential bridge between the user and the phenomena are typically thought of as “outside” the “interior” human domain. This is, of course a tactic to cultivate natural reflexivity in the user.

Reflexivity: A particular state of a component within a system that is simultaneously aware of its agency within the system and can thus modify its actions/impact according to a desired individual and/or systemic outcomes.	The final experience of the <i>Cosmosis1</i> app is a lived-experience of the CBR. This experience is designed to synthesize all previous insights into a culminating experience of self-cosmos systemic reflexivity. This new, transformative learning is based in the assertion that the radical, relational creativity of the universe (as captured in the CBR image) is an extension of the user’s personal self-narrative. This tacit knowledge then supports the invitation to cross transcalar-fractal bridges between self and cosmos and participate in new emergences. Reflexivity, therefore, is the ultimate goal of the <i>Cosmosis1</i> app and the <i>Cosmosis Reflexivity Framework</i> . If the app can begin to cultivate these new narratives of connectivity between the user and the natural universe, then it will have succeeded in reaching this goal.
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Table 3: Exegetical Components of *Cosmosis1*

Summary

The intended culminating epiphany of the *Cosmosis1* app is a lived experience of a cosmic phenomenon, the Cosmic Background Radiation.⁸⁰ This experience of CBR is intended to become the basis for a self-system reflexive reinterpretation of the phenomenon. The interpretation, with its emphasis on relations evident in the afterglow of the Big Bang, is also intended to become the foundation of an ecological identity that, writ-large and collectively, can help shape an appropriate response to the Anthropocene. This is also the argument encapsulated by the dissertation overall.

⁸⁰ Acknowledgement: Macquarie University Innovation Scholarship Program provided funding for the *Cosmosis1* project. The Macquarie University Astronomy and Physics Department and the Center provided content and technical collaboration for Learning and Teaching. Dominican University (USA) First-Year Experience in Big History students provided student feedback, and Fred Adam at ubik2.com provided the user interface design and programming coordination.

Chapter 8

PRACTICE 2

A cosmology ... needs to be poetic, symbolic, inspiring of a sense of awe and mystery. ... Since myths arise as a consequence of human creativity; there is a vital future mythogenic role for artists in the realm of ideas, images and stories: people such as mystics, poets and philosophers – including, I hope and expect, creatively-inspired scientists.

— Bruce G. Charlton (2008, pp. 7–8)

Purpose of this Chapter

This chapter documents the development and delivery of the second of two creative practice projects that applied *Cosmosis* as praxis in cultural communication. The project constitutes an experiment in cultural communication in three ways. First, it aimed to implement the components of the *General Framework for Big History Transformative Learning* (Chapter 5, Table 2). Second it demonstrates the key elements of the *Cosmosis* praxis developed in Chapter 6. Finally, it aimed explore the intersections between the intellectual and phenomenological dimensions of Big History in the form of a public lecture.

Shakespeare in the Cave: A Big History of Art

Shakespeare in the Cave: A Big History of Art was delivered as a “Special Presentation” on August 8, 2014, to an audience of 38 Big History scholars at the International Big

History Association conference at Dominican University, San Rafael, California. That the audience was already familiar with the narrative of Big History was relevant in that it presented a unique opportunity to focus on interpretation, as opposed to the content of the narrative itself. The choice of a public lecture is also legitimated as a common form of cultural communication. In this presentation, I trace the scientific, cosmic story punctuated with personal anecdotes, connective contemplations, provocative thought experiments, and what were designed to be aesthetically designed, phenomenological and intellectual moments of transformative learning. That is to say the presentation attempted to cultivated particular moments wherein narrative disruption could happen.

The entire videotaped lecture is linked through timestamps to an online version indicated in the table below. The complete transcript, edited for clarity, follows.

Transcript: *Shakespeare in the Cave: A Big History of Art*

I would like to begin this talk with a little habit I picked up from my Australian colleagues, and that is to pay respects to the human and non-human inhabitants who were the custodians of this land where we are meeting today. I use the word “custodian” deliberately to signify that the coast Miwok did not own this land and neither do we. The land doesn’t belong to us. *We belong to it.*

I’m here to tell you this story, sort of. The idea is that this will be a little more adaptive because I think everyone in the room pretty much already knows the story, so I will gloss over a lot of it.

This is the Harvard University version of Big History. I’m sorry, but I find this impoverished. This is merely a description. There’s a slight bit of it interpretation, but there’s nothing meaningful in this. So the idea behind this talk is to tell this story in more meaningful ways That is the work of my research, to find more meaningful ways of doing this. So this talk is also the culmination of a PhD that I have been working on.

So let me just tell you a little bit about this talk before I get going. Yesterday we heard a lot about asking the really big questions and how

school is not the place to do that. But that's precisely what I'm doing. I'm really trying to ask the big questions. Sure, where we came from is a big question, but there are bigger questions. There's actually a bigger question and that's why the "s" is in parentheses--that is, what does it mean? How can we find meaning in this story? That is the question I'll be continually asking through this talk. The other thing about this talk, and my whole PhD, is that it is really dedicated to ameliorating the Anthropocene. Finally, this is a big part of the research of my PhD, and a lot of that research is worked into this particular practice.

I've come up with this phrase, although I'm not the first, "radical hermeneutics." I'm the first to come up with it in this context. So the idea here is to reinterpret the story in a radical new way. Hermeneutics is the practice of interpreting texts, it stems from the biblical times when we had this scripture but we also had people to interpret it for us. To tell us what it means. That's what this is a practice of. This is based on research so I've done a lot of conceptual and theoretical research that backs up what I'm doing.

Also, this is a public lecture series. That's why it doesn't go really deep into the science. Another idea is that this is a living practice. I went out on the trail just last night and made changes to it. It's in a constant state of evolution. It's also very adaptive, so I can adapt it to different audiences. I try not to rehearse it. And it's never finished. Don't worry, that doesn't mean it will never be finished today; it just means that I'll never be finished working on it.

I am not an art historian. But I'm going to be talking about art. In fact, I'm not really even a historian. As my bio said, I am a naturalist. So why am I up here telling you about art? I don't have a lot of knowledge about art, but I do have something that I think is more profound, and that is a transformative experience with art. Back in 2008, I was delegate at this conference. The World Congress of Science and Factual Producers was held, as you can see, in Florence, Italy. It was three days of scientists and science producers; people who produce science programming, who decry and bemoan the lack of science literacy, and ask why can't scientists be better at communicating what it is that they do? And why doesn't the public care about what they do? After three days of this, a friend of mine suggested that we go across this bridge into the central part of the town where all of the great art of Florence is. As a scientist, I wasn't really interested at the time (this was 2008), but I thought I would go do it. So I went there, and it was very crowded. It was not my scene, and the sculpture of Michelangelo's David had a very long line. I was like, "Bah

humbug!” I didn’t really want to wait. So I started walking around the square. But another thing that I saw was a sculpture called the *Rape of Sabine Women*. This sculpture tells the story about the founding of Rome, and how the women on the tribal areas were abducted to found the city of Rome. And as I’m walking around, and looking at it, I am thinking to myself, “Oh, this is that 500 million-year-old Carrera Limestone that was deposited at the end of the Cambrian, and that’s all that foraminifera which creates that translucence that everyone talks about. This is the famous Carrera Marble.”

But at the same time, I’m feeling this sense of uneasiness. I can actually feel a bit lightheaded, dizzy, and I’m walking around the sculpture. I was such a sucker, because the sculptor Giambologna designed this sculpture to be walked around in 360°. You can look at it from any angle. So, I am slowly getting drawn into it. But I was still thinking. I took one trip around it, and then I suddenly noticed that my toes are beginning to curl under my feet and I was having a hard time walking. I started to feel a shortness of breath and I wondered what the heck was going on. And then saw this. And everything changed. I mean, I went in there a skeptic. I did not give a hoot about art. All I could see was the science--and suddenly there was this. And I have ever since changed. So much so that now I have become an advocate for art. And this was after three days of listening to those people complain that they can’t communicate their science. And then this appears. The other take-home message from that experience is that if art can transform me, a scientist, maybe science can transform some of the artists as well, and together these two things combined can really be a powerful force in the service of how Big History is communicated. So that is the framework of this talk.

Interestingly enough, after this whole incident, I almost fell down. But this guy I was with helped me out into the street, where I slowly recovered. I didn’t think about it for a little while. And then about a month later, I get an email from this guy and it says, “Dude, you got Stendhal Syndrome,” and there was a link. So I looked it up. And this is what Stendhal, which is the pen-name for this guy, wrote: “I was in a sort of ecstasy from the idea of being in Florence absorbed in the contemplation of sublime beauty. I reached a point where one encounters celestial sensations--everything spoke so vividly to my soul. Ah, If I could only forget. I had palpitations of the heart--what in Berlin they called nerves. Life was drained from me. I walked with the fear of falling.” I knew exactly what this guy was talking about!

But here's the funny thing: this was published in a scientific journal. So there is no evidence for that experience that I had. It doesn't quite matter. I was profoundly changed by this experience, but because there's no scientific evidence for it, it doesn't exist. Okay, right.

So that's the spirit of this work. The other thing that I would like to say is that we are living in precarious times that we call the Anthropocene. I assert that it is this kind of engagement with the big history narrative that will be with us on the other side of this Anthropocene moment, if we get there. Something about this experience, we will bring that with us, if we make it to the other side of the Anthropocene. I know that this is a hard thing to articulate, but that's what I'm trying to say here: that there is something valuable and something important in this process of awakening.

So the point, then, of this lecture is to explore the cosmic narrative with a particular theme in mind. The theme will be the emergence of art (and I take emergence very seriously, as you'll see in a moment). We will not depart from the science. But we will reinterpret the science as a new art form. I just want to finish by saying that this is an experiment in cultural communication. I am really most concerned with the cultural impact of Big History, not so much the scientific details, because we have scientists for that.

You've come in at just the right time; the universe is about to begin. We all know the story of the Big Bang. This is the singularity. This is the emergence of the fundamental forces. This is a very simplified representation of that moment. But not just that moment, but all the moments up until right now. I'm here to ask, What does this mean, or where is the meaning in this? So I'll start here. This is the beginning, right, 10^{-43} seconds. What does that mean? Well, a mathematician can give me this as an explanation, a derivation of what that means. But what does it actually mean?

So to get a sense for what it actually means, I'd like to go on a little journey. 10^{-43} seconds refers to a Planck Time. So we're going to go back to the first Planck Time. The stand-in here is scale for time. We're going to go on a journey back through the scales of the universe here. And we'll think of it like a bus ride. On the bus is a diverse spectrum of people--all of us. We've got religious people, we've got scientists. Everyone is on the bus. And there is a soundtrack for this, so I will turn it on. It gives it a nice mood.

So, is everybody strapped in? We're on our way, and we're now at 10^0 meters, which is about the size of a human, and we're trying to get back to

10x-43 meters. We see dodo birds and lots of other things that we recognize. And we keep going, keep going, and we get to this circle here, which is 10x-3 meters. At this scale, we can still see most of the stuff. Then we get to here, the smallest thing visible to the naked eye. This is the first stop. So that means there may be certain religious traditions that have to get off the bus because they don't really buy into anything below that which we can see. So they're off the bus. I don't mean to degrade those religions, but that's just where they decide that their journey ends.

But we keep going. Now we are getting into some really small things. Now we are starting to get down into things that we can't really experience. So this is the next stop. Here, the Goetheans decide to get off. The hard-core phenomenologists, they need to get off because they can't believe in anything that they can't experience. This is their stop.

But we keep going, we keep going. We're going to keep going down, down, down. We are now at 10x-9 meters. We are into the size of molecules and big atoms, but we keep going. 10x-12. Now at 10x-15, and we get to something very important here. I recently read an article where somebody described themselves as an empirical materialist. If you are a hard-core empirical materialist, then this is your stop. This is because below 10x-16 meters we have measured nothing. We have no observational evidence for anything smaller than this. So if you really are a hard-core empiricist, you've got to get off the bus. This is your stop.

But we can keep going because the good news is we have theoretical physicists, and they have the power of math. We can go deeper. So let's go. We keep going. We're at down-quarks, strange-quarks, charm-quarks; this is like *Alice in Wonderland* material here. And then we get into this really long tunnel at 10x-24. And this is logarithmic by the way. This isn't linear. So every one of these rings is a power of 10 smaller than the one before and then.... Ugh. We have bottomed out now at the Planck Length.

So what's the meaning of a Planck Length, which is closely related to the Planck Time? A Planck Time is the time it would take for a single photon traveling at the speed of light, in a vacuum, to cross one Planck Length. That's what a Planck time is. But here's the funny thing, and I read this in a physics book: using the current framework of physics, we cannot measure or detect any change smaller than this. So even the math breaks down at this point.

So now we are getting at what that actually means. 10x-43 seconds is

where the math breaks down. Even the theoretical physicists cannot figure out what that means. Even the theoretical physicists get off the bus here.

So, what does 10^{-43} seconds really mean? Mystery. We don't know what it means. In fact, I just went to Whole Foods and I picked this up yesterday. The question is, "What came before the Big Bang?" You should look at this. This is all about what we don't know. This isn't about what we do know.

Audience member: *Come speak to me tomorrow.*

Me: *Why, do you claim to know what happened before the Big Bang?*

Audience member: *Yes.*

Me: *You do? Okay, then I stand corrected... So it's no longer a mystery to you?*

Audience member: *Correct.*

Me: *Ok. I guess you're off the bus.*

Well, that's what it means to me personally, and that's what I think it means to a lot of people: that there is a mystery at the beginning of the universe.

And there are other things in this diagram that we call moments of *emergence*. Each one of these circles represents the emergence of a fundamental force in the universe. We say that nonchalantly, "emergence." But what does that actually mean? What does emergence mean? Can we derive meaning from this thing called emergence?

To find out, I want to try another little thought experiment. You can think about this black grid as the fabric of space-time. But what it really is, is a playing-field and there are rules to this game. I can take the cursor and I can put a little click here. Now that cell is alive. Just by highlighting that square. Now, there are some very simple rules that we need to keep in mind. This is a game, and it's going to play out over generations. So the rules are there are eight cells that surround each single cell. If two or three of the cells surrounding that cell is alive the cell will survive into the next generation. But if less than two or more than three then the cell will die in the next generation. So what you need to know is that if there are three or more neighboring cells alive, the cell will die of overcrowding. But if there are two or less, it will die of loneliness. Also if there are between two

and three squares around an empty cell, then that cell will then be born for the next generation and then be available for the next generation.

So I will let the game run for one generation. In the first generation we see that some of these cells have died and some have been born. And we get this new shape. I will now run one more generation, and again we see how it has changed.

But now I am going to let the computer run the generations very quickly....

Now, what was that? I will venture an interpretation. That was a little creature walking across the screen. But remember there is nothing in the rules that says anything about a little creature. That is emergence! That is an emergent moment in this universe. Not only is there nothing in the rules about little creatures, but there is also nothing about walking. So these are emergent properties of these very simple rules of this particular universe. That's what emergence is. Emergence happens when there are relationships between things. As they play out over time, new things can happen and you can't predict what's going to happen. The other part of that little thought experiment is that we participate in it. When I say that's a little creature, I have participated in the system I have participated in the creativity the system by making an interpretation. Let me show you what I mean about that a little better.

Now I'm just going to add a new configuration. Go back to full screen. Now this is a new particular arrangement of cells. Same rules. Now I'm going to let them run...

My interpretation? What I see here are two big creatures, and they go off on a cycle. They go out into the world, come back, in the evenings perhaps, and do something to create these little creatures that they send out into the world. Anyway, that's my interpretation. The point is that I am participating in this system by making the interpretation.

So I'm just going to do one more, which is pretty cool. I'm going to make these very specific initial conditions and let those run. Now what do we see here? This one has a lot more random motion. It is less structured than the previous. Perhaps these can be interpreted as bacteria in a growth medium, or perhaps these are civilizations coming into power, rising and falling, leaving behind ruins, which are then absorbed by future civilizations. The point is, there is an interpretive process that is going on in this system and that helps to create. That is emergence!

So that's where the meaning is. I want to show you one more thing because if that one doesn't get you, maybe this one will. These are just balls that are hanging from strings. Watch this. The rules in this system are defined by the strings, gravity, and so on. So structure has just emerged from the system, but you will notice that it goes into chaos, but then boom suddenly new structure emerges for a moment, and then it goes into chaos, but then boom! New structure emerges. Emergence is happening here too, and an interpretation. We are creating that structure. This is just real time. Pretty cool. Anyway, that's emergence.

So now, when we get back to this diagram, it is no longer an impoverished diagram. We've got mystery, we've got these radical emergent moments, with gravity, the electromagnetic force, the strong and weak nuclear forces. That's what emerged back at the beginning of the universe. Before that is mystery. And the other thing is we don't know how the story ends. So this whole thing is immersed in mystery. But not for you.

Now why don't we acknowledge that? I can stand up here and tell you about all about we know, the science of all this, but at some point it's like acknowledging the people that lived here before us, there is a mystery that infuses the entire narrative a Big History, and I think it needs to be acknowledged. Because that's where the meaning can hide.

So if that's the case, if reality is the one thing that doesn't go away, then perhaps mystery is the only reality.

Anyway, we've got the story of the Big Bang; we got this hot plasma where the nuclear forces are in reaction and fundamental forces are coming into being. At 380,000 years later, this whole thing cools and slows down and we get this familiar iconic image called the Cosmic Background Radiation. What this represents are these tiny fluctuations in in temperature and density in the early universe. We are going to assume that we all know the science of the Cosmic Background Radiation. It represents a wall and behind that wall is the Big Bang itself. This is just to orient ourselves. We can see this background radiation. We are looking at this 380,000-year boundary of the Big Bang. But how can I make meaning out of this? I know we teach this stuff. But I am wondering now if we can actually make meaning of it.

The English poet, Gerard Manley Hopkins, who I adore, wrote a poem in 1877. It wasn't reported until 1918. He didn't really find much success in his life. He was not highly regarded in life. I'm going to read you just a

few lines from his poem and I would like you to look at that, and listen to what Gerard Manley Hopkins said. It is a poem called “Pied Beauty”:

GLORY be to God for dappled things—
For skies of couple-colour as a brindled cow;
For rose-moles all in stipple upon trout that swim;
Fresh-firecoal chestnut-falls; finches’ wings;
Landscape plotted and pieced—fold, fallow, and plough;
And áll trádes, their gear and tackle and trim.
All things counter, original, spare, strange;
Whatever is fickle, freckled (who knows how?)
With swift, slow; sweet, sour; adazzle, dim;
He fathers-forth whose beauty is past change:
Praise him.

Glory be to God for dappled things...? Do you think Gerard Manley Hopkins could have found meaning in the cosmic background radiation? Do you think Gerard Manley Hopkins may have had Stendhal Syndrome? In any case, he was a man before his time. That’s an instance of radical hermeneutics.

The CBR cooled, and beneath the surface of things, at this point in universe, the science reveals that there was a structure happening beneath the surface. We call it now the Mega-Scale structure of the universe. And here’s an image of it... oh I am sorry, that’s not the right image. That’s actually a brain scan of a rat. There it is, that’s the right image. Sorry about that. You can make of that, whatever you wish.

So this is the dark matter and dark energy in filaments, tendrils extending out across the universe in relationship, interacting with one another, sharing information through photons, and I don’t know, maybe this is a pretty good representation of what that might be.

So we know the rest of the story. After the Cosmic Background Radiation cooled, there was a period called the dark ages when photons were free to roam through the universe without bouncing off of anything. It’s kind of counterintuitive that it would be dark at this time, but because there was nothing for the photons to reflect off of, there was no light. Until the first stars formed. These are first-generation stars they are all about the same

color, fusing hydrogen and helium. Some of those stars organize themselves into these beautiful structures we call galaxies and some of the stars in those galaxies explode into supernova. And we know what happens then. So I would like to read you another quick excerpt from a poem. This is Walt Whitman's *Song of Myself* published in 1861. As you look at this image, I would like you to keep this in mind. This is Walt Whitman, 1861:

I believe a leaf of grass is no less than the journey-work of the stars,
And the pismire is equally perfect, and a grain of sand, and the egg of the wren,
And the tree-toad is a chef-d'œuvre for the highest,
And the running blackberry would adorn the parlors of heaven,
And the narrowest hinge in my hand puts to scorn all machinery,
And the cow crunching with depress'd head surpasses any statue,
And a mouse is miracle enough to stagger sextillions of infidels.

Again, do you think Walt Whitman would have found meaning in a supernova if he had known the science? And again, do you think he may have had Stendhal Syndrome?

So from the debris of a supernova about 5 billion years ago, our solar system formed. This is an image of a highly violent time of heavy bombardment of the surface of the earth. But somehow, on this planet, life emerges. There are three pretty plausible explanations: panspermia, the warm pool hypothesis, which is Darwin's idea, which is plausible, and also the theory concerning hydrothermal vents. Then, by about the Cambrian time, 500 million years ago we had something like this. Does anyone see the emergence here? This is an ecosystem. This is the ecosystem that would have deposited the Carrara limestone in the statue of David. But with this is really is, is the emergence of an ecosystem. This is a whole new pallet of relationships. So what do we see happening here? These relations start to create creatures like this. Then these trilobites go through a series of transformations, creating more and more complex and beautiful forms. These are actual creatures. The question I ask is: Is this art? We will think about that later. But while that's what we have got going on here, on the other side of the globe there are volcanic eruptions now called the Russian Traps that eject lots of particulate matter into the atmosphere. This creates an unstable climate and the trilobites go extinct. There was an environmental catastrophe and whatever the trilobites were

doing at the time, it wasn't what they needed to survive. So they went extinct.

But a tragedy for one species is an opportunity for another. So there is another round of emergences and evolution and much more complex creatures come onto the scene. They are beginning this experiment with a new biological network. But if you remember back, in the formation of the solar system, when some of those asteroids had been cast out to the outer reaches of the solar system, well some of those exiled bits of debris are now returning back 65-million years later and another environmental catastrophe, this time caused by the asteroids, and the dinosaurs go extinct.

So whatever it was they were doing, it wasn't what was needed to survive an environmental catastrophe. But one species' disaster is another species' opportunity, and through a long series of events that we know about, *Homo sapiens* emerged onto the scene. Humans get a chance, and they take what the dinosaurs were doing, and they run with it. So they take that neural network experience and they bring it to a whole new level. So where do we go from here? We've got these hominids and they're in Africa and they're experimenting with this whole new way of being in the world and they end up doing something like this. What is this the emergence of? Tools, yes, but something even more personal... This I think we can meaningfully interpret as the emergence of a narrative. To make something like this, you need to be able to see a story. You need to be able to see a sequence of events as a story. This is that neural network experimenting with the stories.

Now, have you ever wondered what it might have felt like to live back then, to be that creature, well... did you feel that? Did you feel the difference between that, and that? Well that's a feeling that connects us to the people that made these. We do know what it felt like because we just felt it. In that instant from this, to this. That's also something like the moment that I felt with that sculpture.

I would just like to point out now at the person who made this did not have to make it so symmetrical. They didn't have to make it this beautiful; this is the emergence of aesthetic.

It's interesting to note though, that this is 2.9 million years ago and this is 1 million years later. That's how much the technology changed in 1 million years, which isn't a lot. This is a very successful tool, but it took a long time for us to figure it out.

I want to show you this one now. This one might not look all that interesting at first glance. But what we are seeing here is a stone tool-making technique called *Levallois*. What's interesting here is that these are the pieces that the person wanted to create. But they had to create a core in order to create that one single piece. Archaeologists can sequence these clips in such a way that it shows how you are creating a surface from which you're going to create the tool you want. I've tried this, so I've actually felt what it felt like to organize and to process this idea. When you do this, you're seeing one thing in terms of another. Does anyone know what that means? To see one thing in terms of another? Metaphor. This is the emergence of metaphor. This is why this talk is called "Shakespeare in the Cave." So that's the idea here, we have these three incredibly important moments that we tend not to really interpret this way. We simply interpret these as stone tools, but that's the emergence of narrative, aesthetic, and metaphor.

Now, if we think about that way and then we really rethink about the diaspora out of Africa. If we think about these brainy primates and their capacities for story, aesthetics, and metaphor, and then they had out of Africa. They have to cross every habitat that there is to get out of Africa. They have to cross mountains and glacial areas and rivers and bays and swamps and deserts and savannas. They are having to cross every one of those habitats. Over the generations they have relations with every one of those habitats. So what I like to think about is that when this, story, becomes this, aesthetic capacity, and this, the ability for metaphor, encounters this, in its environment, it becomes this.

Now I don't know if you've ever watch this creature underwater, but it does this movement where it swims down, and when it catches what it wants, it releases and it just goes straight up like that. So whoever carved this had intimate knowledge and had spent time observing this creature in nature. This is an application of an intimate relationship with nature.

Here's another habitat they may have crossed, which becomes this. And if you look closely at this, this is carved from a mammoth tusk so that person who carved this had to really plan this out. And knew the intimate details of the life histories of these organisms. Not only did they know and observe them but they probably depended on them for sustenance. Because the person who carved this had an intimate knowledge of the interior of this animal. In other words, they had to butcher this animal in order to know how to carve this with such detail. This is an expression of an intimate relationship with nature.

So getting back to this question of, “Do trilobites do art?” there are many ways to explore this. On the one hand, this is an expression of nature itself, but it didn’t survive an environmental catastrophe. And this one didn’t make it. It’s now extinct. But this one also is an expression of a relationship with nature, but it’s now causing an environmental catastrophe.

I’m hoping that Art, in deep connection and relationship with nature, is going to be able to curtail the current environmental catastrophe. I guess what I’m trying to say here is, that I’m hoping art can come to the rescue in conjunction with science.

Finally, there is a tradition here. Keep in mind that this capacity for stone tools and bone carving are the heritage for sculptors like Giambologna. There is a lineage here that matters. I wonder how many sculptors acknowledge this lineage, indeed, take ownership of it.

I’d like to now read a little bit of Shakespeare. I apologize for bastardizing it, but this is from *As You Like It* act two, scene one written in 1600 by William Shakespeare.

Sweet are the uses of adversity
which like the toad, ugly and venomous
wears yet a precious jewel in it’s head
in this our life exempt from public haunt
finds tongues in trees
books in the running brooks
sermons in stone
and good in everything
I would not change it.

So I would like to do just one final example now of radical hermeneutics: A new way of interpreting the science we know. This is Blombos cave in South Africa. In here, archaeologists have found lots of stone artifacts, including this one. But not only is this a nice little piece of abstract art, but this is made from ochre. And they also found abalone shells. What these people would do is grind the ochre and mix with some medium, in the

shells, and use it as paint. Like any kid with new paints, the first thing they do is something like this. Again, this is another expression of self in the universe with this new medium called paint. Then that ultimately becomes this (Van Gogh), which is cool.

In this region (southern Spain) 60 feet above and 45,000 years later, we have this. We've seen this. David Christian referred to this painting in his opening talk. This is a new way to interpret a van Gogh painting, and it's great because it shows us the stars and the earth, the rise of civilization, the lights and the people trying to figure it all out. That's an interpretation. But now I want to give you a radical interpretation of a van Gogh.

How can I make more cosmic meaning out of this? Well, we know that when van Gogh painted this, he probably used lead white or titanium white and chrome yellow to paint the stars. Well, both of those substances go right back to nucleosynthesis. This is the classic star stuff, in paint, which is a pretty cool interpretation. Another way to interpret this is that van Gogh had such fine motor control of the brush when he painted this. To bring the brush to the canvas and to push it around with such exquisite artistry, he had to use his muscles, which are controlled by his brain, which uses what? When the brain sends a signal down to the muscle, that is an electrical phenomenon. Where have we come across this electromagnetism before? Back at the Big Bang.

That van Gogh could paint the *Starry Night*, is a direct result of his intimate connection with the Big Bang. But we don't see that, yet.

The final interpretation is this, remember van Gogh went insane, which itself is a manifestation of electromagnetism, so he painted this from inside an asylum. Remember, he could not see the night sky. He had to conjure this image in his mind. What is that? Even that is a manifestation of electromagnetism. Van Gogh's visions, his dreams, are connected to his ability to sequester the fundamental force of electromagnetism from the universe in order to paint *Starry Night*. That is a radical interpretation of the world.

Now, just one final bit of poetry while we look at that this. This is William Wordsworth; it's called "Lines Written a Few Miles above Tintern Abbey," which is a magical place. It is from the *Lyrical Ballads*, written 1798. As I read this, just think about that image:

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And I have felt
A presence that disturbs me with the joy
Of elevated thoughts; a sense sublime
Of something far more deeply interfused,
Whose dwelling is the light of setting suns,
And the round ocean and the living air,
And the blue sky, and in the mind of man;

Interestingly enough, that got him fired from his job as a government clerk. Another man before his time.

Thank you.

End of Script.

Exegetical Discussion

The purpose of the lecture *Shakespeare in the Cave: A Big History of Art* was to artistically explore the cosmic narrative in terms of the emergence of art. It was an experiment in the aesthetics of self-system reflexivity at the scale of Big History. My aim was to reinterpret contemporary understandings of science while, most decidedly, not departing from the science. In this case the interpretation of science itself, is proposed as a new, self-reflexive, hermeneutical, art form. As a creative work culminating from creative practice research, it was also designed to integrate the concepts, ideas, and theories of the overall dissertation. As a public lecture, it was designed to bring the work of the thesis directly into culture. As an artistic multimedia presentation, it integrates spoken word, visuals, intellect, imagination, and emotion. The presentation unfolds as a series of fact-laden “vignettes” interspersed with anecdotes, contemplations, and visualizations. The presentation culminates in a chronological, musical, multimedia montage or coda. I chose the title *Shakespeare in the Cave: A Big History of Art* because the lecture explored the cosmic narrative with an emphasis on how art, as a human

manifestation of narrative, aesthetics, communication and especially metaphor, can emerge and impact in systemic ways. This is the essence of systemic reflexivity.

As a work of hermeneutic experimentation, the lecture explored the topic in unconventional ways that may need further explanation. For example, this talk was structured to meander. But this meandering was a *design* decision aimed at inviting a diverse public audience to reconnect with the cosmos in personal, intimate ways. The meander was signposted by artistic reinterpretations of the science of cosmic evolution in ways that fostered personal connection. The structure of the lecture embeds “markers” of such connection. An audience member with a previously established, high degree of natural systemic reflexivity may easily recognize and value these moments of connection. Audience members with a lower degree of natural reflexivity may begin with a sense of confusion, insignificance, and not quite understand the value of such feelings. But they will as their previously unexamined narratives about nature and self are disrupted (assuming they are willing). The goal is an audience member who walks away with a potentially shifted sense of reality (narrative disruption), identity, appreciation of relational being, gratitude for participation (reflexivity), a bigger sense of self as embodiment of cosmos (fractal thinking] - or at least a feeling that lingers to perhaps lodge a small perceptual shift later on.

Several anecdotes illustrate how tacit knowledge leads artists to create art (enactivism) that expresses the artist’s reflexivity. The art, in turn, communicates the artist’s reflexivity cybernetically with audiences. Ancient art, with its use of natural materials, evinces a higher degree of natural reflexivity than does modern art. Why Shakespeare? Because even the pinnacles of human artistic achievement are rooted in what we know. Shakespeare’s ancestor made a stone tool. Art is connected to the cosmic narrative. Art as a form of cultural communication can connect us meaningfully to the natural, cosmic narrative.

As another example of artistic experimentation, the talk integrates decidedly Elizabethan Romantic views toward reimagining late Paleolithic and Neolithic human evolution. However, it should be noted that my view is not a typically Romanticized view. If it were, the view that Neolithic humans caused great faunal extinctions (and presumably spent a lot of time “in nature”) could be seen to contradict the spirit in which I am arguing for a naturalized response to the Anthropocene. But that contradiction would be simplistic because it lacks the critical aspects of emergent-future thinking and reflexivity. A naive or atavistic view of early humans living in harmony with nature is not what I am proposing. But I am proposing, in the spirit of Romanticism, a view that can take into account the scientific advances in understanding of anthropological, ecological, planetary, systems and communication theory in cosmic evolution to elicit a new romanticism. Thus, I aimed to retain what I hold valuable about the human poetic impulse, but only by wedding it to a steadfast commitment to current scientific understanding. Neolithic humans did not have the same scientific insights that we do about extinction. I presume that natural resources probably seemed in effect endless to the average Neolithic hunter, and we can ascertain in Romantic Era literature different but equally grounded outlooks. Both of these stereotypes emerged in their own, different, biological, social, ontological systems. I am not proposing that we simply transfer worldviews of the past onto the present (or future). That approach would be both misguided and impossible because it would lack a genuine, contemporaneous, systemic reflexivity. Neither a Neolithic or Elizabethan Romantic worldview would be an appropriate response to Anthropocene because it would not be reflexive to the current planetary system. The question then becomes, what does the equivalent of a modern Romantic view wedded to science, look like? It is hard to say from within such an uncertain and rapidly changing systemic state, but *Shakespeare in the Cave: A Big History of Art* is one proposal, rooted in empirical evidence.

Table 4 below presents a selection of illustrative excerpts from the script of *Shakespeare in the Cave: A Big History of Art* public lecture in the left column, along with corresponding *Elements of Transformation* (Chapter 3, Table 1) and The *General Framework for Big History Transformative Learning* (Chapter 5, Table 2).

Table 4: Exegetical components of [*Shakespeare in the Cave: A Big History of Art*](#)

Concept	Discussion & Example from script
Narrative: A constellation of narrative-centered theories and concepts on how human beings make meaning of the world and draw on narratively constructed knowledge. Narrative infuses human experience across scales of personal cognition to culture by providing a durable structure that can be recalled through time.	The entire lecture is a narrative containing sub-narratives. The overarching narrative is the story of cosmic evolution. The sub-narratives include my own story of transformation, the stories of the phenomena (Cosmic Background Radiation, supernova, nucleosynthesis, extinctions, the human evolution and diaspora, etc.) and organisms (trilobites, dinosaurs, humans, etc.). Many of these stories told include emergence and transformation, and all transformations are implied as embedded within and contiguous to larger, contextualizing stories. In this way, narratives are fractally integrated across the domains from personal to cosmic scales.
Phenomenology: Mindful awareness and analysis of the human lived experience. A deliberate preoccupation with the structures and experiences of human consciousness.	The lecture is designed to be highly phenomenological and is infused with elements of lived-experience for the audience both in the Big History content and in my own personal narrative. A particularly clear example of audience phenomenology is provided as part of the Stone Tool sequence when I visually present the transition between Oldowan “chopper” and Achulean “hand axe.” At 33:18 I linger in the visual moment to allow a lived-experience of aesthetic to lodge in consciousness. But immediately following that pause, I highlight the experience by saying; “Did you feel that?” Letting the audience feel the difference between a crudely shaped and utilitarian lump of rock and a finely carved symmetrical tool is an instance of phenomenological storytelling. I assert that this practice of telling the story of Big History in a phenomenologically designed way can encourage us to make new meaning of the science. Sometimes it is appropriate to make new meaning of the cosmic narrative by stopping to feel new interpretations.

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Transformative learning: The process of learning based on the disruption and reconstructing of personal narratives. A transformative learning experience implies a change in the way a learner thinks, perceives, and is valued beyond the learning context.	The opening anecdote about my own transformative experience with art in Florence recounts a shift in my personal identity narrative as a scientist, toward that of an artist. This shift is illustrated by my initially limited scientific perceptions of the Cambrian limestone, which then transition through a lived-experience to an artist's understanding of Carrera marble. My valuing of the transformed view is indicated by the fact that I now design lectures about the scientific history of art. Note: This anecdote also embeds the elements of phenomenology, cybernetics, tacit knowledge, enactivism, and reflexivity (see below).
Tacit knowledge: A mediating “hard to articulate” learning or knowledge gained through first-person experience. Tacit knowledge is also embodied knowledge, or indwelled, and is thus entwined with an ethical dimension and enacted (see below).	Instances of tacit knowledge are integrated throughout the lecture. A particularly clear example of tacit knowledge is delivered as part of the vignette on the human diaspora out of Africa. At 35:35 I specifically draw attention to how the knowledge acquired by humans is relational to the diversity of habitats encountered over millennia and generations, and is expressed in Paleolithic art forms. This qualifies as tacit knowledge because it is experiential knowledge, articulated through artistry that is likely indwelled, and because it is at least partly ritualized, it is presumably associated with some cultural component.
Enactivism: A socio-psychological theory of mind considering how cognition arises from the interaction between the thinker and its natural environment. It is, in essence, the naturalization of thought. The theory of cognitive enactivism (as opposed to representationalism) is closely aligned with the social constructivist views.	All of the artists featured in this lecture exhibit a degree of enactivism as their creativity emerges from the interaction of their neuronal network and the environment. Whether the enactment is found in an archaeological context with no explanatory record (such as stone tools and cave art) or expressed with language. William Wordsworth expresses this naturalization of thought phenomenologically when he writes in “A Few Lines Written Above Tintern Abbey” of feeling “a sense sublime / Of something far more deeply interfused, / Whose dwelling is the light of setting suns, / And the round ocean and the living air, / And the blue sky, and <i>in the mind of man.</i>”

Cybernetics: A communication theory in which information can be seen to carry agency across disparate domains. 2nd-order cybernetics in particular acknowledges how an observer of a system is always a nested component in the system observed.	The entire lecture is infused with instances of cybernetic theory. Indeed, the lecture itself is an instance of cybernetic communication: the transmitting of information from the natural to the cultural domain. Cybernetic communication is perhaps best exhibited in the vignette concerning how nuanced animal behaviors and morphology are captured in Neolithic bone carvings. The environment that the early humans lived in was communicated through to their artistic expressions. This feature is captured linguistically a millennium later by William Shakespeare when he writes in <i>As You Like It</i> the phrases to “finds tongues in trees, books in the running brooks, sermons in stone, and good in everything.”
Emergence (Emergent-Future thinking): Emergence is the fundamental natural process by which novelty arises in the universe. The potential for emergence increases under certain circumstances of optimum complexity. Emergences are generally unpredictable and therefore can appear mysterious.	The Big History narrative is a narrative of increasing complexity and therefore emergence. Emergence is made palpable early in the lecture through the series of visualizations on <i>Conway's Game of Life</i>. This sequence shows how a relatively simple set of rules and a set of initial conditions can interact (relate) to produce novelty and accumulate into unpredictable complex forms. These visualizations are designed to give the audience a lived-experience of emergence. When the first Gosper Glider appears, and walks across the screen, viewers are given a glimpse of an analogue of the radical creativity of the universe. This emergent thinking then qualifies as future-emergent thinking when it is transferred from the past and applied equally as radically into the future.
Transcalar-fractal thinking A natural phenomenon of complex systems wherein attributes are sustained across scales. Often these attributes are symmetrical. Fractals present an opportunity to forge new connections, which are a key component to reflexivity and the Cosmosis process.	Engaging with a Big History curriculum is invariably an exercise in transcalar thinking. It becomes Transcalar-Fractal when a learner senses symmetries that cross scales. The identification of fractals becomes a particularly important component of reflexivity when they are seen as the intellectual and fractal bridges between the self and other. Such a fractal is presented in the lecture, for example, by the allusion to the similarities between the mega-scale structure of the universe and neuronal structures in the brain of a rat. The poetry of Gerard Manley Hopkins provides an illustration of symmetry seen in the world that he also felt in his mind – Hopkins sees divine patterns in “dappled things” such as “skies of couple-colour as a brindred cow,” “stipple upon trout,” “Landscape plotted and pieced,” and “whatever is fickle and freckled.”

Reflexivity: A particular state of a component within a system that is simultaneously aware of its agency within the system and can thus modify its actions/impact according to a desired individual and/or systemic outcomes.	Reflexivity is the goal of the entire framework and integrated throughout the talk through several devices. The poetry of Walt Whitman (1855) not includes an early intuition of nucleosynthesis when he writes “I believe a leaf of grass is no less than the journey-work of the stars” (a process not understood scientifically until after 1940). The poem reveals reflexivity through Whitman’s keen awareness of the larger system in which he is embedded. Reflexivity, for Whitman and all of humanity, is expressed through his creating a space for human agency. He does this by alluding to “machinery,” “the statue,” and “infidels,” all of which are human constructs embedded within nature.
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Table 4: Exegetical Components of Shakespeare in the Cave: A Big History of Art

Chapter 9

CONCLUSION

In considering the study of physical phenomena, not merely in its bearings on the material wants of life, but in its general influence on the intellectual advancement of mankind, *we find its noblest and most important result to be a knowledge of the chain of connection, by which all natural forces are linked together, and made mutually dependent upon each other*; and it is the perception of these relations that exalts *our* views and ennobles *our* enjoyments. Such a result can, however, only be reaped as the fruit of observation and intellect, combined with the spirit of the age, in which are reflected all the varied phases of thought.

— Alexander von Humboldt (1858, emphasis added)

Chapter Summaries

The two overarching contexts chosen to situate this dissertation were the Anthropocene and Big History education. While the specter of environmental problems in the Anthropocene represents some uncertain and potentially catastrophic changes to the planetary system, Big History education has simultaneously emerged amidst claims of profound transformative learning. This dissertation set out to explore how these two seemingly disparate contexts might be systemically related. More specifically, the research sought to better understand how the particular cognitive elements associated with Big History transformative learning may in some way help humans better understand themselves in relation to the biosphere. How this understanding may inform better teaching practice in both formal pedagogical and cultural communication contexts was also explored.

The inquiry took a grounded approach that unfolded iteratively and cumulatively through

nine integral chapters.

Chapter 1 (CONTEXT) sought to better understand some of the fundamental mechanics behind the contextualizing issues of the Anthropocene and Big History, each in the context of the other. In order to do so it became necessary to find a suitable unit of investigation that could apply to both Big History education and the Anthropocene. Since there has been increasing enthusiasm over the power of Big History education as transformative learning, I chose to specifically examine some of the claims being made in the literature by Big History practitioners and educators. Like learning generally, transformative learning is a cognitive process. Therefore transformative learning in Big History can be readily understood in terms of human cognition. Simply put, understanding transformative learning in Big History means understanding its cognitive dimensions. As the goal was to find links between Big History and the Anthropocene, I then proposed cognition (or cognitive-level phenomena) as the potential common denominator and a suitable unit for comparative analysis. However, understanding the Anthropocene in cognitive terms required an additional, intermediating step in the logic. The first step in this two-step logic was to first adopt the scientifically accepted view of the Anthropocene as a result of human activity. Then, taking a view of human activity as ultimately, and at least partially, a manifestation of human thinking allowed the second step: to consider the Anthropocene in terms of its more cognitive dimension. Despite that the Anthropocene is an extremely complex issue with myriad social, environmental, historical and cultural components, framing the Anthropocene in this simplified way provided the relevant and suitably manageable “least common denominator” (cognition), with which the potential links between Big History transformative learning and the Anthropocene could be compared.⁸¹

⁸¹ This same “least common denominator” logic also served as the approach for operationalizing culture as a collective expression of human cognition, and therefore a medium for effectively communicating the impacts of Big History transformative learning from the domains of cognition to biosphere (See Chapter 6).

A specific literary lineage within the Big History corpus further revealed several concepts that became essential to the overall thesis. These included transcalarity (Christian 1991, 2005a, 2005b), complexity and dynamism, (Christian 2005; Chaisson 2002, 2005), ontological continuity (Chaisson, 2014) and the claims of sociocultural and environmental impacts of Big History education (e.g., Christian 2005, Rodrigue 2008, Spier 2005). A supplementary analysis within a different but allied academic field, Deep History, also revealed useful parallels between the cognitive tools and capacities of deep history researchers (Shryock & Smail 2012) and the transformative learning claims of Big History educators (e.g., Christian 2005b, Rodrigue, 2005, Simon et. al., 2014).

Chapter 1 further situated the thesis within the required biospheric context by describing the Anthropocene in terms of the Planetary Boundaries Framework (Rockström et al., 2009; Steffen et al., 2015). This discourse revealed that the concepts of complex systems spanning the entire Big History narrative also span the biospheric processes informing our scientific understanding of the Anthropocene. Later, by adopting a “super wicked problem” model (Rittel & Weber 1973; Levin et al., 2007, 2012), it also became possible to frame the Anthropocene more broadly in terms of complex psycho-social and cultural terms as opposed to strictly biological or geological phenomena independent of the human component. This was not intended as an argument for a solely cognition-based understanding of the Anthropocene, but it does suggest that approaches that fail to sufficiently consider the cognitive components that drive much of human-biosphere relations would likely be ignoring the point of calling it the Anthropocene.

The concepts highlighted as emanating from the content of Big History were later integrated into the cognitive repertoire proposed to constitute Big History transformative learning. This is important because it serves as an early instantiation of what was later identified as self-system reflexivity. If reflexivity is defined as the willingness and ability for agents within a system to self-reflect with the system in which they are embedded (whether a researcher or Big History learner), then a commitment to reflexivity means

that the transcalarity espoused by Christian (1991) is not only a concept visible in the narrative of Big History but is also a concept that can be reflected as a component of human thinking. This exercise of transferring the content of the cosmic narrative into the mind of the learner is a move that can effectively link the cosmos to personal cognition. Another example of this self-system reflexivity from Chapter 1 is Chaisson's (2008) conception of "ontological continuity" which implies that the dynamics of increasing complexification apply not only to systems "out there" in the cosmos, but also "in here" in the domain of personal cognition. Again, this is an intellectual maneuver that can, in effect, connect a researcher and a learner to the narrative of Big History. As a final example from Chapter 1, complex dynamical systems are not only an observable fact of the Big History narrative, they are also intrinsic to the workings of the human cognition. This is the basis of the psycho-socioecological model (Chu et al., 2003) which sees human cognition itself as emerging from a complex dynamical system at the individual level.

These three examples demonstrated how human cognitive capacities can be rightly understood as reflecting the system from which they emerged and how individual cognition might be linked, transactionally (cybernetically), to the cosmic narrative. In this way, the mining of the Big History literature for fundamental concepts in Chapter 1 provided some of the initial raw materials for understanding Big History transformative learning reflexively (and for the subsequent development of more reflexive teaching practices). Further, in the cultural context explored later in this dissertation, this process of reflecting the self in the system, and the system in the self, was proposed as an exercise in reflexivity which, if cultivated in personal practice and thus culture, becomes available to help shape an important, if not essential, new capacity for the *Anthropos* in the Anthropocene.

The intended contribution of Chapter 1 is a purposefully integrated application of self-system reflexivity, as applied to investigate the potential links between Big History

education and the Anthropocene. This is more than simply alluding to the concepts discussed in the Big History literature (as was the intention of the authors cited in the literature). The proposal of some originality here also concerns a recasting of the concepts integral to the Big History narrative as precursors to the narrative cognitive elements of transformative learning. Linking the concepts from Big History to cognitive transformation in this way also set the stage for new understandings of how other elements of Big History learning (revealed empirically later through the qualitative survey of Chapter 3) could likewise be reflected in the biosphere. This is what it means to understand the Anthropocene in terms of its namesake. In this case, self-system reflexive learning concerns humans learning about ourselves by studying how we are reflected in the systems in which we are integral. Learning about the *anthrpos* in the Anthropocene means learning about the self as reflected in the systems we create. This is what self-system reflexivity means and it implies that if there is something amiss in the Anthropocene, there is something amiss in the *anthropos*. The exercise of Chapter 1, then, was an attempt to reflect the “material” processes of natural cosmic evolution into the “cognitive” processes of transformative learning and vice versa. This is what results from taking the insights invoked by Big Historians, such as transcalarity, complex systems, ontological continuity, etc., and the Anthropocene to their logical conclusion.⁸² This is Big History in practice.

Chapter 2 (DESIGN) was an attempt to take the insights of Chapter 1 equally seriously and apply them to the design of original doctoral research. The work of design was to outline an overall dissertation methodology that could summarily address the contexts and concepts identified in Chapter 1 while also supporting the generation and integration of *original empirical data*. This design process prompted the adoption of a “Learning Sciences” approach and it associated design-based research principles (Brown, 1992; Barab & Squire, 2010). Chapter 2 also initiated a preliminary discussion on the function of the “creative practice” research approach by linking back to the complex psycho-

⁸² As far as I have been able to discern this had never before been articulated in this way before.

cultural dimensions of wicked problems.⁸³ Such an invocation of complex systems principles and wicked problems compelled the cultural-level communication agenda that the creative practice model could ostensibly provide. However, by the end of Chapter 2, it was also clear that the overall dissertation had become necessarily interdisciplinary and complicated. Thus, an “Integral Inquiry” paradigm was enlisted for its appropriately inclusive ability to “range across a variety of different perspectives, drop into them where needed, use them for as long as is necessary, and move out of them again when their utility for the current aspect of inquiry is exhausted” (Voros, 2008 p. 198).

The intended contribution of Chapter 2 is an original, philosophically grounded and empirical design-based methodology with pragmatic creative practice outputs (i.e., Doctoral Dissertation with Creative Components)

Chapter 3 (EMPIRICAL) sought to directly address the problem of a paucity of empirical data to support the claims of transformative learning in Big History. The research employed a qualitative phenomenological survey to surface the specific cognitive elements of Big History transformative learning using an instrument designed largely on Deweyan constructivist educational principles (Pugh et al., 2011: 2012) and Transformative Learning Theory (Mezirow, 1981).

The intended contributions of Chapter 3 are; 1) an original instrument for assessing transformative learning in Big History (See Appendix A) and; 2) an empirically derived understanding of the specific cognitive elements of Big History transformative learning. These learned capacities were described and summarized as the *Cognitive Elements of Transformative Learning in Big History* (See Table 1) as follows; *Narrative Awareness and Disruption, Urgency of Amelioration, Reflexivity, Causal Thinking, Empowerment and Participation, Appreciation and Gratitude, Fractal Thinking, and Emergent-Future*

⁸³ This discussion is picked up again in the justification of cultural communication practice in Chapter 6.

Thinking. These findings also constituted the basis for part one of the three-part, iterative grounded theory stated as: *Big History education can result in transformative learning by eliciting a unique suite of cognitive changes in learners.*

Chapter 4 (CORRELATION) set out to address the remaining question of whether or not Big History education could play a role in shaping an appropriate response to the Anthropocene. To investigate this, a additional *correlational analysis* was conducted on the empirical data (student utterances) in order to find and articulate any potential links between transformative learning in Big History education and the Anthropocene. The discourse of Chapter 4 revealed how the unique suite of cognitive changes described in Chapter 3 (Table 1) do indeed reflect the changes needed to transform attitudes and the environmental issues of the Anthropocene. This literary analysis surfaced many of the elements of Big History transformative learning including narrative theory (e.g., McAdams, 2008), urgency and amelioration (e.g., Hörl, 2013) cultural identity (e.g., Gardner, 2006), reflexivity (e.g., Krippendorf, 2008), appreciation and gratitude (e.g., Leopold 1944) and aesthetics (e.g., Dewey, 1934). A particularly good example was the clear correlation between Transformative Learning Theory (Mezirow, 1991) and the element of “Narrative Awareness and Disruption.” Similar linkages were shown to apply in varying degrees to all of the elements of transformation revealed in Chapter 3, Table 1.

The intended contribution of Chapter 4 is the finding that constituted part two of the three-part grounded theory stated as: *the cognitive elements of Big History transformative learning correspond particularly well to several changes thought necessary to constitute an appropriate response to the Anthropocene.*

Chapter 5 (INTEGRATION) sought to further develop the thesis by curating a number of relevant concepts and theories that could serve as practical resources for Big History practitioners and educators. For example, marshaling Polanyi’s concept of *Tacit Knowledge* (1996) was argued to provide Big History educators a better understanding of

how their subject—by cultivating the affective, moral, and participatory dimensions of tacit knowledge—may also trigger new, untapped motivations for students to want to learn more. Another component of transformative learning (also surfaced in the empirical data from Chapter 3) I termed *Emergent-future thinking*. Emergent-future thinking happens when the fundamental natural process understood to be driving the rise of complexity in the universe, emergence, is paired to thinking about the future. The utility of this composite concept for teaching practice can be realized by understanding how Emergent-future thinking is proposed as being capable of radically expanding conceptions of possible futures by breaking the limits of unexamined preconceptions about dynamism in the universe historically. Put another way, if that radical creativity can find a way to be suitably reflected in the cognitive capacities of the learner, and expressed in imaginings of the future, then the transformative learning component of emergent-future thinking can be said to have occurred. Chapter 5 also discussed several other potentially powerful but not heretofore described conceptual resources for Big History transformative learning. These included; *phenomenology, narrative theory, transformative learning, fractal and transcalar thinking, enactivism, cybernetics and systemic reflexivity*. These practical resources were organized into the *General Framework for Big History Transformative Learning* (Chapter 5, Table 2) and each was described along with its proposed functional significance and implications for educator practice. Knowing how these concepts manifest equally in the content, students, and potential wider impacts of Big History education, may also help practitioners craft more effective and transformative teaching interventions. These cumulative insights are proposed as original contributions to Big History education and as such constitute the third theory added to the running grounded theory.

The intended contribution of Chapter 5 is the finding that *the cognitive elements of Big History transformative learning are intrinsically linked to concepts engaged within the Big History narrative and can be supported by established educational and communication concepts*. This finding is presented as *The General Framework for Big History Transformative Learning* (See Table 2) which includes the empirical findings of

Chapter 3 (See Table 1) as well as each resources significance and practical implications.

Chapter 6 (PRAXIS) transitioned the dissertation from theory to practice by building on the cumulative works of Chapters 1 through 5. The work of praxis began by clarifying the relationship between the thesis research and the creative practice format (e.g., Krauth, 2011). It then justified the value of cultural communication in the Anthropocene based on series of arguments that included; cultural-level narrative dynamics (e.g., Korten, 2007; Charlton, 2008), urgency (Speth, 2009), efficacy (e.g., McNeill, 2011; Kasser, 2009), bridging the science-humanities divide (e.g., Callicott, 2009), the inherently collaborative nature of culture (e.g., Raskin, 2009), and the need for new metaphorical models (e.g., Shryock & Smail, 2011). The chapter then transitioned into a more artistic “creative practice” mode to present a practical model of Big History transformative learning that I termed *Cosmosis*. The *Cosmosis* praxis is a metaphorical model of Big History transformative teaching based on systems-thinking, narrative disruption, that intends to increase the “permeability” of previously established conceptual membranes between the self (learner) and the biosphere (cosmos). I then provided a critical example of how the *Cosmosis* praxis could be applied in cultural communication using the diagram of the Planetary Boundaries Framework (Rockström et al., 2009). At this point in the dissertation I had argued from numerous, integrated fronts, for the utility of the creative practice genre by showing how cultural communication can directly, effectively and beneficially link the impacts of Big History transformative learning to the Anthropocene.

The intended contribution of Chapter 6 is the metaphorical model for implementing the cumulative findings of Chapters 1-5 in Big History cultural communication practice (called *Cosmosis*). Praxis means theory in practice so applying the theoretical findings of the dissertation in practice is the essence of praxis. If Big History educators wish to cultivate transformative learning in their audience, they may find practical insight by applying a *Cosmosis* praxis as follows:⁸⁴ Principles of phenomenology suggest that

⁸⁴ See relevant chapter text for further explanation of terms used in this section.

transformative learning in Big History (and learning in general) may be enhanced by providing experiences that link personal identity narratives to natural cosmic narratives through cybernetic information exchange. Practitioners should also understand how transformative learning refers largely to the process of narrative awareness and disruption which can be acquired as tacit knowledge by learners. This tacit knowledge may be hard for learners to articulate but educators should understand that because tacit learning is experiential, it is more likely to motivate future learning, be embodied in learners (indwelled), and enacted through individual agency. Engaging with the Big History narrative also offers unique opportunities for transformative learning through experiences of fractals and emergence. Transformative learning in Big History is well correlated with enhanced ecological identity and self-system reflexivity. This is highly relevant to environmental education because ecological identity and self-system-reflexivity may be a critical human cognitive capacity to avoid further ecological degradation in the Anthropocene, and perhaps, future amelioration.

Chapter 7 (PRACTICE 1) adopted a tactic common in the Learning Sciences to design and produce a technology-based teaching intervention. *CosmosisI: The Cosmic Background Radiation Explorer* smartphone app was meant as a prototype learning opportunity to supplement Big History pedagogy by focusing on a subject commonly encountered early in the Big History curriculum. Chapter 7 discussed the phenomenological grounds, technological challenges, and includes a transcript of the app experience. By guiding users toward a lived-experience of the CBR through a step-wise progression of simulated visualizations, *CosmosisI* attempts to highlight the everyday relevance of an otherwise abstract and static visual image. Several Deweyan educational principles are also implemented such as; the distinction between concepts and ideas; the distinction between experience and “AN” experience; the role of aesthetic experience in transformative learning and meaning making; and the power of lived-experience to bring everyday relevance to understanding. How these findings were integrated into the *CosmosisI* app is presented in an exegetical table (Table 3) which includes a link to a video screencapture of the smartphone version.

Chapter 8 (PRACTICE 2) reported on efforts to design and produce the second exemplar of Big History cultural communication for transformative learning based on the cumulative findings of the thesis research. The result was an informal public lecture titled *Shakespeare in the Cave: A Big History of Art*. This creative practice output was designed to elicit transformative learning by exploring human meaning-making as an integral part of the Big History narrative. How the findings of the research are intended to be integrated into the lecture are presented in an exegetical table (Table 4) which includes an edited transcript and link to a video recording of the public lecture as it was delivered at the 2015 International Big History Association conference.

The intended contributions of Chapters 7 and 8 are the creative practice outputs insofar as they demonstrate the *Cosmosis* praxis (theory applied in action).⁸⁵

Conclusion of Dissertation:

It may be helpful now to briefly return to the interrelated questions that initiated and guided this thesis throughout the researches above. This question was framed as follows:

What constitutes an appropriate human response to the problems associated Anthropocene and can Big History education play a role in shaping that response? If so, how?

The first part of this question can be answered by saying that an appropriate human response to the Anthropocene will be reflexive. That is, it will be rooted in an appropriately deep understanding of the anthropogenic causes of the Anthropocene.

⁸⁵ The criteria for judging these creative outputs are listed at the end of Chapter 6.

Appropriately deep in the context of the Anthropocene means a willingness to consider that the environmental problems that make up the Anthropocene are not just problems of the external environment, or simply problems of human activity, or even problems of human cognition. An appropriately deep understanding of the Anthropocene will acknowledge that human cognition, and thus human activity, is relative to the anthropogenic changes that have been accumulating in the biosphere over the past few centuries. This means that present cognitive structures and the social structures they reflect, although they may have been not been problematic historically, may have become outmoded or maladaptive in the Anthropocene.

The answer to the second part of this question, which asks if Big History education can play a role in shaping that appropriate response to the Anthropocene, is “yes.” How? By engaging learners with a vast, transcalar, complex, and ontologically continuous narrative that systemically spans nature, culture and the self, Big History education can provide a fecund intellectual space wherein personal identity narratives can transact with the cosmic narrative in new and disruptive ways. Transformative learning is more inclined to happen in this space because of the narrative, scalar and dynamism of the Big History content. Further, the elements of transformation learning in Big History contain many additional cognitive changes that may lead to fractally similar, social and cultural changes that relevant experts believe can help mitigate further ecological deterioration. In this way, the research conducted in this thesis suggests that Big History education can play a uniquely vital role in shaping an appropriate response to the Anthropocene because it presents an opportunity to cultivate increased self-system reflexivity with the biosphere.

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Appendices

Appendix A: Big History As Transformative Experience Survey Instrument

SPLASH PAGE: Previously hosted at <http://www.bighistorysurvey.com>.

This voluntary, anonymous, and very short 5-question survey seeks some basic information about people's experience with Big History. Chances are you have been selected to participate because you have recently completed a course in Big History (but others are invited to participate as well). Please be aware that your participation (or non-participation) will in now way influence your mark or grade and there are no right or wrong answers. So please be as honest and thorough as you can. After agreeing to consent below, you will be presented with the questions Thank you for participating! Your answers will help us in improving Big History education.

CONSENT PAGE:

Do you consent to participate in this survey and agree to the conditions?

☐ Yes

☐ No

CONDITIONS (Pop-up window): The purpose of the study is to explore the value of big history and how it is taught. The study is being conducted by Richard Blundell, PhD, candidate at Macquarie University to meet the requirements of a PhD under the supervision of Dr. David Christian in the Department Modern History.

You should not experience any risks or discomforts, nor will you receive any remuneration for your participation. Unless you instruct otherwise, any information you provide may be published. Any data collected will be available only to the co-investigator listed. Participation in this study is entirely voluntary and you are free to withdraw at any time without adverse consequence or having to give reason.

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics (telephone (02) 9850 7854; email ethics@mq.edu.au).

Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

By checking the “Yes” box and clicking the “>>” button you indicate that you have read and understand the information above and agree to participate in this research.

STATUS PAGE:

What is your current status with Big History?

- ☐ I am about to finish or recently finished a Big History course (Please enter course name, school ,end-date, and instructor/tutor). _____
- ☐ I have some other experience with Big History (Please describe; Did you read a book? Watch a television program? Visit a website? etc.) _____

IF “OTHER EXPERIENCE” THEN Notice: The questions that follow are worded for people who have recently completed a Big History course. You are still invited to participate in this survey, but because you selected that you have "some other experience" you will need to overlook the "course" and "class" wording and answer the questions according to your particular experience. Click the >> arrow to continue to the survey.

Transformative Experience Block

Q1 Do you ever think about what you’ve learned in your Big History experience, or talk about it with others outside of class (in everyday life)?

- ☐ Yes
- ☐ No

If yes, how much do you think/talk about Big History and what do you think/talk about?

Q2 Has your Big History experience changed the way you see or understand aspects of the world?

- ☐ Yes
- ☐ No

If yes, how has your Big History experience changed your perspective?

Q3 Do you think taking a Big History experience was valuable?

- ☐ Yes
- ☐ No

If yes, what was the value in your Big History experience?

Extra Questions Block:

Q4 Has your Big History course changed the way that you interact with the world?

☐ Yes

☐ No

If yes, how has your Big History experience changed the way you interact with the world?

Q5 Your responses indicate that Big History has transformed the way you view the world. Does any specific aspect of what you've learned stand out as particularly transformative?

Q6 What were the best and worst parts of your Big History experience?

CONTACT PAGE:

Please provide your email address if you don't mind being contacted by one of our researchers so that we may clarify, confirm, or follow-up with you.

Appendix B: Student Survey Responses

1. Made me appreciate the vastness of everything; how truly insignificant human beings are in this big view; and noticed and appreciated huge patterns in our universe and world.
2. Gives me a bigger perspective in everyday life
3. Made me more aware of the world around me, and how things happened and got where they are..
4. The best was being exposed to a new way of thinking and broadening my horizons among immediate and recent history which makes up the vast majority of historical scholarship.
5. YES :) Especially in the last week really reflecting upon how rapid our development has been within the last 100 years and how much further can we go? / Also personal reflection about the future prompted by topics which were brought up in recent tutorial discussion.
6. It shows the human impact on things that might be better left alone; how we can fix our mistakes and learn more about our universe and earth
7. when looking at geographical positions (mountains) i consider how they were created, and how species of the environment evolved
8. hominid evolution was particularly interesting and transformed the way I understand humans
9. Learning just how interconnected we are with the start of the world /
10. Very often, I found it a fascinating way to look at the world.
11. I understand our species more, and our past. And just how drastic the human impact has been on the Earth.
12. It's a totally different way of thinking about the world which is becoming more and more relevant as the human population faces challenges it's never before had to face. It

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also helps understand why the world is the way it is in terms of large-scale/international arenas such as economics.

13. I have a greater appreciation for the miracle it is that we're here in the first place and that how incredible it is that our universe has got so incredibly complex and continues to do so at an ever increasing rate. The persistency of life and the precursors before it and how rare and infirm our world is.

14. Best part: seeing the history of the world unfold like a massive creation story and there is no 'right' answer

15. Philosophical through to environmental and general history- things such as our place in the universe, how much we have changed the natural landscape, have we progressed. Etcâ€¦

16. enhanced my love of the subject of Human Evolution

17. I am a fairly art based mind, but it was great seeing a connection between science and the arts, and seeing how math, science history were all part of the Big Bang.

18. I feel a lot smaller in the whole comparasion of the world!It showed for me that the world as we know it today, with the dominant West and relative poverty in many other places didn't emerge because their civilisations were superior, it was more of a 'right place, right time' situation.

19. Mostly I talk about the stars or grass, they're pretty basic fundamental things but the completely changed everything.

20. I have a lot more respect now for everything in our world. I have an appreciation about the food we have and how far we have come.

21. I became more open to new ideas

22. It shaped the way I look at it more than how interact with it, I'm still the same person but my view towards the world by how its changed and maybe the direction its headed by looking towards the past. The sense of large repeated patterns

23. The best part was partipating in a life changing educational experience.

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24. When Im driving and looking at my surroundings I find myself thinking about the Big History course and how something that I used to take for granted was actually much more complex to create.

25. I feel big and small at the same time! I feel like the work I do can make a small difference now and a BIG one down the road.

26. I actively seek to educate and inform others as well as a new passion for more holistic studies in other areas. The scale and interconnectedness.

27. best wholly engaged/inspired/enlightened / worst - the realization of how dire consequences could be if current unsustainable current growth rates are continued (a scary thought)

28. I have always pondered over Cosmological issues...ie., the Big Picture.from both scientific and Metaphysical perspectives. / With me it has always been an obsession to gain a total world view. This is why I have been so passionate about this Unit. / / I have shared my learning experiences with a few friends, esp. when they show an interest in what I am doing. One couple have asked to read my essays from the course, and we have subsequently had discussions on various aspects of Big Histgory.

29. It has extended my view of history to the beginning of time and made me understand the inter-relation of all aspects of humanity, the environment and universe.

30. Understanding of more than just human history. Able to see big patterns that emerge throughout time, and on universal scales and microscoptic scales. This gives you an appreciation that everything is related, that we as humans arent 'amazing' and 'important' in any real sense, that we are just the process of billions of years of emergence.

31. Perhaps on a small scale just being mindful of the complexity a fly or bug has and how I don't want to destroy such complexity simply by squishing it cause it is an inconvenience to me.Just in general puts things in perspective and the knowledge I now have has been empowering ???!!! /

32. The best was just having so many pre-existing ideas shattered.

33. At least once a day. Generally I'm telling people what the course is--the history of the Universe from the Big Bang to the present. Or we talk about science and religion, or the remarkable likeness between humans and apes. It's very common that our conversation turns to the importance of offering college students a well-rounded education in which they can contextualize their future learning to better the planet and provide for our species.

34. I definitely feel like I see the big picture. I've often found myself thinking about our modern world very differently - I'm now more aware that the life we lead now is VERY different to 99% of human history. I'm questioning our modern lifeway more, instead of taking it for granted.

35. I appreciate it more Um, I don't know. I thought that grass and stars were...for lack of a better word: stellar. I don't think that's 'particularly transformative' though.

36. I liked expanding my thoughts to things that weren't just in front of me, thinking about stars and the galaxy made me more open to new ideas because it is not something I can confirm with my own hands but rather a belief and idea.

37. I thought about the Big Bang and would look at the sky at night wondering about the beginning of the universe. I constantly thought about how we came to be who we are as a global community.

38. It opened my eyes on how little us humans are apart of the whole creation of the Earth. We are just a little point on such a large line of events that have occurred throughout the billions of years. The amount of science and history this Earth has is too much to handle but makes things more clear about why things are today.

39. It was so comprehensive and accessible and I feel that I have been empowered to give a documented account of all existence

40. I am more observant and interested in where we have come from, where we are now and where we will end up. I would say that it has made me look at timescales and see how humans have only been around for such a small time, yet have done so much to the earth.

41. All the time. I talk about it's potential to create a more cohesive understanding of how we as humans fit into the environment/universe, about how it has potential to be a wonderful children's story of wonderment and education, how once we understand that everything is connected, we can understand the potential consequences of actions, and so on. I also think about how the paradigm could be discussed and taught more effectively to reach a greater audience. Even though we are covering massive amounts of data, there are numerous avenues to create succinct fun programs and visualizations of this data.

42. Gives more meaning to thing because i know where everything has come from and what has happened in the past to get to the present day

43. I have learnt so much about the workings of the Earth and its history. Its hard to put into words.

44. i think how what i do affects other things now. The scale of change has really been clarified to me and I am astonished at what the past actually consists of

45. I think about Big History everyday. With the world below my feet, seeing how things have changed get my mind wondering about what it could be if somethings never happened. Starting with the big bang and how society is shaped or formed today, with one little detail missing, it astonishes me with how different this place we call home could really be.

46. It allowed me to focus not only on the present or recent past but to look beyond that and see how the present and recent past tie in to the whole of history. It really makes the smallest of things that we take for granted seem mind-blowingly huge.

47. It opened my eyes to the things that have always been in my surrounding which I have never appreciated.

48. More awareness of how we came to be where we are today The amazing thing about Big History is that it can make you feel insignificant; but, if you stick with it, it can also empower you. That feeling of empowerment has stuck with me.

49. I think about the concepts a lot outside of class and talk about the course to almost all of my friends. The way the course is taught and the concepts within the course just light up all of my interests from science to modern history.

50. I now look at the world with a greater appreciation. I understand the complexity of each element, that I once took for granted, and understand how significant the history of the world is. Not just the history of the last few centuries, but the entire history of the world. The significance of the 'Goldilock theory' whereby every element had to be 'just right' to develop into the complex and innovative world that we live today.

51. Getting the opportunity to explore many intricate thresholds in which complexities enhanced, realising the importance of macro-history.

52. It just made me view the world in a much different way. Now when I see new things i think about what they could have evolved from and how long this certain species has existed. I have become more scientific. A feeling of connection to all who have come before and all who will follow.

53. I seem to think about it all the time now. Not so much about 'big history' as a concept, but more so about what I have learnt about myself and humans in relation to the rest of the universe. It really grounds you and helps you understand your place.

54. Studying Big History has enabled my to better understand the how the pieces of the jigsaw puzzle that is the world and everthing within and without it, fit together. This has been especially true for the human history part of the course as this is the section on which i had the littlest idea about before beginning this course. it is fascinating to think about early human civilisations and how they have helped shaped society today. I guess Big HIstory has changed my perspective in the sense that i am now able to think deeper and more critically of our history as a human race.

55. I think it was valuable to learn about our past from the very beginning from a scientific stand point. All of my learning about the past has been from a historical or literature based stand point. It was nice to see things in a different way.

56. I see beauty in more things, but I also look at them more critically. Learning how the transition to agriculture from hunter-gathering did not necessarily improve humans' quality of life.

57. I tell my friends all the really interesting facts that I have learnt all the time - they're probably sick of me by now. Knowing more about the whole story makes me really think about the ways that everything in the universe is linked.

58. It has given me a better understanding of how history and science are interlinked. I have a greater understanding of the links between all the disciplines of the natural and human sciences.

59. The value of an open mind is priceless...

60. More humble perception of ourselves Through studying BH, I was able to reconnect with my love for science, and combine that with my passions for creative work and learning.

61. I talked a lot actually, more than most people wanted to listen! I found myself thinking and talking about things i had never thought of let alone understood before. Eg, the big bang, how life possibly started, where religion even came from and how it came to being such a big part of life, does religion deserve the role it play if perhaps big history really is more of a science than power of god, i thought long and hard about issues that perhaps weren't discussed in as much detail like how skin colour came into being about slavery or nobility, and a lot more about power and what little control we really do have over the way we live our lives oh and the fact that humans are no longer self sufficient human beings amazed me as id never really thought about it like that before... i do know that if i was dropped in the middle of an ice age or deserted country i wouldn't know where to start- prob wouldn't last long either!

62. i look at the creation of the world and the development of the world in a different light. i can see how complex society and how interrelated modern and past environments and societies are.

63. It has changed my perspective, my view of my responsibility as a global citizen and an understanding that there is a reaction/consequence to all decisions we make for future generations. Time seems far more cyclical than linear now.

64. I am far more aware of the fact that decisions made in our and other parts of the world affect all of us. There is no individuality in the global community. The formation of "civilisations" and the creation of power has made me criticise the way society is today

65. I talk about Big History several times a week, to discuss things I have learnt. I also talk a lot about the perspective that I gained in understanding the human story in terms of the wider story. Further I talk about the empowerment to seek change that this perspective has provided.

66. That there should not be distinction between human and environment but humans are also part of the environment and that we should cooperate as one global citizen.

67. I think everyone should do Big History. I think if we are going to make well-informed decisions about our future we need to know how we've gotten to where we are now.

68. I'm questioning our modern life more than I did before. I see how incredible the stage in history we live in now is. That everything we see and touch, including ourselves originated from the center of a star.

69. It has made me understand the vastness (if that is a word) of our universe and the history of the universe in terms of how i see myself and how insignificant I am in relation to everything.

70. It makes you think about not only yourself but about the world and universe as a whole. How things are connected and how wide open possibilities are

71. It gave me a better lens to understand the connections I was already seeing. Big History invites one to take a step back from our microscopic perspective and examine a system as whole, how it interacts with other systems, and notice patterns. Learning about the Big Bang and the specifics behind that was particularly impacting on me as I had previously avoided the subject as I don't consider myself a particularly science-y person so studying content with a science base was a fruitful challenge for me.

72. I never realised that things that happened billions of years ago had such a profound impact on why the world is the way it is today.

73. The way in which I view the world lets me appreciate where I am and where we are as a race so much more.

74. Anything is possible as long as you put your mind to it. There are no limits to where you can stop. Only yourself can be your own barrier. Just the audacity of the human spirit and the enormous complexity of our universe and everything in it.

75. makes you feel insignificant at the start - but at the same time alerts you to the problems we face today and how it has been humans that have created these problems. So it was kind of a motivation to make a positive change!

76. I think the value of the course is simply to open up your mind to something bigger than just society and now.

77. I feel much less important now than I did before the course. The fragility of the planet and humanity's impact upon the planet as a whole.

78. I think I have a wider perspective on topic and am a bit more open to ideas /

79. It helped me to consider the universe at a more holistic level.

80. Im such a small part of everything that has happened, but at the same time makes me understand the pastthe amount is stars tand the univerese around us - how small we are oin teh scheme of things but the major impact we have on such a complex being ie the earth.

81. its further my knowledge of how humans have came to be what they are.

82. i has given me knowledge that has deepened my understanding of the world around me which helps when thinking about the bigger issues.

83. Before, I suppose I saw myself in the world as just a human, now I see myself more as a compilation of years and years of history. In the first lectures I remember being told that matter can never be destroyed meaning that when we die, it is really only our subconscious that dies.. i found that really interesting. And it has really made me ask, what is the point of everything?

84. I think I now see humans as being both seemingly insignificant in comparison to everything else that has happened, and also the most complex and fascinating thing that has ever occurred.

85. it was an interesting eye opener on the relations and development of the world and what influence those changes

86. The Big History has enabled me to alter my perception of world in that humans aren't everything. History doesn't begin with life but rather the Big Bang or maybe even further beyond that. I've learnt the insignificance of humans in this perspective. But at the same time, I appreciate the complexity of humans and how through collective learning and social powers, we were able to expand and diversify. Therefore I see myself as insignificantly small when looking at the big picture but then appreciate my species so much more. The creation of stars due to the big bang and how the planets were all created as a by product of the sun's creation. That really made me open my eyes and see that, what I thought was just the way the world is, is not the case. That we are here by, really, a luck of the draw.

87. It's really helped me to make sense of other elements of history, science and astronomy that I learned in high school, but I didn't realise that they all linked in such a complex way and created a huge story.

88. I think it's really important to know the history of the world because then we can have more knowledge when it comes to facing future problems that humanity and the earth are set to face.

89. It's stopped me from seeing myself as the centre of the universe. Rather I'm able to understand exactly how I came to be in this position. The fact that we are all essentially star dust

90. Aspects of the world are more interconnected than I once perceived

91. Other than improving my essay writing Big History helped me see the world in a much larger picture than I thought it was. I previously viewed History as "Roman Empire"

"Spartan Era" "Chinese Era" "Development of Earth" etc and never thought that these could all be connected.

92. it has made me question my existence. I feel somewhat like a speck of dust floating through the air, illuminated only by the sunlight. Existent for moment in time and at the mercy of external factors.human history!

93. Seeing history taught as a whole instead of seperate narrowed accounts has made me much more aware of our past as a whole and where the story is going

94. Opening my eyes! I have learnt a great deal about why the world is the way it is today.

95. It has shown me how small but also how important humans are to the story of the universe. The main thing is thinking about the "big picture". Understanding the place of humans in the biosphere.

96. Its given me a better understanding of how the world has come about, and indicated trends for the future to look out for.

97. I actually found history interesting for once! And it's changed the entire way that I think about what history should mean. I also feel like I just have a much more robust knowledge of the world, and why things are the way they are now.

98. I see that the world is a much bigger, more complex place and that what happens here on earth is due to what happened billions of years ago in space. It makes me seem much smaller but at the same time, that I still have a role to play. With learning how big the world is it's also easier to justify eating a piece of cake, it won't really have much effect in the long run :)The scale and expanse to the universe

99. Before taking Big History, it was easy to forget how far our species have come, in evolutionary terms. But then again, I was reminded of how our actions and behaviors often reflect our animalistic instincts.

100. Yes, well I think I see the things I described above as being inherently valuable. But also, I think it's a great course because it's multidisciplinary, which gives you a sense of how really all knowledge is related.

101. Makes me feel like a bit of an ant to be honest! But also makes me realise just how powerful humans can be, particularly when it comes to our manipulation/ destruction of the environment. Collective learning, as I mentioned before, definitely had an impact on me. It explains the difference between human species and other species, it explains why humans have history while other animals do not, it might even provide a framework for explaining the relationship between the individual and society. So, yes, I find this aspect of the course really interesting.

102. Well, to begin with, it gives one an idea of humanity's place in the larger scheme of things. Of course, one can never really get a proper idea of the scale of some of the things discussed in the course and for those things one can only take recourse in analogy. Nevertheless, the course really gives one a clear sense of how the world came to be as it is and that, in a way, makes you look at the world in a more critical way. The part of the course I really loved, however, was collective learning. I'm a major in philosophy, so maybe that's why this sort of thing really appeals to me and maybe that's why I take it the way I do, but I think there are all kinds of philosophical implications of that. Not just in ethics (since, by this understanding, human individuals would appear to be defined socially), but also in aesthetics. For example, if collective learning is what makes us human, then science must be the most human of all acts. This all sounds very poetic but oh well.

103. Understanding basically, big history touches upon so many things i have never really thought about let alone understood. And seeing it as one whole story, everything in the past has affected our place in the world today and everything we do today will affect our future. Nothing stays the same and i think understanding past changes helps appreciate current life, or at the very least acknowledging the difference. / I think big history should definitely be brought into high schools!! Beats the random disjointed uninteresting stuff i got taught.

104. I see myself as more important. Im the culmination of 13.7 billion years of history, all leading to the most complexity to have ever occurred. The similarities between ancient civilisations and our modern ones. We have not progressed as far as we think.

105. I'm not even sure the way i express myself saying this can clearly demonstrate how this topic has changed my perspective. I understand things now that are just unbelievable- it also sparked interest in things and i found myself spending time looking up things like the role the moon plays in everyday life. I think the main thing that has changed in my perspective is appreciation. i appreciate things i probably wouldn't have so much before. The idea of our earth being one whole rather than your country/ my. Just like the astronauts saw earth as one beautiful whole i saw what they saw- perhaps everyone needs to take a trip out of earth to reflect and appreciate just how extraordinary lucky we are to exist on it. / And... not that this point has entirely changed but it baffles me how a world with such intelligent species (us) became consumed with money and power... somewhere along the way we lost respect for individuality and difference and went from meeting basic needs to everything in life being about human wants best for humans when we are by no means the only species that make this world what it is...!

106. It completely changed my way of thinking in nearly every aspect of life. It really was the most enjoyable thing I have ever done.

107. Its made me view myself as far less significant, but also as a part of a far greater galactical system, a system I was mostly ignorant of before The Paleolithic period and the way humans lived in the earliest stage of our history. The origin of religious thought possibly as early as 70,000 years ago, deflating the value of dominant religious traditions only a few thousand years old.

108. Events in life no-longer seem so dramatic or lifechanging when compared to the scale of our universe.

109. It offered some perspective and context for a lot of ideas. It helped create a frame by which my role in life can be a little more easily measured.

110. It really shows me how significant humans have been in world history. The realisation that humans, on the largest scale of history, are actually fairly insignificant in relation to the amount of time we've been around.

111. i started the course by accident as a history student, I didn't realise what the course actually was. It has changed my perspeticve because I never knew very much

about the scientific aspect of the beginning of the universe. Now I find myself comparing these history with science in every history course I take.

112. As an atheist, I have always been comfortable with not believing in God, at the same time I had little knowledge of things such as the big bang and evolution which I purport to believe in. I found learning about these concepts caused me to question all of the stories upon which I base my identity as a human. This process has led me to explore my values, my purpose and my beliefs leading me to expand my understanding of who I am, what I am a part of and what purpose I may find in my life.

113. Well, you do become aware of your insignificance in the universe. On the other hand, it makes one realise how unique a planet like Earth is. It makes one more appreciative. I actually knew a lot of what we went over already, at least in some vague way. What stood out was the way random tidbits of information got sorted out and connected. / Reminded me of those moments in long stories when you realise that This character and That character are actually connected in some interesting way.

114. Has reinforced the extent of how insignificant humans are in the huge scale of the universe, and how trivial and specific particular cultural traditions are, negating the need for patriotism/racism/religion in light of a common story.

115. I feel like I can do much more to help change the world, but I kind of wish people had started to change their ways way before that way we wouldn't have as many problems as we do today.

116. Again, it broadens my focus on the world as I now have a much better understanding of how I (as a human) am able to live the way I do. As well as simply how things have come to be the way they are, both human and non-human elements. maybe things that are too complex are dysfunctional. maybe we need to resort to a simpler life and simpler way of thinking about things to ensure the survival of our species....for longer at least. extinction is inevitable

117. It's made me more much aware of the overall history of the universe and our earth. From this I have come to better understand the importance of evolution in this

history and also see the importance of agriculture, innovation and collective learning in this. /

118. I know that I need to keep recycling and conserving water. These may be small things, but they all add up.

119. I guess i feel more connected to my world, my surroundings, having given me the opportunity to think outside trivial everyday life and beyond makes me feel like i fit a bit better.. if that doesn't sound too funny for you Rich :) / / i know people say ignorance is bliss.... but def not when it comes to the world you are living in and how you came to be in it. / / Understanding collective learning, I was already thinking a lot about what makes humans different from animals and where our differences are leading us. I had got it down to communication being absolute key to our development and thought that the current technological explosion showed that this was a human strength. I now think that communication is the tool that enables collective learning rather than key in its own right.

120. Big History has changed my perspective because it has shown me a big-picture perspective of, not only human history, but the entirety of history from the Big Bang to the present day.

121. It made me open my eyes more to the damage that we, as a species, are doing to the planet and ways to stop it.

122. Though I feel less significant in the grand scheme of things, I realise that I do matter, as one person, while not being significant in themselves, can radically alter the course of history.

123. It's actually made me more interested in politics (and more disappointed with some of the infantile aims of current governments). / I'm more conscious of the histories of even everyday objects, and wonder what long-term impacts current living habits will have. / Still xenophobic at times (worried about our culture disappearing), but more accepting of the inevitability of change, and the illusory idea of cultures "always being this way".

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124. Making an impact in other people's lives, so that I know that I did something wonderful in my lifetime.

125. things seem far more trivial now than they use to and our own issues seem smaller than before. The course really has a calming affect on the way I view things now.

126. it really has helped me grasp bigger issues then what i may encounter each day and has put things into perspective - our kind and our part in history and everything that ever was.

127. I feel that I should do more to try and save and protect the world because it will benefit the generations to come

128. Giving a sense of humility and reducing the sense of humankind's self-importance in the universe.

129. Big History has helped me to understand that everything that at the end of the day, our bodies are a collection of cells that are joined together for a greater purpose. Learning about Big History planted a seed in my mind that perhaps to resolve our social problems humans need to consider ourselves not as individuals but as a species which has the ability to change our history through working for a common good rather than the individual good in much the same way that the cells in our bodies do. I believe that this is a potential next step in increasing complexity. / / Big History has also illuminated how incredibly wealthy and privileged I am and how this has been gained at the expense of others. In particular it has changed my view on Karl Marx. While his proposed world system hasn't worked in actuality, the problems with capitalism he outlined remain the same. I think that it's time to imagine something else. / / I have also felt a renewed sense of kinship with non-human animals, plants, geology etc when I reflect on how much of human history is shared.

130. I see how we can make a huge difference and the world changes due to our acts

131. My Big History experience has contextualised my place in the world by allowing me to trace back the fundamental origins of human life.

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132. It makes me appreciate all of the things I have more, including the chance to live.

133. Humans are the dominant species. We practically own the biosphere, that's a lot of responsibility to uphold.

134. In terms of scale, I see I'm very small and very brief. Humbling, I guess. But also a little awed by the precariousness of this world. / It makes it harder to take things for granted.

135. I just think of how things are made and how far back they come from

136. I am apart of something greater and though I am only one person, I can still influence my environment.

137. I think about the history of where I live, where I am from and I would like to travel to many places to see history there also.

138. I have begun to view the world as a much bigger place.

139. I am pretty small and insignificant compared to the grand scheme of things.

140. although i am very small and wont change much in the world I feel as though i understand the world a bit better.

141. Throughout my schooling I have been taught history in small chunks, for example, US history or European history. It was great to be able to string everything together in one big class!

142. I feel I am able to have more control and have a better understanding of why the world works a specific way.

143. I feel that I am a part of a the Western culture and the great webs of the world are still colliding meaning that this separates me from those who are culturally different. Better understanding my cultural background has broken down a lot of prejudice I felt towards different cultures and understanding a bigger picture of history has helped to understand how cultural differences have arisen and also how little these mean in a big picture. Big History has made me feel committed to believing in a world

where cultural differences may be accepted and where humans may see all individuals as more the same than different.

144. Enjoy every day like it's my last.
145. I need to take a bigger role in saving the biosphere.
146. Everything has a complex background, even the simple things.
147. It makes me feel smaller and more in unity with my species rather than higher and different i feel like we are all the same.
148. I take appreciation in all of the little things in my life because i now realize how long and hard the world has come along to create small things like grass and flowers, and the clothes we wear and so much more.
149. I feel the need to give back to the earth more
150. I learned that all entities both animate and inanimate share a symbiotic relationship.
151. I now know that we, humans, have a huge role in the world and we need to preserve life.
152. I just appreciate everything a little more and I understand more of my history.
153. I am here for a purpose and the world is open for me to explore, learn, and grow in it.
154. I always thought the stars were simple rocks, but knowing the elements and how they were composed. As well as the coming of humans and the evolutions and understandings and different stories to how as humans we were created.
155. Made me realize that my life has an impact on the future of this planet
156. I understand much more how big an impact the human race as a whole has had on the universe (in context).
157. It has allowed me to see that I am more of a part of the bigger world than I thought. Even if I am just one in 7 billion

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158. We are killing it.
159. Will treat the world with more respect, nature is all we have and we don't need to abuse it
160. I did not know about different cultures' interpretations of the beginning of the universe
161. it has made my realize how capable I am of making changes in the environment
162. I now know how certain things emerged on earth and it fascinates me.
163. Makes me feel that i am very unique and different from everyone else. And something that i do now could effect the way future generations are.
164. Every single, little detail of everything in this world has a reason and a purpose
165. I am questioning the purpose of my role in this world if I am going to die anyways and life on Earth is going to end when the sun expands.
166. it has helped me become more aware of how to make smart decisions of how to use renewable energy sources.
167. I feel like at this moment, I should try to do more recycling and less polluting in order to keep the earth healthy enough to sustain life
168. I appreciate history more and where i have came from. Also have been more thankful for seeing how everything and everyone has developed over time.
169. I see myself as tiny in comparison to billions of years of the past, the universe, and the future; but I also see the large effect one species can have on the world.

Appendix C: Inter-rater Reliability Worksheets

The following four worksheets were used to establish inter-rater reliability coefficients. A Blank worksheet was sent to each of two anonymous, knowledgeable reviewers with instructions as shown. Answers were recoded as shown below and transferred to correlation grid (final worksheet).

Step 1. Paste as many codes (or none) from this list into the CODE(s) column as you see fit. If you feel strongly about adding a new code, please type in CODE(s) column.

Biosphere Kinship	Human Kinship	Personal Impact
Causal Connections	Identity Shift	Planetary Awareness
Cosmic Awareness	Interconnectedness	Relevance to Self
Expanded Perspective	New Perspective	Scalar Shift (Time)
Historical Awareness	Pace of Change	Scale of Change
Future Awareness	Personal Identity Shift	Sense of Place

TEXT	CODE(s)	CATEGORY(s)
Now when I see new things I think about what they could have evolved from and how long this certain species has existed.	Expanded perspective Historical awareness New perspective Planetary awareness Scalar shift	Narrative shift
I understand our species more, and our past, and just how drastic the human impact has been on the Earth.	Biosphere kinship Causal connections Historical awareness Identity shift New perspective Personal impact Planetary awareness Personal identity shift Pace of change Scale of change Scalar shift	Urgency/agency/future thinking Connection/unification/ecological identity
I gained a feeling of connection to all who have come before and all who will follow.	Causal connections Expanded perspective Historical awareness Future awareness Human kinship Interconnectedness New perspective Personal identity shift Relevance to self Scalar shift	Connection/unification/ecological identity Community/biospheric/cosmic context Urgency/agency/future thinking
Not so much about 'big history' as a concept, but more so about what I have learnt about myself and humans in relation to the rest of the universe.	Causal connections Cosmic awareness Expanded perspective Identity shift Interconnectedness New perspective Personal identity shift Sense of place	Narrative shift Connection/unification/ecological identity Community/biospheric/cosmic context
Made me realize that my life has an impact on the future of this planet	Biosphere kinship Causal connections Expanded perspective Future awareness Identity shift Interconnectedness New perspective Personal identity shift Scale of change Personal impact Planetary awareness Relevance to self Scalar shift	Connection/unification/ecological identity Urgency/agency/future thinking

Step 2. Paste AT LEAST one of the following full sets into the CATEGORY(s) Column

Narrative Shifts	Community/Biospheric/Cosmic Context
Connection/Unification/Ecological Identity	Urgency/Agency/Future Thinking

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Step 1. Paste as many codes (or none) from this list into the CODE(s) column as you see fit. If you feel strongly about adding a new code, please type in CODE(s) column.		
Biosphere Kinship	Human Kinship	Personal Impact
Causal Connections	Identity Shift	Planetary Awareness
Cosmic Awareness	Interconnectedness	Relevance to Self
Expanded Perspective	New Perspective	Scalar Shift (Time)
Historical Awareness	Pace of Change	Scale of Change
Future Awareness	Personal Identity Shift	Sense of Place

TEXT	CODE(s)	CATEGORY(s)
Now when I see new things I think about what they could have evolved from and how long this certain species has existed.	Expanded Perspective Historical Awareness New Perspective Scalar Shift	Narrative Shifts
I understand our species more, and our past, and just how drastic the human impact has been on the Earth.	Causal Connections Biosphere Kinship Expanded Perspective Historical Awareness New Perspective Pace of Change Personal Identity Shift Personal Impact Planetary Awareness Scale of Change	Urgency/Agency/Future Thinking Connection/Unification/Ecological Identity
I gained a feeling of connection to all who have come before and all who will follow.	Causal Connections Expanded Perspective Historical Awareness Future Awareness Human Kinship Identity Shift Scalar Shift Interconnectedness New Perspective Personal Impact Relevance to Self	Narrative Shifts Connection/Unification/Ecological Identity
Not so much about 'big history' as a concept, but more so about what I have learnt about myself and humans in relation to the rest of the universe.	Causal Connections Cosmic Awareness Expanded Perspective Identity Shift Interconnectedness New Perspective Personal Identity Shift Personal Impact Relevance to Self	Narrative Shifts Connection/Unification/Ecological Identity Community/Biospheric/Cosmic Context
Made me realize that my life has an impact on the future of this planet	Biosphere Kinship Causal Connections Expanded Perspective Future Awareness Identity Shift Interconnectedness New Perspective Personal Identity Shift Personal Impact Planetary Awareness Relevance to Self	Connection/Unification/Ecological Identity Urgency/Agency/Future Thinking

Step 2. Paste AT LEAST one of the following full sets into the CATEGORY(s) Column	
Narrative Shifts	Community/Biospheric/Cosmic Context
Connection/Unification/Ecological Identity	Urgency/Agency/Future Thinking

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Step 1. Paste as many codes (or none) from this list into the CODE(s) column as you see fit. If you feel strongly about adding a new code, please type in CODE(s) column.		
Biosphere Kinship	Human Kinship	Personal Impact
Causal Connections	Identity Shift	Planetary Awareness
Cosmic Awareness	Interconnectedness	Relevance to Self
Expanded Perspective	New Perspective	Scalar Shift (Time)
Historical Awareness	Pace of Change	Scale of Change
Future Awareness	Personal Identity Shift	Sense of Place

TEXT	CODE(s)	CATEGORY(s)
Now when I see new things I think about what they could have evolved from and how long this certain species has existed.	Sense of Place Scale of Change Scalar Shift (Time) Pace of Change Expanded Perspective Historical Awareness New Perspective	Narrative Shifts Community/Biospheric/Cosmic Context
I understand our species more, and our past, and just how drastic the human impact has been on the Earth.	Historical Awareness New Perspective Causal Connections Personal Impact Human Kinship Biosphere Kinship	Urgency/Agency/Future Thinking Community/Biospheric/Cosmic Context Narrative Shifts
I gained a feeling of connection to all who have come before and all who will follow. REVERENCE	Biosphere Kinship Cosmic Awareness Human Kinship Identity Shift Interconnectedness Personal Impact Scalar Shift (Time) Sense of Place Historical Awareness New Perspective Expanded Perspective	Narrative Shifts Connection/Unification/Ecological Identity Community/Biospheric/Cosmic Context Urgency/Agency/Future Thinking
Not so much about 'big history' as a concept, but more so about what I have learnt about myself and humans in relation to the rest of the universe. REVERENCE	Personal Identity Shift Interconnectedness Biosphere Kinship Relevance to Self Planetary Awareness Personal Identity Shift	Narrative Shifts Connection/Unification/Ecological Identity Community/Biospheric/Cosmic Context
Made me realize that my life has an impact on the future of this planet	Causal Connections New Perspective Cosmic Awareness Personal Identity Shift Personal Impact Relevance to Self	Narrative Shifts Urgency/Agency/Future Thinking Connection/Unification/Ecological Identity

Step 2. Paste AT LEAST one of the following full sets into the CATEGORY(s) Column	
Narrative Shifts	Community/Biospheric/Cosmic Context
Connection/Unification/Ecological Identity	Urgency/Agency/Future Thinking

Appendix D: Inter-rater Reliability Results Worksheet

Appendix D Explanation

The responses from three coders (two anonymous plus the author) were logged for each sample of text from the student survey data. Agreement percentages were calculated for each attribute (CODES and CATAGORIES) and plotted. Averages were calculated for agreement among CODES, CATAGORIES and OVERALL. The OVERALL reliability coefficient was .803 agreement. The general rule of thumb for percent agreement is presented in Neuendorf: "Coefficients of .90 or greater are nearly always acceptable, .80 or greater is acceptable in most situations, and .70 may be appropriate in some exploratory studies for some indices" (Neuendorf, 2002, p. 145).

Attribute	Response			%	Response			%	Response			%	Response			%	Response			%
Coder (RB is author)	#1	RB	#2	agree	#1	RB	#2	agree	#1	RB	#2	agree	#1	RB	#2	agree	#1	RB	#2	agree
CODES	Sample 1				Sample 2				Sample 3				Sample 4				Sample 5			
Biosphere Kinship				100	x	x	x	100			x	50			x	50	x	x		50
Causal Connections				100	x	x	x	100	x	x		50			x	50	x	x	x	100
Cosmic Awareness				100				100			x	50	x	x		50			x	50
Expanded Perspective	x	x	x	100				100	x	x	x	100	x	x		50	x	x		50
Historical Awareness	x	x	x	100	x	x	x	100	x	x	x	100				100				100
Future Awareness				100				100	x	x		50				100	x	x		50
Human Kinship				100			x	50	x	x	x	100				100				100
Personal/Identity Shift				100	x	x	x	100	x	x	x	100	x	x	x	100	x	x	x	100
Interconnectedness				100				100	x	x	x	100	x	x		50	x	x		50
New Perspective	x	x	x	100	x	x	x	100	x	x	x	100	x	x		50	x	x	x	100
Pace of Change			x	50	x	x		50				100				100				100
Personal Impact/Relevance				100	x	x	x	100	x	x	x	100		x	x	50	x	x	x	100
Planetary Awareness	x			50	x	x		50				100			x	50				50
Scalar Shift (Time)	x	x	x	100	x	x		50	x		x	100				100	x			50
Scale of Change			x	50	x	x		50				100				100	x			50
Sense of Place			x	50				100			x	50	x			50				100
AVG:				87.5				84.375				84.375				71.875				75
CATAGORIES																				
Narrative Shifts	x	x	x	100			x	100		x	x	50	x	x	x	100			x	50
Conne c /Uni/Eco-Id			x	50			x	50	x	x	x	100	x	x	x	100	x	x	x	100
Comm/Bio/Cosmic				100			x	50	x		x	0	x	x	x	100				100
Urg e /Agen/Future-think				100				100	x	x	x	100				100	x	x		50
AVG:				87.5				75				62.5				100				75

Agreement Coefficient for CODES	.806
Agreement Coefficient for CATAGORIES	.800
Agreement Coefficient OVERALL	.803

Ethics Application Ref: (5201200400) - Final Approval

Dear Prof Christian/Rich Blundell

Re: (Big History Experience: Online Survey)

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Arts Human Research Ethics Committee and you may now commence your research. The following personnel are authorised to conduct this research:

Mr Richard Blundell

Prof David Christian

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).
2. Approval will be for a period of five (5) years subject to the provision of annual reports. Your first progress report is due on 1 June 2012. If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.
3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).
4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:
5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.
6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

If you need to provide a hard copy letter of Final Approval to an external organisation as evidence that you have Final Approval, please do not hesitate to contact the Faculty of Arts Research Office at ArtsRO@mq.edu.au

Please retain a copy of this email as this is your official notification of final ethics approval.

Yours sincerely

Dr Mianna Lotz

Chair, Faculty of Arts Human Research Ethics Committee