**Integrating Science and CTS: A Revolutionary Step towards Learning That Makes Sense**

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**Abstract**

A lasting issue in our educational system is the segregation of disciplines. The existing structure used to work well in the past, but with the anticipated change in the world of work, the advancement of technology, and the reshaping of future careers, this structure is no longer effective; learned skills are not transferring into real life situations. In this paper, I will focus on the cross-curricular integration of Science and CTS - Environmental Stewardship, and look through the lenses of posthumanism and decolonization to shed the light on the hidden aspects of curriculum that are standing in the way of attaining scientific and environmental literacy. In a time when the careers of the future are becoming unclear, students must be prepared for critical thinking, innovation and problem solving, which changes the face of career training and makes integration of disciplines more important than ever.

*Keywords:* Career and technology studies, Science curriculum, cross-curricular integration, scientific literacy, environmental literacy, posthumanism, and decolonization.

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One does not simply remember oneself seeing, experiencing, learning; rather one recalls the situations in the world in which one has seen, experienced, learned. (Ricoeur, 2004, as cited in Panayotidis, Lund, Towers, Smits, 2012, p.80)

**Integrating Science and CTS: A Revolutionary Step towards Learning That Makes Sense**

**Introduction**

As educators, we strive in our daily practice to engage students in quality education that will illuminate the way for them to achieve their goals and become educated citizens of the world. But sometimes our practice can become one of methods and application; more of “technique” as a foundation for professional practice (Smits, 1997, p. 290). Being human in teacher education and teacher practice “is much more than technique…. [it] is the responsibility for others and how to manifest that through good actions…. [and] understanding” (Smits, 1997, p.290). My goal as a teacher as I move into my 16th year of teaching would be to enrich students’ minds and carve educated citizens who can lead the world; not through the transfer of knowledge or the delivery of facts; because, with experience, I know that is not enough. This method, known as the banking model[[1]](#footnote-1) of education only serves to “dehumanize” (Freire, Macedo & Shor, 2018, p. 75). In the passages that will follow, I will analyze the humanizing factor in a curriculum, which is hidden behind the words[[2]](#footnote-2) in an aim towards dehumanizing curriculum rather than dehumanizing the human. I will encourage teaching curriculum by “presenting reality as it truly is'' (Rose, 2017) utilizing cross-curricular integration as my guiding torch, and coming to know how we think rather than what to think (Higgins, Wallace & Bazzul, 2019, pp.156-157). Rousseau’s insight appears in Visser’s (2016) Testing towards Utopia, “Schools are thought to make children free, but everywhere they’re in chains” (p. 14). In this paper, I will not suggest a foundational change in the educational system because it is most likely that the core academic disciplines of high school would continue to serve as the organizing rubric for the system as Noddings explains in Flinders & Thornton (2013, p. 405). My suggestions can trigger a change by providing a pragmatic form that can help dissolve the boundaries between disciplines.

**Problems and Possibilities**

Alberta high schools offer what are called core academic disciplines or mainstream courses such as the sciences, mathematics, and humanities. Other courses are *optional*, these may include Career and Technology Studies (CTS). “Career and Technology Studies (CTS) is a provincially authorized curriculum for Alberta secondary schools designed as a pathway to offer flexible programming using 1- credit courses” (Alberta Education, 2020). The CTS program (previously referred to as vocational education[[3]](#footnote-3)) was first introduced in 1989 in response to changes in the world of work and society (at that time), the introduction of technology, and an attempt to revitalize curriculum (Taylor & Lehmann, 2002, p. 147). Its flexible modular nature was designed specifically for its integration into core academic courses (Taylor et al., 2002, pp. 144-147). Integration would serve as “preparation for future study and careers in highly skilled and technical fields” (Taylor et al., 2002, p. 148), but in order to accomplish that, vocational education should “build competence[[4]](#footnote-4) in math, science and communications” (Nata, 2003, p.104). The structure of this curriculum would allow schools to design unique programs that meet the needs of students and draw on community resources and partnerships (Alberta Education, 2020; Taylor et al., 2002, p. 147). Unfortunately, this unique program of studies is still not utilized for its intended purposes. Students who couldn’t make it through the mainstream core academics would be enrolled in CTS courses with no clear pathway to follow. Only 1% of high school students in Alberta are in the RAP[[5]](#footnote-5) program that is aimed at encouraging students to consider the trades (Taylor et al., 2002, pp. 144-150). Furthermore, CTS is currently not serving its intended function as mentioned above, due to lack of funding and institutional support, instead it often serves as a relief for students with special needs (Taylor et al., 2002, pp. 144-145). The remaining middle, those who fall between the academically inclined and others with special needs, do not have the prerequisites to enter university or technical institutes and without the minimum requirements of grades and attendance, even employers are hesitant to hire them (Taylor et al., 2002, p. 151). This dichotomy that the school system has created, also created a dichotomy in our society between those who are cognitively able to advance into postsecondary and those who have settled for vocational careers (Pinar & Irwin, 2005, p. 357; Taylor et al., 2002, p. 156).

**How Did We Get Here?**

In the 1970s, two visions for Alberta Education were presented in the Harder report and the Worth report. The findings of the Harder report reflect our current educational system’s “back-to-basics approach”, originally designed for students to develop the knowledge, skills, and attitudes required for the world of work (Taylor et al., 2002, p. 142). The Worth report presented the need for a “shift toward student-centered inquiry learning, curricular options and open classrooms” where the student is the “prime architect” of their program (Taylor et al., 2002, p. 142). At the time, the Harder report was preferred in response to industry requirements, but now it is useful to revisit the Worth report to address “competing goals in a changing society” and in the world of work where the trades themselves have become more complex (Taylor et al., 2002, pp. 143-150).

**What Kind of Possibilities Are We Talking About?**

When talking about integrating core curricula with CTS, teachers think about the competencies that are required for success in these domains: Physical sciences would be at the foundation of the trades; biological and chemical sciences at the center of agriculture, environmental education and health, they also constitute the fundamental concepts behind the study of foods, fashions, and cosmetology. However, the sciences are considered academic courses while CTS ‘optional’, they are not integrated as they should be and the disciplines remain segregated. Students are obligated to choose four or more of the core disciplines and are missing out on so many interesting option courses. But student interest is not merely the goal… the integration of disciplines for *learning that makes sense* is the ultimate goal. Chemistry/Foods, Chemistry/Fashions, Mathematics/Constructions, Physics/Mechanics, Biology/Environmental Studies, Biology/Health Studies, and even Literature/History as Noddings pointed out in Flinders et al. (2013, p. 403). If curriculum makers put their minds together to find the common themes, they can match common objectives between the different courses taught at school.[[6]](#footnote-6) Who better than “inspired teams of professional teachers” who are at the front line battling their way through the system to develop these course combinations and to “develop a new language to think and talk education at their own schools” (Visser, 2016, p.21). “It is not the subjects offered that make a curriculum properly a part of education but how those subjects are taught” (Flinders & Thornton, 2004, p.169). There is an opportunity here to combine the knowledge and skills of two teachers from two different disciplines. “Teachers teaching other teachers - colleagues working together to better understand teaching and learning - is the core of collaborative teacher professional learning” (Parsons, 2013).

Chemistry teachers can teach the organic chemistry objectives of the curriculum while the Food teachers demonstrate those theories in the Food lab with real food and real-life experiments (cooking). Chemistry teachers can also combine forces with Fashion teachers or Cosmetology teachers to explain the chemistry of dyes, hazardous combinations and new creations. Physics teachers can teach the concepts of motion and torque in the mechanics lab, and the list goes on for teaching Math in the construction shop and Biology outdoors and at hospitals. The possibilities are endless when it comes to combining the subjects taught at school and the probability of having more choice increases. The subject matter becomes relevant and makes sense, or as Dewey calls it “The organic connection between education and the personal experience” (as cited in Flinders & Thornton, 2004, p. 169). No more memorizing how to balance a chemical reaction when the reaction is abstract and the chemical compounds are mere scribbles on paper. And no more finding x when x is an unknown number in an unknown problem you have no idea why you are asked to solve it. This segregation of disciplines has led to loss in meaning and meaningful engagement, and an end to learning in all school subjects as is most beautifully described in Flinders et al. (2013, p. 400):

There is only one subject matter for education, and that is Life in all its manifestations. Instead of this single unity, we offer children Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows; History, from which nothing follows; a Couple of Languages, never mastered; and lastly, most dreary of all, Literature, represented by the plays of Shakespeare, with philological notes and short analysis of plot and character to be in a substance committed to memory.

In other words, the learning comes to an end when what we want to create is meaningful learning for life-long learners. Teaching each subject separately and unrelated from the others makes the meaning of each subject lacking. The segregation of disciplines and the lack of integration and transfer of skills due to the lack of “knowledge-building process” makes Science less appealing to students who eventually lose motivation and see it as irrelevant (Wallace, Venville & Rennie, 2012, p. 2; National Research Council and Institute of Medicine, 2004). A detailed explanation of this phenomenon is presented later in this paper.

**My Personal Connection to CTS**

During the past six years, I have had the opportunity to teach many courses in the Career and Technology Program of Studies: Communication Technology in the MDC Cluster “(Media, Design and Communication Arts), Environmental Stewardship in the NAT Cluster (Natural Resources), and Leadership in the HRH Cluster (Health, Recreation and Human Services). Reflecting on my observations of teaching both Science and CTS in a segregated fashion strengthened my position in the necessity of cross-curricular and “multi-level interdisciplinary integration” of subjects (Clark, 1997). Instead of students asking “why do I need to learn this?” they would be asking if they could learn more and enjoy more of the interesting new learning experiences they acquire. The teachable moments that educators describe need to be more abundant. In my many years of teaching, describing the evolutionary behaviors of the different male and female pine cones rather than simple labelling and drawing them has never failed me as a teacher in recreating that “aha” moment and the fascinated looks on my high school students’ faces, even when this is a concept they would have learned in elementary school. This foundation would later extend their inquiry into learning about Forestry, a branch of CTS - Environmental Stewardship, understanding about forest fires and where that falls in terms of global climate; a continuous chain of learning that connects disciplines and integrates them into inseparable units. Some readers may be thinking after reading this: “teachers cannot teach all these disciplines” - and that is correct! But when teachers team up to teach, these disciplines together, all that wealth of knowledge can be at the students’ disposal. Team teaching in its different forms has proven to be a successful model of education that brings about motivation and engagement in students. Team teaching of academic and technical teachers is also encouraged to strengthen the connection between the concepts learned (Clark, 1997; Thompson & Dow, 2017).

Career and Technology Studies in its five subdivisions instructs students through hands-on applications of solutions to real world problems. Teaching Science courses with the practical model of the CTS curriculum through inquiry-based learning can reduce the limitations of theory-based learning, and can also increase student interest and impetus (DeBoer, 2000). It is important to highlight that the majority of Alberta schools offer CTS courses in Culinary, Fashion, Woodworking, Design and Communication Technologies, but not in Natural Resources (the cluster that represents Environmental Stewardship); very few schools have an Outdoor Education program that capitalizes on Alberta’s Natural Resources and the rich CTS: Natural Resources curriculum. A province such as Alberta should be ripe with environmental careers and our schools can be promoting this through Environmental Education (CMASTE, 2019).

In a recent experience I had at my high school, a Schulich Leader scholarship was to be offered to a student who exhibited superior academic achievement, innovation, and entrepreneurship. Of the 1500 students at my school, a handful applied but didn’t quite have the requirements of an innovative entrepreneurial citizen. Many excelled in math and science and had superior grades but only a few had an idea of what being innovative meant. High school should be an environment that provides students with opportunities for innovation and entrepreneurship, a place where they can explore their passions and experiment with their education. What will these students do after they finish university? They will graduate with the highest grades and the best standing but what would they be able to offer industries when their knowledge might not transfer into creative designs and solutions to real world problems that are arising every day (Taylor et al., 2002; Charette, 2013). Our work needs to begin at the level of high schools and teachers have a crucial role in educating students who can all qualify for a Schulich award, and we can start by “integrating learning” (Clark 1997, p. 122).

It is important to determine and to describe how teachers will be able to integrate CTS courses with their scientific curricula. Research indicates an emphasis on project-based learning as a principle for guiding authentic inquiry and knowledge construction (Thomas, 2000). Students ﬁnd project work more meaningful when they conduct real inquiry and hands-on learning. “Deep Learning” according to Hoachlander & Yanofsky (2011, p. 63) is connecting STEM (Science, Technology, Engineering, and Math) to real world experiences in project-based learning; project-based learning that is at the center of CTS.[[7]](#footnote-7) Real world situations and social experiences are what students need to transfer these skills and become invested in learning; a curriculum that crosses traditional discipline boundaries (National Research Council and Institute of Medicine, 2004, p. 191; Hoachlander et al., 2011; Wallace et al., 2012). Projects[[8]](#footnote-8) also help students build skills such as collaboration, communication, and critical thinking, and the productive use of technology will serve them well in and out of the workplace (Larmer & Mergendoller, 2012). The emphasis on building practical skills is a major part of the CTS curriculum and should be a part of Science curriculum as well. The models for designing these efficient and productive (standards-based) projects can be found in CTS, shifting the responsibility to learners and using metacognitive strategies to ensure their goals are achieved. Collaborating with CTS teachers could help science teachers better manage the limited time they have to cover their curricula while carrying out practical projects to help students understand scientific theories on a deeper level. The Edmonton Public Schools (2020) district priorities summarize my goals for this project:

1. “Foster growth and success for every student by supporting their journey from early learning through high school completion and beyond '': Through CTF (Career and Technology Foundations)[[9]](#footnote-9), students can identify their passions early on - in middle school - and then build on that or even identify new paths in high school once introduced to the rich fields of Physics, Chemistry and Biology all taught in a project-based fashion integrated with CTS.

2. “Enhance public education through communication, engagement and partnerships”: Partnership with organizations to support the CTS pathways provide students with the necessary experiences, resources, and application of learning relevant to their lives (Taylor et al., 2002).

3. “Provide welcoming, high quality learning and working environments”: Team teaching of CTS and Science teachers will bring about a wealth of high quality knowledge that cannot be provided when disciplines are segregated.

**Literature Review**

**School Science and STEM**

“Should curriculum emphasize science subject matter itself, or should it emphasize science in life situations in which the science plays a key role?” (Bybee & NSTA, 2010, p. 6) Several questions asked by Bybee et al. (2010) and Chesky & Wolfmeyer (2015) inquire into the future of science and its role in the lives of our students. High school science is “no longer enough for knowledge acquisition of a modern citizen” according to Chesky et al. (2015, p. 18), it must be intertwined with technology and engineering in order to achieve STEM education. STEM education has become a popular concept in schools because of the assumed shortage of STEM graduates (Charette, 2013). Studies have shown however, that there isn’t a shortage in STEM employees but rather a “STEM knowledge shortage” which can achieve a “solid grounding” understanding of math and science, “when science, math, and engineering are taught well, [and] engage students’ intellectual curiosity about the world and how it works”(Charette, 2013). In my professional judgement, I believe that a solid grounding in science constitutes “what it would take to bridge theory and practice in science education” which translates into incorporating both content and process in the science classroom (Bybee et al., 2010, p. 4). These concerns echo the goals for scientific literacy as stated in Bybee et al. (2010), as well as my concerns as a classroom teacher with more than 15 years of experience. Specifically, student apathy grows as student engagement dwindles and classroom knowledge, skills, and attitudes (KSA[[10]](#footnote-10)) are not being transferred into real life situations.

I once took my students on a field trip to the University of Alberta - Faculty of Agriculture for a day of learning about sustainability. The students never thought that cows could contribute to global warming nor that planting hemp would be a better alternative to so many agricultural practices in our province. The field trip was informative and very “entertaining”, if I may say, but without follow up and taking action, the knowledge is rendered “value-free...produced without context” (Chesky et al., 2015, p. 25). The students would then become observers in a sustainable world thinking that they are not required to do anything. Scientific literacy is now more than ever necessary which includes preparing students for life and work as citizens - not necessarily for a professional career - especially that the careers of the future are changing with the advancement of technology and the jobs of the future have yet to be invented (Let’s Talk Science, 2019; Chesky et al., 2015; Yacoubian, 2018). The integration of higher science skills in career training will equip students with knowledge based in science to meet the demands of scientific discovery (Barrick, Heinert, Myers, Thoron, & Stofer, 2018, p. 44; Nata, 2003; Charette, 2013).

**Scientific Literacy in School Science**

In the following sections, I will present an overview of the history of school science and how it became the school science that we present to students today. Then I will begin to breakdown the objectives of two CTS - Environmental Stewardship courses in order to show how it can support science teaching and achieving inquiry in a way that is required by the science curriculum. The goal of scientific literacy according to Alberta Education (2016) is to “develop the science-related knowledge, skills and attitudes that students need to solve problems and make decisions, and at the same time help them become lifelong learners— maintaining their sense of wonder about the world around them.” However, in order to achieve this through CTS, I will need to transform the observer into participant by integrating content and practice beyond the parameters of a lab or field trip, defeating the traditional humanist approach.[[11]](#footnote-11)

***Inquiry in School Science***

When the concept of scientific inquiry was first introduced into science textbooks, it was phrased in a way that indicated science was uncertain and there were no known conclusions, in such a way as: “scientists are uncertain, we have been unable to discover the mechanism, and the favored theory is…” (Bybee et al., 2010, p.17). The purpose was to allow students to experience science as an investigation for which answers were not provided (Bybee et al., 2010); students were and are always expected to question science and not take it as truth. With time, the “declining support for the innovative NSF[[12]](#footnote-12) programs resulted in wider acceptance of conventional textbooks” (Bybee et al., 2010, p.17). Science as inquiry in the conventional textbooks became a set of laboratory experiments and hands-on activities (Bybee et al., 2010). Even though science as inquiry has had its comeback in the current rhetoric of education policy, its application hasn’t changed in our schools - which is heavily linked to assessment policies and teaching for the test (Bybee et al., 2010; Staszenski & Smits, 2008, p.48). The issue “is not that there is too much science but too much shortsighted application of it, too little dissemination of its deeper meanings, and too little appreciation of the need for proceeding by its method of free inquiry” (H. J. Muller as cited in Bybee et al., 2010, p. 16)…. reducing [inquiry] to a few laboratories and a slogan” (p. 17). With all that being said, it is necessary now more than ever to find alternative ways to teach science utilizing the resources we have at hand due to the limitations of funding (Taylor et al., 2002). I propose using CTS taught alongside science to fill in the gaps. There are endless common outcomes between the CTS and science curricula as demonstrated in Lidston (2015), but I will only use CTS - Environmental Stewardship to emphasize my point. In the following sections, I will offer different lenses through which we as teachers and policymakers can look at CTS, and end with a comprehensive blueprint that can give thought to further investigation. Making CTS teaching more effective to support science rather than segregate them, can make them much stronger together.

**A Revolutionary Step towards Learning That Makes Sense**

My vision for *A Revolutionary Step towards Learning That Makes Sense,* is to teach CTS and science in a holistic way breaking down the barriers that segregate the disciplines and giving students a chance to visualize learning outside the confines of a classroom. To focus my research and allow for reconceptualization of teaching and learning through integration, I have chosen to analyze two courses from the CTS - Environmental Stewardship program of studies. The purpose is to demonstrate how teaching CTS - Environmental Stewardship from a posthumanist perspective can bring about meaningful learning for students who would take action willingly and become engaged citizens and see value in saving their environment; the definition of environmental literacy.

Environmental Stewardship constitutes a major part of CTS, it is a significant topic in every science curriculum and it is also a trendy topic of vital importance. The CTS - Environmental Stewardship curriculum, when designed to promote the careers of the future and awareness towards environmental issues, fails in the majority of cases, for real world experiences which defeats the purpose of its design. The science curriculum, when designed to teach the Nature of Science (NOS) and promote scientific literacy, also fails to prepare students for future careers that have yet to be designed. Taking these two programs of studies *outside of the box* -the walls that segregate these two disciplines and the listed objectives that constitute the recipe for learning - will hopefully begin an era of new possibilities for scientific literacy and the future of careers. We can start this journey by looking at them through new lenses that will challenge our perspectives and inspire us to take new pathways for teaching and learning.

**A Posthumanist Perspective**

In a world of social media and high speed internet, natural disasters happening all over the world have been reduced to fictional scenes in the “feeds” of our youth’s smart devices. The disconnect from the real world and the feeling of being invincible when untouched by said disaster, specifically that of global climate, necessitates that we look at our curriculum through a different lens to find what’s hidden that would signal their attention and call for action rather than stand by and think that *Science* will fix it -“a blind faith embedded within subjectivities and political/economic contexts” (Chesky et al., 2015, pg. 24); a humanist practice, where nature is thought to be knowable and predictable (Higgins, 2016, p.186). For how can nature be knowable when the world becomes trampled under the weight of a pandemic that paralyzes the global economy and kills thousands. Citizens of the world wait for science to solve the problem and predict an unforeseeable future, while still being taught how to wash their hands and prevent the spread of the pathogen. Should that knowledge not be a commonsensical derivative of the science we learn at school?

In a time when technology is embedded in every aspect of life, a posthumanist perspective would remove the human from being at the center of all that matters and makes attending to the more than human and decentering the human its goal, thereby “challen[ging] the residual humanism that underpins the very idea of education, and instead foregrounds the entanglement between human and nonhuman… promoting interdisciplinarity within curricula and pedagogical practice”; “the ‘post-’ in ‘posthumanism’[being] an ongoing destruction of humanism” (Herbrechter, 2017, p.1125). Integrating the disciplines of science and CTS - Environmental Stewardship will bring about whole education.

Environmental education is grounded in science-based curriculum therefore one should inform the other (Rotas, 2014, pg. 91). A definition for environmental literacy proposed by the North American Association for Environmental Education (NAAEE) states:

An environmentally literate person is someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life. Those who are environmentally literate possess, to varying degrees, the knowledge and understanding of a wide range of environmental concepts, problems, and issues; a set of cognitive and affective dispositions; a set of cognitive skills and abilities; and the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts. (Hollweg, Taylor, Bybee, Marcinkowski, McBeth, & Zoido, 2011)

This definition echoes the common goals for scientific literacy which include democratic decision-making resulting from critical thinking, equality, and social justice (Yacoubian, 2018, pg. 309),“reject[s] the objectivity of scientific knowledge, and instead favor the ways that science functions within and for societal goals” (Chesky et al., 2015 p. 25). With these goals in mind, for both scientific and environmental literacy, it becomes essential to look at the curriculum through a different lens and perhaps teach from the perspective of a posthumanist lens that “undoes binary logic by *thinking* and *doing* simultaneously” (Rotas, 2014, p. 101)

***CTS - Environmental Stewardship in a Different Lens***

The following presents a window through which teachers may view CTS - Environmental Stewardship from a different perspective that also supports the goals for scientific literacy:

Resource Management - ENS1115, Students describe the practices used to manage air, water, soil and land use, hydrocarbons and minerals, forests and wildlife and present the results of their research on one or more issues related to resource development. (Alberta Education, 2015)

Describing and defining “nature”[[13]](#footnote-13) is at the heart of Science education but it is not only a “human meaning-making practice” but is “co-constructed” with non-humans as well (Higgins et al., 2019, p. 156). In looking at the curricular objective above through the perspective of a posthumanist lens, it is not telling me that nature and man are equal but rather humans are responsible for the control and management of air, energy, forests, land, water, and wildlife; “a ‘nature’ constructed by humans to pretend they are superior to it” (Weaver & Snaza, 2016, p.1060). Teaching it in a literal sense would have several hidden implications including but not limited to: humans (students) learning that they are the managers of the environment and that scientists will always have the solutions. They have created the assumption that what we learn through the scientific method is “true, correct, objective, and value-free” and we can rationalize nature (Chesky et al., 2015, p. 24). This feeling of control also contributes to the dissonance that settles in when what they learn conflicts with what really happens (Stoknes, 2015a; Stoknes, 2015b), until suddenly the reality sinks in leading to either a doomsday feeling or denial, “everything will be business as usual” (Grant & Littlejohn, 2018, p. 3).

Furthermore, the language used in the Environmental Stewardship curriculum does not help and the fact that meaning is separated from the physical world contributes to the problem (MacRae, Hackett, Holmes & Jones, 2017, p. 505). For meaning to exist and learning to make sense, it should emerge “from diffuse and diverse relationships between non-human and human” (MacRae et al., 2017, p. 507). In the words of Karen Barad as cited in MacRae et al. (2017, p. 507), “rather than the child acting on the world, materials also act on the child; *intra*-action rather than *inter*-action”. Or, as Higgins (2016, p. 190) best explains it, “bodies of meaning” the social aspect of science and, “bodies of matter” science itself are “co-constitutive”. These relationships put at center, not only achieving meaning but also achieving inquiry by interacting with the empirical world (Chesky et al., 2015, p.18). When the human subject seizes to be the “sole locus of agency”, then meaning can emerge from relationships with the nonhuman, then and only then, air, energy, forests, land, water, and wildlife can be understood as having agency (MacRae et al., 2017, p. 507).

***The Entanglement of Posthumanism and Decoloniality***

The important lesson here is that meaningful teaching and learning requires the creation of a pedagogical context that fosters an organic, life-giving, and life-sustaining form of hope... what we want to learn cannot be separated from the processes we go through while learning…...we need to see ourselves in ecological relation to that which we want to know. Relations always come first. (Donald, 2011)

It is almost impossible to talk about posthumanism without its “entanglement” with decolonization (Bayley, 2018, p. 245). Donald is calling for the necessity of living the experience of learning through experiencing the process. Decolonization according to Higgins (2016, p. 187) is the “deconstruction of (neo-) colonial structures and strategies” as well as the “reconstruction*”* that centers Indigenous and other postcolonial ways in reshaping education. Decolonizing curriculum is an essential practice because the teacher interpreting and executing this curriculum would not necessarily recognize colonialism in structure, language, and sequence of objectives, as well as the humanism prevailing over any meaning or connection with nature. Furthermore, the “methodocentrism” that maps Western science, reduces nature to data that has “no truth” and becomes constructed based on what “human power brokers” deem valuable (Weaver et al., 2016, p. 1062). When students are asked to research and record their data on legislations and practices relating to our natural resources in Alberta, the fear is that the collection of data is creating “a hierarchy as to what is valued and important in the world” (Weaver et al., 2016, p. 1061). When teachers become aware of these dispositions they can start to see the importance of teaching CTS - Environmental Stewardship with the goals of environmental literacy in mind. Furthermore, the integration of Indigenous perspectives into our current curricula is a requirement by the new TQS[[14]](#footnote-14). Teaching CTS - Environmental Stewardship and science combined from a posthumanist and decolonizing[[15]](#footnote-15) perspective, can bring that sacred wisdom into the classroom (CMASTE, 2019).

Integrating science and CTS - Environmental Stewardship will bring the reasoning behind the action to the forefront of decision making, providing meaning and value to learning as well as action that doesn’t come to an end. In looking further at the CTS - Environmental Stewardship curriculum ENS2030 - Ecological Economics (Alberta Education, 2015):

Students will **compare and contrast ecological and neoclassical (e.g., supply and demand, Keynesian) economic models, considering:**

* + **natural capital**
  + **human capital**
  + **manufactured capital**
  + **sustainability**
  + **externalities (indirect or external costs or benefits)**
  + **cost-benefit analysis**
  + **economic analysis and valuation**

Here students are expected to compare and contrast ecological and neoclassical economic models while considering human capital and natural capital. It was interesting to see how this objective, which was emphasized in bold letters unlike many others, suggests that nature is important but not at the expense of the capital it can raise and its value to the economy. It is also worthy to note here that “seeking truth via rational means'' by data collection and “knowledge produced without context” rather than “something deeply embedded in social engagement”, as is abandoned by those in political and economic power, defeats the purpose of environmental literacy as mentioned above (Chesky et al., 2015, pp. 24-25). The objectives of the CTS - Environmental Stewardship curriculum are written in a structured, top - down model using the verbs of Bloom's taxonomy to emphasize the order in which they need to be taught. “The belief has been that the right information from the proper knowledge system, sequenced in the correct order, presented in the correct way, would produce the desired effect in the student” (Donald, 2011). This method of pedagogy is Euro-centric in its focus and a symptom of positivism according to Weaver et al. (2016, p. 1059): the need to classify and organize in a prescribed process of meaning making, the “need to pretend that certainty and stability define nature and human reality” when nature is everything but that; global warming and pandemics prove otherwise.

***“The Informational Problem”***

As teachers in Alberta, we are required to teach curriculum as a legal document, making sure that all the objectives are taught and assessed. This requirement has contributed to a   
“curriculum and pedagogy... regarded as mechanistic tools that aid in the educational attainment of single-minded and exclusionary notions of truth” [[16]](#footnote-16)(Donald, 2011). The current kind of curriculum and the limitations of its teaching pedagogy have pre-determined goals that are meant to produce the “right” kind of citizen (Donald, 2011; Yacoubian, 2018); one that fits the expectations and needs of the state. Looking at this curriculum through a decolonizing lens exposes the language used as that of a convergent lens - the knowledge must come to an end (Rotas, 2014, p. 102). “This approach longs for surety, a conclusion, and the language it uses suggests a troubling kind of foreclosure” (Donald, 2011). Curricular objectives present environmental matters as issues that need to be addressed by humans and terms that students need to define (Rotas, 2014, p. 92). Donald (2011) refers to this approach as an “informational problem” in the relationship between the Indigenous and Canadian people. He further argues that the assumption of “talking about Indians with students will somehow improve the relationship” (Donald, 2011) thus regurgitating “truths'' and putting an end to the vast knowledge that lies hidden in the forbidden ways; the information [itself] is thought to solve the problem (Donald, 2011; Rotas, 2014, p. 92). Or as Bayley (2018, p. 246) best describes it, “simply paying lip service to the idea of decoloniality”. What we need for meaning making to happen and to be accountable towards nature is developing reciprocity with Mother Nature, a love story of mother and child, one that cannot exist without the other (M. Tremblay, personal communication, February 27, 2020).

Therefore, what is required for “knowledge to become organic and make a claim on us that will facilitate a necessary shift in our understanding is a storied approach to knowledge that helps us see ourselves implicated in and in relation to what it is that we want to know” (Donald, 2011). We need to think and do to understand “the possibilities for curriculum” (Smits, 2008, pp. 106-107). The stories Donald (2011) suggests, “enable this instruction by providing us with vivid examples of how not to behave….” if this is not the definition of being stewards of the environment, then I don’t know what is. This kind of knowledge can only have a lasting effect through storytelling not through stating definitions and simply believing that “students will learn about,” as the document suggests (Alberta Education, 2015). What we ask of our students to know without forming a lasting relationship with the knowledge or meaning to it, is like “making love to death… to attain the unattainable” (Donald, 2011). The notion of “making love to death” that Dwayne Donald coined, seems to come from a cry of agony in light of current and historical obstacles that Indigenous people suffered. Donald (2011) in one of many ways, references this idea to “the ongoing human love affair with market capitalist devoted notions of technology, progress, and development juxtaposed with the environmental damage done in the name of such devotions.” Human researchers, in this case curriculum writers and policy makers, continue to centralize the human as it appears in this curriculum and only tweak curricula in hope to fix the problems, another humanistic property, one in which Dwayne Donald thinks “anyone who has tried to negotiate these tensions knows that this is a very complex task” (Donald, 2011). We also see this tweaking phenomenon in the new TQS where integrating Aboriginal perspectives has become mandatory and we are now responsible to retrofit rather than reinvent the curriculum. I would suggest reinventing[[17]](#footnote-17) and re-conceptualizing the curriculum rather than tweaking it and even though curriculum reform may be underway, it is still abstract to teachers in Alberta waiting for it to become a reality, for we remain, as Pinar suggests, “what we do not know” (Erevelles, 2005, p. 425).

So what do we take from this? We are supposed to integrate Indigenous ways into the Science curriculum, but Indigenous ways cannot be separate from nature nor from Environmental Stewardship (CMASTE, 2019). Therefore, we need to teach science and the environment as one, as part of our mandate to teach Indigenous perspectives (Alberta Education, 2018).

***We Are Not Without All These “Others”***

The struggles I’ve had with the CTS curriculum, as mentioned earlier, are with the language. Euro-centric, converging into one truth, language of the curriculum has been a blindfold that I didn’t recognize was there. After being guided by these lenses, I am finally able to see the endless possibilities this curriculum offers and while I don’t intend to discredit Western guidelines in designing this curriculum, I would like to morph and blend a decolonizing and posthuman approach as Little Bear would suggest in De Line (2016), and disable the hidden crippling factor that classifies this curriculum as unimportant and secondary to what is mainstream. We can construct a curriculum “that enables the collective interests of all students” by “ invert[ing] the oppressive logic of the ‘BASIC’ [the human, the data and the truths] and shin[ing] the spotlight on the shadows while making the periphery central to a reconceptualization of curriculum theory” (Erevelles, 2005, p. 423).

While there are no doubt such curricula that are radically humanist, offering

students a dominion - or stewardship - based way of understanding the human’s relations to plants, soil, animals, wood, water supplies, tools, and so on, these curricula could also produce the awareness of the fundamentally *interconnected*, non-dissociable nature of these relations. “Humans” are not without all these Others: These nonhuman Others are not here for us to “use”; they are the condition of possibility for our existence. (Snaza & Weaver, 2015, p. 8)

After all that is said and done, we remain far behind in our educational journey and must act quickly to fully acquire what we claim to have accomplished. For how can we say that colonialism is in a post-period (De Line, 2016) and how dare we think that we are superior to other beings, for without the plants we have no air and without the rock we have no existence to declare.

**Conclusion**

The divisions among “subjects” and segregation of disciplines that still prevail in our K-12 schools were first instituted to prepare students for the disciplines they might encounter in college (Snaza et al., 2015, p.8), but with the advancement of technology and the global transformations around the world, it is said that the jobs of the future are only being imagined. The programs of studies we teach are not set up to develop these dispositions and attitudes towards future jobs, so a change in our pedagogy is required to keep up with the changes. Revealing the hidden curriculum that lies beneath the words and teaching with environmental and scientific literacy in mind by integrating science and CTS can be one of the ways that we start to plan for the future. Our students depend on us to help them map their future and with nothing certain in this day and age, a critical look at curriculum and pedagogy is more important than ever. We must remember our “mission” as educators and remain committed to education as a ‘beautiful risk’ (Biesta, 2014, as cited in Smits, 2016, p. 64) such that over time we should hope that our understanding of our work and ourselves evolves (H. Smits, personal communication, Feb.7, 2019).

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1. Banking model of education: “The ‘banking’ concept of education is a method of teaching and learning where the students simply store the information relayed to them by the teacher” (Rose, 2017). [↑](#footnote-ref-1)
2. From Hannah Arendt’s concerns of wordlessness in a wordless age, where technique is at the center of teacher education rather than questioning “what kinds of ‘stories’ we ought to attempt to create in order to situate ourselves and our students in the world that is both given to us and awaits our concerted thinking and action” (Panayotidis, Lund, Towers, & Smits, 2016, p.19) [↑](#footnote-ref-2)
3. This policy was borrowed from the US before it became CTS (Taylor et al., 2002, p. 143) [↑](#footnote-ref-3)
4. “A competency is a broader concept that involves the ability to use skills to meet complex demands in different scenarios” (Institute for Competitiveness and Prosperity, 2018). [↑](#footnote-ref-4)
5. The most popular CTS pathway: Registered Apprenticeship Program [↑](#footnote-ref-5)
6. See Lidstone (2015), for more information on common objectives between curricula. [↑](#footnote-ref-6)
7. See (Albert Education, 2015, 2020), for more information on project courses. [↑](#footnote-ref-7)
8. For more information on project-based, student centered learning see Spencer, J., & Juliani, A. J. (2016). *LAUNCH: using design thinking to boost creativity and bring out the maker in every student.* [↑](#footnote-ref-8)
9. See (Alberta Education, 2019), for more information on CTF. [↑](#footnote-ref-9)
10. See (Alberta Education, 2014, p. 3), for more information on KSA. [↑](#footnote-ref-10)
11. “A humanist view of research is predicated on a language that searches for stable, coherent meanings and origins of things - the essence of the ‘thing itself’ that is out there, objective, waiting to be perceived” (Jackson & Mazzei, 2017, p. 723). [↑](#footnote-ref-11)
12. NSF: National Science Foundation [↑](#footnote-ref-12)
13. Nature is defined as the construction of scientific knowledge (Higgins et al., 2019, p. 156). [↑](#footnote-ref-13)
14. TQS: Teaching Quality Standard (Alberta Education, 2018) [↑](#footnote-ref-14)
15. More details on the decolonizing perspective are found on page 21. [↑](#footnote-ref-15)
16. For more information see Chesky et al. (2015, p. 24) [↑](#footnote-ref-16)
17. For more information on education reform see Zhao, Y. (Ed.). (2016). *Counting what counts: Reframing education outcomes*. Solution Tree Press. [↑](#footnote-ref-17)