Environmental Education in Technical and Vocational Education.

This is a resume of the document prepared by Sven Grabe for UNESCO—UNEP along with supplementary comments by me, with particular reference to India and the Third World countries. This is intended to initiate discussion on the scope and place of Environmental Education for the technical and vocational streams.

The document from Sven Grabe is structured as follows-

I - Why environment education for technical and vocational student
II - The main environmental issues.
III - The needs of the various levels and sectors of T and V education.
IV - Integration of environment education into the curriculum
V - Likely effects of the curriculum changes on the instructor •
VI - Summary of the paper.

The above paper is very thoughtful and comprehensive.
Necessarily it cannot stress or give weight age to issues relevant to a region. Yet environmental education has no meaning unless it relates to the local environment. So I have taken the liberty to add to, modify or in some cases even to counter the points made in the original document.

Chapter-I Introduction

There are reports everydays of damage to environment resulting from a wide range of technology applications. Forests dying due to acid rains, arising out of sulfurous fumes from fossil fuels, lakes and water streams polluted by-detergents, animal and human wastes and excessive use of fertilisers, pesticides, and herbicides choking aquatic life.

Even more frightening, are the increasingly frequent gas leaks, explosions, and fires caused by sloppy handling of risky operations, or neglect in control and maintenance of safety equipment.

In almost all of these, the human- factor is to be blamed. The root causes are often ignorance and /or negligence. Somewhere along the line are technical manpower who did not know, who did not understand or who did not care" what the effects could be.

The technical manpower is concerned with the environment in two ways
l) As technical men, they may be at the source of the environment problem. They could help solve the problem or aggravate it.
2) Like all others-in the society they are also the victims of the environment problems. They should therefore get environment education, that will -help them in both their roles.

Whatever environmental education they received as part of their general education, must be reinforced during technical education. In addition, they must get -skills to tackle environmental problems and solve them at-the- -source in; the particular area they are working in.

The challenge in imparting such an environmental education to the technical and vocational stream (T V S), arises from the large variety of "trades" these technical personnel will undertake in their future careers. The - variety of forms in which these

technical personnel get their training varying from the very formal and organised Engineering degree students at one end to the large number of agricultural workers (including independent farmers) who have had no formal or non-formal training but only "incidental" education on the job. This makes the environmental education task doubly challenging.

The objective of the environmental education should be to create the awareness, impart knowledge, develop attitudes and skills, and encourage participation Environmental education should be a continuous lifelong process; it is interdisciplinary (like all problems in life) and should be viewed in all its different dimensions-local, national, international and at the planetary level.

What has been said above is a world view. The weight age for the environmental risks will vary with the region.

In India and generally in the Third World countries, poverty is the lain pollutant. Whether poverty should be considered an environmental risk factor should be debated and this will be discussed further in the next chapter. Arising directly or indirectly from poverty are the following pollutants.
1. Animal and human wastes
2. Adulteration of foodstuffs
3. Ignorance in handling pesticides and other toxic chemicals and smoke from incomplete combustion.
4. Unsafe working practices and conditions.
5. Road and railway accidents.
6. Degradation of land and forests by uncontrolled grazing.
7. Anti-social practices, including "sati, dowry, obscurantism, superstitions, and corruption.
8. Diseases arising from lack of nutrition and hygiene.

On the their hand we, in the developing countries have less problems with sulfurous fumes, fluorinated hydrocarbons, excess use of detergents and fertilisers pesticides etc.,

Poverty and ignorance go hand in hand and reinforce each other. Lack of proper infrastructure for education of the diverse categories of the students as described in the paper is the major hurdle in the education effort.

The objectives of awareness, knowledge, attitudes, skills, and participation are as relevant here as anywhere else in the world. Sven Grabe rightly points out that the education of technical personnel should provide a wide range of skills that are required in devising effective solutions to these environmental problems.

If we do not succeed in this, the technical man feels helpless and will rather aggravate the problems of the environment than give up the short-term benefits that accrue to him through the use of any technology. Thus strategically, environment education, in its broadest sense gives us the hope of getting all the technical personnel to help in improving the environment rather than spoiling it

Chapter II—Environmental Issues and Risks

For the purpose of discussing the environmental issues, the author classifies them as l) the outer environment and 2) the inner environment.

The outer environment is the world around the work place. The inner environment is the work place. The author cites as the criteria the impact on the quality of life.

Waste disposal is of prime importance in considering environmental degradation. Such problems are found in all types of human activity. Our understanding of the cause and effect of environmental pollution is complicated by the findings that often what may be inoffensive in small quantities can get concentrated in pockets and may enter the food chain and life cycles in quite unexpected ways-getting structurally transformed in the process. Examples are the spread of chlorinated hydrocarbons like DDT or BHC, their concentration in bird and animal tissues, concentration of mercury, arsenic, lead etc. in living tissues, mainly the fish. An example of a different type, less malevolent perhaps, are the residual effects of open pit mining.

As a solution to such problems, the Recuperation and Recycling is the most feasible option. More and more materials formerly considered waste are being recycled, reconditioned and recovered. Literally this is production of wealth from waste.

For technical personnel education should concern. l) What impact will his activity have on the outer environment? 2) What can be done to reduce the ill effects from above? 3) How can the short term, and long term costs and benefits be evaluated?

The inner environment affects the technical person more directly and in the short term. The main issues here are l) the organisational risks 2) the equipment related risks 5) the process related risks and 4) the product related risks. These are mostly straightforward cause and effect relations and are easily perceived - but not necessarily rectified.

The organisation risks arise from bad layouts, poor training, improper work systems and procedures, poor discipline or drilling for emergencies. Equipment related risks are improper tools, inadequate safety- devices like guards etc. fatigue production, use of wrong postures in work, and perhaps even boredom. Process related risks include risks from radiations (welding, furnaces etc) fumes, toxic gas leaks, uncontrollable reactions, fire and explosion risks. The product related risks are represented by products that carry risks to the client. These may include unsafe, allergy producing or even carcinogenic components in the formulation, substandard designs that do not have adequate safety built in or even incomplete or improper user instructions that expose the user to above normal risks. The author rightly stresses the need for more education for the agricultural labour in avoiding environmental risks from farm machinery, excessive or improper use of chemicals and waste disposal.

In order to get an insight into the problems of the Environment, I feel we should understand some basic "laws of nature".

1) Entropy. This may be defined as a measure of 'disorder'. The law states that all systems, left to themselves tend to increase in Entropy. This means that if things are classified and segregated, they tend to get mixed up again in the non-living world. It is a distinctive character of all life that living things tend to reduce disorder and increase segregation.

Thus if a dose of mercury is let out into the environment the inanimate world tends to disperse it throughout the planet, while the living, from microorganisms to plants and animals tend to concentrate them in pockets. Thus water hyacinth, considered a weed, (what is a weed?) picks up a large number of hazardous compounds, like mercury, arsenic etc. from ponds and these get concentrated in the plant tissues.

NASA carried out studies to use these for effluent treatment. This is the good side of the effect, the bad side is, fish do the sane from effluents. It is bad because we eat the fish and we don't want to pickup the mercury.

2) Theory of Evolution. This, though termed as a theory is a established law of nature, though not as mathematically precise as the law of Entropy. Living things undergo 'natural selection' and only those that "match" with the environment survive. The others get extinct. This is why we find in nature so many creatures who beautifully blend in to the surroundings. Boiling water springs, breed microbes that need hot water for growth, Salt water breeds "salt loving" or halophilic organisms. Oxygen lacking environment encourage life forms that can do without elemental oxygen, (it can be even toxic to them) but use oxygen from chemical compounds in the environment. But all the evolutionary changes are very slow, compared to the life span of the human race and the history of our civilisation. They are therefore unacceptable to us as methods of change. Mankind has produced its own cultural or intellectual evolution, which could also eliminate the incompatibles! Therefore when we talk of environmental risk, w do not mean risk to the planet, but to the human race and the life species it likes. The mosquitoes, the flies, the small pox virus and the cockroaches are not in our "environment" list.

I have no quails about being selfish in wanting to protect human and other friendly species. But would someone want to extend the sane principles to ethnic groups within the human race?

3) Alternate Pathways: In nature everything undergoes change, even if ever so slowly. And there are always many paths they can take. Not all of these paths, produce change at the same rate. Some are fast and some are slow. Some take precedence over others. But when the primary paths, (reactions, (cannot cope with the input the alternate paths begin to gain significance, A simple example will illustrate the principle. When rain falls, the evaporation of water is the first reaction. When the quantity of Mater in the rain is lore than what can evaporate off, it falls as rain on the ground. What falls on the ground is absorbed in the soil and when it saturates, it percolates down into the ground as groundwater. When the rainfall accumulates on the ground, it indicates that the rain input is more than the percolation rate and it starts to runoff- the third path.

Thus each pathway is affected by others and has the capacity to affect others. Thus when we ingest a "chemical" our body reacts to eliminate it through metabolism. Some are eliminate (after transformation,) fast, some are eliminated slowly. If we ingest these chemicals, at a high dose, the common pathway gets saturated, and the chemical overflows into other paths. These effects may be harmful or deliberately produced in order to deliver a drug at a specific point in our body. The lows of nature are beyond our control. We can only understand them so that we can live in harmony with them.

(4) Laws of Scale - There are some operations which give economy of scale. Others act in the reverse direction, (the law of diminishing returns.) Both effects may be seen in the sane operation in different phases of growth, urbanisation is a phenomenon arising indirectly out of the economics of scale. Urbanisation overloads the processes of nature - causing the pollutants to "overflow" into unacceptable paths, we call this pollution.

On the other hand it follows from the principles of entropy, that it is easier to tackle a pollutant in high concentration, (Which it is at the source) than after it has dispersed even partially, Also in the high concentration, it can mean better recovery of the

product (e.g. sugar) than when it gets out dispersed as a pollutant (sugar factory washings). Thus avoiding pollution can often mean better efficiency for the main operations

Urbanisation is a pollutant by itself. However, the second industrial revolution may help to reverse the urbanization trend. There is a hope in this for the third world countries. We may be able to use the second industrial revolution to develop without excessive urbanisation.

Chapter III - Technical and Vocational Systems.

Estimating the needs of the various technical and vocational education systems in regard to the environmental curriculum and how best to implement it, is a complicated task. The main reason of this complexity is the diversity of technologies this education covers and the many levels at which it is given.

Diversity – Engineering Health Agriculture etc.
Graduate
Diploma
Technician
General students
Unorganised - on the job
Extension, adult education etc.

The curriculum has to bring out the relationship between the "trade" and the environment-what are the specific hazards and the possible solutions. The variety of topics makes it difficult to be specific. 'The variety is almost as great as the variety of income generating activities in the society. This makes it necessary to categories and give "models". This means abstraction and conceptualisation.

This brings us to the other dimension of this diversity, the levels at which the education is given.

The training of graduate engineers does not pose much of a problem. They are trained to learn through abstraction and can (or should be able to) use concepts to develop a line of action. These engineers will also .be occupying more influential positions in their future career. The variety of graduate technical courses could be counted in tens and many of these could share common courses.

At the technician level, the number of different courses will already rise to hundreds and the trainees need more specific instruction with less conceptualisation. They also need more practical demonstration of actual practices desired.

At the nonformal / adult education / extension work level, the short term training courses will run into thousands. The materials they handle, the processes and the local environment, will all be different and changing all the time.

Environmental problems are interdisciplinary. They relate not only to the physical sciences, but also the biological sciences and the earth sciences. The students are likely to be familiar with only one of them. How can they be taught the principles of all of them?

This is the contradiction in the modern world; even as specialisation increases, the importance of multidisciplinary studies also increases.

In order to tackle this complex task, Sven Grabe is proposing three channels, l) Adult training and retraining systems 2) Extension wings of agriculture, health and engineering education centres, 3) Public and private enterprises, who in the end are related to every possible - technology, either as producers of inputs, users of output, or actual processes (e.g. fuels/chemicals, consumer goods,). Somewhere in the environment chain, the public and private enterprise could intervene to show the way for tackling environmental problems. They are often the generators of new technology and are in the best position to influence the technology.

In short, if the environmental education needs of each technology are different and complex because of the diversity, -the environmental education is best given by integrating it with the technological curriculum itself. How to do it, is discussed in Chapter IV.

Chapter IV – Planning Environmental Education.

Conclusions from earlier chapters are as follows:

1) General environmental education should precede entry into the technical - vocational stream.
2) Environmental education in technical streams should relate to the outer environment and the inner environment.
3) There should be differentiation in what is taught about the environment, depending on how the trainee is concerned with the environment and what possibilities exist for him to influence it.
4) Environmental education should be a life long process
5) A multitude of channels should be used for giving environmental education to technical streams.

General (Initial) Environmental Education:

This should include, the concept of ecosystem, energy, and material flows in the various "cycles" that we consider important in nature. The dynamic of population growth (not only of humans, but animals, insects and microbes, the common mechanics) are important.

This pre-education will be more effective for the higher levels-graduate engineers etc. For the technician levels, it may not be absorbed in the first place and may be less critical. For this the relevant, parts of the general environment education are best integrated with the skills training. The parts to be stressed are the awareness, development of skills, and participation in maintaining the quality of the environment.

Occupation oriented Environment Education.
This should deal with specifically-, the followings:
a) Create awareness about all the outflows from their activity and how they merge into the outer environment.
b) Information and skills for recycling by products, waste disposal practices.
c) Maintaining the "beauty" of nature.
d) Safety consciousness in work.
e) Standards of performance of their products.
f) Indirect costs of damage to the environment, arising from their activity.

In all this calculation, the habit of looking ahead into the future, of visualising, is one of-core importance. But this is not possible to the same degree -for all levels of technical personnel. For those who cannot visualise - easily drilling in safe and sound working practices is all that can be ensured.

3) Adult and Continuing Education.
Both Science and Technology in the present age are moving fast. While new processes and new materials, products etc. are coming into use. Science is giving new methods, instruments and analytical techniques, modeling etc. to detect and trace even minute perturbations in the environment. Every curriculum can become out of date even before its implementation becomes standard.

Environmental education, therefore, has to be a continuing life long process. Adult education, therefore becomes an important channel for environment education, not only for those, who missed it in their youth, but also for those who enter the working life in future with a proper-background in environment studies.

The prime target group in adult education should be those responsible for products- and processes (particularly important for reducing environmental risks). Training and personnel Development Officers should be trained first.

Environmental education for adults will also make it easier for the younger generation to implement their ideas on environment clean up, because their elder-s- may understand what they intend. Environment Education can start as an extension of Safety education, with which many in the Industry are already familiar.

The awareness and standards for environment will -vary from country to country as they do now for safety. But essentially every region has to start from where they are
Subjects in Environmental Education:
In higher technical education, the curriculum should includes
1) Pollution from wastes and emmissions and technologies for cleaning up.
2) Basic ergometric and Industrial Engineering
3) Activities and norms of public authorities and public bodies dealing with environment.
4) Sources of authoritative information on environment and pollution.

The course work will be theoretical and practical, and the practical content will increase in the intermediate and lower level technical education. Students should be encouraged to take up projects, particularly at the graduate and postgraduate levels of technical education. They will include identifying, defining and solving problems.

The following topics are in my opinion of prime importance in India and perhaps in all Third World countries.
1) Operations which are inefficient and cause pollution as a consequence:
a. Incomplete combustion: domestic stoves, industrial furnaces, IC engines, - diesel and two stroke.
b. Incomplete Recovery of product: e.g. sugar, other food and chemical industries.
c. By-products not fully utilised: Sugar and many organic and inorganic industries.

In these there is money in stopping pollution, what is lacking is organisation and knowledge.

2) Factors responsible for loss of production, life, and property:
a. Lack of discipline - instructions are not followed meticulously.
b. Road and rail accidents
c. Concepts and pride of Good Citizenship-civic sense. Garbage, unhygienic public places, disregard in use of public property, disregard for other peoples needs.
d. Lack of health consciosuness.
e. Adulteration and use of non permissible ingredients in food products.

f. Lack of safety consciouness in working/handling energy, hazardous materials, fragile things etc.
g. Economical use of scarce resources e.g. water.
h. Training and drilling in emergency procedures- first aid and fire-fighting, explosions, collapses, snake bites etc.

On the one hand, third world countries recycle more material (for example, waste paper, plastics, metal scrap etc.) and on the other, they spread more garbage around and are less conscious of aesthetic needs (slums!) particularly during urbanisation. - lacking discipline and awareness.
3) Factors where environment could be core pleasant and healthy, with little monetary cost but a lot of collective effort.

a. Afforestation. Good sanitation. Clean villages. Removal of slums.
What is lacking is awareness and local leadership.

Chapter V - Teacher Training.
All technical and vocational education should combine:
1. Study of related science and Technology.
2. Development of skills.
3. Application of knowledge and skills.
The environmental education must also have the same three components. The trainees must handle live environmental problems; experience the constraints and limitations of the work place. They must learn about the organisation and the role of economic and human -factors that mould decisions.

The environmental discipline is best learnt by having the direct experience of working in such a well-organised group. Unfortunately such groups are not too common. If teachers can be induced to maintain such a work place, the problem will be much simpler.

Environmental discipline is like a "health" factor; lack of it attracts criticism, having it does not bring rewards. The decisions therefore give precedence to output rather the environmental discipline.

There are two distinct groups among the teaching staff. The "lecturers" and the "instructors". The former are more at eas e with preaching and the fatter have less concern with theory and are concerned with getting-ahead with the job in hand. The teaching and practice are bifurcated and this is problem also in teaching environment related curricula.

The core of teacher training should relate to ergonomic principles and-practices, work place-organisation, and sources of information on-environmental issues, including safety and health. It maybe integrated with industrial engineering programs. The bulk of the environmental education, however will have to be sharply focussed on individual subject areas and' the stress should be on practicing rather than teaching only.

The general education on environment would have been given already to the trainee teacher; therefore the task will be to 1) update 2) Supplement those who did riot have the formal initial education. The channels for environment education will be 1) Teacher Training Institutes 2) In-service training for full time teaching staff 3) Extension services, Management training institutions, Industrial training and Development associations and 4) The professional journals, reaching the teachers.

SUMMARY AND CONCLUSIONS.

The subject is complete because of l) the wide variety of environmental risks 2) the diversity in technical Institutions 3) Fast changing scenario.

The technical staff has a great responsibility for environment protection as they play a strategic role because they can improve it or damage it.

The objective of this education as defined by UNESCO/UNEP Conference is to create awareness and give the "tools" to solve the environmental problems.

The paper repeatedly stresses the complexity of the tas6 of environmental education. But it does not formulate any strategy apart from seeking integration of environment education with the technical curriculum.

This is because the implementation has to be tailored to each group individually. It is therefore left to a seminar like this to work out the strategy.

I reccomend that each group identify and prioritise its list of environmental tasks. In the Third World countries, Poverty should be priority number one.

I suggest the following strategy- to initiate the debate: Identify the environmental risks, which do economic damage as well. If these are tackled, not only the environment must be improved but it will bring economic benefits to the society, thus encouraging the solving of other environmental problems. Demonstrate the results in as many situations as possible.
Examples -
Incomplete combustion of fuels,

Optimum use of animal, human and agricultural wastes.

Recycling of waste and by-products,

Packaging and distribution of essential foods to counter adulteration of foodstuffs.

Safety in work, home, and road-rail systems.

New forest and common land policy, that will give a vested interest to the section of the community whose life is dependent on them.

National campaign against health hazards like smoking and chewing tobacco and similar products.

National campaign against unsocial practices, such as dowry, discrimination against women, and certain castes etc. Many of these are already being done, but not seen as part of the battle for a better environment. Also they do not go into the educational system.