Integrating Environmental and Science Education: Issues and Possibilities

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ABSTRACT

The paper attempts to pursue critical reflection of the linkages between Science Education and Environmental Education (EE) and examines the challenges and possibilities of integrating and broadening science education using perspectives from environmental education. Although the pedagogical and epistemological conflicts between the two disciplines are often debated, it is argued that both the subjects have much to contribute to each other in terms of offering different perspectives and in creating a somewhat broader goal for science in the curriculum that encompasses interdisciplinary approach central to EE. Finally, the paper attempts to elaborate socio-scientific issues presented in the current science curriculum through epistemic and educational lens to highlight the lacunae in the existing science textbooks.

Keywords: Science Education, Environmental Education, integrating, socio-scientific issues, science textbooks.

Environmental Education (EE) has been viewed as an integral part of school curriculum. Report of the Education Commission (1964-66), National Policy of Education (1986) and National Curriculum Framework (NCF) 2005 stressed on the inclusion of environmental education in school curriculum and recommended that EE should be infused in all the subjects. This integration poses possibilities as well as challenges for the curriculum developers and educators at the level of selection of content as well pedagogical practices.

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With regard to integration of science education with perspectives of EE, the pedagogical and epistemological conflicts between the two disciplines are often debated. This inclusion calls for a broadening of the science curriculum that recognizes uncertainty and a plurality of conflicting but legitimate perspectives. For environmental education to be fully integrated into schools, particular care must be taken to properly incorporate it into the curriculum (Conde, M.C., & Sánchez, J.S., 2010) and not just a mere addition of environmental issues to existing content. There is a need of consistently aligning it with the ethical, conceptual, and methodological principles underlying environmental education such that it provides opportunities to learners to identify and think about the complexities of issues from various perspectives, acquire ability to analyze issues and understand the values underlying opposing positions on issues. This calls for examination of the teaching-learning resources including the science textbooks for its alignment with the vision of infusion of issue-driven, multidisciplinary EE.

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Thus, this paper attempts at analyzing the material on controversial socio-scientific issues' incorporated in the science textbooks at two levels. First, ***Epistemic level,*** which involves examining the text as a set of conclusions: identifying the main conclusions, examine the evidence and arguments in support of and against the conclusions and identifying the underlying assumptions. Second, ***Educational Level,*** which involves examining the material from the perspective of the value of content in achieving the learning objectives.

Environmental and Science Education: Conflicting Paradigms?

The teaching of environmental education has traditionally occurred in science classrooms. Yet, the interrelationships between science and EE are discussed and debated for their incongruity and incompatibility in terms of goals as well as pedagogical practices. Pedagogical approaches in EE are aimed at embracing a complex view containing multiple, undetermined and interdependent causalities as opposed to the nature of scientific activities focused on the simpler physical and chemical systems (National Focus Group, Position Paper on 'Habitat and Learning', 2005).

The discipline of science as it is taught in most schools is constructed largely as a value-free, objective domain aiming at understanding the cause-effect relationships governing the natural environment through experiments. Traditional science classes are based on a positivist paradigm and are replete with bodies of discrete content knowledge that are considered beyond dispute, politically and socially neutral and laboratory activities that are not investigations into the unknown, but recipes to be followed (Gough, 2002; Hodson, 2001; Hodson & Bencze, 1998). Conventional science teaching includes dealing with established and secure knowledge, while contested knowledge, multiple solutions, controversy and ethics have been excluded (Hodson, 2003). This is in sharp contrast with EE, which is considered to be issue-driven, value-laden and includes social dimensions. Referring to the problem of integration of EE and science education, Hart (2001) points out that science education represents a worldview that is ontologically distinct from that of EE. He asserts that "The science teacher's typical preoccupation with objective observation and quantification represents a scientifically determined philosophy of teaching and learning characterized by knowledge transmission which often excludes active independent learning."

Science teaching and learning is dominated by the transmission of indisputable scientific facts that have been accumulated through rigorous experimentation, observations and theory building. This is in sharp contrast with EE which involves a critical understanding of the complex, often contradictory issues, reflection on one's assumptions, beliefs, biases and ideological boundaries (Hart, 2001). Following the experimental method of science to study the complex systems poses serious difficulties as it assumes depends on the experimenters' ability to control all relevant parameters and to replicate conditions at will (National Focus Group, Position Paper on 'Habitat and Learning', 2005). Hence, the reductionist approach science teaching is in contrast with the systems approach of EE that focuses on holistic thinking and inter-disciplinarity, ethical, political, social and cultural components to curriculum thereby challenging teachers' views that science should be value-free (Dillon, 2002).

Integrating Science Education and Environmental Education: Towards a holistic view

Although the pedagogical and epistemological conflicts between the two disciplines are often debated, it is argued that both the subjects have much to contribute to each other in terms of offering different perspectives on the "pedagogy of understanding" and in creating a somewhat broader role for science in the curriculum(Zandvliet, 2001). Integrating perspectives from environmental education with science education requires reconceptualization of goals of science education, role of teacher and pedagogy (Gough, 2002). To accomplish this goal, science educators must better understand the multiple perspectives inherent in the conceptual framework which informs the pedagogy of environmental education and need to discard the old scientific reductionist models.

This view was echoed by Dillon (2001) who suitably pointed out:

"Environmental education can offer science education a range of perspectives on knowledge and situated learning that assist those in the science education movement who wish to challenge existing orthodoxies. Through its multi-disciplinary origins and traditions, environmental education offers a conceptual richness that challenges some current thinking in science education."

The integration between EE and science education is stressed upon in National Focus Group, Position Paper on 'Habitat and Learning' (2005) both at the level of content as well as

pedagogy. It recommends that EE should permeate every discipline being taught in the schools. Further, describing the method of science as objective, grounded in observations and empirical facts, it argues that elements of the scientific method are equally pertinent to the exploration of other branches of knowledge as well including EE and helps in building capacity for critical thinking and problem solving. Thus, it calls for strengthening of the scientific perspective in EE. With regard to ways of knowing, Hart (2001) argues that a mere accumulation of scientific knowledge that presumes progressive technological development (which has been the focus in traditional science classrooms) will not resolve the tensions between the individual and the collective. Clarity and balance between the cognitive and the interpretive perspectives is required to ensure better personal-social environmental decisions at the level of practice. Environmental education provides an opportunity to bring in these interpretive perspectives to the science classroom through inclusion of contemporary and challenging social and scientific issues and deepens the idea that science curricula should provide for experiences that are flexible, experiential and which students perceive to have personal as well as social meaning. Such an approach negates issues of right and wrong and allows individuals or groups to consider multiple perspectives on an issue. On the other hand, scientific viewpoint, without consideration of socio-cultural perspectives, does not present the holistic picture on environmental issues.

Thus, it is argued that distinct, yet interrelated epistemologies of science education and EE have much to offer to each other. Integrating dimensions of EE in science education could facilitate the understanding of the nature of science, and scientific inquiry, using the natural environment as a context for investigating real world problems, and the development of socio-developmental skills and cognitive attributes through learning experiences in natural settings (Zandvliet, 2001).

Translating Vision into Practice: Examining Science Textbooks

Through examples of two contentious socio-scientific issues, namely, Genetically Modified (GM) crops and Global Warming, the content in science textbooks has been examined critically with reference to the objectives of EE.

Educational Level

The focus of EE (National Focus Group, Position Paper on 'Habitat and Learning', 2005) is to

- ❒ expose students to the natural and social world
- ❒ to enable them to analyse, evaluate, and draw inferences about problems and concerns related to the environment; to add to understanding of environmental issues
- ❒ to promote positive environmental actions in order to facilitate the move towards sustainable development.

The issues of global warming, GM crops, incorporated in textbooks can provide a context to promote active student learning, present a realistic and dynamic view of science, and provide a mechanism for integrating the scientific, political, economic and social dimensions of global environmental change (Schweitzer, 2005) offering opportunities to analyse, evaluate, and draw inferences about problems and concerns related to the environment. Research has shown that inclusion of contentious environmental issues in the science curriculum is a useful way of organising the curriculum to develop concepts in a way that supports an integration of the cognitive and affective domains in science (Littledyke, 2006) and promote critical thinking, moral reasoning and understanding of nature of science. It provides students with opportunities to learn about the functioning of natural systems, to identify their beliefs and issues, to consider a range of perspectives to make informed and responsible choices.

Moreover, these controversial issues provide opportunities to educators to address a number of important goals pertaining to environmental issues in the broader curriculum with the goal of sustainable development. Inclusion of such issues marks a departure from the previous approaches to EE that focused primarily on apolitical and aesthetic work without addressing the need of developing closer links among environmental quality, human equality, human rights and peace and their underlying political threads. Incorporating and addressing these links between social justice and ecological sustainability are central to education for sustainability (Tilbury, D., Stevenson, B., Fien, J. And Schreuder, D., 2002). The selection of contentious issues like Global warming provides a mechanism for integrating the scientific, political and social dimensions of global environmental change and provide opportunities to learners to obtain valuable socio-developmental and cognitive skills through exposure to real-world problems.

As pointed out by Gayford (2002):

"Inclusion of controversial issues, such as global climate change within the school science curriculum presents several different challenges to teachers. Firstly, the controversial nature of the

topic, secondly it does not relate well to the normal sequencing and division of topics within most science courses and thirdly there are important non-scientific aspects to possible solutions to the problem. It helps to create a learning experience for students that allowed them to explore and develop their own value system in a rational way."

Thus, the inclusion of these environmental issues provide a context and opportunity for teachers and learners to consider multiple values-based views about environmental education (including the scientific view) and develop socio-developmental skills and cognitive attributes through exposure to real-world problems. Developing understanding of the interconnectedness in nature and in human society is integral to the concept of environmental education. It cannot be viewed mechanistically to indicate availability, scarcity and use of physical resources and encompasses relationships among people, land, water, forest etc. as well as the cultural and spiritual aspects of human existence.

Epistemic Level

Genetically Modified Crops

Chapter-XII in the Biology textbook of Grade-XII has a section on GM crops.

The text mentions the advantages of Genetic modification, namely, ***(i) made crops more tolerant to abiotic stresses (cold, drought, salt, heat). (ii) reduced reliance on chemical pesticides (pest-resistant crops). (iii) helped to reduce post harvest losses. (iv) increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil). (v) enhanced nutritional value of food, e.g., Vitamin 'A' enriched rice. In addition to these uses, GM has been used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals.*** (italics added)

These uses/advantages are presented as indisputable conclusions. The text does not cite evidence in support of the conclusions and offer the opportunity to engage with the issues and concerns. However, literature on GM foods clearly shows the lack of consensus on these highly debatable issues and raises concern over social, economic, political, ecological impact of GM crops. This is in contradiction with the objectives of EE that aims at enabling students to analyse, evaluate, and draw inferences about problems and concerns related to the environment The points listed above are contestable and raises the following socio-political, economic, ecological, and ethical concerns that have been sidelined in the text:

- ❒ Issue of Hunger vs. Antibiotic Resistance

With the increase in the population and a major section facing issues of shortage of food leading to hunger and poverty, biotechnology is considered to be a powerful enabling tool that can revolutionalise agriculture.

On the contrary, concern has been expressed that the antibiotic resistant genes, used in the genetic modification process, have the potential to adversely affect the efficacy of antibiotics and are considered potentially unsafe for human consumption. The risks involve generation of antibiotic resistant protein in consumption.

- ❒ Advancement in technology vs. food quality and nutrition

Bt-crops offer a solution to the enormous losses in crop yield by creating drought-resistant and pest-resistant crops. On the contrary, it is argued that genetic modification in plants may lead to changes in nutritional composition resulting in a negative impact on the nutritional heath of the consumers.

- ❒ Increased crop yield vs. farmer's autonomy

It offers an incentive to the poor farmers, by increasing the crop yield as well as profit making, thus reducing their dependence on the unpredictable climatic changes.

However, it takes away farmers' autonomy and self-reliance and makes them dependent on foreign companies to supply seeds.

- ❒ Genetic modification vs. Local agricultural knowledge

Modern biotechnological methods used for cultivation of crops may lead to rejection of indigenous methods of production, and adopting advanced agri-based technology.

- ❒ Pest resistance vs. Religious faith

Extensive use of herbicides and pesticides affect the health of the consumers. Bt-crops help in reducing the dosage of these pesticides, and hence provide us with healthy food. However, concerns have been laid about mixing human and animal DNA with plants as many religions prohibit such foods.

- ❒ Superweeds vs. Herbicide resistance

Bt-crops help in reducing the use of herbicides, and hence provides healthier food. However, the herbicide resistant gene that is being genetically transferred to the GM crop can sometimes become resistant to the effect of pesticides or herbicides.

Global warming

Chapter-seven in the Chemistry textbook of grade XI has a section on global warming.

The text, broadly, talks about following aspects:

- ❒ Concepts of global warming and green house effect;
- ❒ Its causes, namely, Chlorofluorocarbons (CFCs)-man-made industrial chemicals, use of chemical fertilizers and the burning of fossil fuels;
- ❒ Impact of increase global temperature- melting of polar ice caps and flooding of low lying areas all over the earth, increase in the incidence of infectious diseases like dengue, malaria;
- ❒ Ways to reduce global warming

The text claims that global warming is occurring (although no evidence is presented in favour/against it). No data has been presented in the text in support or against the claims and learners are expected to accept these conclusions. It is important to present data as research has shown that students make use of observation-based climatic data sets in crafting their arguments in four ways: to support their central argument; to negate the central argument of the opposing side; to present challenges to the opposing side; and to raise new scientific questions and while discussing the social and political dimensions of global warming. (Schweitzer, 2005)

In addition, causes of global warming highlight an underlying assumption that this phenomenon is due to human activities and sidelines the following issues/debates concerning global warming.

- ❒ Is the global temperature and sea-level rising?
- ❒ Are Glaciers retreating?
- ❒ Acidification of oceans?

Further, the physical, social, ecological and economic ramifications are ignored in the text. Its crucial to establish these linkages between the social, political, economic and ecological issues as it highlights the interconnectedness and multidisciplinary nature of EE and transcend the boundaries and compartmentalization imposed by the 'subjects' taught as part of the pre-decided syllabus.

Socio-political-economic issues

- ❒ Understanding the political debate on climate crisis between developed and developing countries
- ❒ Impact on agriculture
- ❒ Health issues

Ecological issues

- ❒ Impact on ocean: rise in sea levels and ocean acidification
- ❒ Increase in the frequency of natural disasters
- ❒ Change in weather patterns
- ❒ Impact on biological systems-loss of biodiversity

The overemphasis on scientific perspective in the text cannot be overlooked. However, it is argued that the lack of a social or emotional component in the teaching and learning of environmental issues is the greatest deficit in the scientific perspective (Deloria, in his book ***Red Earth, White Lies:Native Americans and the Myth of Scientific Fact,*** as cited by Zandvliet, 2001). Analysis of these socio-cultural, political, environmental and economic

issues based on evidence helps learners to understand that there isn't always a "right" answer, and reinforces the importance of making informed decisions that are well-supported by evidence. These provide opportunities to teachers to help learners understand nature of science, that contradictions and conflicts are very much a part of science, which negates the popular but faulty notion of science being thought of as a black and white, all-or-nothing proposition, and scientists are portrayed as purely logical with no personal feelings. It is, therefore, crucial for teacher to bring these debates to the fore in the classroom.

This requires a shift from a simplistic, reductionist view where issues and concepts are presented as indisputable, value-free ideas. This requires curriculum to be restructured so as to incorporate elements that require learners to critically

analyse these issues from multiple perspectives on the basis of statistical data and arrive at informed conclusions. The advances in science and technology have always been regarded as progressive steps towards the development of the nation. However, this notion needs to be revisited and examined owing to recent science and technology disasters. These incidents have compelled us to think about fundamental questions like - what constitutes development and development for whom? Is the trajectory of development heading in the right direction?

Conclusion

As envisioned in the policy documents, the integration of environmental and science education calls for a paradigmatic shift from a traditional, discipline-oriented, objective, value-neutral approach (as observed in traditional science classrooms) to a comprehensive, interdisciplinary, holistic approach which is characteristic of environmental education. As argued in the paper, the distinct, yet interrelated epistemologies of science education and EE have much to offer to each other. The teaching-learning resources should reflect this vision and incorporate the elements that provide opportunities to teachers and learners to engage in critical evaluation of the socio-political, economic, ecological and ethical perspectives. Just a mere addition of the issues in the curriculum and over-emphasis on scientific perspective will not help achieve the goals of EE, as envisaged in National Curriculum Framework, 2005.

References

Conde, M.C., and Sánchez, J.S. 2010. The school curriculum and environmental education: A school environmental audit experience. International Journal of Environmental and Science Education 5(4): 477-494.

Dillon, J.T. 2002. Editorial-perspectives on environmental education-related research in science education. ***International Journal of Science Education*** **24**(11): 1111-1117.

Dillon, J. T. 2001. Perspectives on Environmental Education- Related Research in Science Education. Paper presented at NARST Symposium on Relations between Science Education and Environmental (Science) Education. Retrieved from http://www.nku.edu/~scienceed/NARST_319.PDF

Gayford, C. 2002. Controversial environmental issues: A case study for the professional development of science teachers. ***International Journal of Science Education*** **24**: 1191-1200.

Gough, G. 2002. Mutualism: A different agenda for environmental and science education. ***International Journal of Science Education*** **24**(11): 1201-1215.

Hart, P. 2001. How Policy Research in Environmental Education has Informed Curriculum Development in Science Education in Canada. Paper presented at NARST Symposium on Relations between Science Education and Environmental (Science) Education. Retrieved from http://www.nku.edu/~scienceed/NARST_319.PDF

Hodson, D. 2003. Time for action: Science education for an alternative future. ***International Journal of Science Education*** **25**: 645 - 670.

Hodson, D., and Bencze, L. 1998. Becoming critical about practical work: Changing views and hanging practice through action research. ***International Journal of Science Education*** **20**(6): 683-694.

Hughes, G. 2000. Marginalization of Socioscientific Material in Science–Technology–Society Science Curricula: Some Implications for Gender Inclusivity and Curriculum Reform. ***Journal of Research in Science Teaching*** **37**(5): 426–440.

Littledyke, M. 2006. Science education for environmental awareness: approaches to integrating cognitive and affective domains. Paper presented at International Conference on Sustainable Management and Development of Mountainous and Island Areas, Island of Naxos, Greece.

GoI 1966. Education and National Development, Report of the Education Commission, 1964-66. New Delhi: Ministry of Education.

GoI 1986. Ministry of Human Resource Development 1986. National Policy on Education. New Delhi: Ministry of Human Resource Development, Government of India.

Misra, S. 2010. PM Qualifies Bt brinjal Moratorium. Down to Earth, pp 22.

NCERT 2005. National Curriculum Framework, 2005. New Delhi : NCERT.

NCERT 2005. National Focus Group, Position Paper on 'Habitat and Learning'. National Curriculum Framework, 2005. New Delhi : NCERT.

National Council for Educational Research and Training. Textbook for Biology for class XII. New Delhi : NCERT.

National Council for Educational Research and Training. Textbook for Chemistry for class XI. New Delhi : NCERT.

Anuradha, R.V. 2002. GMOs – Promises and Concerns. Frontline **19**(8): 13-26.

"Risks posed by GMOs" 2002. Frontline, **19**(9).

Purkayastha, P. and Rath, S. (2010, May). Bt. Brinjal: Need to Refocus the Debate. ***Economic and Political Weekly,*** XLV **20**: 42-48.

Schweitzer, D.M. 2005. An Investigation of Student Engagement in a Global Warming Debate. ***Journal of Geoscience Education*** **53**(1).

Stevenson, R.B. 2007. Schooling and environmental education: Contradictions in purpose and practice. ***Environmental Education Research*** **13**(2): 139-153.

Tilbury, D., Stevenson, B., Fien, J. And Schreuder, D. 2002. Education for Sustainability: Responding to the global challenge

Zandvliet, D. 2001. ***Towards a holistic view of environmental education.*** Paper presented at NARST Symposium on Relations between Science Education and Environmental (Science) Education. Retrieved from http://www.nku.edu/~scienceed/NARST_319.PDF