

Transformative STE(A)M Education for A Sustainable World

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ABSTRACT

Students of the natural sciences learn to understand objectively and reductively the world out there – at arm’s length - the world of naturally occurring systems. However, this materialistic worldview has not only fueled the 4th Industrial Revolution but has also triggered the Anthropocene, an unprecedented geological era that is disrupting the planet’s natural systems and giving rise to global crises such as climate change, extreme weather, acidification of the oceans, catastrophic wildfires, loss of biocultural diversity, and plastic pollution of our rivers, oceans and food chains. But all is not lost! As a mentor of STEM educators undertaking transformative research, I have witnessed the power of the arts to generate deep insights into the nonmaterial world – the world in here - the subjective realm of personal experience wherein lies our sedimented values that underpin our professional identities and practices. For visionary STE(A)M educators, the arts provide powerful methods for transforming the worldviews of their students, to empower them with the capacity and commitment to live and work sustainably. In this presentation I will argue the moral (ethical) imperative that STEM educators need to embrace the arts for the purpose of preparing their students for the sustainable development of Society 5.0.

Keywords: *Stem, Materialist Worldview, Education for Sustainability, Steam, Arts*

1. INTRODUCTION

The ascendancy of the Age of Enlightenment in 17th century Europe gave birth to the modern scientific-technological worldview which values objective knowledge obtained primarily from experimental evidence generated from our technology amplified senses. Technology has historically supported scientific inquiry, from the first microscopes that revealed a hidden universe (the domain of Covid-19) to the highly complex machines exploring our solar system and beyond.

1.1. Related Work

1.1.1. Materialistic Worldview

Our modern education systems immerse (some say ‘indoctrinate’) students of STEM in this worldview. They learn objectively about the mechanics of naturally occurring systems, a material world that appears to lie out there, separate from them, and available to their dispassionate analysis. This powerful materialistic worldview, which underpins the global economic order, is producing mixed results for us and the planet that supports us.

Research and development framed by this worldview, in partnership with industrial production, has enhanced and extended the lives of many millions (but certainly not all). We benefit from advanced health care and medical interventions, global communication and transport systems, domestic labor saving devices, pest-resistant GM food crops, robotization of industrial production, and so on.

1.1.2. Unsustainable Development

On the other hand, the materialistic worldview is aiding and abetting the near extinction of life on Earth as a consequence of ushering in the Anthropocene, a geological era in which the human footprint is irrevocably disrupting the planet’s natural systems [1]. The scientifically well-documented phenomenon of climate change is giving rise to extreme weather conditions that are acidifying the oceans, fanning catastrophic wildfires, causing coastal flooding, and decimating ecosystems and biodiversity [2]. Meanwhile the global production, packaging and waste disposal of plastics is polluting our rivers and oceans, and microplastic particles are killing marine wildlife and intruding into our food chains [3].

1.1.3. Disconnect From Nature

Why do we persist in acting destructively towards the ecosystems that support life on Earth? Some might ask why we have such disrespect for ‘mother nature’ (or Gaia)? A key question to address is what are the values driving our destructive habits of mind and practice?

My view is that we have become estranged from the natural world as a result of our metropolitan lifestyles that have divorced us from living in/with the natural world. We have become alienated from nature, the source of our existence! This sense of disconnection becomes further entrenched when we educate young people exclusively in the materialistic worldview of science and technology. In so doing, we instruct them to examine the natural world dispassionately and objectively through the lens of reductionism [4]. In this way, they learn to value primarily forensic analysis of discrete parts of the natural world while ignoring the whole, especially their deeply embedded relationship with the biosphere [5].

1.1.4. Transformative Learning

So, how can we transform this traditional view of STEM education, to enrich the inner (nonmaterial) worlds that students bring with them to the classroom? For this we need a theory of learning that reconnects students (emotionally, spiritually) with the wonder and beauty of the natural world, and that empowers them with the capabilities and commitment to practice ecojustice in their personal and professional lives. This crucial educational goal lies at the heart of transformative learning theory [6] which aims to engage students in five modes of transformative learning:

- (1) Cultural self-learning involves engaging in self-reflective thinking to become aware of the nature and source of the values underpinning one’s habituated patterns of social behavior that impact the (trashing of the) natural world.
- (2) Relational learning involves developing an empathic (loving, awe-inspiring) relationship with the natural world and an openness to engaging respectfully with others (peers) in collaborative decision-making to resolve ethical dilemmas of sustainable development versus exploitation of the natural world.
- (3) Visionary-ethical learning involves (a) imagining creatively and ideally how the natural world can be restored and conserved and (b) committing morally to upholding ecojustice principles that value sustainable development.
- (4) Critical social learning involves (a) identifying the deeply embedded social, cultural, economic, historic, philosophical and political structures that contribute to the destructive exploitation of the natural world, and (b) engaging in critical self-

reflective thinking to identify one’s complicity in uncritically (and perhaps unknowingly) supporting these structures.

- (5) Practical learning involves developing a willingness and ‘can do’ attitude (or agency) to taking concerted social action to help protect, restore and conserve the natural environment and ensure sustainable development.

However, the materialistic worldview of traditional STEM education generates a relatively impoverished pedagogical perspective on student learning, focusing largely on developing students’ objective knowledge and related inquiry skills. The challenge for socially responsible STEM educators, therefore, is knowing how to develop students’ disciplinary knowledge and skills as well as transdisciplinary capabilities

2. DISCUSSION

2.1. The Arts

This brings me to consider how the arts can help to save us from our misguided destructive tendency of viewing the natural world as a combination of infinite resource and trash can. The ‘us’ I am referring to are fellow STEM educators in schools and universities who are uncritically (and perhaps unknowingly) transmitting the materialistic worldview to students, many of whom become STEM teachers of future generations. And so the wheel continues to turn.

As a long-serving mentor of STEM educators undertaking arts-enriched postgraduate research, I have witnessed the power of the arts to elicit transformative insights into students’ nonmaterial worlds – the world in here. This is the subjective realm of personal experience wherein lies our heartfelt values that underpin our identities and actions in the world. The literary arts, performing arts, visual arts, media arts provide a range of powerful pedagogical methods for transforming the worldviews of STEM students, thereby enabling them to expand their inner horizons, raise their consciousness, and become more fully human [7].[8].

2.2. Reconnecting With Nature

Arts education teaching goals for promoting sustainable development of the natural world derive from the following four classical domains.

- (1) Aesthetics: to consciously appreciate the beauty and wonder of our interconnectedness with the natural world.
- (2) Ethics: to value protecting, restoring and conserving the natural world - its ecosystems and biodiversity.
- (3) Creativity: to design ways of participating to ensure the sustainability of the natural world’s

life-giving systems: the atmosphere, cryosphere, oceans, forests, soils and ecosystems.

- (4) Rhetoric: to communicate informatively and persuasively the urgent need for sustainable development of the world's natural systems upon which diverse life forms (including humanity) are essentially dependent.

Today, an increasing number of socially responsible STEM educators are collaborating with arts education colleagues to develop transdisciplinary STE(A)M curricula that engage students in transformative learning for sustainable development [9].

3. CONCLUSION

To conclude, I am advocating that STEM educators need to embrace arts-based methods for the purpose of enriching and expanding the worldviews of their students. As agents of salvation of a deeply troubled world, these future citizen-scientists need to develop the ability to navigate ethically, aesthetically, rhetorically and creatively the dynamic intersection of their external and internal worlds.

To embrace the goal of education for sustainability STEM educators can benefit from collaborating with arts educators to create interdisciplinary STE(A)M curricula and pedagogies [10].[11]. For an empowering Society 5.0 transformative education for sustainability is an urgent moral and ethical imperative. The ultimate future of humanity lies in the hands and minds of our young people.

REFERENCES

- [1] P.J. Crutzen, and E. Stoermer, "The Anthropocene", *Global Change Newsletter*, vol. 41, pp. 17-18, May 2000.
- [2] International Panel on Climate Change (IPCC), *Summary For Policy Makers Of IPCC Special Report On Global Warming Of 1.5C Approved By Governments*, 2018. <https://www.ipcc.ch>
- [3] World Economic Forum (WEF), *The New Plastics Economy: Rethinking The Future Of Plastics*, 2016. http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf
- [4] L.J. Shepherd, *Lifting The Veil: The Feminine Face Of Science*, iUniverse.com, 2007.
- [5] S. Esbjörn-Hargens, and M.E. Zimmerman, *Integral Ecology: Uniting Multiple Perspectives On The Natural World*, Boston: Integral Books, 2009.
- [6] P.C. Taylor, and B.C Luitel (Eds.), *Research As Transformative Learning For Sustainable Futures: Glocal Voices And Visions*, The Netherlands: Brill-Sense, 2019.
- [7] J.G. Knowles, and A.L. Cole (Eds.), *Handbook Of The Arts In Qualitative Research*, CA: Sage, 2008.
- [8] P. Leavy, (Ed.), *Handbook Of Arts-based Research*, New York: The Guilford Press, 2019.
- [9] United Nations (UN), *Transforming Our World: The 2030 Agenda For Sustainable Development*, 2015. <https://sustainabledevelopment.un.org/post2015/transformingourworld>
- [10] P.C. Taylor, and E. Taylor, "Transformative STEAM education for sustainable development". In Y. Rahmawati & P.C. Taylor (Eds.), *Empowering Science and Mathematics for Global Competitiveness*, London: Taylor and Francis, pp. 125-131, 2019.
- [11] E.(L). Taylor, and P.C. Taylor, (Eds.), *Transformative STEAM Education For Sustainable Futures*, Netherlands: Brill-Sense, in preparation/2021.