Community Montessori Teens' Program

Cosmic Education and Big History Guide

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I. Philosophical Overview

"Let us give the child a vision of the whole universe. The universe is an imposing reality, and an answer to all questions."

~ Maria Montessori

"The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home...In the last few millennia we have made the most astonishing and unexpected discoveries about the Cosmos and our place within it, explorations that are exhilarating to consider. They remind us that humans have evolved to wonder, that understanding is a joy, that knowledge is prerequisite to survival. I believe our future depends on how well we know this Cosmos in which we float like a mote of dust in the morning sky."

~ Carl Sagan

"All professions, all work, all activity in the human world finds its essential meaning in the context of a people's cosmic story."

~ Brian Swimme

"The Universe story is the quintessence of reality. We perceive the story. We put it in our language, the birds put it in theirs, and the trees put it in theirs. We can read the story of the Universe in the trees. Everything tells the story of the Universe. The winds tell the story, literally, not just imaginatively. The story has its imprint everywhere, and that is why it is so important to know the story. If you do not know the story, in a sense you do not know yourself; you do not know anything."

~ Thomas Berry

COSMIC EDUCATION

If ever there were a context into which absolutely everything fit, the universe is it. If ever there were a source of infinite mystery, endless wonder, and boundless exploration, the universe is it. If ever there were an answer to the most fundamental and exciting questions that humans have been asking for thousands upon thousands of years - "How did I get here? Why am I here? What is the totality to which I belong?" - the universe holds it. If for no other reason, this is why Cosmic Education and Big History ought to be central to every curriculum we write.

Cosmic Education is Montessori's educational paradigm for the second plane of development. She bases it on the recognition that "nature has made this a period for the acquisition of culture" (*To Educate the Human Potential* 5). She makes it clear that, "Our teaching must only answer

the mental needs of the child, never dictate them. Just as a small child cannot be still because he is in need of co-ordinating his movements, so the older child, who may seem troublesome in his curiosity over the what, why and wherefore of everything he sees, is building up his mind by this mental activity, and must be given a wide field of culture on which to feed" (5).

We can think of "culture" in this sense as the accumulated wealth of knowledge that humans past and present have stored up in every conceivable field of study and made available to the child's generation. Indeed, culture as Montessori uses the word implies *human* culture. Furthermore, it does not merely involve a study of the foods and customs of various groups, but also, and more importantly, the vital instincts and fundamental needs of mankind that unite all of us, no matter where we exist in time and space. This identification with all humans, as well as the cultivation of a profound sense of wonder and gratitude for the labor and ingenuity of mankind, is central to Cosmic Education, as it lays the groundwork for constructive education for peace and the realization of one's Cosmic Task.

Montessori points out that, "A second side of education at this age concerns the child's exploration of the moral field, discrimination between good and evil" (4). Thus, the child feels "not only a hunger for knowledge and understanding" but also a "...claim to mental independence, a desire to distinguish good from evil by his own powers…" (4). These two sensitivities - a hunger for knowledge and a desire to make independent moral judgements - go hand in hand, as who can make moral judgements without an understanding of culture?

Therefore, we can see that Cosmic Education in the second plane is primarily concerned with arousing interest in the child in all areas of study (for all are interconnected) but "not merely to make the child understand, and still less to force him to memorize" (11). Rather, the primary goal is "to so touch his imagination as to enthuse him to his inmost core" (11). This enthusiasm for learning will fuel his understanding in the next plane and thereafter. Further, Cosmic Education ought to excite the child's moral sensitivities, to provide opportunities for exploring the moral boundaries of society at different scales (interpersonal, group, classroom, school, country, etc.). All of this serves to orient him to humanity and his place in cosmos as he approaches the third plane of development in which, for better or worse, the specific formulae, theorems, facts, and details of each field of study that constitute the middle/high school curricula become more prominent.

BIG HISTORY

In 1989, David Christian, a professor of History at Macquarie University in Sydney, Australia, felt compelled to go beyond particular, isolated histories and provide his students with a history of humanity itself. In order to do that, though, he realized he had to provide a context for the

story of humanity. Ultimately, he came to see that he needed to pull together the discoveries and insights from otherwise disconnected disciplines, such as cosmology, astronomy, physics, chemistry, geology, biology, anthropology, and archaeology, to create one unified narrative, and thus, Big History was born. With the help of Bill Gates, Christian launched The Big History Project in 2008 with the goal of bringing this curriculum to as many schools as possible. Though Christian did not deliberately set out to create a conceptual academic framework that would also preserve the philosophical integrity of Cosmic Education, he managed to do just that.

Just like Cosmic Education, Big History is "the attempt to understand, in a unified, interdisciplinary way, the history of Cosmos, Earth, Life, and Humanity" (Christian What and Why of Big History 2008). A unified, interdisciplinary approach is essential because it promotes the realization that each field of study enhances and is enhanced by every other field of study. Such an awareness dispels the illusion that one must identify as a math person, or a science person, or a language person, and so on. Delivered from this restrictive mentality, the student of Cosmic Education and Big History feels enthusiasm (though to varying degrees) for all forms of knowledge, as each one fulfills a function in making sense of the grand drama of our origin story. As Montessori explains, ...

Also just like Cosmic Education, the overarching goals of Big History go far beyond content. Christian invites us to think of Big History as a modern scientific origin story that produces a vast map of space and time, which provides the student a "sense of place, identity, and even purpose" (Christian What and Why of Big History 2008). Just how Big History accomplishes this goal will be addressed in sections II and III of this document, but at this point we should pause to appreciate why helping students find their place and purpose has such value (as compared, say, to getting high test scores or memorizing a lot of bits of information).

Christian recognizes that traditional education disorients students because it offers them no large scale map of space and time. He calls this failure "calamitous" because it "leaves students stranded" philosophically and ethically (2013). By tracing the route that humanity (and the universe as we know it) has taken thus far, Big History allows stranded students to locate their current position and see where they can, should, and *need* to go from here. Knowing where we are and how we got here gives the student "a sense of being at home in the universe" (2013), which expands the boundaries of his world and equips him with the penetrating insight that he is sharing one miraculous planet for a very brief moment in Time with one human family that in fact lives as "a single organism, one nation" (BIMET 126). Herein lies the paramount goal of Cosmic Education: to pull back the veil that blinds us from our place in nature and from our responsibilities to the natural world and one another; in so doing, with each young person educated in this manner, we cultivate a more peaceful, cooperative, and environmental world.

COSMIC TASK

So, to put it plainly, Cosmic Education aims at nothing short of changing the world by facilitating human progress on a moral level. Both philosophies place the student in the context of the universe to help them see for themselves why they are here and what role humanity itself has to play in the ecosystem of our planet (and possibly beyond!). This profound revelation is what Montessori calls our Cosmic Task. She explains that all living organisms work consciously for their own survival but also serve an unconscious cosmic function of perpetuating life for other species. "Each kind works for the whole," she observes, "and upon the work of each depends the possibility of the life of the whole" (*Basic Ideas of Montessori's Educational Theory* 129). She then asks us to wonder if it might be "possible that only Man spends his brief span of life suffering in this terrestrial world to no purpose" (129). Of course, it would be absurd to assume so. Thus, cosmic theory includes all life, from plants to bees to bacteria, and Man is no exception. "[He] too, like all beings, has the two purposes, conscious and unconscious. He is conscious of his own intellectual and physical needs, and of the claims on him of society and civilization. He believes in fighting for himself, his family and nation, but has yet to become conscious of his far deeper responsibilities to a cosmic task, his collaboration with others in work for his environment, for the whole universe...towards creative fulfillment" (*To Educate the Human Potential* 27).

In order to take control over our creative power to influence the natural world and shape our own future, humanity must become conscious of its cosmic task. Given the magnitude of such an endeavor, we must remember that the seeds are sown in the fertile mind of the elementary child, but to reap the harvest, we must nurture the seedlings we have helped "to grow under the flaming heat of imagination" (*Ibid.* 11). The manual and intellectual pursuit of the Mission of Man must carry over into secondary education and beyond to be achieved in reality. This is why Big History should have a prominent place in every Montessori secondary program.

A. <u>Principles of Cosmic Education</u>

★ Universe as context for all studies/inquiries ("an answer to all questions")
★ Enthusiasm, awe, and wonder much more important than "understanding" facts
★ Imagination as a means of processing the cosmos, life, and human history
★ Marvel at mankind
  - "They must feel the pride and privilege of belonging to humanity"
  - "Man must appear as a sacred being of creation…."
  - Arouse "the sentiment of 'gratitude and love' for all the advantages we enjoy in life."
  - Supernature (see Anthropocene in section B. below)
    - Both awesome and potentially dangerous

★ Moral explorations (interpersonal, social/group, environmental, civil "justice")
  - gratitude, love, *optimism*, peace, respect for life, etc.
  - Cosmic Task - mankind's role to play in the "fulfillment of life"
  - Valorization - "filling up" with esteem, pride, and purpose that does not inflate ego but rather diminishes it and thus allows individual to transcend the self and identify with a collective purpose and shared meaning

★ Five Great Lessons (key experiences)

B. <u>Principles of Big History</u>

★ Evolving universe as context for all studies/inquiries
★ Scientific origin story
  - incomplete and always being updated; not just "True"
  - same as any other origin story: the making (mapping) of meaning

★ Claims testing as a means of deciding for oneself what one believes
★ Overarching themes weave through the whole narrative and tie it together
  - increasing complexity and order in a universe that should be getting simpler and more chaotic
    - fragility - the more complex and ordered something is, the more energy it takes to sustain, and thus the more fragile it is
  - patterns of scale - understanding the rules of order and change at multiple scales to find differences as well as universal patterns that seem to govern all "ordered entities"

★ Human society as a stunning example of complexity
  - Anthropocene - "a potential geological epoch" in which mankind is the single most dominant species affecting the biosphere and geology of the planet

★ Eight (or Nine) Threshold Moments

II. Core Concepts of Big History: A Conceptual Toolkit

A. Threshold Moments

Since we have been describing Big History as a scientific origin story, then we might think of the eight threshold moments as the chapters of this story. These chapters demarcate the most significant, large-scale turning points in the evolution of our universe toward greater and greater complexity. The particular threshold moments will be explored in greater detail in section III, but for now, it's important to see why the concept of an increasingly complex universe is integral to Big History.

B. Increasing Complexity

The early universe was a very simple "homogeneous sludge of hydrogen and helium atoms" (Christian 2013), so the fact that we have complex structures now like stars, galaxies, planets, and living organisms is not only remarkable but seemingly implausible from a scientific standpoint. As Alan Watts puts it, "It would be much easier for there to have been nothing at all!" According to the second law of thermodynamics, entropy (energy loss) ought to be moving the universe from order to chaos, that is, toward greater and greater simplicity. Just like a snowflake, geometrically structured in complex crystalline patterns, eventually melts into a simple drop of water, so the universe ought to be breaking down in much the same way.

However, the reality is that our scientific origin story defies the second law of thermodynamics, at least at a certain scale. Christians explains that it might not be "strictly true that the universe is getting more complex. What is true is that more complex things are appearing in the universe...where conditions are just right" (*Ibid*.). Life represents one of the most remarkable manifestations of complexity, and "close to the pinnacle of complexity as we know it" is mankind and the modern global society we have created (*Ibid.*). Thus, increasing complexity is a main, overarching theme of our modern origin story.

C. Play of Scales

That all of the mind-boggling complexity, degree of order, and magnitude of organization that we see all around us on our planet ultimately evolved from a stupendously simple state of cosmic plasma in which matter and energy were interchangeable can only be appreciated through the dynamic study of what Christian calls the "play of scales."

As he explains:

> "At every level, we will be interested in ordered entities, from molecules to microbes to human societies, to large chains of galaxies. Explaining how such things can exist, how they are born, how they evolve, and how, eventually, they perish is the stuff of history at all scales. Of course, each scale also has its own rules - chemical in the case of molecules, biological in the case of microbes - but the surprise is that some underlying principles of change may be universal...So a central theme of big history is how the rules of change vary at different scales, despite some fundamental similarities in the nature of all change." (7)

Modern scholarship tends to view particular subjects at one scale, what we might call a "zoomed in" scale. The benefit of zooming in, of course, is that one can see the fine details that otherwise remain indiscernible at larger scales. Big History acknowledges and utilizes the advantages of zooming in, but it also acknowledges and utilizes the advantages of zooming out. Sometimes, if we zoom in too far, we can't make sense of the whole to which the fine details belong. So, by zooming out, we not only see how the details comprise the whole, but we might even see how what we thought was the whole was actually one part of a larger whole. This zooming in and zooming out is the play of scales, and the value of this pedagogical concept is that it "reveals patterns and yields new insights into familiar historical problems" (Christian 2013).

Here, the famous quote of Edmund Burke applies: "Those who don't know history are doomed to repeat it," but despite this quote being so well known, humans continue to repeat the follies of the past. By offering a "meta-perspective" or an "overview," Big History illuminates both the destructive and constructive patterns of the past at various scales in both space and time (from distant galaxies to our own planet, from billions of years ago to the modern age).

These illuminations lead to realizations about how to deal with important, global, complex issues, such as "climate change, energy shortage, nuclear proliferation, declining biodiversity, [and] increasing inequalities" (Christian 2012). By this measure, we can say that the primary goal of Big History is to empower young generations to move mankind forward in a more peaceful, ecological, constructive manner, just as Montessori intended with Cosmic Education. To do so, they will need the whole spectrum of knowledge from the sciences to the humanities, and they will need to be able to analyze problems at various scales of space and time.

D. Goldilocks Conditions

One pattern we can see from the play of scales is that history (on any scale) is shaped not by one but rather by many forces coming together in just the right way at just the right time and place.

Christian refers to these favorable confluences of forces as "Goldilocks conditions," named after, of course, the famous children's story *Goldilocks and the Three Bears,* in which the young protagonist stumbles upon the Bears' cabin in the woods and tries out all of their chairs, porridges, and beds until she finds the one in each case that is just right for her. So, applying this trope to the story of the universe, every now and then, in tiny pockets of the cosmos, where temperatures are not too hot, not too cold, where entities are not too big, not too small, where a variety of variables are "just right," something entirely new and seemingly "magical" will emerge, and this new thing will exhibit its own peculiar properties, which will then create conditions conducive to the emergence of other totally new entities with their own unique emergent properties, and so on.

E. Emergence and Emergent Properties

Although it is true that quantum physics suggests that it is possible for subatomic particles to emerge from nothing, at bigger scales, we feel fairly certain that there is no effect without a cause. Tracing the staggered progression of complexity in tiny corners of the universe, showing how one emergence lays the groundwork for the next emergence organizes our cosmic narrative into a coherent and cohesive series of events.

Perhaps the most famous example is that of stars, which emerged after the universe had expanded and, thus, cooled enough for hydrogen atoms to form. Over time (at least 200 million years according to data generated from NASA's WMAP), gravity had pulled massive clouds of hydrogen together and condensed the atoms more and more until they fused into helium, thus igniting the radiant points of light and heat that we call stars. The emergence of stars was only possible as a result of the emergent properties of the hydrogen atom and gravity. Stars are so critical to the story of the universe because they exhibit the emergent property of nuclear fusion, which then makes possible the emergence of new complex elements.

One of the complex elements cooked in a star is oxygen. When hydrogen and oxygen atoms join up in just the right way, the water molecule emerges. From the emergence of water comes the emergent property of "wetness," which is a necessary property for the emergence of life as we know it, and life itself introduces a dizzying array of new emergent properties, with consciousness being one of the most fascinating properties that we currently associate solely with humans.

To put it simply, none of the complex organisms and structures we see on our planet - from our bodies to our buildings, from the grass to the oceans, from planes to paper cups, to the very planet itself, none of it would exist without the emergence (and the emergent properties) of stars. Thus, to appreciate our cosmic lineage and to sequence our origin story, we need to understand and convey the concept of emergence and emergent properties.

III. Big History as Connective Tissue

In order to assemble and make sense of this origin story, we need to synthesize information produced from every field of study. Thus, Big History requires an interdisciplinary approach, and around this multidisciplinary framework, we can build meaning. Piecing together the "fragmented account of reality that has dominated modern scholarship...for a century" (Christian 3), does much more than marry schools of thought. "By offering memorable and authoritative accounts of how everything began" (2) and by illustrating how it all links up, our modern creation story "provides universal coordinates within which people can imagine their own existence and find a role in the larger scheme of things" (2). This "role" that we have to play on the universal stage is another way of describing our cosmic task, and realizing this purpose is as integral to Big History as it is to cosmic education.

The academic content that Big History delivers within this meaningful context also becomes easier to understand. Montessori says it well: "to teach details is to bring confusion. To establish the relationship between things is to bring knowledge" (*From Childhood to Adolescence* 58). This knowledge shifts the learning experience from extrinsic (doing for the grade) to intrinsic (doing it for the satisfaction of discovery). An obligation to memorize disjointed facts for this class or that transforms into an authentic will to learn because "The knowledge [the student] then acquires is organized and systematic; his intelligence becomes whole and complete because of the vision of the whole that has been presented to him, and his interest spreads to all, for all are linked and have their place in the universe on which his mind is centred" (*To Educate the Human Potential* 6). On this point, Christian and Montessori are clear. If we want to inspire the curiosity and wonder of our students, we have to give them a "vision of the whole" so that they know what it is they are trying to make sense of.

The table below attempts to illustrate how Big History, Cosmic Education, and standard high school courses align thematically. Educators attempting to weave their particular subjects into a whole cloth of knowledge can, at a glance, see where each thread appears in the design to help form the emergent image of our universe, our planet, and ourselves.

It should be stressed that this list is by no means exhaustive, as there are certainly other subjects that could be nested within each of the Threshold Moments and Great Lessons. Furthermore, the implication is not that Big History Project can cover the entire curriculum of any of these courses. Rather, Big History as a "conceptual toolkit" provides the context into which each of these otherwise isolated courses fit. Or, to think of it another way, Big History is the connective tissue that binds all subjects together into one cohesive and unified "body" of knowledge.

A. Threshold Moments/Great Lessons/Secondary Subjects Chart

Threshold Moments	Corresponding Great Lesson(s)	Corresponding Secondary Subjects
1. The Big Bang	★ First Great Lesson: The Coming of the Universe	➔ Cosmology ➔ Earth and Space Science ➔ Physics ➔ Debate ➔ Cultural/Religious Studies (Origin Stories)
2. The Stars Light Up	★ First Great Lesson: The Coming of the Universe	➔ Astronomy ➔ Earth and Space Science ➔ Chemistry ➔ Physics
3. New Chemical Elements	★ First Great Lesson: The Coming of the Universe	➔ Chemistry ➔ Earth and Space Science ➔ Physics
4. Earth and the Solar System	★ Second Great Lesson: The Coming of Life	➔ Geology ➔ Earth and Space Science ➔ Geography/History of the World ➔ Chemistry ➔ Biology ➔ Zoology
5. Life Appears	★ Second Great Lesson: The Coming of Life	➔ Biology ➔ Ecology ➔ Geology ➔ Chemistry ➔ Anatomy ➔ Physical Education/Nutrition ➔ Debate ➔ Geography/History of the World ➔ Social Studies: Current Issues, Problems, and Events
6. Humans and Collective Learning	★ Third Great Lesson: The Coming of Humans ★ Fourth Great Lesson: The History of Communication	➔ Anthropology ➔ Language Arts ➔ Archaeology ➔ Cultural Studies ➔ Biology (DNA and Heredity) ➔ World History

		➔ Genealogy ➔ Sociology ➔ Religious Studies
7. Agriculture and Civilization	★ Third Great Lesson: The Coming of Humans ★ Fourth Great Lesson: The History of Communication ★ Fifth Great Lesson: The History of Mathematics	➔ World History ➔ Language Arts ➔ Mathematics ➔ Anthropology ➔ Middle/Far Eastern Studies ➔ Mediterranean Studies ➔ Mesoamerican Studies ➔ Agricultural Sciences ➔ Fine Arts: Ceramics/Sculpture/Fiber ➔ Sociology ➔ Economics ➔ Government ➔ Political Theory/Political Science ➔ Philosophy ➔ Religious Studies ➔ Social Studies: Current Issues, Problems, and Events ➔ Debate
8. The Modern Revolution: Expansion, Interconnection, and Acceleration	★ Third Great Lesson: The Coming of Humans ★ Fourth Great Lesson: The History of Communication ★ Fifth Great Lesson: The History of Mathematics	➔ Technological Studies (Computer Applications, Programming, Digital Citizenship, etc.) ➔ Language Arts ➔ Mathematics ➔ Economics ➔ Chemistry: Study of Gold ➔ Geology: Climate Change and the Anthropocene ➔ Government ➔ Political Science ➔ Military History ➔ European History ➔ US History ➔ Geography/History of the World ➔ Medical Studies: Pathology ➔ Biology: Microorganisms ➔ Religious Studies ➔ Ecology: Biodiversity ➔ Environmental Science ➔ Debate ➔ Social Studies: Current Problems, Issues, and Events

IV. Threshold Moments: Considerations and Reflections

A. Origin of the Universe/Big Bang (Cosmology)

"All knowledge systems, from modern science to those embedded in the most ancient of creation [stories], can be thought of as maps of reality. They are never just true or false...like maps, [they] are a complex blend of realism, flexibility, usefulness, and inspiration. They must offer a description of reality that conforms in some degree to commonsense experience. But that description must also be useful. It must help solve the problems that need to be solved by each community, whether these be spiritual, psychological, political, or mechanical" (Christian 11).

Embarking on the telling of this modern scientific origin story is certainly an exciting prospect, but at the same time, the subject of when and how our universe came into existence and what mechanical (automatic) or divine (purposeful) laws govern it is arguably the most polemic and perilous endeavor an educator can undertake. Here, at the outset of our epic study, as we cross the very first threshold, we encounter the turbulence of different faiths and family values, of impassioned and entrenched worldviews. Indeed, there is little else in education that compares with the potential perils underlying this beginning of beginnings.

So how we frame this whole study from the start is absolutely critical. If we alienate any of our students at this juncture, the rest of the story will likely fall on deaf ears, and it may even stir up ire and resentment, be it silent or vocal. As the guides of this study, then, one of our highest values has to be neutrality. We have to act as the fulcrum between the extremes of faith and atheism. In acting as the point of balance, we help students maintain spiritual and cognitive equilibrium. To put this another way, when considering a position (thesis) and its negation (antithesis), we ought not lead students to believe it's an "either-or" decision. Rather, elements of each position can be extracted and melded into a synthesis that reconciles the two opposing points of view.

Implicitly or explicitly, we must convey the notion that science and faith need not be mutually exclusive. After all, the study of nature (science) and the study of the divine (theology) can be viewed as one in the same, since nature is Creation itself. Thomas Berry explains it well when he says, "The divine communicates to us primarily through the language of the natural world. Not to hear the natural world is not to hear the divine."

At the very least, science and *spirituality* can be rather easily reconciled when viewed in this way. We would do well to keep in mind that Montessori, a devout Catholic, was a devout

scientist, too! She understood that science can "penetrate life's secrets" and, in so doing, point to our purpose, which she aptly called our Cosmic Task. She viewed science and faith as complementary rather than combative, which allowed her to synthesize the two fields of thought into one grand cosmic field. Rather than threatening her faith (or anyone else's for that matter), the discoveries of science that she was privy to in her time were evidence of the grandeur of divine Creation.

Brian Swimme, a contemporary cosmologist, voices this same idea when he says, "The creation story unfurling within the scientific enterprise provides the fundamental context, the fundamental arena of meaning, for all the peoples of the Earth. For the first time in human history, we can agree on the basic story of the galaxies, the stars, the planets, minerals, life forms, and human cultures. This story does not diminish the spiritual traditions of the classical or tribal periods of human history. Rather, the story provides the proper setting for the teachings of *all* traditions, showing the true magnitude of their central truths" [emphasis added].

Describing Big History as a modern origin (or creation) story is important because such a classification is disarming and inclusive: no one gets left out because no one's beliefs are treated as "right" or "wrong." The story of our universe as modern science understands it is not infallible, nor is all of it based on absolute empirical fact, so it ought not be presented in that way. As Christian admits, "Many of the stories we tell today will seem quaint and childish in a few centuries, just as many elements of traditional creation [stories] seem quaint today...In their day, all creation [stories] offered workable maps of reality, and that is why they were believed. They made sense of what people knew." Similarly, a modern creation story "must start with modern knowledge and modern questions, because it is designed for people who live in the modern world. We need to try to understand our universe even if we can be certain that our attempts can never fully succeed. So, the strongest claim we can make about the truth of a modern creation [story] is that it offers a unified account of origins from the perspective of the early twenty-first century" (11).

Origin stories from various times and cultures play an important role in this first threshold, as they demonstrate the universal importance of such stories. Humans throughout time and across cultures have yearned to understand how they got here, how this world itself came into existence, and what the stupendous "show" is all about. Thus, when we present these origin stories, however "quaint and childish" they may seem to us today, our role should always be to preserve the dignity of the people who found meaning in them and to help our students find similarities among them because, upon closer inspection, the similarities abound. Once we have adequately conveyed that all humans have attempted to explain the story of how we got here and that none of them - including those of us in the modern world of scientific technologies - have solved all of the mysteries, we can move to the next threshold without having left anyone behind.

B. The First Stars and Galaxies (Astronomy)

"The first stars and galaxies were constructed from little more than hydrogen and helium. But they were a sign of our universe's astonishing capacity to build complex objects from simple building blocks. Once created, stars laid the foundations for even more complex entities, including living organisms, because in their fiery cores they practiced an alchemy that turned hydrogen and helium into all the other elements of the periodic table."

~ David Christian

It's hard to imagine a universe without a single star shining light and radiating heat, but for at least 100 million to possibly 200 million years, that was the case. In the very beginning, the universe was a hot, dense plasma in which matter and energy were interchangeable and through which photons of light could not move. After about 380,000 years, however, the universe had expanded (and thus cooled) enough for matter and energy to separate, which released the cosmic microwave background radiation (CMB) that we can still detect today. After this release of energy, the universe grew progressively colder and darker, ushering in the "Cosmic Dark Ages."

The release of CMB represents a mini-threshold, not just because it allowed for the possibility of matter to form, but because there were miniscule fluctuations in the temperature and density of the universe thereafter, making the distribution of matter just slightly "rough" instead of "smooth." In a totally uniform and perfectly smooth universe, gravity has nothing with which to work, so the tiny fluctuations that the Wilkinson Microwave Anisotropy Probe (WMAP) and Planck missions have detected are extremely important to the evolution of the universe.

These scattered points where matter was slightly more dense became denser and denser over time as gravity pulled more and more hydrogen and helium together, forming what would become nebulae or "stellar nurseries." These would be the birthplaces of the first generation of stars. Once the first stars turned on the lights and ended the Cosmic Dark Ages, it would take nearly a billion years for gravity to pull communities of stars together into galaxies.

It's humbling to recognize that if the universe had never crossed this second threshold and the stars would have never formed, nothing else would have formed either, at least nothing that we can imagine. This is so because stars were the first "features" or entities in the universe (other than elementary particles), and their emergence ultimately led to the creation of new elements (see threshold three), which would then provide the heavy elements needed for planets such as our own (see threshold four), and these planets would in turn contain the chemical ingredients necessary for life (see threshold five), and life would eventually evolve into the abundant and complex variations that we see in the past and today, including humans (see threshold six).

Thus, we owe a great deal of gratitude to these ancient and silent ancestors of ours, and though we have an exciting opportunity to arouse interest in a multitude of astronomical studies by telling this story, the primary goal of this threshold should be to communicate the awe, wonder, and gratitude that surges into us when we realize that, as Carl Sagan famously said, "We are made of starstuff."

C. Chemical Elements (Chemistry)

"The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of starstuff."

~ Carl Sagan

The third threshold of increasing complexity is similar to the second but stands alone in its own right. Indeed, students often conflate the two thresholds into one, so it's important to emphasize the difference.

Even once stars are born, the universe is still not very complex in a chemical sense. It consisted mainly of hydrogen and helium (still true today) with trace amounts of lithium and beryllium. Note the conspicuous lack of oxygen, for instance, needed to form the water molecule. So, while the universe was more complex with stars in it, it could not produce life...yet. In the main sequence phase of their lives, stars fuse hydrogen into helium, producing energy enough to overcome the relentless force of gravity. Once the star runs out of hydrogen, it fuses helium into beryllium and so on down the line up to iron. At that point, there's no usable fuel left, and so gravity begins to have its way, collapsing the core of the star into a dense mass. If the star is massive enough, it will explode into a supernova, and in this stupendously energetic force, most of the remaining elements on the periodic table are created, all the way up to uranium. In these explosions, the heavy elements are spewed out into the neighboring region, thus "seeding" space with the elements necessary for the formation of solar systems with rocky planets containing water...like ours!

D. Solar System and our Earth (Geology)

"People usually consider walking on water or in thin air a miracle. But I think the real miracle is not to walk either on water or in thin air, but to walk on earth. Every day we are engaged in a miracle which we don't even recognize: a blue sky, white clouds, green leaves...All is a miracle."

~ Nhat Hanh

About 4.6 billion years ago, we cross a critical threshold when our very own solar system forms. We now know that there are billions of potential planets orbiting stars in just our galaxy alone, so it's not that the formation of a solar system never happened before ours appeared. It's just that there are no other solar systems that we know of containing life, and since this is, after all, our origin story, we now focus in on our very own little solar system in an unassuming corner of the Milky Way galaxy.

Perhaps most important of all, in this threshold we focus on the geology or "deep time" of the Earth. Indeed, the history of our planet is rich enough to warrant a Little Big History. Again, the main goal should be to inspire a kind of enchantment with our planet, to turn the attention to the miraculous reality of "spaceship Earth."

Our planet formed through a process known as accretion, and the layers of the planet settled into place through a process known as differentiation. These concepts should be explored thoroughly in this threshold.

Once the formation processes have been explored, it's important to introduce the geologic time scale, as it provides a way to track the main phases of our planet's history. Montessori students with a strong background in Cosmic Education during elementary should at least be familiar with these geological distinctions.

The Hadean or "hellish" Eon (4.6-3.9 bya) is aptly named after Hades, the god of the underworld. At the outset of this eon, the nascent planet would have been more molten than solid, and there would have been ongoing cataclysmic impact events. Obviously, this was not yet a world hospitable to life.

The Archean ("ancient") Eon (3.9-2.5 bya) is significant not only because the oldest known rocks date back to this period, but also because it demarcates the first appearance of life, a group of single-celled organisms known as Archaea. "By the start of the Archean Eon, the Earth's crust had cooled. The atmosphere was composed of volcanic gases, including nitrogen, hydrogen, carbon, and possibly low levels of oxygen. Water vapor was abundant and the first oceans had formed. A complex set of chemical reactions in these early oceans transformed carbon-containing molecules into simple, single-celled life forms...By the end of the Archean the first photosynthesizing organisms had evolved and begun to produce oxygen, which was released into the oceans and atmosphere. This process would dramatically change life on Earth during the following Proterozoic Eon" (paleobiology.si.edu).

The Proterozoic Eon (2.5 bya to 540 mya) ushered in a period known by many different names: The Great Oxidation Event, the Oxygen Revolution, the Oxygen Catastrophe, and the Oxygen

Holocaust. Whatever you call it, we have cyanobacteria to thank because they reduced the amount of carbon dioxide in the atmosphere and released free oxygen as a waste product of photosynthesis. While this was great for us (though we weren't around yet, obviously), it was doomsday for most of the anaerobic life on Earth. This was also when the supercontinent Rodinia formed.

The Phanerozoic Eon (540 mya to present) begins with the Cambrian period, also known as the Cambrian explosion, which is a fascinating and somewhat perplexing time when the Earth's flora and fauna rapidly diversified. Thus, this entire eon demarcates a great flourishing and diversification of life...including us!

Of course, there is so much more to Earth's history than the geological time scale, but the scale provides 4 main phases that make a 4.6 billion year history easier to grasp. Within these eons, and then within the eras and periods, student have categories within which they can place key events (threshold moments) in order to assemble the Little Big History of our planet.

E. Life on Earth (Biology)

"There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved."

~ Charles Darwin

The origin of life and the topic of evolution are two of the most controversial subjects one might ever dare to broach. And yet, they are fundamental questions, absolutely essential to the plot and meaning of our origin story. For that reason alone, they ought to be explored, but there's another: we have to prepare our students to engage in difficult but productive, thoughtful, cooperative conversations. We can prepare an ideal environment for these mutually beneficial conversations in which the implicit driving force is not proving your case, but learning more about all of the ways of thinking about how we came to be, speculating about all of the possibilities, questioning your own underlying assumptions and modifying them accordingly, seeking synthesis from thesis and antithesis.

Furthermore, we do have a responsibility, both from a Montessori perspective and a secular school perspective, to explore this question of origins from a science-based perspective. However, it should be stressed again that such a perspective does not exclude the possibility of spiritual or religious feelings about Creation.

Montessori demonstrates this synthesis between science and religion again and again through her approach to Cosmic Education. For her, to understand the science of the universe, the earth, and life is to understand the world of the spirit, of the Divine, of God. As a scientist, she appreciated the need to consider new evidence and amend one's views as necessary. For her, the knowledge produced in various fields of science enhanced, rather than threatened, her faith.

As she explains, "If asked whether I agree with the theory of Evolution, I answer that agreement or disagreement is a matter of no importance. We must look to facts to correct errors in existing theories, and thus add to knowledge, and I now accept the Geologist's view of evolution...[which] shows us life of more dimensions, one with the earth and evolving with and through it, contributing to its upkeep and welfare" (26).

That life and the earth are symbiotic is the meaning that Montessori extracts from modern science. Therein lies the point! The mission of mankind. Our Cosmic Task. Since we are not separate from nature in this scientific story, since we are every bit of nature as the oceans and mountains and soil and streams and all the living organisms around us, we are special. We are important. We do have a role to play. Figuring out what that role is, and then performing it, is equivalent in Montessori education to graduating at the top of the class with a perfect GPA in a traditional system. It's what the show is all about.

F. Human Beings/Collective Learning (Anthropology)

"An ardent admiration towards this prodigious humanity must be the fundamental sentiment of the new generations. They must feel the pride and privilege of belonging to humanity. Man must appear as a sacred being of creation and as the greatest marvel of nature and the sentiment of "gratitude and love" for all the advantages that we enjoy in life must be aroused with every step that is taken in the field of culture."

~ Maria Montessori

At this point of the story, we turn our attention to our own species' prehistory, and in the following two thresholds, our history. From here on out, humans take center stage, and some people take issue with narrowing the focus in such a way. After all, who are we to deem ourselves so important? However, Montessori tells us that a central tenet of Cosmic Education is the "directing of the consciousness towards humanity" (*Basic Ideas of Montessori's Educational Theory* 131). In order to help the child (or teen, as the case may be) see through all of the superficial differences that divide humans, we must present them with a vision of the whole of humanity to which they belong and relay to them the work, cooperation, ingenuity, and

perseverance that it took to make the world (the Supernature) that they live in today possible.

From a Big History perspective, "There are two justifications for narrowing the focus in this way. The first is that we...belong to this species. To know ourselves, we must know the history of *Homo sapiens*. The second reason...is that the history of our species is significant at some surprisingly large scales" (Christian 139). Indeed, on the scale of living organisms, the fact is that we do represent a new level of complexity, both in terms of our cognitive powers (evolving consciousness as opposed to sentient awareness) and our staggeringly complex and interconnected societies. On the larger scale of planetary impact, we can apprehend one singular species - our own - making more of an impact on the biosphere and ecology of the planet than any other (hence the proposed geological era of the Anthropocene).

Zoom out again, and we can see our species transcending the limits of nature by traveling beyond the planet entirely. We have sent astronauts to the moon and robots to explore Mars. On the largest scale of all, humans have explored the farthest known reaches of the universe itself through extraordinarily advanced technologies like colossal infrared telescopes, artificial satellites, space probes, and so on. Hence, we have evolved to become the eyes of the cosmos, or, as Carl Sagan put it, "We are a way for the cosmos to know itself." That's pretty significant by any measure.

So what is it that separates *Homo sapiens* from every other living organism? What is it that has allowed our species to move "beyond the Darwinian rules" (Christian 139)? There are many variables that have given us an evolutionary advantage, "from bipedalism, which freed our dexterous hands for toolmaking...to hunting and meat eating, to large brains, to human languages" (145). It is this last variable, however, that truly distinguishes humanity from every other group. Every animal communicates in some way, and some forms of communication, like the pheromonal messages of ants, for instance, are quite sophisticated, but no other animal has developed a symbolic language like ours.

Spoken language itself is a remarkable adaptation because it allowed humans to converse about aspects of the environment that are not immediately visible. Furthermore, and perhaps even more importantly, language allows humans to contemplate the realm of the abstract. Endowed with language, we can discuss the past and the future, what might happen after death, spirituality, love, grief, and a whole host of concepts that do not exist in the material world.

However, it is when we develop symbolic, or written, language that the game really changes in a dramatic way. With every other species, the knowledge about the environment developed by each generation gets lost when that generation dies off, and so the next generation begins from scratch. Symbolic language, on the other hand, allows information to be stored and accumulated, so that each generation begins where the last generation left off. To put it another way, each new generation inherits the wealth of knowledge developed from every generation prior. Thus,

collective learning takes our origin story across a whole new threshold of complexity.

As A.J. McMichael, an Australian epidemiologist, explains:

> The advent of cumulative culture is an unprecedented occurrence in nature. It acts like compound interest, allowing successive generations to start progressively further along the road of cultural and technological development. By traveling that road, the human species has, in general, become increasingly distanced from its ecological roots. The transmission of knowledge, ideas and technique between generations has given humans an extra, and completely unprecedented, capacity for surviving in unfamiliar environments and for creating new environments that meet immediate needs and wants." (Christian 146)

Montessori actually speaks to this same concept in *From Childhood to Adolescence*, though she uses the term "collective humanity" rather than collective learning. She points out that as a result of our accumulated knowledge and technologies,

> "...civilized man is becoming more and more 'supra-natural' and the social environment progresses correspondingly....The 'supra-natural' man is the king of the earth, of all things visible and invisible, he penetrates the secrets of life, growing new flowers and breeding new animals that are supercreations, increasing through chemistry the natural produce of the earth, transforming things as though by magical powers. These are the proofs of the greatness of collective humanity: each man may add something to them." (77)

And again, in another extract of an essay on Cosmic Education, Montessori writes,

> "And man himself, in building that which we call civilization, multiplied his powers to the point that he overcame all the limitations of nature and rose above the conditions that were his at the moment of his first appearance upon the earth...Human intelligence has become almost all-powerful and today has arrived at a point where it can dominate the energies of the world and penetrate the most intimate secrets of life…" (*Basic Ideas of Montessori's Educational Theory* 130)

Symbolic language allowed man to "multiply his powers" to such a degree as to overcome the "limitations of nature" and thereby erect a Supernature. It should be noted that such a "supra-natural" status is not achieved at least until the dawn of ancient civilizations (threshold seven) but most certainly by the modern era (threshold eight); however, at this juncture, we ought to lay the groundwork for appreciating what mankind has accomplished in an astonishingly short amount of time by pointing to what is coming.

The idea that collective learning has produced a Supernature is important because it brings into consciousness the reality that "today man exchanges not only the produce of his material activity but also the thoughts, the discoveries, and all the products that arise from the work of pure intelligence. One thing is very clear today: that humanity is effectively united" (*Ibid.* 130). Recognizing the union of humanity allows us to see past the artificial borders, nationalities, and histories that divide us. Having this revelation allows our students truly appreciate the fact that "We are all a single organism, one nation" (*Education and Peace* 25). From this elevated vantage point, we can see that "war is now pointless and cannot yield any material profit...The impoverishment of one nation does not make another nation richer; rather all nations decline. Destroying one nation is tantamount to cutting off one hand in the mistaken hope that the other hand will thereby become twice as strong" (*Ibid.* 25). Herein lies a pathway to constructive education for peace.

Of course, in this threshold, time should be devoted to the anthropological study of the evolution of the *Homo* genus, the origins of language, the foraging lifeways of hunter gatherers, the *Homo sapiens*' migration out of Africa (and the competing multiregional theory), the development of ritualistic practices and new technologies, but from a philosophical perspective, the primary objective should be to marvel at the powers of mankind and to appreciate our common interests on this shared planet.

G. Agriculture (Archaeology)

"We did not domesticate wheat. It domesticated us."

~ Yuval Harari

About 10,000 to 11,000 years ago, mankind began making the transition from nomadic forager to sedentary farmer. A warming climate at the end of the last ice age resulted in areas of local abundance, proverbial Gardens of Eden, in which nomadic tribes could settle down and find everything they needed. These areas, always near major rivers like the Nile and Euphrates in the Fertile Crescent,, or the Indus River Valley in India, or the Yangtze River in China, became the locations of the world's first civilizations.

Despite the temptation to view this transition as voluntary, there is much evidence now to suggest that a confluence of forces "trapped" foragers into a life of sedentism, as Yuval Harari has suggested in his work *Sapiens: A Brief History of Humankind.* As glaciers retreated and the climate warmed at the end of the last ice age, resources became plentiful, which meant that the basic necessities were easier to meet. Moreover, the burdens of traveling were no longer a consideration for sedentary communities as they had been for nomadic foragers. As a result, the

practices of population control - infanticide and senilicide - were relaxed. Thus, populations began to increase. As populations began to increase, and as those populations became more and more habituated to sedentism, going back to a life of foraging wasn't an option. First of all, the communities now were too big to be sustained by hunting and gathering, and secondly, with each new generation born into a life of sedentism, the skills of foraging and the customs of nomadism were not practiced and inculcated. Herein lies the trap. These communities were forced into full blown agriculture to sustain the life they had grown accustomed to, and as they were being pushed into a whole new type of existence, they had no way of knowing that humanity itself was being pushed across a new threshold of complexity, one in which the increasing world population would revolutionize sociopolitical organization (government, bureaucracies, social hierarchies), means of defense (standing armies), spirituality (state religion), communication (written language), accounting (numerics and maths), scholarship (science, philosophy, literature), art (ceramics, clothing, sculpture), food production (agriculture), construction (architecture), transportation (land and sea trading routes), and energy sources (irrigation, wood fuel, and animal power) that would forever transform mankind and the planet itself.

This threshold offers a platform from which we can dive into contextual studies of ancient civilizations that emerged in Mesopotamia, Egypt, the Indus River Valley, and China, as well as those that would come later like the Aztec, Inca, Greek, and Roman empires. However, we must keep in mind that the "play of scales" requires us to also zoom out to get a broader view of the trends and forces shaping world history at this time. In other words, beyond the particular civilizations and the differences among their cultures, what overarching patterns can we detect that bind them all together and help us make sense of this period of human history in a unified way?

Perhaps the single most important feature that characterizes this time and helps explain how we got from here to the Modern era is the acceleration of collective learning. There are two main forces that affect the intensity of collective learning, namely, population density (or scale) and diversity. As populations grew at this time, cities and states became not only larger but also more diverse than smaller villages or communities could have ever become. "And diversity itself was a powerful motor of collective learning, for it increased the ecological, technological, and organizational possibilities available to different communities, as well as the potential synergies of combining these technologies in new ways" (Christian 284). In addition to this diversity,

> "...states also increased the *scale* of human interactions. Because they were so much larger than all earlier human communities, their powerful gravitational fields sucked in resources, people, and ideas from great distances. By doing so, agrarian civilizations created vast new networks of exchange...that were more extensive, more varied, and more dynamic than those of any earlier era, [which] increased both the scale and variety of exchanges and the potential synergies of collective learning." (284)

The two most prominent networks of exchange, the Silk Roads and Indian Ocean Trade Routes, deserve special attention here, since they were so critical to intensifying the power of collective learning, but again, their study should mainly serve to illuminate these larger trends and structural features that define the agrarian era. An important point to stress is that *ideas* were the most valuable assets being exchanged through these trade networks, not goods.

There are several other key features that run throughout agrarian civilizations, but for our intents and purposes, the division of labor stands apart due to its contribution to collective learning. With a larger population and new agricultural technologies producing a surplus of food (in years when famine did not decimate food supplies), not everyone in agrarian society had to participate in the labors of food production. That meant leisure time for parts of the population, and leisure time led to innovation. Thus, at this time "specialists" emerge in a variety of fields who can devote their time to a specific trade or study. Bureaucrats, priests, writers, poets, scientists, accountants, mathematicians, philosophers, architects, soldiers, merchants, artisans, and so on all emerge at this time as a result of the division of labor. In this environment, with a rich diversity of crafts, religions, technologies, philosophies and other ideas being exchanged along expanding and intensifying networks of exchange, collective learning accelerated the rate of change so much that mankind overcame the limitations of nature and moved all of humanity across yet another threshold of complexity in a geological blink of an eye.

H. Modern Era (History)

"The man of supernature is no longer the man of nature. Having discovered how to tap enormous energies, he has to learn how to use them, to make them subservient to his life task, to set them to work. He has created a miraculous supernature by harnessing and using the energies of nature. And this very creation has made man a prodigious being, who sees and listens and rises above matter.

"Man has also worked another miracle, which is the basis of everything and the key to everything, the greatest miracle of all, but also the one of which he is most unaware. Man has raised the level of human intelligence...The single treasure of man, the raw material that promises to yield man everything, is human intelligence, an inexhaustible treasure."

~ Maria Montessori

Approximately 250 years ago, the Western world began making the transition from an agrarian to an industrial world. In that short time span, as most of the rest of the world has joined the industrial movement (be it eagerly or reluctantly), the face of the planet and the lifeways of

mankind have arguably changed more drastically and more rapidly that at any other point in human history. Thus, this transition takes us across the next and last threshold (for now), into the Modern Era.

There exist many landscapes to explore in this threshold beyond the particular history of the industrial revolution itself. Since a defining feature of this era is the rapid acceleration of change in our technologies and, as a result, our personal and social values, we can explore the ways in which mankind has pursued production and profit at the expense of the natural world. Philosophically (or ecologically), we can examine how this revolution finally removed us far enough from nature to feel like we might not be a part of nature at all. Historically, we can investigate how industry and wage work led to the exploitation of workers, widened the gap between the working class and business owners, and led to the spread of the potent ideology of Communism. All of these possible areas of study find their context in this threshold.
If the Modern era is defined by a rapid acceleration of change, then the twentieth century is the paragon of rapid change in nearly every aspect: technology, social values, global interconnectedness, transportation, communication, forms of government, types of warfare, and perhaps most outstanding of all, the environment itself.

According to Christian, "In a recent environmental history of the twentieth century, John McNeill has argued that 'the human race, without intending anything of the sort, has undertaken a gigantic uncontrolled experiment on the earth. In time, I think, this will appear as the most important aspect of twentieth-century history, more so than World War II, the communist enterprise, the rise of mass literacy, the spread of democracy, or the growing emancipation of women'" (440).

In Cosmic Education, improving our relationships with each other in order to work toward the common goal of attaining a more peaceful global society is the primary objective. Closely related to that objective, though, is improving our relationship with the planet and all of the living organisms that make up the delicate ecosystem on the planet, and it is this objective that Big History particularly emphasizes.

Therefore, in this threshold, a special study should be made of the conflicts and resolutions of the past century as well as the environmental consequences of our collective choices. Nevertheless, the tone ought not be doom and gloom because, as Montessori puts it, "Contemporary man, the victim of his time, must become the master of his era" (Education and Peace 64). We cannot help our students become masters of the Modern era if we instill pessimism, cynicism, and a sense of victimization in their hearts and minds. This does not mean that we should mislead them about the gravity or complexity of the problems that we face in the Modern era. Rather, we should present a balanced account of reality by also pointing their attention to the miracles and wonders of the Modern era, to the progress that we're making in human rights and international

diplomacy, to the labors of humans throughout time that have brought this marvelous world and all of its luxuries to fruition.

If we can capture this complex and awesome reality, then we can overcome the understandable pessimism that this generation feels. And then, if this method of education spreads widely and delves deeply enough, then "[r]ather than being paralysed with fear as it is today, mankind would be aware of its strength and courage and would be able to organize in order to achieve its own ends (*Ibid*. 64).

I. Futures

"The basic mood of the future might well be one of confidence in the continuing revelation that takes place in and through the Earth. If the dynamics of the Universe from the beginning shaped the course of the heavens, lighted the Sun, and formed the Earth, if this same dynamism brought forth the continents and seas and atmosphere, if it awakened life in the primordial cell and then brought into being the unnumbered variety of living beings, and finally brought us into being and guided us safely through the turbulent centuries, there is reason to believe that this same guiding process is precisely what has awakened in us our present understanding of ourselves and our relation to this stupendous process. Sensitized to such guidance from the very structure and functioning of the Universe, we can have confidence in the future that awaits the human venture."

~ Thomas Berry

Christian explains in several lectures that when deciding what he should be teaching his students, he keeps his grandson Daniel in mind because he wants Daniel's generation to be prepared to find creative and sustainable solutions to the problems they will inherit. As a result of this litmus test, the most serious and urgent problems facing mankind get put front and center in Big History, particularly with the eighth threshold, as the spectres of overpopulation, destruction of the biosphere, deforestation, mass extinctions, nuclear proliferation, socioeconomic inequality, pollution of oceans and atmosphere, terroristic violence, ongoing civil and international warfare, and sundry other humanitarian and geological issues haunt the Modern Era.

Thomas Berry, a cosmologist and "Earth scholar," offers a sanguine but realistic prognostication of where mankind might go from here. He suggests that we are on the cusp of an awakening that will move us out of the Cenozoic era and into what he calls the Ecozoic era, a time in which mankind lives in harmony with the Earth, which is certainly similar (if not exactly the same) as Montessori's vision of the future when humanity becomes conscious of its Cosmic Task.

Sure, it sounds grandiose, perhaps even quixotic, but the truth is that the illness of pessimism (parading as "realism") leads us to believe nothing can change for the better, and so when nothing does, our pessimism gets validated and reinforced, which spreads the illness to others. Thus, the need for optimism. Thus, the need for celebrating the beauty of the natural world and acknowledging its fragility. As Berry explains, "So with the human, our entry into the Ecozoic period can only come through celebration of the grandeur and loveliness and joy of existence on the planet Earth. Once we begin to celebrate, all things become possible - even an Ecozoic era" (ecobuddhism.org).

Cosmic Education and Big History are fundamentally about lifting back the veil that blinds us from the "joy of existence on the planet Earth." At this point, it's the only home we have, and we have such little time to enjoy it. Our attention must turn from conquering nature to preserving it, from extracting riches from the planet to enjoying the richness it gives willingly. What does the future hold? What will the next threshold be? Can we influence what it will be, or are we hapless victims of circumstance? Students delight in exploring these questions, and explore them they should because they will almost certainly be the ones to see us cross the next threshold in this origin story.

V. Literary and Video Resources by Threshold

Threshold One: Origins (Big Bang)

★ Nonfiction
- *A Brief History of Time* by Stephen Hawking
- *The Grand Design* by Stephen Hawking
- *The Day We Found the Universe* by Marcia Bartusiak
- *A Universe from Nothing* by Lawrence M. Krauss
- *How it Began: A Time Traveler's Guide to the Universe* by Chris Impey
- *Cosmos* by Carl Sagan

★ Videos
- Brian Cox: *Cern's Supercollider* (Ted Talk on LHC and Higgs Particle) https://www.ted.com/talks/brian_cox_on_cern_s_supercollider?language=en
- *Particle Fever* (documentary available on Netflix about LHC and Higgs Particle)

Threshold Two: Stars

★ Nonfiction
- *How it Began: A Time Traveler's Guide to the Universe* by Chris Impey
- *The Universe Within: The Deep History of the Human Body* by Neil Shubin (Chapters 2 and 3 in particular)
- "The First Stars in the Universe" by Richard B. Larson and Volker Bromm http://www.astro.yale.edu/larson/papers/SciAm04.pdf

Threshold Three: New Chemical Elements

★ Nonfiction
- *Elements: A Visual Exploration of Every Known Atom in the Universe* by Theodore Gray
- *The Periodic Table* by Primo Levi
- *The Disappearing Spoon: And Other True Tales of Madness, Love, and the History of the World from the Periodic Table of the Elements* by Sam Kean
- *Oxygen: A Four Billion Year History* by Donald E. Canfield
- *Oxygen: The Molecule that Made the World* by Nick Lane
- *The Universe Within: The Deep History of the Human Body* by Neil Shubin

★ Videos
- "The Most Astounding Fact" by Neil DeGrasse Tyson https://www.youtube.com/watch?v=YFKDGuZG3rM

Threshold Four: Solar System and Earth

★ Nonfiction
- *Newton's Clock: Chaos in the Solar System* by Ivars Peterson
- *Cosmos* by Carl Sagan
- *Pale Blue Dot* by Carl Sagan
- *The Story of Earth: The First 4.5 Billion Years, from Stardust to Living Planet* by Robert M. Hazen
- *Reading the Rocks: The Autobiography of the Earth* by Marcia Bjornerud
- *Origins: The Evolution of Continents, Oceans, and Life* by Ron Redfern
- *The Home Planet* by Kevin Kelley

★ Videos
- The Overview Effect https://vimeo.com/55073825
- To Scale: The Solar System https://vimeo.com/139407849
  - Making the Solar System (math involved with video above) https://www.youtube.com/watch?v=O_MZ8tda_1I

Threshold Five: Life

★ Nonfiction
- *Life's Origins: The Beginnings of Biological Evolution* by J. William Schopf
- *Prehistoric Past Revealed: The Four Billion Year History of Life on Earth* by Douglas Palmer
- *Darwin and Design: Does Evolution Have a Purpose?* by Michael Ruse
- *The Origins of Life: From the Birth of Life to the Origin of Language* by John Maynard Smith
- *Life's Engines: How Microbes Made Earth Habitable* by Paul G. Falkowski
- *The Universe Within: The Deep History of the Human Body* by Neil Shubin
- *The Vital Question: Why is Life the Way it is?* by Nick Lane
- *Life Ascending: The Ten Great Inventions of Evolution* by Nick Lane
- *A New History of Life: The Radical New Discoveries about the Origins and Evolution of Life on Earth* by Peter Ward and Joe Kirschvink

★ Videos
- *Of Ants and Men* (available for purchase on Amazon)

Threshold Six: Humans and Collective Learning

★ Nonfiction
- *This Fleeting World* by David Christian
- *Sapiens* by Yuval Hurari
- *Catching Fire: How Cooking Made Us Human* by Richard Wrangum
- *A Short History of Progress* by Ronald Wright

- *The Universe Within: The Deep History of the Human Body* by Neil Shubin
- *Genome: The Autobiography of a Species in 23 Chapters* by Matt Ridley
- *Deep History: The Architecture of Past and Present* by Andrew Shryock and Daniel Lord Smail

★ Dystopian Fiction

- *The Giver* by Lois Lowry
- *Fahrenheit 451* by Ray Bradbury
- *1984* by George Orwell

★ Videos

- *Incredible Human Journey* (BBC documentary about human migration routes) https://www.youtube.com/watch?v=vwa6o-s1Yvs
- *English: Birth of a Language* (BBC documentary about origins and development of English) https://www.youtube.com/watch?v=h-OiNxknXdY

Threshold Seven: Agriculture

★ Nonfiction

- *Guns, Germs, and Steel* by Jared Diamond
- *The First Civilizations to 500 BCE* by Clare Collinson
- *1493 for Young People: From Columbus' Voyage to Globalization* by Charles Mann
- *Against the Grain: How Agriculture Has Hijacked Civilization* by Richard Manning

Threshold Eight: Modern Era

★ Nonfiction

- *Manufacturing Consent* by Noam Chomsky
- *Night* by Elie Wiesel
- *The Diary of a Young Girl* by Anne Frank
- *The Sixth Extinction:* An Unnatural History by Elizabeth Kolbert
- *The Ghost Map: The Story of London's Most Terrifying Epidemic - and How it Changed Science, Cities, and the Modern World* by Steven Johnson
- *The Better Angels of Our Nature: Why Violence Has Declined* by Steven Pinker
- *The Unsettling of America: Culture and Agriculture* by Wendell Berry
- *A Short History of Progress* by Ronald Wright
- *The Wayfinders: Why Ancient Wisdom Matters in the Modern World*

★ Fiction

- *The Return of the Soldier* by Rebecca West
- *Number the Stars* by Lois Lowry

★ Videos
- *Generation Earth* (documentary about shelter, transportation, and food in modern era; available on Netflix)
- *Surviving Progress* (kind of a dark documentary about many current problems facing humanity; available on Netflix)
- "The Best Speech About Humanity" by Carl Sagan https://www.youtube.com/watch?v=EWPFmdAWRZ0

Threshold Nine: Futures

★ Speculative Nonfiction
- *The World Without Us* by Alan Weisman
- *Physics of the Future* by Michio Kaku

★ Nonfiction
- "The Ecozoic Era" by Thomas Berry http://www.ecobuddhism.org/wisdom/psyche_and_spirit/thomas_berry/

★ Dystopian Fiction
- *Brave New World* by Aldous Huxley
- *The Road* by Cormac McCarthy
- *Fahrenheit 451* by Ray Bradbury
- *The Giver* by Lois Lowry
- *1984* by George Orwell
- *The Year of the Flood* by Margaret Atwood
- *The Handmaid's Tale* by Margaret Atwood

★ Science Fiction
- *The Martian* by Andy Weir
- *Foundation* by Isaac Asimov
- *Galapagos* by Kurt Vonnegut
- *The Time Machine* by H.G. Wells

★ Videos
- Progress is Not a Zero Sum Game by Robert Wright https://www.ted.com/talks/robert_wright_on_optimism?language=en
- "We Humans are Capable of Greatness" by Carl Sagan https://www.youtube.com/watch?v=EWPFmdAWRZ0

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