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Transformative STEAM Education for Sustainable Living: Ethical Valuing in The Classroom

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ABSTRACT

Humanity has recently entered the Anthropocene, a geological era that is unprecedented in the history of our planet. Our addiction to fossil fuels and powerful technologies has dangerously altered the Earth's natural systems, giving rise to well-documented global crises such as climate change, plastic pollution of the oceans, and tragic loss of biocultural diversity. These global crises have created a unique challenge for STEM educators, given that STEM disciplinary knowledge and skills are traditionally viewed as the key to solving the world's economic development needs, a narrow view that results in STEM students learning objectively about the world out there, beyond the classroom. Such a restrictive approach largely ignores the crucial role STEM education can and should (ethically) play in shaping students' attitudes and values - their inner worlds - that fuel their moral agency for living and working in sustainable ways. Around the world, however, many STEM educators with a moral conscience are embracing a socially responsible vision by adapting Arts-based methods of teaching and learning to prepare young people with transformative capabilities, including moral values, for actively contributing to the sustainable development of a world in crisis. Practical examples of these innovative pedagogical approaches are illustrated in my co-edited book: Transformative STEAM Education for Sustainable Development.

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Since the European industrial revolution, we have increasingly benefitted from the productive power of science and technology to enhance our lifestyles with material splendor, comfort and convenience. But at what cost to the environment? Thanks to recent international scientific research (IPCC, 2023), the world is becoming aware that our vastly powerful industrial revolution has created a new geological era - the Anthropocene - characterized by the harmful impact of our technological footprint on the planet's natural ecosystems - oceans, soils, forests, rivers and atmosphere. Consequencently we are experiencing global crises that must be urgently resolved, including climate change, loss of biocultural diversity, and plastic pollution of our marine environments (OECD, 2022; Ceballos, et al. 2015; Skutnabb-Kanga, et al., 2003; World Economic Forum, 2016).

In the newly emerging interdisciplinary field of STEM education the passionate drive to create curriculum synergies between Science, Technology, Engineering and Mathematics learning areas is being treated as a priority by governments and education systems worldwide. However, this reform agenda tends to focus largely on preparing students for the workforce of the fourth industrial (digital) revolution (Alper, 2016; Pricewaterhouse-Coopers, 2015). This narrow economic rationalist focus is doing little to enable students to recognize and respond proactively to ethical dilemmas associated with global production, consumption and disposal of STEM-related processes and products, especially how they are implicated in actively destroying our planetary life-support system, thus putting in jeopardy the lives of future generations.

To help protect our ecosystems from terminal demise, thereby ensuring humanity's future survival, we need a transformative perspective (i.e., a paradigm shift) that gives rise to socially responsible education systems. This can be achieved, in large part, by integrating STEM with the Arts to create interdisciplinary STEAM curricula and pedagogies. The goal is to develop not only students' STEM disciplinary knowledge, skills and objective values but, most importantly, also to awaken their self-consciousness, elevate their moral and spiritual awareness, and enhance their agency to practice environmental justice in their homes, local communities, and places of work (OECD, 2024).

This presentation draws on our recently published book to illustrate how STEAM educators, driven by a moral conscience, are addressing the urgent need to prepare young people with essential transdisciplinary capabilities for responding proactively to the global crises of the Anthropocene (Taylor & Taylor, 2022).

Calling Out Unsustainable Development

We are experiencing an unparalleled period in the history of the Earth - the Anthropocene - a new geological epoch in which, it is argued, we have largely wrested control over Nature (Crutzen & Stoermer, 2000). This unprecedented era has its genesis in the European industrial revolution (with the invention of the steam engine) and is characterised by our prolonged use of fossil fuels and powerful technologies for exploiting the planet's natural resources. Alarmingly, our largely uncritical and uncaring employment of these technologies for economic gain is dangerously altering the natural systems of the planet, including the atmosphere, oceans, rivers and soils, resulting in fundamental changes to biological and geological systems. The impact of our modern human footprint has become so profound that, for the first time in history, natural ecosystems are at the mercy of human systems.

In the public mind the clearest evidence of our detrimental impact on the planet is human-induced climate change due to release of carbon-based exhaust gases into the atmosphere (National Research Council, 2011). The OECD reports (2022) that we have until 2030 to limit average global temperature increase to 1.5C! Already we read daily reports that we have exceeded this tipping point!

Another major impact, one that is not so well embedded in public consciousness, is loss of linguistic, cultural and biological diversity, which taken together are known as biocultural diversity. The importance of the intimate (spiritual) inter-relationship between indigenous cultures and the natural world has been documented by UNESCO, The World Wide Fund for Nature and Terralingua (Skutnabb, Maffi, & Harmon, 2003, p. 10):

> In the language of ecology, the strongest ecosystems are those that are the most diverse. That is, diversity is directly related to stability; variety is important for long-term survival. Our success on this planet has been due to an ability to adapt to different kinds of environment over thousands of years (atmospheric as well as cultural). Such ability is born out of diversity. Thus language and cultural diversity maximises chances of human success and adaptability.

The more we reduce cultural and linguistic diversity, especially the worldviews and languages of indigenous peoples, the more we lose our library of spiritual wisdom about how to live in harmony with Nature. And the more we reduce biological diversity through overharvesting of the ocean, deforestation, soil salination, microplastic pollution of the food chain, and so on, the more we despoil the life-affirming wonders and beauty of the natural world.

Educating for Sustainable Development

Because we have failed to resolve human-induced global crises during the United Nations Decade of Education for Sustainable Development 2005-2014, the UN recently established the 2030 Agenda for Sustainable Development, with 17 Sustainable Development Goals (United Nations, 2015). Goal 4 is Education, which aims to foster the well-being of self, family, community, nation, and humanity at large, as well as the planet's living systems and other life forms. In setting out the following principles of education for sustainable development, UNESCO (2020) recognises that sustainable development is an ethical challenge as well as a scientific concept. Education for sustainable development (ESD):

- is based on the principles and values that underlie sustainable development
- deals with the well-being of all four dimensions of sustainability – environment, society, culture and economy
- uses a variety of pedagogical techniques that promote participatory learning and higher-order thinking skills
- promotes lifelong learning
- is locally relevant and culturally appropriate
- is based on local needs, perceptions and conditions, but acknowledges that fulfilling local needs often has international effects and consequences
- engages formal, non-formal and informal education
- accommodates the evolving nature of the concept of sustainability
- addresses content, taking into account context, global issues and local priorities
- builds civil capacity for community-based decision-making, social tolerance, environmental stewardship, an adaptable workforce, and a good quality of life
- is interdisciplinary. No single discipline can claim ESD for itself; all disciplines can contribute to ESD

In response to these principles, designing education to address sustainable development incorporates values education and citizenship education, and embraces transdisciplinarity. In addition to developing disciplinary knowledge and skills, a socially responsible STEM education contributes to preparing students as future citizens with crucial transdisciplinary capabilities. The Arts can help with this.

Embracing The Arts

Over the past decade, the Arts have established a strong presence in the social sciences, including education. The Handbook of Arts-Based Research (Leavy, 2018) and the Handbook of Arts in Qualitative Research (Knowles & Cole, 2008) define the field of the Arts as comprising literary genres, performative genres, visual arts and audiovisual arts. The significance of these branches

of the Arts is that they provide powerful methods – narrative inquiry, visual thinking, critical reflexivity - for developing the subjectivity and character of the learner.

Leading Arts educator, Eliot Eisner (2008), explains that the Arts are concerned with expressiveness, evoking emotion, generating empathic understanding, stimulating imagination that disrupts habits of mind and creates open-mindedness, and eliciting emotional awareness. In sum, the Arts enable us to discover our humanity. Such an altruistic goal sits well with educating for sustainability where exploring one's (deeply felt) moral values and reconnecting spiritually with both the natural world and culturally different (especially indigenous) others are of central concern. A succinct account of what the Arts can offer was coined by Arts educators Bucheli, Goldberg and Philips (1991):

> The arts can be, for both students and teachers, forms of expression, communication, creativity, imagination, observation, perception, and thought. They are integral to the development of cognitive skills such as listening, thinking, problem-solving, matching form to function, and decision making. They inspire discipline and dedication. The arts can also open pathways toward understanding the richness of peoples and cultures that inhabit our world, particularly during this period of global change. The arts can nurture a sense of belonging, or community; they can foster a sense of being apart, or of being an individual. By acknowledging the role of the arts in our lives and in education, we acknowledge what makes individuals whole.

But is there a compelling moral philosophy of education that urges STEM educators to reach out into unknown territory, beyond their established disciplinary comfort zones (or disciplinary 'silos'), to embrace their colleagues in Arts education and co-design (and perhaps co-teach) innovative STEAM curricula and pedagogies aimed at developing students' transdisciplinary capabilities for participating as concerned citizens in helping to resolve the global crises of the Anthropocene?

Transformative Learning

Missing from the Arts + STEM = STEAM equation is a moral philosophy of education that guides the design of STEAM teaching and learning approaches aimed at developing students' transdisciplinary capabilities for engaging as future citizens in sustainable development debates, decision-making and practices. To address this need we turn to a philosophy of transformative learning that has been articulated in various ways for much of the 20th century by leading educational philosophers and psychologists, including Jack Mezirow, John Dewey, Parker Palmer, Carol Gilligan and Abraham Maslow, who call for our subjectivities and lived experiences to be addressed in the curriculum of formal education. This inner education perspective resonates with

the Ancient Greek maxim of know thyself.

Transformative learning involves engaging students in reflecting critically on the presuppositions underpinning their (largely invisible) values and beliefs. Using cognitive, emotional, social and spiritual development methods, students learn to reconceptualise and reshape the relationship between their outer and inner worlds. Transformative learning comprises five interconnected (and interwoven) ways of coming to value, to know, to become, and to act (Taylor 2015; Taylor & Taylor 2022).

1. **Cultural-self knowing** (or self-realisation) involves coming to understand our culturally situated selves, in particular how the (mostly invisible) premises underpinning our (automatic) habits of mind – moral values, beliefs, ideals, emotionality, spirituality – give rise to our cultural identities and govern our habituated ways of making sense of our social and natural worlds.
2. **Relational knowing** (or opening to difference) involves learning to connect empathically and compassionately with our true (nonegoic) selves, our local community, and culturally different others; and to appreciate firsthand the beauty and inspiration of the natural world.
3. **Critical knowing** (or political astuteness) involves coming to understand how and why (political, institutional, economic) power has structured historically our social realities by creating seemingly natural categories of class, race, gender, vocation, intelligence, etc., and how this mostly invisible power governs (especially distorts) our lifeworlds, our relationships with others, and our relationship with the natural world.
4. **Visionary and ethical knowing** (or 'blue-sky' thinking) involves engaging in creative, inspirational processes of imagining, idealizing, poeticising, romanticising, meditating on and negotiating a collective vision of what a better world could be like and, most importantly, what a better world should be like.
5. **Knowing in action** (or making a difference) involves consciously developing our agency to help make the world a better place by committing to making a difference and taking action locally while thinking globally.

Taken together, these five dimensions comprise a 21st century philosophy of transformative learning that supports the moral imperative for STEM educators to draw on Arts education methods to develop students' transdisciplinary capabilities for participating as citizens (i.e., key stakeholders) in sustainable development debates, decision-making and social actions.

Transformative STEAM Education

In 1959 the renowned physical chemist and novelist, Charles Snow (1998), argued for a rapprochement of the cultures of Science and the Arts. Today, there is a new and growing wellspring of opinion that combining Science and the Arts in the form of transformative STEAM education is essential for producing a creative, scientifically literate, and ethically astute citizenry

and workforce for the 21st century (Boy, 2013; Edwards, 2010; Feldman, 2015; Piro, 2010).

Recognising their limitations in developing students' transdisciplinary capabilities, visionary and ethically astute STEM educators are teaming up with colleagues in Arts learning areas to design innovative transdisciplinary STEAM curricula and teaching approaches (Root-Bernstein, 2008; Sousa & Pilecki, 2013). Already, the USA and Korea have begun producing an array of STEAM curricula for their respective nations (White, 2010). It should be noted, however, that many of these STEAM approaches do not necessarily involve transformative learning for achieving the crucial goal of sustainable development.

CONCLUSION

Transformative STEAM education is a compelling moral philosophy of education that empowers visionary STEM teachers to engage in community-based, interdisciplinary curriculum development with colleagues in the Arts with a primary focus on education for sustainable development. Transformative STEAM learning engages students in developing not only STEM disciplinary knowledge/skills but also the transdisciplinary capabilities of cultural self-knowing, relational knowing, critical knowing, visionary and ethical knowing, and knowing in action. Transformative STEAM education is not in opposition to STEM education; instead, it aims to foster development of socially responsible education at the heart of which is a moral commitment to urgently resolving the global crises of the Anthropocene.

As we have seen recently in the media, young people worldwide are deeply concerned about the global crisis of climate change that, in its various modes, is threatening their futures, and they are demonstrating en masse around the world to demand urgent action from their national leaders. As their teachers, are we not morally obliged to respond authentically to their pleas to provide the means for enabling them to help secure a sustainable future?!

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