Necessity for Inclusion of Environmental Ethics Curriculum in Engineering Education

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Abstract

In the current tech savvy world, scientific and technological education has gained prominence among students. Engineering has become one of the prominent disciplines with various avenues of inquiry. The need for understanding ethical frameworks that extends from various professional to the personal life of an individual has gained momentum due to the shortcoming of science to provide a viable solution for the problems of the modern age. Even though various interventions in the engineering curriculum have been made, there is still a need to effectively embed ethical standards that should be followed in our daily life to the engineering curriculum. Given this backdrop paper aims to understand the need for integrating environmental ethics framework in the engineering education to create ecological, social, and ethical standards in the life of the students. Keeping this in view the paper also attempts to create a model curriculum for the engineering students.

Keywords: environmental ethics; engineering curriculum; ethical standards

Introduction

The ecological imbalance that we are currently confronted within various aspects of social and personal life underscores the necessity of integrating a holistic approach in addressing the ethical frameworks that guide an individual. The Cartesian way of thinking that is dominating the current perception of existence limits ourselves from understanding the interconnectedness that sustains the natural world. Fritjof Capra avers, “Our culture takes pride in being scientific; our time is referred to as the Scientific Age. It is dominated by rational thought, and scientific knowledge is often considered the only accepted kind of knowledge. That there can be intuitive knowledge, or awareness, which is just as valid and reliable, is generally not recognized. This attitude, known as scientism, is widespread, pervading our educational system and all other social and political institutions.” The rational understanding of existence has integrated

into all the distinct social institutions viz., economic, health, and educational. Due to the predominance of scientific thinking, society often overlooks the spiritual connections that exist between humans and the environment, treating the environments as merely tools for their end goals that are temporal in its nature. Fritjof Capra avers: "We have favored self-assertion over integration, analysis over synthesis, rational knowledge over intuitive wisdom, science over religion, competition over cooperation, expansion over conservation, and so on. This one-sided development has now reached a highly alarming stage, a crisis of social, ecological, moral and spiritual dimensions."

The traditional practice of seeking solutions from the academics for the global crisis has been replaced by the Tech companies which resulted in disharmony among the government, academicians, and the policy makers. This has altered the entire education system and its very purpose giving space for temporary priorities in life eventually, fragmenting the essence of moral obligation that human beings have towards their environment to a mere transactional entity viz., job-oriented, sustenance in profit- driven economy. This profit-driven economy has brought a shift in the entire thought-process of Man, the species within and without giving scope for anthropocentric view of the entire universe disrupting the ecological balance. This is evidential from the very emergence of the term 'ecocriticism' that aims to address the environmental concerns that are often over-shadowed due to the linear human centric perspective, the extension of which is emanated in the themes discussed in global academic platforms viz., environmental justice, ecophobia, posthuman directions, animal studies, postcolonial ecologies, deep ecology, social ecology, environmental ethics, new materialisms, green/ blue humanities, place studies, bioregionalism and Anthropocene studies etc. Given this backdrop the onus lies on the educators to bring a shift in the thought- process of the future nation builders which could bring about huge impact in the ongoing global environmental crisis. Keeping this in view the paper aims to bring changes in the higher education curriculum more so in the engineering studies that focusses much on science and technology. Marshall McLuhan rightly said that, "We become what we behold. We shape our tools and thereafter our tools shape us." reflections of which are evident in the current AI driven techno-capitalistic world. To bring a major shift in the thought process of the prospective engineers there lies a necessity to educate them of the limitations of science and the repercussions of living in a mere scientific world. The authors put a humble effort to design and develop a teaching module and curriculum that highlights on the ecological imbalance and the role of science and beyond it.

Ethics and the discussions on what constitute good and bad virtue have been a topic of discussion since the evolution of human civilization. The idea of morals has branched out to various dimensions throughout history as humans began to explore and create more diversified fields for their social structures. The plethora of social institutions and the subsequent fields of inquiry that it created has eventually led to the development of various kinds of virtue frameworks viz., professional ethics, normative ethics, virtue ethics, societal ethics, applied ethics, meta ethics, digital ethics, deontology, utilitarianism and so on. All these varieties of ethical standards were based

on anthropocentric outlook that governed the greater part of the world in the recent human history and owes its origin to the western philosophical inquiries that was rooted in scientism. In the process of ecological destruction caused by humanity during the periods of world wars, cold wars, and creation of nuclear armaments, several philosophers and thinkers began to raise their concerns over the resultant environmental devastations. This realization led to the development of environmental ethics that aims to create a moral obligation towards the surrounding environment. The field of environmental ethics aims to highlight the fact that the natural world has an intrinsic value of its own, independent of the purpose it serves to humanity. The 20th century saw a significant shift in the religious and mythological explanations of human existence with the emergence of the field of ecology that understood the biological evolution of human beings and its interdependence with the other life forms through a logical lens thereby causing a major perspective shift towards understanding the natural world and the crisis that humans endowed upon it through empirical evidences.

Several indigenous and global environmental concerns mounted the development of the field of environmental ethics. Specifically, the anti-nuclear movement, consumerism movement, population explosion, London smog, the Chernobyl, and Bhopal disasters etc. Environmental ethics emerged in the 1970's especially as a response to these growing environmental concerns and the need for a theoretical framework to evaluate human relationships with the non-human world (Udoudom et al. 2019). From 1970's on most newspapers and journals have reported on the environment on a systemic, day-by-day basis in a manner increasingly comparable to that in which they handle social and economic issues (L. Hens & C. Susanne, 1998). This represents the extensive anxiety and environmental awareness that spread across the western world thereby drawing al spheres of inquiry in an effort to address the rising environmental concerns. Several environmental writers, thinkers, and philosophers like Racheal Carson, Aldo Lepold, Arnae Naess, and Richard Routley began to address the mounting issue of environmental anxiety and laid the foundation for the development of the field of environmental ethics. While Holmes Rolston became widely known as the "father of environmental ethics" as he published, "Is there an Ecological Ethics?" in the leading philosophy journal Ethics in 1975 marking the birth of the field of environmental ethics (Preston CJ, 2013). Homles Rolston proposed "environmental ethics must be more biologically objective – nonanthropocentric. It challenges the separation of science and ethics, trying to reform a science that finds nature value free and an ethics that assumes that only humans count morally." This paper attempts to highlight the necessity of integrating environmental ethics in engineering curriculum through critical thinking that shall bring a paradigm shift in the thought process of prospective engineers towards engineering education for better environmental sustainability development goals. Additionally, designs a training module and model curriculum tailoring to the needs of environmental ethics course and preparing readiness in the teachers concerned for imparting the same.

Research on environmental ethics from a critical thinking and holistic perspective

in education is relatively new and consequently any studies on the integration of the same especially in engineering education has been hardly were carried out. Given this background and the need to understand the significance of integration of environmental ethics in engineering curriculum, the present study was carried out.

The purpose of the study is to critically examine and related concepts of environmental ethics and its applications in the present system of education and to highlight its application for developing environmental awareness and understand better sustainable practices aligning with the Sustainable Development Goals (SDG). Further, to understand the impact of the integration of environmental ethics in engineering education and develop a model course for engineering studies.

Keeping in view the vast scope of the topic and its implications to wider perspectives, the study is focused only on the aspect of environmental ethics and its implications on environmental education with particular reference to engineering studies. For the purpose of the study, secondary data was drawn from journals, relevant books, and research articles related to environmental ethics and environmental education are taken for analysis and interpretation.

Methodology

The present study examined the necessity for implementing environmental ethics in engineering education. An extensive review of literature on environmental ethics was done further analyzing the ideas proposed by scientist cum philosophers from various professional backgrounds and the its implications on education was done highlighting its relevance in the engineering curriculum for developing a holistic educational setup. Further, a model curriculum for engineering studies based on the concepts of environmental ethics has been designed accordingly.

Results and Discussion

1. Essence and principles of Environmental ethics for Engineering studies

Environmental ethics has been dealt only from the scientific view point in engineering education and more so under the course titled environmental sciences. Hardly this has been imparted from a critical thinking and holistic perspective. The scriptural texts of all religions especially Hinduism. Sanatana Dharma has embedded both critical thinking and holistic perspective in the Upanishads which are dialogues between the guru and the shishya about the enquiry of the Self, the relationship of Self with the Nature, Self with the Universe etc. Upanishads are considered as the treatises on the afore-mentioned topics.

While this is so the Western approach to Environmental ethics has been showing certain rays of hope with respect to critical thinking skills and holistic perspective in

education, very recently from the teachings of scientist cum philosophers such as Fritjof Capra, Dravid Frawley, Martin Heidegger etc. Beyond the barriers of the current institutionalized religion of Hinduism lies a profound understanding of the environmental ethics principles. The Sanatana Dharma or the eternal ethics forms the undercurrents of the Hindu culture where each element is respected with divine reverence.

प्रकृते: क्रियमाणानि गुणै: कर्माणि सर्वश: |
अहङ्कारविमूढात्मा कर्ताहमिति मन्यते || 27|| (Bhagavad Gita: Chapter 3, Verse 27)

Which meant, “All activities are carried out by the three modes of material nature. But in ignorance, the soul, deluded by false identification with the body, thinks of itself as the doer.”
This verse delves into the profound idea that sans the boundaries of human centered thinking and the binaries of mind and soul. It could help broaden the minds of the students and make them understand the concepts of binaries, which is the fundamental problem behind all human problems,

भूमिरापोऽनलो वायु: खं मनो बुद्धिरेव च |
अहङ्कार इतीयं मे भिन्ना प्रकृतिरष्टधा || 4|| (Bhagavad Gita: Chapter 7, Verse 4)

Which meant, “Earth, water, fire, air, space, mind, intellect, and ego—these are eight components of My material energy.”

The manifestation of nature and the basic elements that constitute it are described here. For the students engaged in the daily discourse of machine learning and technical classes, such verses can effectively guide them to the understanding of the natural world they exist in. It can further provide a holistic perspective to their critical thinking skills.

मत्त: परतरं नान्यत्किञ्चिदस्ति धनञ्जय |
मयि सर्वमिदं प्रोतं सूत्रे मणिगणा इव || 7|| (Bhagavad Gita: Chapter 7, Verse 7)

Which meant, “There is nothing higher than Myself, O Arjun. Everything rests in Me, as beads strung on a thread.”

The character of Krishna personifies the ultimate environmental consciousness and his advices to Arjun on his ethical dilemma showcases the nature’s eternal way of dealing with unethical practices. Krishna’s advice showcases man’s role in the natural world and can open up deeper discussions in the classrooms about topics of life, death, ethics etc.

प्रकृतिं पुरुषं चैव विद्ध्यनादी उभावपि |

विकारांश्च गुणांश्चैव विद्धि प्रकृतिसम्भवान् || 20|| (Bhagavad Gita: Chapter 13, Verse 20)

Which translates to, “Know that prakṛiti (material nature) and puruṣh (the individual souls) are both beginningless. Also know that all transformations of the body and the three modes of nature are produced by material energy.”

The concepts of purusha and prakriti can guide the students understanding of the essence of all the elements around them and make them view the world as an interconnected web of existences. These thoughts have other parallels in western philosophy as well like “substance” and “accidents” further underlining similarities in the inquiry of the Self in various parts of the planet.

कार्यकारणकर्तृत्वे हेतु: प्रकृतिरुच्यते |
पुरुष: सुखदु:खानां भोक्तृत्वे हेतुरुच्यते || 21|| (Bhagavad Gita: Chapter 13, Verse 21)

Which means, “In the matter of creation, the material energy is responsible for cause and effect; in the matter of experiencing happiness and distress, the individual soul is declared responsible.”
This verse points towards the origin of human crisis that lies within each individual psyche. Such discussions can make the students contemplate and reflect on the issues like anxiety and depression that is currently consuming the modern society. Group discussions on the immediate issues that the current generation is encountering can make the students more interested in the debates and can enhance their critical thinking skills.

रसोऽहमप्सु कौन्तेय प्रभास्मि शशिसूर्ययो: |
प्रणव: सर्ववेदेषु शब्द: खे पौरुषं नृषु || 8|| (Bhagavad Gita: Chapter 7, Verse 8)

I am the taste in water, O son of Kunti, and the radiance of the sun and the moon. I am the sacred syllable Om in the Vedic mantras; I am the sound in ether, and the ability in humans.

Krishna’s expression of him in every natural element in the universe draws upon the idea of interrelatedness that goes along with modern ideas of “systems view of life” discussed earlier in the paper. This verse can initiate discussions on how humans are connected to their environment and whether the current scientific education is making them aware of this affinity.
The environmental ethics principles that are dealt in these verses and in several other religious texts of various belief systems along with the scientific approach in developing an ethical environmental framework when implemented in the engineering classroom can initiate deep philosophical debates and reflections that can help us develop an environmentally conscious modern society that rejects these principles based on their inability to comprehend this understanding through their rational perspective. But with

the evolution and growing relevance of environmental ethics, it becomes clear that the concept of environmental ethics cannot be confined to or fragmented into multiple theories but should be based on the realization that environment and our interaction with it lies beyond human conception.

An environmental ethics that transcends the boundaries of anthropocentricism and ecocentrism moves towards an understanding that creates an emotional and spiritual connection between the natural environmental should be taught through our channels of education along with the current scientific and technological education. The exposure to various contrasting avenues of enquiry forms the essence of true education. To understand the essence of true education there lies a necessity to integrate critical thinking skills that fosters holistic education. Moreso in this scientific world where arts and humanities are kept at the backstage it is high time for the educators in the engineering studies to integrate critical thinking skills that nurtures holistic tendency towards environmental awareness that could achieve the sustainable development goals (SDG). A model curriculum has been designed to integrate critical thinking skills into engineering education that fosters SDG's that assimilates holisticity into its very system.

Table 1. Model curriculum for engineering students

	Listening	**Speaking**	**Reading**	**Writing**
1	Videos of Scientists cum philosophers can be given Fritjof Capra, David Frawley, Subash Kak, Ray Kurtzweil, Marshal McLuhan, Martin Heidegger, Dr. Abdul J Kalam, Mohammed Mustafa, Oswald Spengler, Thomas Fuchs.	Group Discussion A Case study can be given and ask them to speak on that	Critical Reading of the works of Heidegger, Fritjof Capra, Gerd Leonard	Students can be asked to create a case study after the listening session on the videos
2	The systemic view of life by Fritjof Capra https://www.youtube.com/watch?v=If2Fw0z6uxY	Group Discussion One-minute talk Debate	Paragraphs from Fritjof Capra's Turning point can be given	Students can be asked analytical questions from those they listened to Capra's video on what does exactly systemic view of life mean, how is relevant to the current age etc.
3	The Age of Spiritual Machines - The Future of The 21st Century By Ray Kurtzweil	Group Discussion One-minute talk	Ray Kurzweil's Essay titled, "Theory of Accelerating returns" can be given.	A Case study can be given to students ask them to analyse it from ray

	Listening	Speaking	Reading	Writing
	https://www.youtube.com/watch?v=-inK0esaIgk			Kurtzweil's, 'the theory of accelerating returns 'perspective
4	AI and Humanity at the Crossroads: A Vision for Tomorrow by Gerd Leonard https://www.youtube.com/watch?v=4tSZI8AFbL4	Group Discussion One-minute talk Debate	The Good, Bad and the Future by Gerd Leonard	Students can be asked to write on What exactly Gerd Leonard meant by 'Future'. How does he interpret the future from the present's perspective
5	The end of polite society by Marshal McLuhan https://marshall-mcluhan-speaks.com/lectures-panels/the-end-of-polite-society	Group Discussion One-minute talk Debate	Laws of media – The four effects: A McLuhan contribution to social epistemology, Gregory Sandstrom	Students can be asked to integrate the same in their life and do a SWOT analysis of themselves based on McLuhan's Tetrad
6	J. Krishnamurti - Ojai 1982 - Discussion with Scientists 1 - Roots of psychological disorder https://www.youtube.com/watch?v=AoMS5b2MLRc	Group Discussion One-minute talk Debate	Chapter titled, 'The implicate order and the super implicate order' by David Bohm can be given to read from the book titled Dialogues with scientists and sages (Renee Weber)	Students can be asked to write a paragraph on what exactly David Bohm meant by the terms implicate order and super implicate order.
7	The End of Social Science as We Know it | Brian Epstein | TEDxStanford https://www.youtube.com/watch?v=FLbEKpL-5Z0	Group Discussion One-minute talk Debate	Essays on the limitations of Science and Technology and the essence of Technology can be given The Question concerning Technology by Heidegger, and relevant essays from his book 'What is called thinking'.	Students can be asked relevant analytical questions. What did Heidegger mean by questioning, What are the benefits of knowing how to question. What exactly does he mean by 'essence of technology'
8	ALS - John Bickle - Heterodox scientists: A sliver of hope for our	Group Discussion One-minute talk Debate	Read the article by Looren de Jong, H., & Schouten, M. K. D.	Students can be asked on exactly what is

	Listening	Speaking	Reading	Writing
	increasingly conformist times? https://www.youtube.com/watch?v=p52-gGmKpHs		(2005) titled, "Ruthless reductionism: A review essay of John Bickle's *Philosophy and neuroscience: A ruthlessly reductive account* from the journal *Philosophical Psychology*, *18*(4), 473–486. https://doi.org/10.1080/09515080500229928	reductionism and its repercussions in the thought-process of an individual and society.
9	Electrochemistry: The Philosophy & Science by UL space club https://www.youtube.com/watch?v=KLC9-cZ7SoQ	Group Discussion One-minute talk Debate	Essays related to philosophy of science by various scientists cum philosophers can be given to read.	Students can be asked to write an analytical essay on 'are philosophy and science separate entities and not interconnected
10	Mieszko Talasiewicz - Imagery in Science and Religion https://www.youtube.com/watch?v=KrHQIiuOprA	Group Discussion One-minute talk Debate	Essays can be given on understanding science from holistic perspective from various religious studies	Students can be asked an analytical essay on the limitations of science and the necessity of integrating holistic perspective.

Table 2. Model curriculum for engineering studies

Course Title: ENGINEERING STUDIES AND CRITICAL THINKING FOR ENVIRONMENTAL SUSTAINABILITY	
Aims and Objectives	Aims to provide students with: • What is Thinking? What is critical thinking? • Being familiar with the evolution of the concept and the eminent thinkers. • To understand the life and influences behind the philosophers • To foster critical thinking skills among students that extends to all aspects of their life • To develop a holistic educational setup • Introduce and promote interdisciplinary and transdisciplinary approaches and worldviews among students.
Expected Outcome	After successfully completing this course, the students will be able to: **1** To understand the importance and limitations of scientific inquiry

Course Title: ENGINEERING STUDIES AND CRITICAL THINKING FOR ENVIRONMENTAL SUSTAINABILITY	
	2 To foster environmental awareness among the students **3** Align with the UN Environmental Sustainability Development Goals
Unit No.	**Topics**
1	• **Origin, Background and Introduction to Critical Thinking skills** • What is Critical Thinking? • Definitions, Role of critical thinking in education, Lives and contributions of various critical thinkers. Role of critical thinking in various disciplines • Scientist cum philosophers of the contemporary times. • Fritjof Capra, David Frawley, Subash Kak, Ray Kurtzweil, Marshal McLuhan, Martin Heidegger, Dr. Abdul J Kalam, Mohammed Mustafa, Oswald Spengler, Thomas Fuchs.
2	**Critical Thinking- Western approaches: Theory and Practices** • Socrates way of questioning, Plato, Aristotle, Charles Darwin, Rene Descartes, Albert Einstein, Martin Heidegger, Aldo Leopold, Arnae Naess, Richard Routley. • "As We May Think"—Vanevvar Bush • "Medium is the Message"—Marshall McLuhan.
3	**Critical thinking- Eastern approaches: Theory and Practices** • Selected verses from the Bhagavath Gita that emphasizes on the environment • Selected verses from Bhagavatham • Verses from selected Upanishads
4.	**Theories, trends and movements** • Land ethics • Deep ecology • Environmental justice • Ecophobia • Ecosophy • Econarratives
5.	**Eco-pedagogical practices** • Field study • Retreat centres • Dialogues with scientists cum eminent philosophers • Dialogues with educators cum spiritual leaders

2. Analysis and Interpretation

Environmental ethics aims at developing a moral obligation in the way human beings treat their environment and all the forms of life that constitute within it. This virtue framework focuses on breaking away the human superiority by making them aware of

the part they play within the broader spectrum of the universe. This realization would eventually help them understand that every element in our environment have an intrinsic value of their own. Engineering education is historically dominated by the anthropocentric worldview and environmental ethics could play a fundamental role in bringing about a paradigm shift in this perspective. Even though the rational and reductionist approaches help in yielding technological advancements, the Cartesian outlook contributes to more ecological devastations. Holmes Rolston's claim that environmental ethics must be "biologically objective- nonanthropocentric" counters the traditional engineering curriculum that confines ethical considerations to professional and economic aspects. Through the analysis of the prevailing engineering curriculums a clear gap in addressing the issues of environmental sustainability from an ethical standpoint in the classroom can be observed. Even though the field of environmental ethics have gained momentum since 1970's, a lack of its proper implementation is still visible in engineering education. This omission becomes particularly problematic given the engineers direct impact on environmental systems through infrastructural development, resource extraction, industrial processes, and technological advancements.

By integrating the ethical principles of approaching the environment that was proposed by the western and eastern philosophers throughout history. The model curriculum proposed in the research could help broaden the environmental awareness of the students. By engaging in the discussions of ides like the "systems view of life" proposed by scientist cum philosopher Fritjof Capra, the students could gain a better understanding about the aspects of environmental ethics in a more comprehensive way, thereby enhancing their critical thinking skills as well. By incorporating the works of philosophers from various fields of inquiry the teacher could create a more vibrant classroom atmosphere. Additionally, by engaging the students in meaningful discussion about the lives, works and ideas proposed by the selected philosophers could help foster a sense of awareness, curiosity, and respect towards other fields of inquiry that is otherwise stereotyped as something that stands in contrast with science namely, religion, intuitive thought and wisdom, spirituality etc.

The paper further highlights the importance of digital media and how its regulated usage in the classroom could assist the teachers in enhancing their engagement with the students. Technological gadgets like smartphones, and laptops have become an integral part of the modern-day classrooms and its unregulated usage have majorly affected the environmental awareness of the students. By engaging the students through videos, talks, interviews of eminent personalities in the field of environmental ethics the curriculum provided aims to pave a digital pathway that could guide the students in the further explorations as well as in developing a sense of awareness. Furthermore, by conducting debates, group discussions, and individual presentations on the topics related to environmental ethics as discussed by eminent thinkers fosters critical thinking skills among the students, that is necessary for the development of ecological awareness. The implementation of such a holistic educational environment is

necessary to promote interdisciplinary and transdisciplinary approaches and worldview among the engineering students.

Conclusion

The paper primarily suggests that the implementation of such a holistic curriculum can foster a proper understanding of the importance and limitations of science, thereby making the engineering students aware of the fact that science and technology constitute one among the several paths of understanding the universe. Secondly the integration of environmental ethics can play a crucial aspect in engineering curriculum as it could open up further scope for the balanced development of intuitive wisdom and emotions which have witnessed a great decline in the recent human history. Finally, the implementation of the curriculum that focuses on the aspects of environmental ethics could help align the engineering education further towards the sustainable development goals mentioned by the United Nations and the multidisciplinary perspectives it engages with. In essence the proposed model curriculum focuses on interdisciplinary engagements with scientist cum philosophers whose work bridges technical and humanistic inquiry. By incorporating thinkers like Martin Heidegger, Marshall McLuhan, Fritjof Capra and many others the proposed curriculum cultivates the capacity to examine one's own disciplinary assumptions and recognize its limitations. This cognitive development proves essential for engineering students who will shape the humanity's material relations with the planet through their professional decisions and technological innovations.

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