Little Learners, Big History, Bigger Future:
How Big History Widened the Worldviews of 8-9 Year Olds

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Abstract

This article is based on a workshop I presented at the 2018 Big History International Conference in Philadelphia, where I addressed findings from my recently completed PhD thesis: *An Tairseach (threshold): An exploration of connecting the emerging scientific story of the universe to authentic Catholic primary school environmental education.* My research investigated the extent to which students' environmental values could be informed through integrating story, values, environmental education, personal cultural origins, and Big History into the primary school curriculum. The methodology focused on employing Big History as a vehicle to achieve a cohesive, wider worldview for young learners, empowering them to engage in transformative thinking for the future. Semi-structured interviews were conducted along with a 17-week Big History pedagogical program with 8-9 year old students and their teacher. Qualitative analysis of these interviews indicated that primary students[1] could successfully access a shared, evidence-based and flexible narrative. Five interdependent themes emerged: 'shared vocabulary and knowledge of Big History' were foundational in allowing students to engage in meaningful discussions, alongside their knowledge of their 'local cultural origin stories,' 'local school values,' 'transdisciplinary learning' and 'environmental values within socioecological learning.' The findings have wider implications for the Big History collective, providing evidence that Big History is accessible and relevant to primary students within a transdisciplinary based and critical inquiry-learning structure.

[1]Primary education is the term used in Australian schools to describe schooling for 5-11-year-old students. In this particular article the term more particularly pertains to middle primary years (8-10-year-old students).

Orientation

In keeping with the essence of the chronological 'story' of Big History, particular scenes from *Alice's Adventures in Wonderland* have resonated with me throughout my PhD journey.

> *In another moment down went Alice after* [*the rabbit*], *never once considering how in the world she was to get out again. . . . The rabbit-hole went straight on like a tunnel for some way, and then dipped suddenly down, so suddenly that Alice had not a moment to think about stopping herself . . . .* (Carroll 1886, Prologue)

I invite you to share in my journey down the PhD rabbit hole.

Reviewing the storyline— Literature review

The literature reviewed needed to inform my query: if I adapted the Big History online project (2019) for 8-9 year old students in a Catholic school, would it inform them with an additional perspective to explore environmental education through the lens of our precious universe?

> *There were doors all round the hall, but they were all locked; . . . trying every door, she walked sadly down the middle, wondering how she was ever to get out . . . .*
>
> *Suddenly she came upon . . . a tiny golden key. . . .* [*S*]*he tried the little golden key in the lock, and to her great delight it fitted!* (Carroll 1886, Chapter 1)

My contemplation for my re-search involved how the cohesive universe story, as told in Big History, could inform values in environmental education from the perspectives of international and Australian environmental education documents, the positioning of the Catholic Church, and the mandatory Australian curriculum in Catholic primary environmental education.

Weaving aspects of the story: International, Australian, and Catholic environmental education values

When considering values as integral to my research, I referred to international documents that stress their significance. These include *The Belgrade Charter* (UNESCO-UNEP 1976), also sanctioned in the *Declaration of Thessaloniki* (UNESCO 1997), where it set ground-breaking future directions for the consideration of values in environmental education with the objective that individuals and groups be helped to acquire "social values and strong feelings for the environment" (2), as well as the *Tbilisi Declaration* (UNESCO-UNEP 1978, 1.3), and *Agenda 21* (United Nations 1992, 36.33), both of which echoed *The Belgrade Charter* as being indispensable to addressing environmental awareness in education. The commonality of terms in such documents informed my research forward.

Other key international environmental educational literature addresses the importance of framing knowledge, values and transdisciplinary approaches in policies (see UNESCO 2012; UNESCO Education sector 2012; UNESCO-UNEP 2008, 2012). United Nations (1987) advocated a transdisciplinary approach where "environ-mental education should be included in and should run throughout the other disciplines of the formal education curriculum at all levels" (1987, 96). This appropriates to recent calls from the International Catholic sector in Pope Francis' statement:

> *The fragmentation of knowledge and the isolation of bits of information can actually become a form of ignorance, unless they are integrated into a broader vision of reality. . . . We are part of nature, included in it and thus in constant interaction with it.* (Francis I 2015)

Australian education research likewise has addressed the importance of values in developing curriculum (Board of Studies 2010; Lovat, Dally, Clement, & Toomey 2011; Mitchell 2012). In promoting transdisciplinary learning, the current *Australian Curriculum* (ACARA 2019) embeds a sustainability cross-curriculum priority aimed at effecting a change in centring environmental education across the mainstream core subjects. That is highly significant for the study as one quarter of students attend Catholic schools in Australia, where the *Australian Curriculum* is mandatory. Not only does this place importance on transdisciplinary learning but also highlights that *The Melbourne Declaration on Educational Goals for Young Australians* (2008) is publicly acknowledged as the foundation of the Australian curriculum (see

ACARA, 2013; Board of Studies 2010; Hamston et al. 2010; Lovat et al. 2011; MCEETYA 2008; Mitchell 2012).

The emphasis on transdisciplinary learning is also in keeping with Big History's storyline that transverses multiple disciplines. In the words of Christian (2011),

> It is one of the many odd features of modern society that despite having access to more hard information than any earlier society, those in modern educational systems…teach about (our) origins in disconnected fragments. We seem incapable of offering a unified account of how things came to be in the way they are. (2)

The story thread weaves through my research to converge logic, faith, and values in both secular and Catholic writing (Benjamin 2009, 5). In a radio interview, David Suzuki (ABC Radio National 2016 at 39.00 mins.) articulated a similar inclusive view:

> I've been an atheist all my life. . . Laudato Si (Francis I 2015) is a magnificent document and I regret that'we' (environmentalists) didn't write it first, but what he (Pope Francis 1) has done is take issues of social justice, hunger and poverty and the environment and he's never split them into silos—they're all together.

The above document correlated with Suzuki's own vision for the future of the environment where a whole-systems approach embraces social justice, hunger, poverty, and the environment, rather than being viewed in the silos of our own limited cultural worldviews (Sterling, 2011). Snaza and Weaver (2015) request that education "call into question the entirety of the discipline structure" and

cut across the divisions (disciplines) "all constructed around the human" (5). The impressions of Suzuki, Sterling, and Snaza, and Weaver add weight to the findings of this research, that anthropocentric thinking could be transcended by Big History to broader, transdisciplinary socioecological thinking, thus empowering students with a whole- systems worldview. Further, such thinking transcends and is inclusive of local cultural norms, which, in the setting of my research, involves Catholic education values.
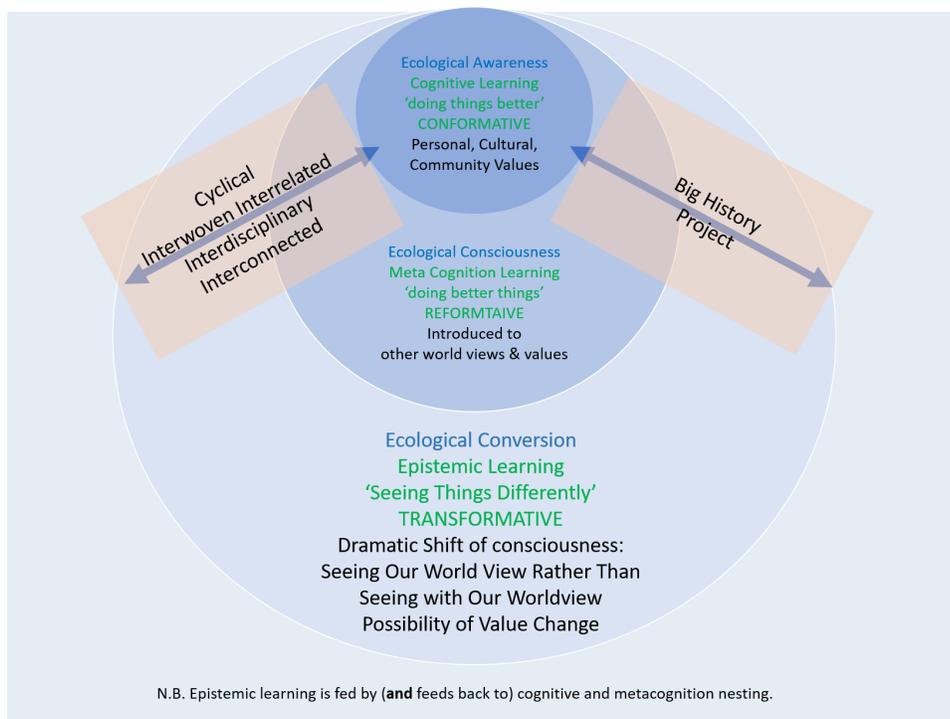
Theoretical framing

> Alice replied, rather shyly, "… I knew who I was when I got up this morning, but I think I must have been changed several times since then." (Carroll 1886, Chapter 5)

Narrative, when viewed from an environmental education perspective, "*fundamentally* alters our relation to the world, our relation to others, and our relation to our humanity. . . . It intertwines the condition of the world with

the condition of our humanity" (Rodriguez 2002, 6). The review of relevant literature changed the frame of my thesis story to both socioecological education, linking environmental values to Sterling's understanding of whole-systems thinking (2003, 2011, 2016), and curriculum theory (see Pinar 2012; Wraga & Hlebowitsh 2003). In underpinning transdisciplinary learning in socioecological education, students in this study were empowered to incorporate an understanding of the changing deep-time universe metanarrative, with the interconnected interrelationships of ecological, social, economic, and holistic perspectives of socioecological education (Berry & Swimme 1992; Bowers 1994; Catholic Earthcare Australia 2013, 2017; Johnson & Duberley 2000; Wallette & Edgren 2013).

Figure 1 below illustrates my framing, centered on values where Environmental and Religious Education informed and were informed by a broader transdisciplinary educational model of curriculum theory

Ecological Awareness
Cognitive Learning
'doing things better'
CONFORMATIVE
Personal, Cultural, Community Values

Cyclical Interwoven Interrelated Interdisciplinary Interconnected

Big History Project

Ecological Consciousness
Meta Cognition Learning
'doing better things'
REFORMTAIVE
Introduced to other world views & values

Ecological Conversion
Epistemic Learning
'Seeing Things Differently'
TRANSFORMATIVE
Dramatic Shift of consciousness:
Seeing Our World View Rather Than
Seeing with Our Worldview
Possibility of Value Change

N.B. Epistemic learning is fed by (**and** feeds back to) cognitive and metacognition nesting.

Figure 1. An Tairseach: A framework for transforming our story

and systems theory. In this framework the Big History unified account of the emerging story of the universe was adapted to incorporate whole-systems thinking (see Burford et al. 2013; Dahl 2012; Podger et al. 2010, 2013). Figure 1 incorporates my framing of opportunities for growth in learning. It merges both the Catholic environmental terminology (ecological awareness, ecological consciousness, and possibility for ecological conversion), alongside Sterling's theory (2011, 25) of conformative learning ('doing things better'), to reformative learning ('doing better things'), and the possibility of transformative learning ('seeing things differently').

Designing the story: Methodology and Method

Humpty Dumpty advises Alice:
It would be just as well if you'd mention what you mean to do next, as I suppose you don't mean to stop here all the rest of your life. (Carroll 1872, Chapter 6)

My next steps revolved around an action-based methodology, within whole systems thinking, to develop a qualitative, interpretative, and participatory research design. The action research took place within a child-framed ethnographic and cyclical framework. Figure 2 represents the nesting of my research methodology and methods, summarising my directions for the alignment of the chosen overarching theoretical model of values viewed from the perspectives of transdisciplinary and whole-systems thinking (see Lewis & Baudains 2007; Sterling 2003).

The setting was a third grade classroom of thirty students in a Catholic primary school. It involved fifteen eight to nine-year-old students and their teacher. The positive learning environment encouraged child-framed learning opportunities (see Spyrou 2011; Kellett 2010)
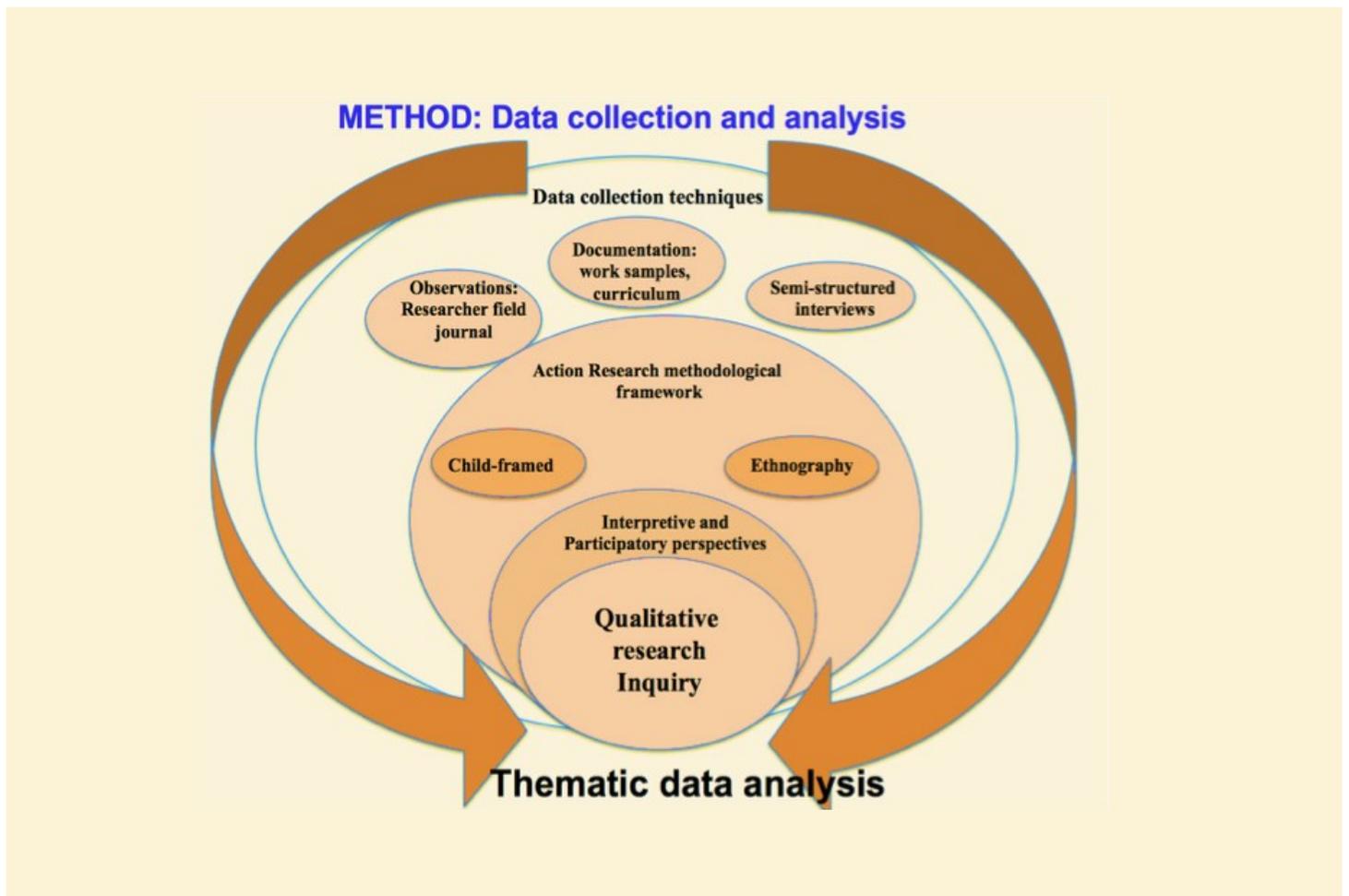

Figure 2.
Method: data collection and analysis.

based on a shared understanding with students that both the classroom teacher and I as researcher were lead-learners in the classroom.

The methods consisted of six semi-structured interviews of three to four students, conducted before, during, and after the implementation of a Big History pedagogical program. Data were principally gathered from the semi-structured interviews and were inclusive of evidence contained in student writing. Researcher journal observations added to the rich data collected during the visible learning pedagogical intervention (see Hattie, 2013).

Analysis of Data

"Alice asked, 'Would you tell me, please, which way I ought to go from here?'" "'That depends a good deal on where you want to get to,' said the Cat." (Carroll 1872, Chapter 6) My research question and data analysis directed me toward five themes that were not seen as linear but rather fed into and informed each other, as represented in an adaptation of Sterling's nesting framework (2003, 2011, 2016) in Figure 3 below.

Nesting the Findings

I present the following findings through my own reflective interpretations of the analysis, alongside the authenticity of class teacher and students' voices as my co-researchers.
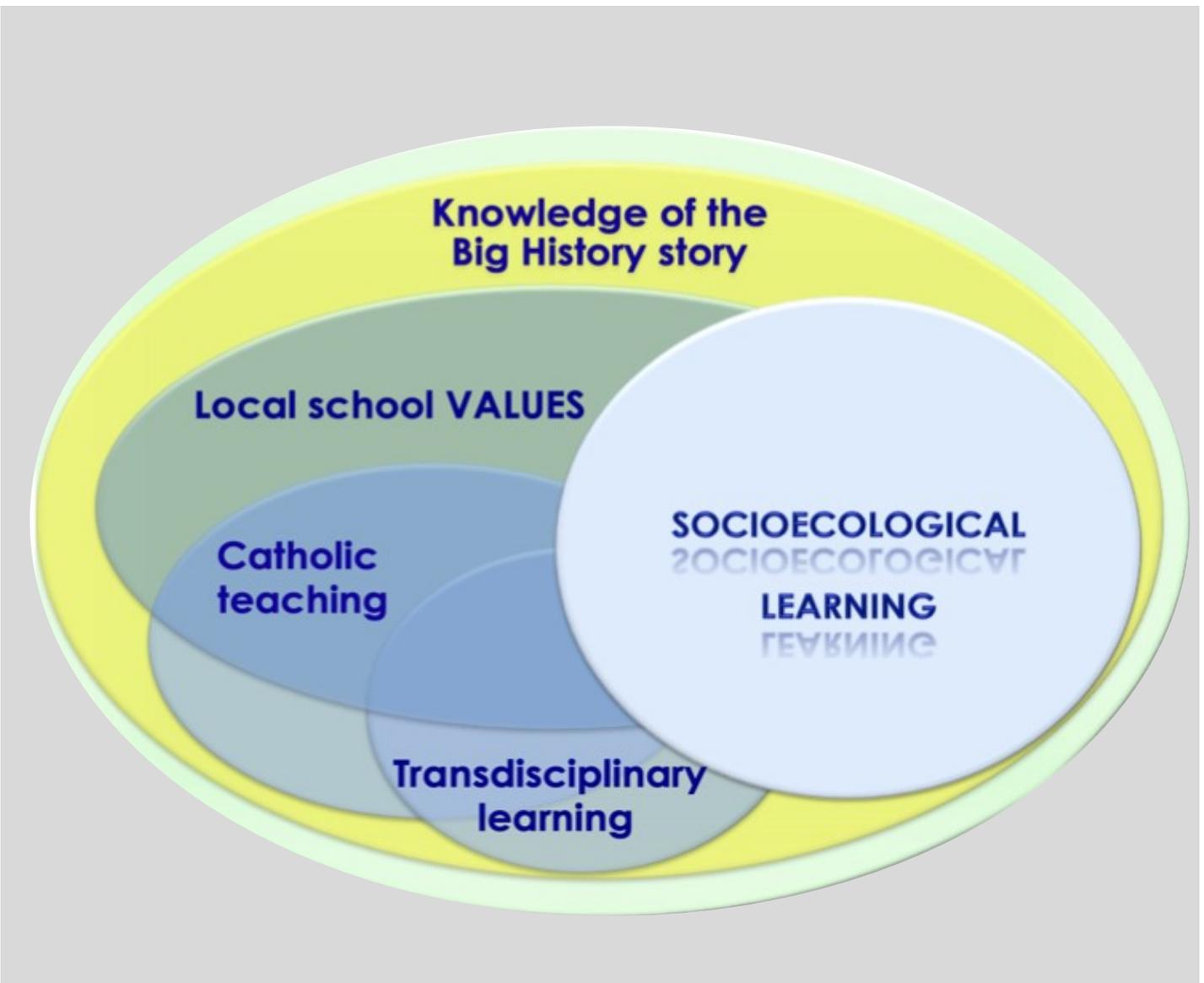
Figure 3.
Extending the storyline: nesting themes

THEME 1. KNOWLEDGE:
The extent the emerging story of the universe, taught through the vehicle of Big History, contributed to informing students' critical knowledge

Justification for the emphasis on teaching explicit knowledge and vocabulary of Big History became evident as students' learning in the pedagogical intervention progressed. The following two interview excerpts were recorded before students' Big History learning. As can be noted, students voiced a variation in the depth of knowledge and vocabulary, but both interview extracts display the lack of a cohesive understanding of the universe timeline.

Researcher:	*Do you think you know everything there is about the universe?*
Mia:	*I reckon a bit more.*
Aaron:	*A bit more.*
Indi:	*I know all about it.*
	(Pre-pedagogical interviews, 29-30 June 2016)

Aidan:	*The universe has a lot of planets, all the planets, and it holds stars and no oxygen.*
Aidan:	*No gravity, no oxygen.*
Jack:	*Because gravity is oxygen, if there is no gravity, there is no oxygen.*
Aidan:	*Yup. That's definitely correct. I agree with him 100%.*
Jack:	*I think I know what the Big Bang is. I think it is when all the planets were together. I have seen on some commercial that they said all the planets were like one big planet and maybe the Big Bang was when they exploded into the planets.* (Pre-pedagogical interviews, 29-30 June 2016)

In comparison, the evidence in the following excerpt, from a post-pedagogical intervention interview, validates students' growth in knowledge and use of appropriate vocabulary while also enabling student initiated inquiry.

Aidan:	*DNA is in many things. It can be in my blood and when the zipper opens, sometimes it can't make the exact same DNA parts so it's slightly different, but they're not really different. That's how everyone looks different.*
Researcher:	*Are there any words you now know?*
Jack:	*Astronomy, astronomer, scientist, archaeologist, ... origin story, history*
Aaron:	*Goldilocks conditions*
Researcher:	*What does that mean for Big History?*
Jack:	*Just right. . . . Thresholds [looking very pleased with his answer].*
	Claim testers . . . to learn about what to ask the experts and knowledge and evidence but in scientific language.
Aidan:	*Intuition, gut feeling*
Theo:	*Light years*
Jack:	*Authority*
	(Fourth pedagogical interview, 17 October 2016)

The latter excerpt shows the students accessing and confidently sharing their common learning. Aaron, in particular, previously had been reticent to join in with routine class discussions, but in this case, was empowered with his newly learnt Big History knowledge and vocabulary.

The critical importance of informing students' knowledge created a meaningful platform for informed, child-framed discussions in student interviews as revealed in the next excerpts.

Mia:	*It's [zipper is] an example where DNA just keeps on splitting and splitting and splitting . . .*
Researcher:	*What happens every time it splits?*
Mia:	*It makes more DNA.*
Aidan:	*DNA is in many things. It can be in my blood and when the zipper opens, sometimes it can't make the exact same DNA parts so it's slightly different, but they're not really different. That's how everyone looks different.*
	(Fourth pedagogical interview, 17 October 2016)

Researcher:	*Why is DNA part of our human story?*
Charlie:	*It's like collective learning ... The scientist tells people and then they pass it on and pass it on and then pass it on.*
Georgia:	*I used to wonder about stuff. . . . Now I know everything that I wondered about. I wondered when the world was created: 13.8 billion years ago!*
Charlie:	*I didn't know that the stars gave elements to us . . .*
Georgia:	*I didn't even know there were elements.*
	(Fourth pedagogical interview, 17 October 2016)

As the teaching and learning program progressed, students used their knowledge base to express their understanding of the evolving universe story. The analysed data verified that students accessed increasingly complex knowledge and common vocabulary through successive Big History thresholds.

Molly:	*If we didn't have Threshold 1, we wouldn't have anything because the world has started up as one little tiny cell . . . and some elements and the gravity fused them together to make bigger elements.*
Gabby:	*As Molly said, if we didn't have Threshold 1, there wouldn't be Threshold 2, 3, 4, 5, 6, 7, 8, 9. There would be no gravity; there would be no space; there would be no time. Nothing would be fusing: no stars; it would just be all dark, and nothing.*
	(Post-pedagogical interviews, 15 November 2016)

The synthesis of that knowledge into a wider worldview opened the possibility of transformative environmental education learning. When comparing the following two excerpts, it is apparent by the second interview that Imogen's use of *'we'* has not only highlighted a growth in knowledge but also transformed her thinking of nature and humans as interrelated.

<center>Excerpt 1:</center>

Researcher:	*. . . Are humans animals then?*
Imogen:	*Yeah, no.*
Imogen:	*Animals belong with nature, so they're kind of nature and at the same time they're not. They kind of blend.*
Molly:	*In the middle, nature, not nature, in the middle of that.*
	(Pre-pedagogical interviews, 29-30 June 2016)

<center>Excerpt 2:</center>

Georgia:	*. . [W]e started off in the ocean.*
Imogen:	*Yes and bacteria. And cells . . . started off as one cell—that surprised me. We started off as like one cell like bacteria in the deep oceans. I thought we started out as like animals. I didn't know.*
	(Fourth pedagogical interview, 17 October 2016)

Jack likewise, in the last interview, used his Big History knowledge to explain his thinking about the future: "When you grow up, if there's a new Threshold, you can study it and you can maybe add new information to the other Thresholds."

The co-researcher teacher emphasised the progression of students' understanding through the teaching of Big History, where she noted they were, ". . . applying and using Big History . . . in their writing and responses throughout the Thresholds and in their journals, . . . they've got a much deeper understanding."

THEME 2. CATHOLIC BELIEF:
The extent that students transferred their prior knowledge of the Catholic teaching on God's Creation to inform their emerging knowledge of the story of the universe

The integration of children's newfound vocabulary into their understanding of the Catholic belief system was integral to embracing the local school culture within the wider worldview interpretation of the emerging Big History narrative.

The limited student perception recorded in pre-pedagogical interviews is in contrast to Catholic literature (Australian Catholic Social Justice Council (ACSJC) 2002; Francis I 2015; Sydney Catholic Education Office 2012), which calls for the embracing of the interrelationship of the environment and humans.

Researcher:	*. . . Do you know how the Earth began?*
Amy:	*No. Jesus created it.*
Jack:	*Yeah, because everything is made up from God.*
	(Pre-pedagogical interviews, 29-30 June 2016)

The ability of Big History to empower students with a richer worldview within their Catholic traditions was apparent when students' prior knowledge and appreciation of God's creation were interpreted within their new knowledge of Big History learning and environmental education values.

Indi:	*How did God get so much power? . . . How did he have such a good idea of building us? I learnt . . . how God created us and the steps that he used to create us. I think [Threshold one—the big bang] is important to humans so they know who created them . . . and they understand that God exists.*
	(First pedagogical interview 1 August 2016)

The growth in students' Catholic understanding of God as creator was evident in students' ability to correlate their known Catholic story and local school's values framework to the new learning context of the Big History story.

Imogen:	*I think Big History is a more amazing story [of God's creation] . . . . It says what was created, how it was created, all these big words like agriculture, dioxide ribonucleic acid, and all of that.*
Gabby:	*God's creation, it's not like it made itself. God made them, and it's like each of the Thresholds is each of the days. I'm saying that they're both like, both together. . . .*

It was reassuring to observe, as the excerpts demonstrate, that students were not disturbed by the scientific evidence that was presented; rather they readily correlated the evidence into a greater sense of awe and wonder at the grander and more complex unfolding of God's creation through the Big History story.

Gabby:	*When it was the beginning, it was just black, and there was nothing there except God. Then, everything started to get more complex, and then the stars came, and the planets came, and then they were all orbiting the sun, and then animals evolved.*
Emma:	*[The universe] is more complex. I've always been wondering how we were here; since I was really little, I've been wondering what will happen in the future. Will there be robots or something? How are we here? How were we made? Who is God?*
Researcher:	*And did Big History help answer that?*
Emma:	*Yes (other students agreed)*
	(Post-pedagogical interviews, 15 November 2016)

The co-researcher teacher commented on students' ready acceptance of the Big History narrative within their Catholic understanding of God's creation: that God is essential to the unfolding story.

THEME 3. VALUES:

The extent that environmental education values, particularly in the context of local school values, were interpreted by students through the lenses of Big History

The importance of analysing values at the local school level, as discussed by Somekh and Zeichner (2009) and Podger et al. (2013), was appropriate to apply to the child-framed methodological basis of my research. The students at the research school were immersed daily in the local values of their school: peace, respect, honesty, justice, empathy, compassion and tolerance. As evidenced in the following excerpt, they voluntarily connected those values to Big History learning, whilst also including the term 'sustainable' in their discussions within the context of student appropriate understanding.

Gabby:	*I think sustainable is also part of our values, because sustainable . . . we have to be fair, justice, and it could be like . . . It's like* **sustainable means like all of our** [**local school**] **values.**
Jack:	*You might need* **PRhOJECT LOVE—Love** *because you need love to take care; you need to re-spect everyone's ways. (* **PRhOJECT LOVE** is an acronym for the local school values of the re-search school—***P**eace, **R**espect, h**O**nesty, **J**ustice, **E**mpathy, **C**ompassion, **T**olerance **LOVE**.)
Aidan:	*I think all of the* [*local school*] *values because if you have all of them you have a stronger heart and you can help the environment. . . . You should only use what you need. I would like to make the world sustainable.*

(Post-pedagogical interviews, 15 November 2016)

The data represented the local school values as a pivotal point around which students centred their discussions because the values were already so deeply embedded in all classes' daily routines.

Gabby:	*We need a sustainable future, and we need all the* [*local school*] *values. Big History helped me think about the future and people.*

Both co-researcher teacher's observations and my journal notes concurred with the advantage of students' previous knowledge of local school values and the ensuing enrichment of interpreting those values through the lens of the Big History universe story.

Co-researcher-teacher	*Now through the Big History programme,* [*students are*] *more articulate and they're more able to see* [*local school*] *values apply to the world and the universe . . . how something that happened so long ago is still something to respect and to value and to love . . . something that's going to happen in the future.*

The above comment validates Dahl's appeal (2012) to incorporate local vocabulary in articulating values, where the important learning of the children corroborates applying values to the past, present, and future from the perspective of the cohesive Big History learning story.

THEME 4. TRANSDISCIPLINARY LEARNING:
The extent of impacts on students' environmental education values

Transdisciplinary learning enriched students' understanding of environmental education values when nested in the emerging Big History narrative, their Catholic understanding of God's Creation, and local school values. In the following child-framed dialogue the children named the limits of learning subjects in 'silos' and highlighted their move away from an anthropocentric worldview.

Jack:	[*We are learning Big History*] *new words . . . so we can speak more like scientists and astronomers*
Aidan:	*You can learn lots more and it's part of different subjects—like religion, maths, history, science and all the other subjects that we know ... because you can't just learn one subject because if you just learn one subject, when you do a test or when something comes to light that you need to do with other subjects, you won't know it and so you should know lots of subjects so then you'll be ready for life's challenges.* (First pedagogical interview, 1 August 2016)

The students' conversation validates the significance of transdisciplinary skills in Big History learning, leading to the ability to articulate a wider worldview.

Students' broadening worldview away from anthropocentric thinking unfolded through the teaching of a universal story, language, and Big History learning framework. This became apparent as other students also articulated the need for the interconnection of subjects to enable a deep understanding across subject areas.

Molly: *I'm surprised that we have learnt all these difficult science things that a lot of us didn't really know at the beginning. . . .*

Gabby: *I'm wondering why we are learning, doing this—shouldn't we do it at Year 6 or university because it's really hard stuff to do and maybe we can't get it all—**but we can!***

(First pedagogical interview, 1 August 2016)

The co-researcher teacher, likewise, remarked on the learning across disciplines and the opportunities for children of varying academic abilities to engage in inquiry learning at their own level of understanding, where they were empowered to see themselves as co-learners with the teachers. This is in keeping with cyclical and reflective components of action research as "part of the joy is in the doing" (McNiff, 2002, p. 17; Mertler 2008, 25).

The nesting of diverse knowledge and transdisciplinary skills of the Big History course were powerful in allowing students to interconnect and to apply their understanding to the wonder of the universe's increasing complexity. The extent of the impacts on students' environmental education values was discernible in students' enriched observations, their use of their newly learnt knowledge from Big History and their known local school values and Catholic teaching.

THEME 5. SOCIOECOLOGICAL LEARNER:
The evidence for conformative, reformative, and transformative socioecological learning process

The fifth interrelated theme from my analysis, the socioecological learner, demonstrated the extent that students' values were informed within the conformative, reformative, and transformative socioecological learning process of the emerging Big History narrative, as illustrated previously in Figure 1. The data representation I collated as central to my research, revolved around the nesting of the first four themes within this final theme of the socioecological learner. I continued to view each theme not merely as linear, but as nested in and informing each other. Theo expresses it as "If you would know any [only one] subject then you won't be that smart to do anything in science or history or any subjects."

The lack of a wider worldview, in how we interact with society and the environment, as noted by Snaza and Weaver (2015), calls into question limited learning that is structured around the human. The evidence I collected is in keeping with the stance Big History Project promotes (2019), which empowers children to integrate a wide range of academic disciplines that aligns with socio-ecological learning (Gruenewald 2004; Hart 2012; Kyburz-Graber 2012).

The learning journey began as teacher initiated, but by the end of the intervention children had taken ownership as active learners with numerous references to themselves as 'big historians' during interviews and class activities. Aidan commented on the last day of school:

> *Oh, my Big History journal: Big History was my most favourite subject this year. It was awesome and my Mum is going to be amazed at what I have learnt when I show her this book. She's going to say, "Good job Aidan. You've learnt so much." I've already told her so much about Big History. I loved Big History. I learnt so much because I didn't know anything about how the world was created and how it was so complex.*

Aidan's comments are in keeping with the concept of the socioecological learner and the report of the Australian Education for Sustainability Alliance Project (2014), which calls for learning that embraces comprehension, complexity, uncertainty, and risk that can be applied to future sustainability. An empathetic deeper level of learning was expressed by Imogen and Gabby:

Imogen: *Imagine if you were nature, and people were building things on you, and cutting you down. How would you feel?*

Gabby: *I think we should treat the earth as what we want to be treated because if we treat the earth (how) we want to be treated then we can help the earth and all the animals because the earth is like a human being, it's like us except it doesn't walk. We want to keep the Earth safe so we have to treat the earth how we want to be treated as well.*

An overall finding from the analysis of this theme was that a cohesive deep time story empowered students to embrace past, present, and future within a shared language and critical inquiry evaluation techniques. They evaluated the implications of our

past, present, and future, moving away from anthropocentric thinking to critically examining the inclusiveness of all that is human and nonhuman in the universe. The following excerpt encapsulates the sense that socioecological learning can happen for any student. The insightful response below comes from a child who initially showed little awareness of the interconnectedness of human and non-human. His simple words echo the Delors Report's four pillars of learning (1996): learning to know, learning to do, learning to live together, and learning to be.

Aaron:	*Big History tells us about stuff that we can't see.*
Researcher:	*So do we need nature?*
Aaron:	*We need nature, but nature doesn't need us.*
Researcher:	*Did you understand why we need nature but nature doesn't need us?*
Aaron:	*Yeah, because if nature faults, we fault, and if it all collapsed, we collapse.*
	(Post-pedagogical interviews, 15 November 2016)

Aaron's observation is in keeping with Sterling's call (2003, 2008) that conformative and reformative learning, may lead to the possibility of transforming how we perceive whole systems and worldviews (also see Wattchow et al. 2014).

The final rich data feedback from both co-researcher teacher and students is affirmation for the rich and emerging Big History story that encourages socioecological learners to be informed, and in turn to interpret, local school environmental education values within a Catholic school setting.

The co-researcher teacher's observations are significant; as lead–learner she naturally incorporated the newly learnt Big History terminology and the local school values to express her opinion:

[*Students developed*] *a very good understanding of—you just can't get some more oxygen; you can't get more helium or hydrogen. What happened in the beginning created what we have now, and if we don't care for it now, and if it's not just and fair, and if we don't respect the environment, then it's going to be gone for the people in the future. If we don't respect each other and respect the environment, then parts of the environment will disappear.*

She believes Big History gives children a more powerful voice to articulate the socioecological aspect of learning in their own child-appropriate language, that humans' relationship with the environment is fragile, and, as such, humans need to play our part for future sustainability.

Socioecological learning became increasingly evident throughout student interviews in their intertwining of deep-time knowledge through the lenses of local school values, their learnt Catholic traditions, and transdisciplinary skills and concepts aligned to the Big History Project.

Conclusion

I conclude with words of wisdom toward a bigger worldview future from Alice, students involved in the action research, Big History, and my research findings:

Firstly, the Queen's advice to Alice:

"I can't believe that!' said Alice. *'Can't you?'* the Queen said in a pitying voice. *'Try again: draw a long breath, and shut your eyes.'* Alice laughed. *'There's no use trying,'* she said: *'one can't believe impossible things.'* *'I daresay you haven't had much practice,'* said the Queen. *'When I was your age, I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast.'* (Carroll 1872 Chapter 5)

Synthesising the five theme

Like Alice, I needed to take the Queen's advice to correlate the extensive findings from my data analysis. Among the most pertinent was the verification that environmental education is all the richer when teachers and students are empowered with a narrative that embraces a wider worldview, encompassing sociological learning. Most importantly the cohesive Big History story enables students to understand the interconnectedness of the evolution of human life within the history of the universe. This knowledge allows them to critique environmental actions being discussed, alongside an underlying joint responsibility to take care of the Earth and the understanding that everything AND everyone is interconnected from a rich values perspective.

Big History learning empowers students to reflect critically on and evaluate their worldviews from a child-framed perspective, which relates to my methods reference to Spyrou (2011) and Kellett (2010), who promote the place of children in education as critical reflective thinkers. The students' immersion in the cohesive story of Big History learning enables them to express confidence in their new, shared knowledge and to articulate a growing sensitivity to and awe of their own interconnection and interdependence as socioecological learners. My research shows that 8-9 year old students easily transferred the emerging scientific story of the universe of the past and present to inform both their local school and environmental values for deeper future thinking. The following written student comments at the conclusion of the pedagogical intervention

school and environmental values for deeper future thinking. The following written student comments at the conclusion of the pedagogical intervention uphold my conclusion:

> *I can tell my family things they didn't know. . . . I'm a Big Historian now! :) [sic]. . . . It's fun and interesting! We need to know about evolution and elements because we need to know where we came from.*

> *I know all the thresholds now and some people can't learn Big History, so I am very grateful; and I think we should now teach everyone. . . . and we should use these thresholds to care for our future environment to make a better universe.*

Employing Big History as a teaching vehicle for the scientific universe story achieves a cohesive, wider worldview for primary-aged learners, empowering them to engage in transformative, socioecological thinking for the future. These significant findings have wider implications for systems-wide education and curricula development, providing evidence that Big History is accessible and relevant to primary-aged students where environmental education is not taught as a silo discipline but as a transdisciplinary-based and socioecological learning structure.

The child-framed pedagogical intervention empowered students with a common learning platform to connect the new knowledge they had gained from Big History within the lenses of their embedded Catholic traditions and local school values. Building on this substantial foundation the transdisciplinary and socioecological learning inspired students to critically reflect on their environmental values and query their previous assumptions of sustainability.

In light of the findings presented, there is clear evidence of students' sharing story and knowledge of the universe to inquire critically and evaluate their learning, not merely to promote a cause (see Scott 2009). The evidence presented is heartening at a crucial time when we need our students' learning to incorporate informed and shared values within a post-humanist environment for a better future for everyone and everything.

Limitations

A clear benefit of my research demonstrates that knowledge of a cohesive and interconnected history of our universe empowers primary-aged socioecological learners to inquire critically beyond anthropocentric models of learning and to embrace an emerging post-anthropocentric future.

The lack of a recognised, evidence-based, and systemic educational framework and affirmation of Big History as a valued learning framework in the primary school made it difficult for me to have my research acknowledged by both Catholic education and state education authorities. I approached many schools before my research was seen in the light of authentic and relevant education. The reticence of some schools was articulated as not wanting to counter the perceived, conservative beliefs of school communities. In the case of Catholic schooling, I produced official Catholic documentation to counteract that concern, particularly Pope Francis I's latest official document on caring for our Earth (Francis I 2015). In hindsight this may have been overcome by holding a pre-research whole-staff discussion to validate the educational worth of my project. No objections from parents arose to teaching the Big History course to the class before or during the intervention, which was a positive sign.

Recommendations for future research

> *Once more Alice found herself in the long hall and close to the little glass table. Taking the little golden key, she unlocked the door that led (back) into the garden.* (Carroll, 1886 Chapter 3)

The findings from my research are an initial validation that teaching Big History to primary-aged students empowers socioecological learning, informs known values, and invites the possibility of transforming student worldviews to an understanding of human and nonhuman interrelationships and interdependence.

As this is an initial study at a doctoral level into teaching the cohesive Big History story in primary education, the holistic and nested nature of the inquiry alludes to a breadth of future directions; however, I outline below the areas that I have identified as significant.

Implications from this research indicate that researchers and educators in teacher education and primary schooling need to be provided with educational models to empower them to use Big History effectively, in line with transdisciplinary learning that is already embedded in contemporary curricula. Future research requires further qualitative and quantitative studies into teaching the universe story that examine how success is managed and maintained throughout a student's primary schooling years, alongside the extent that children's environmental values are transient or long lasting. Macquarie University *Big History School* Project (2019) is worthy of ongoing postgraduate research as it promotes a supportive and holistic primary and secondary education curriculum. Such embedded support networks that are authentic to critical enquiry learning would ensure that the socioecological learner, not the Anthropocene, is at the heart of the teaching and learning.

Significantly, I address unfounded concerns that Catholic schools may not be mandated to teach within a Big History-based scientific model. Student responses from my research provide evidence that students were empowered to further their understanding of sustainability threaded throughout the curriculum. They learnt an enriched worldview of amazing awe and wonder of what God has created, alongside the values needed for a sustainable world.

My research has broken new ground into adding original, significant literature to environmental education research beyond Catholic education. Clear evidence exists that my study raises significant issues requiring innovative address by all primary schooling systems. Environmental education is significantly enriched when viewed from the perspective of a shared universe story, inclusive of transdisciplinary socioecological learning perspectives.

The emerging scientific story of the universe is a story of the past and present informing the future through socioecological learning where action requires love, understanding and, equally as important, cohesively taught critical

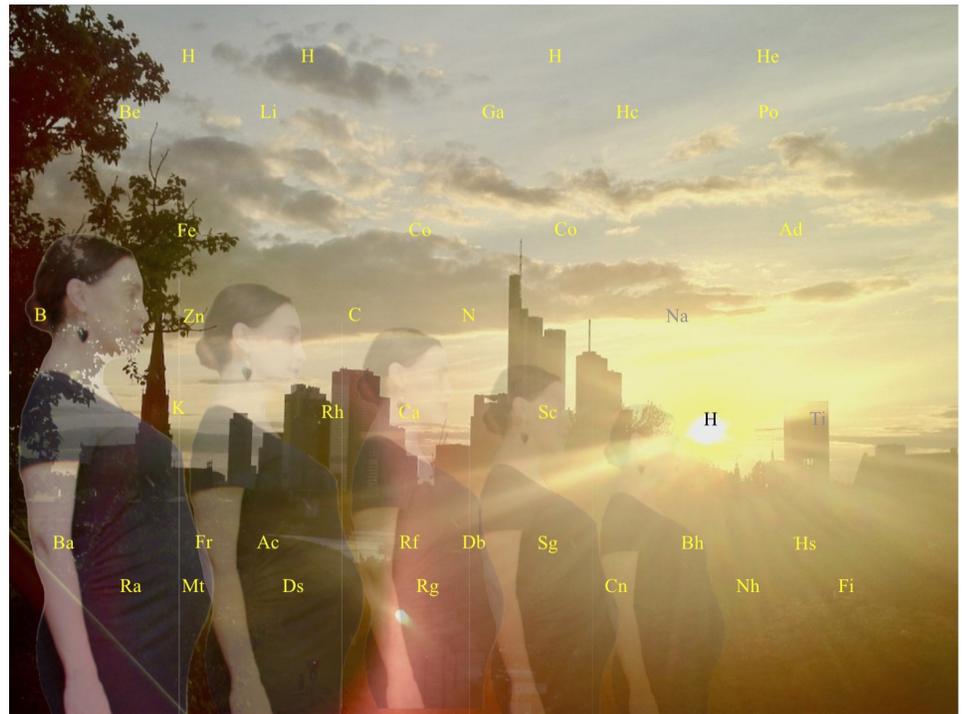knowledge as emphasised in the following quotation:

> It is essential to seek comprehensive solutions which consider the interactions within natural systems themselves and with social systems. . . . We lack an awareness of our common origin, of our mutual belonging, and of a future to be shared. A great cultural, spiritual and educational challenge stands before us, and it will demand that we set out on the long path of renewal. (Francis I 2015, 139 - 202)

The words of Pope Francis summarise my new-found hopes stemming from this research: that Catholic primary school education systems, and education broadly, take up the challenge to evaluate critically the teaching of a cohesive and interconnected history of our universe.

Wider implications from this research open up opportunities for critical inquiry beyond anthropocentric models of learning. The evidence clearly indicates that the deep-time framework of Big History is accessible and relevant to primary-aged students. The research findings were significant in the context of child-framed deep learning pedagogy that informs environmental values for current and future learning. If educators are truly to comprehend the importance that values play in transdisciplinary, socio-ecological learning, then our universal deep-time story needs to be embedded at all levels of the education continuum, inclusive of primary-aged students. Figure 4 captures my post-anthropocentric vision, where **all** education encompasses our learning toward the many questions of our unknown future.

Figure 4. Deep Time Entanglements
Collaborative Deep Time entanglements, Image created by author and photographer (Ahearn, M. & Smith, L. 2019, with permission)

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