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Ecological and Environmental Studies in Education

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INTRODUCTION

Ecology as a science is young and it has become suddenly important in recent years because of the fast deteriorating quality of the human environment and frequent episodes of ecological backlashes and boomerangs. Haeckel, E. in 1869 first gave the term *Oekologie* deriving it from the Greek word *Oikos* meaning 'house' and *Logos* meaning 'study', and the term to mean the study of plants and animals as they occur in their home or nature, i.e., field-oriented study as distinct from the laboratory oriented studies of other biological disciplines. Ecology is defined as the study of plants and animals in reciprocal relationships with the environment or the external world. The subject initially developed more as a branch of botany with emphasis on the development of plant communities in diverse climatic regimes. Clements, F.E. defined it as 'the science of community'. Soon, zoologists also joined to give it a more holistic outlook, and Odum, E.P. (1971) defined it as 'The study of nature' or simply 'environmental biology' while MacFadyen has emphasised that the purpose of ecology is to discover principles which govern the relationship between plants or animals and their environment. Presently, ecology is regarded as the study of ecosystems. The term 'ecosystem', (i.e., ecological system) was first coined by Sir Tansely, A.G. (1935), meaning that the unified whole is made up of interacting and interdependent living components of primary producers (green plants), consumers (animals) and decomposers (microbes living on dead organic matter) and the non-living components of soil, water, air, and forces like light, temperature regimes, wind, and that this system functions through a continuous circulation of matter and flow of energy among the system components and between different ecosystems in the biosphere (the upper zone of earth in which life exists). Ecology embraces all taxonomical divisions of the plant and animal kingdoms, including microbes such as viruses, bacteria, protozoa, fungi, algae and larger organisms like bryophytes, pteridophytes, flowering plants, insects, fishes, reptiles, birds and animals including man. All organisms belonging to different species living together at any place in positive and/or negative interaction with each other and with the sum total of various environmental components constitute an ecosystem. The ecosystems can be conceived to be of any size. They evolve over a period of time and reach a mature or stable and balanced state which perpetuates itself indefinitely. During the evolution of the ecosystem from the young to the mature stages the changing batches of communities are referred to as 'seres' or the seral community and the sequences of change are directional, and, therefore, predictable.

Ecology or the study of ecosystems involves a basic understanding of plant and animal

nomenclature, structure, function, evolution, and behaviour, on the one hand, and of soil types, various formation and decomposition processes, climate including meteorology, hydrology, atmosphere, on the other. Further, in modern times man has become the strongest force of ecosystem modification. Hence ecological ramifications extend to sociology, anthropology, and science and technology connected with industrialisation, etc. With such far-reaching and diverse multidisciplinary ramifications, ecology and environmental education have assumed a much greater importance and complexity.

After the above brief description about the scope of the subject-matter, it would be convenient to develop this trend paper on ecology and environmental education under the following heads.

1. Subject areas of the topic
2. Indian work on environmental education
3. International efforts
4. Conclusion.

SUBJECT AREAS

'Nature' is the key word in ecology and environment. It comprehends all the living and non-living resources of the earth. There has to be some scientific classification in order to avoid overlapping confusion or omission while considering the various areas of nature study. These can be structural and/or functional. Normally, for both the ecology and environment the first division is biotic, and the second, abiotic. The first comprehends all living resources while the second, all non-living. The biotic ones are further classified into: (i) plants, and (ii) animals. There are some microbial forms which are placed in both the categories. From the ecological viewpoint the living components are divided into three categories, mainly on the basis of their broad functions, into: (1) primary producers which include all photosynthetic, i.e., green plants and chemosynthetic micro-organisms; (2) the consumers or secondary producers, i.e., all animals which do not prepare their own food but derive it from primary producers directly (herbivores) or indirectly through herbivores (carnivores) or from carnivores (higher—order carnivores); (3) decomposers or scavengers which derive their food from dead organic matter like various fungi and bacteria. The first produce their own food through photosynthesis; the second obtain it by eating produced food (consumers) but after ingestion re-synthesise the food-matter as per their own needs (hence, secondary producers); while the third perform another very important function of decomposing the dead organisms to humus and then into the mineralised state. In the biotic components, all organisms have a particular function at a place (niche) to perform. These functions are essential for the balance of nature. In the process of evolution of ecosystems, the diversity of life forms (biodiversity) increases. In the early stage fewer species perform broadly many functions, but with system maturity the function specialisation increases and each species performs only a few functions but does so more efficiently. Therefore, when we selectively harvest or take out a few species for human needs, that functional link gets weak. This is the key idea behind preservation of biodiversity. Another point of interest is that each species is a product of long-time evolution and perpetuates itself by virtue of its gene combinations. Once a species becomes extinct, it is impossible to recreate that genetic combination or gene types. In modern biotechnology gene transfer of derived traits from one species, race or ecotype to another useful one is now in vogue. Thus, any rare species is a 'gene pool' of potential use in future biotechnology. Thus the preservation of biodiversity has been very well emphasised in the recently organised Earth Summit of the United Nations (1992). Further, man is also a part of the biotic component of nature. His survival and long-term interest is the key of all environmental education as man is a part of, and not apart from, nature, and very much dependent on the quality of the environment.

The abiotics are usually divided into:

(1) climatic, and (2) edaphic (soil) components. The climate includes the regimes of day length, temperature, light intensity, water in all the three forms (solid, liquid and vapour) including storages and circulating—cloud and rainfall, atmosphere including different gases like nitrogen, oxygen, carbon dioxide, ozone, methane, etc., and contaminants like oxides of sulphur and nitrogen, CFCs (gases used in air-conditioning), etc., and particulate matter (dust or ash, coal, cement, asbestos, soil). Air also contains living particulates like pollen-grains, bacteria, viruses and fungal spores. Another way from the functional viewpoint is to divide abiotics into: (1) inorganic substances like carbon, nitrogen, hydrogen, minerals and mineral salts, water, etc.; (2) organic compounds like proteins, and carbohydrates reaching through dead material and synthetic organic compounds released by mankind; and (3) the energy components like light intensity, quality, duration (photoperiod), temperature regimes (diurnal, seasonal or annual patterns). Both the biotic and abiotic components of the environment are linked closely through continuous cycling of materials across them and flow of energy, entering the biosphere from sunlight through photosynthesis and flowing ultimately to space via the food chain, respiration and death.

Besides the above environmental components in the broadest sense, there are very important areas of function and ecosystem behaviour which must constitute subject-matter of environmental education. For instance, at primary producer or green-plant level, it has to be understood that besides providing food, fodder, timber and other economically important resources, green plants are the 'lungs' of the biosphere which purify our air and continuously charge it with oxygen. How much and in what ways should this economic resource be exploited in order to keep the 'lungs' good enough to meet the oxygen requirement of nature? No life, including man, can survive without oxygen. Similarly, the other environmental components within the desired levels of purity and concentration are a must. We cannot survive if the quality of water is allowed to degrade beyond certain limits. Soil, which is the medium of plant growth, forms at an extremely slow rate and is held in position and in a fertile state by the binding effect of roots and nutrient release by decomposition of leaf and other litter by soil micro-organisms. Excessive removal of canopy cover of trees or herbage removal of ground flora exposes the soil to rain beating effects and erosion by water and wind. Ambasht, R.S. (1962, 1970, 1985) has measured the extent to which soil erosion, water runoff and soil nutrients drain down due to overgrazing of lands in the watersheds and river corridors of India and found out the conservation value percentages of many Indian plants which should not be allowed to be grazed or which should be cultivated for soil conservation. According to one report, the loss on account of soil erosion in India is around Rs.7,000 million, and due to floods around Rs.1,000 million, and both these are largely due to destruction of vegetation in the watershed areas resulting in heavy water runoff, heavy silt load, reduction in the water carrying capacity of rivers, etc.

There are other ecosystem attributes also like homeostasis, feedbacks, checks and balances, resistance, resilience to control minor perturbations. There are self-regulating and self-purification mechanisms, also. There is a phenomenon of biological magnification which has usually escaped the attention of environmental educationists. Biological magnification refers to several-fold increase in concentration of many long-lasting toxic chemicals as we move from the abiotic source to the living world along the food chain. For instance, if toxic material in a very low or trace quantity is let out in the environment, say DDT in a lake, its concentration in green algae increases by over one hundred times and in the body of fishes eating the algae, it may increase by a thousand times. By the time the DDT reaches the top carnivores like fish-eating birds or man, the DDT concentration may be about 70 to 80 thousand times more than the concentration in which it was originally

discharged in the lake. Proper education in correct perspectives is necessary not only for school-children, but also for fishermen and farmers using pesticides in their fields and through runoff to fish ponds or rivers.

In a brief trend paper it is not possible to elaborate the scope of ecology and environmental issues, but it may be necessary to name a few most pressing issues. In the atmosphere these are, first, with respect to a net increase in carbon dioxide and a few other gases like nitrous oxide, methane, etc., which have the capacity to absorb reradiating heat waves reflected by the earth's surface. These are called 'greenhouse gases', and due to their increase, cause warming up of the earth's mean temperature. This has a far-reaching effect on future global climate, snow-melts, rise in the sea-level, submergence of coastal lands and islands, mass extermination of many specialised flora and fauna, alteration in rainfall and evaporation patterns in different parts of the earth, etc.

Another problem area is excessive discharge of chlorofluorocarbons (CFCs) like Freon gas used in refrigeration. This is fast eroding the layer of ozone gas in the atmosphere, located in the 15-30 km altitude. The ozone layer acts as a shield protecting us from the lethal and cancer-causing Ultra-Violet-B radiations (wavelengths 280-320 nm) coming from the sun which are absorbed by ozone gas.

The third problem area is that of acid rains due to factory emission of oxides of sulphur and nitrogen which combine with rain-water to form sulphuric and nitric acids. These acids not only corrode marble buildings like the Taj Mahal but cause incalculable loss to the soil (and water) microflora which regulate the circulation of materials and fertility of crop fields. Europeans had to spray alkaline salts extensively to save their crop fields, but many forests could not be saved from acid rains. We in India appear to be concerned to shift the acid-rain source away from Agra only, due to lack of proper perspectives.

In water, the problem areas are of pollution due to municipal and industrial wastes and non-point runoff of pesticides and fertilisers coming down from crop fields to rivers and lakes. There are numerous episodes of mass-scale human deaths due to one or another pollutant entering the food chain, such as *Minamata* due to methyl mercury (in fishes) and *itai itai* disease due to cadmium content in rice-field water. Another very serious issue is that of nitrate accumulation in our ground-water. Out of the total fresh water, about 75% is in the form of ice on Antarctica, in the Arctics and on mountain tops, very little of which is in active circulation. The ground-water accounts for a little more than 24% while the surface-water in rivers, lakes and soil-moisture is less than one per cent. The surface-water is of immediate concern, but it is getting polluted in all possible ways. The ground-water stock is getting polluted by nitrates percolating down from crop fields where we add chemical fertilisers often in one huge lot. While some is readily absorbed by the crop plants, the rest finds its way down, and over the years its content in the well and tubewell water has increased. Nitrate-enriched water is a health hazard.

In soil, solid wastes, mine spoils, dry and wet depositions of pollutants from air, radioactive fall-out, are causing concern. Much of it can be prevented by proper education. Noise is another environmental hazard due to high energy waves and sonic booms.

INDIAN EFFORTS ON ENVIRONMENTAL EDUCATION

Ecology and environmental studies in education in India have not been satisfactory and do not match with the quantum of researches in these areas of science being carried out in the country, although at international level there have been repeated efforts to identify the problems and stress the urgency of implementing the environmental education and research programmes on a very extensive scale.

On the plant and animal components of the environment Khanna, P.K. (1988), Ghose, G.R.

(1988) and Khattar, N. (1988) have carried out some work on a regional basis. Khanna, P.K. (1988) working with students of Classes IX to XII at Bhopal, collected plants of the city and its environs. While the students learnt about the habit and habitat and nomenclature more effectively than through laboratory studies, Khanna, P.K. (1988) could produce a *Flora* (a volume containing the list of plants with brief descriptions). Field trips in ecology and environmental education are important. Ghose, G.R. (1988) has made a similar study independently under the aegis of the NCERT, and Khattar, N. (1988) studied the fauna in and around Bhubaneswar. Besides these, the floristic and faunistic surveys of different locations and regions have been extensively studied by a very large number of botanists and zoologists of various universities and of the Botanical and Zoological Survey of India, and several volumes of regional 'floras' are available. How best these can be utilised in educational researches is yet to be clearly identified and carried out. The next aspect of environmental education is in regard to school children. Gopalakrishnan, S. (1992) selected 1,451 students of Class V from 10 different primary schools of the Nilgiris, Madras and Coimbatore and exposed them to environmental education and then put them through an Environmental Education Test (EET) and found a very good impact of 'Environmental Education'; the Madras children scored better than those of the other two places. Rajput, J.S. (1988) studied the teaching skills and training strategies for implementing the environmental approach at primary-level teaching at Bhopal. Rane, A.J. (1989) evaluated the environmental study approaches of Parisar Asha in municipal schools in Greater Bombay. His study was on Environmental Study Approach (EVS) in the case of students of Classes I and II and he found the EVS approach functioning satisfactorily. The next category of work is on school-teachers. Praharaj, B. (1991) explored the level of environmental knowledge, attitude and its perception among 416 pre-service and 302 in-service secondary school-teachers in Puri district. The pre-service teachers distinctly had poor knowledge regarding the environment while in-service teachers 'moderately' knew about it. Shahnawaj (1990) worked on the environmental awareness and attitudes (towards environmental issues) of secondary and higher secondary school teachers and students at Udaipur. He found a very high level of awareness on the part of teachers and students regarding the environment and this was more in the urban than in the rural groups. As regards environment-oriented curriculum, Kidwai, Z. (1991) has developed one for geography for secondary-stage students. Sahoo, K.C. (1992) has studied the conceptual perception of environmental education. His central theme was man and environment but the details of his working material are not clear.

A comparison of the above attempts in environmental education with the wide spectrum of pressing environmental issues makes it amply evident that we have not even made a worthwhile beginning, and we have a long way to go. Unfortunately, time is a big constraint and unless educational efforts are identified and tackled urgently, we will be the victims of environmental hazards largely due to our own inaction and ignorance.

INTERNATIONAL EFFORTS ON ECOLOGY AND ENVIRONMENTAL EDUCATION

Ecology and environment were part of the botany and zoology curricula in a very small way during the fifties of this century. The contents were mainly phytogeographical and zoogeographical in nature with emphasis on adaptation. Gradually, with multidisciplinary inputs, the share of the subject increased to half to one paper in different universities. Educationists took up the matter in the early seventies after world attention was drawn to human environment issues following the 1972 Stockholm Conference of the United Nations. The real thrust was made after the recommendations of the Intergovernmental Conference on Environmental Education held at

Tbilisi in the former USSR in 1977. In the over-enthusiasm of championing the cause of environment and due to non-comprehensive understanding, reports started pouring in that the 'Biosphere is in Danger', we are on the 'way to Ecological Catastrophe', 'With an axe at the tree of Life', or 'Civilisation will die in 20 years', etc. These sensational reports gave a terrifying picture of the end of mankind. The need of proper education based on sound primary and secondary observations was therefore felt to answer correctly such pessimistic prophecies and develop short- as well as long-term solutions without any haste or complacency. The philosophy of the human being with his environment has to be changed. Nature serves us in every possible way and we have to serve nature to remain in a healthy state. We cannot afford to overexploit the share of the future generations of mankind.

Some of the landmarks in Environmental Education (EE) at the international level are as follows:

In 1970, The International Union for Conservation of Nature and Natural Resources (IUCN, now renamed as the World Conservation Union but retaining the abbreviation IUCN) called an international working meeting of its 'Commission on Education' to discuss and work out an EE curriculum for schools (IUCN 1970). The central theme was to evolve an educational process through which an understanding of the connections between man, his culture and his biophysical environment is achieved. Soon after (1971) the Organization of American State's 'Conference on Education and Environment in the Americas' emphasised the teaching of this subject in order to develop the ability to clearly think out complicated environmental problems which are political, economic, philosophical and technical. The Finnish National Commission for UNESCO (1974) in their report of the seminar on environmental education, has shown that EE is "a way of reaching environmental protection targets and is not a separate branch of science or a special subject of study. It should be included in the entire lifelong educational process" (Sytnik, K.M. 1985). UNESCO (1977), came up with a report on 'Trends in environmental education'. While some aims were clear, there still was a lack of unanimity about what the EE teacher should know, and how man should treat the complicated and everchanging environment. They agreed that EE was still at the developmental stage. The kind of relationship man maintains with nature would determine the future of the soil, air, and water quality and availability of biotic and mineral resources. In the UNESCO-published *Living in the Environment—A source book for environmental education* (Sytnik, K.M. 1985), says that EE is "an educational concept which considers environment as a scientific and aesthetic resource to be used in a lifelong educational process." EE should inculcate in individuals a sense of responsibility for the improvement of the environmental quality for the benefit of all humanity. The three central themes recognised are: "(1) education in which the environment represents a means, (2) education concerning the environment, and (3) education of the individual as a person living in an environment of a given quality and who is partly responsible for that quality." The most important landmark is the Intergovernmental Conference on EE organised by UNESCO and UNEP (United Nations Environmental Programme) at Tbilisi in the former USSR in 1977. The goals of EE were clearly defined as "(i) to foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas, (ii) to provide every person with opportunities to acquire the knowledge, values, attitude, commitments and skills needed to protect and improve the environment, (iii) to create new patterns of behaviour of individuals, groups and society as a whole towards the environment." This conference recognised three categories of persons receiving EE: (i) general public—for all age-groups and levels, (ii) specific occupational and social groups like engineers, architects, planners, administrators, industrialists, trade unionists, etc; (iii) scientists working on specific

problems of environment. The Tbilisi conference endorsed the guiding principles involving EE. It should: (i) consider the environment in its totality, (ii) be a lifelong process beginning from pre-school level, (iii) be interdisciplinary in approach, (iv) examine the major environmental issues of the locality, nation or region, (v) promote cooperation at the above levels for solving environmental problems, (vi) enable learners to develop into decision-makers and to accept the consequences of their decisions, (vii) help learners to discover the symptoms and causes of environmental problems, (viii) develop critical thinking and ability to identify environmental problems and problem-solving skills. On the whole, EE should also stimulate civic action and an elaborate personal code of conduct with regard to environmental quality and ecodevelopment.The Tbilisi Conference made it evident that EE should be for 'protection and enhancement of the environment for present and future generations'. Even though there is a limitless range of EE objectives, the Tbilisi Conference formulated a few basic ones, like: (i) creating *awareness* and sensitivity to the total environment, (ii) general *knowledge* for basic understanding of the environment, (iii) acquiring *attitudes* to help individuals and social groups develop a set of values and feelings for environment and its improvement, (iv) developing *skills* for identifying and solving environmental problems, and (v) providing opportunity for *participation* at all levels in working towards resolutions for actions on environmental issues.

Mitryuskin, K. et al. (1980) have outlined EE at two levels: (i) education at educational establishments, and (ii) education outside the educational establishments. The first starts from kindergarten, primary, secondary, vocational and technical schools and goes on to higher education bodies, and the second is in the family, on camp holidays,on picnics, in cultural gatherings, public activities, propaganda and information systems, political organisations, scientific societies, press, radio, TV, cinema, etc.

UNESCO has in cooperation with UNEP started the International Environmental Education Programme (IEEP) and this has made a tremendous impact on EE all over the world in recent years. IEEP in cooperation with more than two-thirds of the UNESCO member-countries has played key roles in focusing world attention on different problems, solutions, workshop results, etc. On EE, IEEP is conducting over 25 pilot projects in developing countries and building a computerised information system. It brings out *Connect* in English and *Sampark* in Hindi (which are distributed free to organisations and individuals); it reports on EE activities all over the world, and this has helped nations to incorporate suitable environmental dimensions into their educational practice.

Different developing countries have taken massive steps for EE. In Kenya, the government with the assistance of UNEP and IUCN, and a subcommission of the National Secretariat for Environmental Problems under the President, work out the educational programmes and curricula at all stages of education. The Kenyan experience is utilised by other neighbouring African countries. EE is also imparted without any textbook in *Muktangan* or 'Open-air Study' in nature in Bangladesh. In India environmental education has found place in diverse disciplines but on the teacher-education programmes there is much to be achieved. A better, comprehensive information system based on a set of minimum items should be developed, possibly by the NCERT in cooperation with UGC, ICMR, Technical Education bodies, etc. The training of teachers on EE is most urgent and should be undertaken after adequate background preparation, particularly in poor and populous countries, including India. In Bahrain, for students and teachers special lectures and seminars on EE are held. Sytnik, K.M. (1985) has briefly reviewed such lecture and training programmes in African, Asian and European countries. Hundreds of specific activities and programmes on EE at different levels in different countries are cited in his edited source book on EE.

CONCLUSION

1. In the international context as well as in the context of scientific information generated on ecology and environment in India, the researches on EE teaching are very inadequate and need outright promotion at all levels and regions.
2. The detailed items of ecology and environment have to be enumerated.
3. Apportionment of the contents should be done for different levels of education.
4. Implementation of a well-planned national programme at the grass-roots level all over the country, is needed.

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