

RESPONSIVENESS OF NCERT SCIENCE TEXTBOOKS AT THE SECONDARY STAGE TOWARDS ENVIRONMENTAL CONCERNS AND ISSUES

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The science curriculum at the secondary stage is of great significance in the way that many of the students might not be opting for science at the senior secondary level. Consequently, the secondary science curriculum should help learners develop an attitude which could not only help build a sense of scientific enquiry in whatever they do in their lives but also sensitises them towards their own environment. The curriculum should offer them experiences that could make them responsible for their own activities and empower them to critically look at others' activities from the perspective of environment. Also, considering the present degrading environmental conditions and the relation between science and environment, the secondary science curriculum should provide learners with ample opportunities to engage meaningfully with contemporary issues and concerns related to environment. As the textbooks are one of the most widely used representations of the curriculum, the present research paper attempts to present a critical analysis of the secondary science NCERT textbooks for its responsiveness towards environmental issues and concerns.

Key words: *Environment, environmental education, environmental issues, science curriculum, science textbooks.*

Introduction

Science has a very close association with the environmental concerns and issues in the contemporary world. This is not only because the scientific inventions and discoveries have positive or negative impact on the environment but also because science helps us in understanding the environment per se. Our understanding of the environment varies from being the immediate environment to the local surroundings and widening to the world at large. The understanding of the immediate environment starts with primary science through explorations and discussions about one's environment and extending it to understand others' environment. At the

secondary stage, the focus shifts towards understanding the issues and concerns from a scientific perspective that is by applying the concepts of science. The issues and concerns are located in our society and hence cannot be discussed from a single perspective as many other factors may be involved in it. This is one of the reasons that science shares a mutual relationship with society where both influence each other in several ways. Thus, the societal issues and concerns provide the context to understand the environment as well as other concepts in science learning whereas science provides the conceptual understanding behind it. Hence, science classrooms are expected to offer opportunities to the learners to engage with the environmental issues and

concerns for discovering as well as better understanding of the scientific concepts associated with them. Also, in a science classroom it is important to discuss the interrelationship between science and society for understanding the realities and conditions created through the interplay of various factors (economic, political, social) prevailing in a society which is indicative of the fact that science alone may not be a response to the issue in hand. Similarly, science textbooks should present the environmental issues and concerns as part of the contents, activities, illustrations and assessments that support the teachers and provide them the exemplary frameworks for creating holistic learning experiences for children. *NCF-2005* also recommends the infusion of environmental issues within different curricular areas including science. According to *NCF-2005*, at the primary stage the learners should be exploring the world but by secondary stage they should be able to identify the issues at the local environment and discuss those issues. The other dimension is that as we all know about the immense potential of science to empower one with its discoveries and inventions which could be either constructive or destructive. The last century has witnessed many wars using many scientific inventions including the nuclear weapons which has not only caused massive casualties but has also caused devastating effects on our environment. Many of inventions that we are using in our daily lives have been interfering with the natural environment and impacting our environment adversely both locally as well as globally. On the other side, science has contributed in monitoring, analysing, and predicting environmental changes. Indeed, this proves that we should look at the scientific advances critically so that we can

use them optimally and sustainably such that there is harmony between the present needs and the necessities of the future generations. The engagement with the environmental issues and concerns in a science classroom should encourage students to think and act sensitively and critically as they are to the future. This necessitated the researchers to study the science textbooks for analysing its responsiveness in nurturing the students' creativity, critical thinking and sensitivity towards the environmental issues and concerns. The important fact that also needs to be mentioned here is that from the immediate basic essentials of life like food, shelter, access to drinking water, to all other important issues by which we get affected like health, energy resources, biodiversity, environment conservation, climate change, global warming, etc.; all have a strong science component to it. And everyone should have their opinions as well as access so as to take part in the regional, national or international debates or to get their voice heard. And such scientifically–environmentally aware citizens could only be created by providing them with a strong foundation at their school level. Since not everyone goes on to become a scientist, it is very important to provide them with a science curriculum at the secondary level which educates them about all these issues.

Historical Journey of Environmental Education

The modern environmental education movement gained momentum only in the late 1960s and early 1970s. In the *Phi Delta Kappan* in 1969, one of the first articles about environmental education as a new movement appeared which was authored by James A.

Swan. The *Journal of Environmental Education* in 1969, authored by William B. Stapp was the journal in which a definition of 'Environmental Education' first appeared. The first Earth Day on 22 April, 1970 — a national teach-in about environmental problems — paved the way for the modern environmental education movement. Internationally, environmental education gained recognition when the UN Conference on the Human Environment held in Stockholm, Sweden, in 1972, declared environmental education must be used as a tool to address global environmental problems. The United Nations Educational, Scientific and Cultural Organization (UNESCO) and United Nations Environment Programme (UNEP) created three major declarations that have guided the course of environmental education. They are the Stockholm Declaration, the Belgrade Charter and the Tbilisi Declaration. The Stockholm Declaration (June, 1972) was the declaration of the United Nations Conference on the Human Environment. The document was made up of seven proclamations and 26 principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment. The Stockholm Conference produced, among others, the Human Environment Declaration, with environmental guidelines to the participating countries' governments contained in the World Action Plan, and, in particular, recommending the establishment of an environmental education international programme directed at the common citizen's qualification training, in order to enable citizens to manage and control their environments. The conference granted education the status of key element for confronting the emerging worldwide

environmental crisis. The Belgrade Charter (October, 1975) was the outcome of the International Workshop on Environmental Education held in Belgrade, Yugoslavia (now Serbia). This charter was built upon the Stockholm Declaration and added objectives, guiding principles and goals of environmental education programmes. This charter is important in the history of environmental education as it extended the role of environmental education programme to the general public. Tbilisi Declaration (October, 1977) is a milestone for the history of environmental education. The venue of this conference was in URSS held by UNESCO in collaboration with PNUMA (UNEP), and this granted environmental education the status of international policy. It established principles and general guidelines for programmes to be prepared all over the world. Since then, what is now called environmental education, focus its efforts on informing and providing the necessary knowledge to make people aware of environmental problems. Awareness-training, consciousness-raising and participation are key words and include, the following goals respectively: to awaken individuals and collectivises to environmental problems; to give meaning to these problems by relating them to daily life; and to offer the indispensable knowledge so that individuals may be able to undertake actions on behalf of their environment and quality of life.

The Tbilisi Declaration noted the unanimous accord in the important role of environmental education in the preservation and improvement of the world's environment, as well as in the sound and balanced development of the world's communities.

The Tbilisi Declaration updated and clarified the Stockholm declaration and the Belgrade Charter by including new goals, objectives, characteristics, and guiding principles of environmental education. Again in 1992, at the United Nations Conference on Environment and Development, known as Rio-92, the importance of environmental education as a tool for a qualitative change in mankind's behaviour towards the environment was reaffirmed. Agenda 21, the document proposed by this Forum, includes a chapter specifically dedicated to this theme, entitled 'Promoting Environmental Education', which deals with the redirection of environmental education towards sustainability. The topics related to environment and sustainable development were also discussed at the Cairo Conference on Population (1994), the Copenhagen Conference on Social Development (1995), the Beijing Conference on Women (1995), and the Istanbul Conference on Habitat (1996) which highlight the importance their on the international agenda (Radhika lyengar and Monisha Bajaj, 2011). But to be successful in reaching this goal, environmental education should be taught not only in formal schools but also at the so-called non-formal and informal spaces. For consciousness-raising and sensitisation to happen in a wider spectrum, programmes must be established both at formal educational places and at teacher training schools and courses, and at places designed for non-formal and informal education. Within formal education, we already find environmental education as part of the school disciplines, but what we need to see is that it should be given equal importance with other school subjects.

Environmental Education in Indian Context

The national policies and planning on education eventually determine what course a curriculum and simultaneously a textbook and the classroom pedagogies would take. The importance of environmental issues in science could be understood by referring to the criteria for a science curriculum given by *NCF-2005*. Out of the six aims, as prescribed by the *NCF-2005* for an ideal science curriculum, two are related to environment and ethical issues that expect the science curriculum to contextualise the various issues related to science, society and environment. They are:

- (a) Environmental validity requires that science be placed in the wider context of the learner's environment, local and global, enabling him/her to appreciate the issues at the interface of science, technology and society and preparing him/her with the requisite knowledge and skills to enter the world of work.
- (b) Ethical validity requires that the curriculum promote the values of honesty, objectivity, cooperation, freedom from fear and prejudice, and develop in the learner a concern for life and preservation of environment.

This clearly implies that environmental validity on one hand seeks to contextualise the concepts in science by locating them within the learner's environment whereas the ethical validity requires the learner to develop values that encourage sensitivity, creativity and a critical outlook towards changes in

one's environment. According to the *NCF-2005*, "At the secondary stage the students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analysis on issues surrounding environment and health" (pp. 48–49). The National Focus Group Position Paper on Teaching of Science also states that "While deciding on gradation of science curriculum, it must be borne in mind that a majority of students learning science as a compulsory subject up to Class X are not going to train as professional scientists or technologists in their later careers; yet they need to become 'scientifically literate', since several of the social, political and ethical issues posed by contemporary society increasingly revolve around science and technology. Consequently, the science curriculum up to Class X should be oriented more towards developing awareness among the learners about the interface of science, technology and society, sensitising them, especially to the issues of environment and health, and enabling them to acquire practical knowledge and skills to enter the world of work" (p.11). According to *NCF-2005*, the present status of environmental education in schools had its genesis in the National Policy on Education (NPE) 1986 (modified in 1992), in which 'Protection of the Environment' is stated as a common core around which a National Curriculum Framework (NCF) would be woven. The National Policy on Education 1986 emphasised the need to create awareness of environmental concerns by integrating it in the educational process at all stages of education and for all sections of society. Accordingly, the National Curriculum for Elementary and

Secondary Education: A Framework (1988) presented the NCERT's view that the school curriculum should highlight the measures for protection and care of the environment, prevention of pollution and conservation of energy. In consonance with these documents, Environmental Studies was introduced as a subject at the primary level. The topics related to environment were suitably infused with different science and social science subjects at all school stages. Understanding of the environment in its totality, both natural and social, and their interactive processes, the environmental problems and the ways and means to preserve the environment was one of the General Objectives of Education as per National Curriculum Framework, 2000.

Aims and Design of the Study

The aims of this research are:

1. To analyse the science textbooks at the secondary level for identifying the contents, activities and questions related to environmental issues.
2. To study various opportunities that secondary science textbooks offer to learners for developing their thinking about environment and environmental issues on the basis of analysis of the textbooks.
3. To do a comparative analysis of the Class IX and X textbooks for their environmental content.

The textbook content analysis was done using a grid that was designed on the basis of the 'cognitive process domain' of Revised Bloom's Taxonomy as it is based on different kinds of thinking in which a learner can be engaged with or the learners generally engage in. Thus,

the contents including the text, activities, illustrations, questions were analysed on the basis of their potentiality to engage learners to think in various ways including critical and creative thinking that *NCF-2005* envisages. Also, as the Revised Bloom's Taxonomy is based on the contemporary theories and approaches of learning including constructivism (Amer, 2006) which has been emphasised in *NCF-2005*, hence it seemed to provide a valid framework for meeting the objectives of the present study. The revision of the Bloom's taxonomy in 2001 provided us with a more dynamic system of classification and the Knowledge category was named Remember, the Comprehension category was named Understand, Synthesis was renamed Create and was also made the top category, and the remaining categories were changed to their verb forms: Apply, Analyse, and Evaluate. Taking these six categories as the main descriptors, sub descriptors were framed in the form of questions. These sub descriptors had specific questions to identify and assess the components of all the descriptors present in the textbook. Thereafter analysis was done using this

content analysis grid by examining the text and looking one by one for the evidences for each descriptor. The evidences identified for each descriptor has been described or quoted class wise in tabular form.

Analysis and Interpretation

There is a tendency in the education system that most of the contents, activities, etc., are framed in such a way that expects a mere recall from the learners. Thus a deliberate attempt was made by the researchers to analyse the potentiality of the contents of the secondary science NCERT textbooks from the perspective of the Bloom's taxonomy which also reflects the *NCF-2005* as it states that there should be 'systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology, are to be important parts of the curriculum at this stage' thereby focusing on creative thinking (p. 49). The content analyses of the chapters and contents of the Class IX and X textbooks have been done below in a tabular form on the basis of the grid evolved by the researchers:

Descriptors	Class IX	Class X
1. Remembering		
1.1 Does the textbook provide enough illustrations, examples to list, define, identify recognise the environmental concerns?	There are opportunities given in some chapters like the chapter 'Natural Resources' where topics like air pollution, water pollution, ozone layer depletion have been dealt with examples, illustrations and figures to enable children to identify the environmental concerns. For example, in the topic air pollution, it has been	Some chapters in the textbook like 'Our Environment', 'Management of the Natural Resources' give a lot of examples to illustrate the importance of our environment and the hazards that it is facing. For example, examples have been cited to discuss the biodegradable and non-biodegradable substances. Their definitions have also been given. The meaning of the three R's, i.e., reduce, recycle and reuse, is also discussed in detail.

	written that burning of fossil fuels produces different oxides of nitrogen and sulphur which are dangerous for inhalation and also cause acid rain. The definition of air pollution has also been given. In the topic water pollution, it has been listed in points what effects or changes in water accounts to water pollution. For showing the ozone hole, satellite pictures of the ozone hole over Antarctica in the year 1980, 1985 and 1990 are given.	On page 268, in the Box "Do You Know?", the following paragraph is given in which the case of River Ganga has been presented discussing the various causes leading to its water getting polluted. Also, it describes various ways for gauging the quality of water: Pollution of the Ganga As you can see, there are some measurable factors which are used to quantify pollution or the quality of the water that we use for various activities.... <i>Largely untreated sewage is dumped into the Ganges every day. In addition, think of the pollution caused by other human activities like bathing, washing of clothes and immersion of ashes or unburnt corpses. And then, industries contribute chemical effluents to the Ganga's pollution load and the toxicity kills fish in large sections of the river.</i>
1.2 Does the text provide scope for the children to perform simple tasks or experiments in groups, so that they can share their experiences with each other that helps them to develop a holistic understanding of their environment and hence in remembering the facts in a better way?	Some task and group activities could be included where the children in groups can visit places around their school or in their neighbourhood to study the various environmental issues. This will help them develop a better understanding of their immediate environment.	The text provides some activities to be done in groups. The activities provide learners to recall from their experiences and think critically about the use of certain materials that may be harmful. Such as Activity 16.4 (p. 269): • Have you ever visited a town or village after a few years of absence? If so, have you noticed new roads and houses that have come up since you were there last? Where do you think the materials for making these roads and buildings have come from? • Try and make a list of the materials and their probable sources. • Discuss the list you have prepared with your classmates. Can you think of ways in which the use of these materials be reduced?

1.3 Does the textbook provide enough scope for the students to construct and internalise the knowledge through personal experimentation and observation?	There are several activities followed by some questions in the textbook for the students to construct and internalise their understanding about environmental concerns. Such as Activity 14.6 (p. 193) - Organisms called lichens are found to be very sensitive to the levels of contaminants like sulphur dioxide in the air. As discussed earlier in section 7.3.3, lichens can be commonly found growing on the barks of trees as a thin greenish-white crust. See if you can find lichens growing on the trees in your locality. - Compare the lichen on trees near busy roads and trees some distance away. - On the trees near roads, compare the incidence of lichen on the side facing the road and, on the side, away from the road. This activity is followed by a question "What can you say about the levels of polluting substances near roads and away from roads on the basis of your findings above?" This helps the students in reflecting and understanding the facts and concepts in a very holistic manner. Another Activity 14.12 (pg. 199) is given where the students could search and find out about the facts and in the process may also learn some new information. - Find out what the consequences of global warming would be. Also, find out the names of some other greenhouse gases.	Several activities in the text are given through which the students could construct their own understanding and knowledge through experimenting, observing and discovering on their own. Such as Activity 15.5 (p. 261): - Collect waste material from your homes. This could include all the wastes generated during a day, like kitchen wastes (spoilt food, vegetable peels, used tea leaves, milk packets and empty cartons), waste paper, empty medicine bottles/strips/bubble packs, old and torn clothes and broken footwear. - Bury this material in a pit in the school garden or if there is no space available, you can collect the material in an old bucket/flower pot and cover with at least 15 cm of soil. - Keep this material moist and observe at 15-day intervals. - What are the materials that remain unchanged over long periods of time? - What are the materials which change their form and structure over time? - Of these materials that are changed, which ones change the fastest? This activity would help the students to discover the difference between biodegradable and non biodegradable substance through personal experimentation as well as know the examples which otherwise they would have needed to rote learn.
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2. Comprehension (understanding)		
2.1 Does the textbook provide an understanding about the facts mentioned in the book regarding environment so that the learner can describe, explain, paraphrase, give their own examples, summarize, interpret and discuss those issues? – through group discussions – through assignment – through internet search	A few questions have been given in the text which gives them an opportunity to express their personal experiences related to the environmental issues. Such as, Question No. 3 (pg 201). List any three human activities which would lead to an increase in the carbon dioxide content of the air. This question helps the students to think critically and understand the human activities which could give rise to environmental issues.	The textbook does provide opportunities to the students to understand the issues and express their own ideas in the form of activities such as, Activity 15.2 (pg. 257) Use the library or internet to find out more about biodegradable and nonbiodegradable substances. • How long are various nonbiodegradable substances expected to last in our environment? • These days, new types of plastics which are said to be biodegradable are available. Find out more about such materials and whether they do or do not harm the environment. This activity promotes the learners to search and understand about the nature of the different types of pollutants.
3. Application (Applying)		
3.1 Does the text provide opportunities to the students to predict certain situations about the environment upon reading the content?	In few chapters, some activities have been given which provide students the opportunities to predict certain situations about the environment upon reading the content. Such as Activity 14.1 (p. 190): • Measure the temperature of the following: Take (i) a beaker full of water, (ii) a beaker full of soil/sand, and (iii) a closed bottle containing a thermometer. Keep them in bright sunlight for three hours. Now measure the temperature of all three vessels. Also, take the temperature reading in shade at the same time.	The textbook provides some activities and paragraphs through which students get an opportunity to predict certain situations about the environment. Such as, Activity 15.1, (p. 256): You might have seen an aquarium. Let us try to design one. • What are the things that we need to keep in mind when we create an aquarium? The fish would need a free space for swimming (it could be a large jar), water, oxygen and food. • We can provide oxygen through an oxygen pump (aerator) and fish food which is available in the market.

	This activity is followed by some questions: 1. Is the temperature reading more in Activity (i) or (ii)? 2. Based on the above finding, which would become hot faster – the land or the sea? 3. Is the thermometer reading of the temperature of air (in shade) the same as the temperature of sand or water? What do you think is the reason for this? And why does the temperature have to be measured in the shade? 4. Is the temperature of air in the closed glass vessel/bottle the same as then temperature taken in open air? (i) What do you think is the reason for this? (ii) Do we ever come across this phenomenon in daily life?	• If we add a few aquatic plants and animals it can become a self-sustaining system. Can you think how this happens? An aquarium is an example of a human-made ecosystem. • Can we leave the aquarium as such after we set it up? Why does it have to be cleaned once in a while? Do we have to clean ponds or lakes in the same manner? Why or why not? This activity provides the students with the insights for analysing, applying and foreseeing certain real life issues.
3.2 Are the students getting opportunities to apply or relate the concepts to real life contexts?	Some activities and paragraphs are given in the text by which the students might be enabled to apply the concepts in real life situations upon reading it. Such as Activity 14.4 (p.192): • Collect information from newspapers or weather reports on television about rainfall patterns across the country. Also find out how to construct a rain gauge and make one. What precautions are necessary in order to get reliable data from this rain gauge? Now answer the following questions: • In which month did your city/ town/village get the maximum rainfall?	Upon reading the text, the students could be enabled to determine some real life situations of the environmental issues. For example, Activity 16.3, (p. 268): • Check the pH of the water supplied to your house using universal indicator or litmus paper. • Also check the pH of the water in the local water body (pond, river, lake, and stream). • Can you say whether the water is polluted or not on the basis of your observations? Activities like these not only help the students to relate to the different dimensions of the concept of water pollution but they also help them in applying their understanding to their basic necessities of availability of pure drinking water.

	• In which month did your state/ union territory get the maximum rainfall? • Is rain always accompanied by thunder and lightning? If not, in which season do you get more of thunder and lightning with the rain? These activities and questions stimulate the students to think and apply the larger concepts of climate change through simpler tasks of the day-to-day lives.	
4. Analysing		
4.1 Is there enough content that enables the students to classify, categorise the different changes that are taking place in our environment?	Some paragraphs with specific topics like Air Pollution on page 192 and Water Pollution on page 194 have been given in the book but there is a scope for including other categories of pollution as well. Also if we talk about the pollutants, the different types of pollutants that pollute the environment have been covered briefly.	The text has given some activities to the students for enabling them to classify and categorise different types of pollutants around them. For example, Activity 16.4 on page 269: • Have you ever visited a town or village after a few years of absence? If so, have you noticed new roads and houses that have come up since you were there last? Where do you think the material for making these roads and buildings have come from? • Try and make a list of the materials and their probable sources. • Discuss the list you have prepared with your classmates. Can you think of ways in which the use of these materials be reduced? Definitely the textbook does not provide for a clear categorisation of the pollutants, which may be because it is expected for a Class X student to know all these from the knowledge gained in the previous classes but it helps the students in analysing the different categories of pollutants that are being added up by the day-to-day human activities.

4.2 Do the contents enable the students to draw inferences that may help them to identify the causes behind a particular environmental issue upon reading the book? – through field visits or interviews – through activities given at the end of the chapter or between the text – through debating	There are some activities which could enable the students in developing an analytical ability. Such as Activity 14.4 on page 192. • Collect information from newspapers or weather reports on television about rainfall patterns across the country. Also find out how to construct a rain gauge and make one. What precautions are necessary in order to get reliable data from this rain gauge? Now answer the following questions: • In which month did your city/ town/village get the maximum rainfall? • In which month did your state/ union territory get the maximum rainfall? • Is rain always accompanied by thunder and lightning? If not, in which season do you get more of thunder and lightning with the rain? Activity 14.5 on page 192: • Find out more about monsoons and cyclones from the library. Try and find out the rainfall pattern of any other country. Is the monsoon responsible for rains the world over? These activities build the abilities to think and discuss among themselves the causes behind certain environmental issues.	The contents of the textbook to some extent enable the students to draw inferences that may help them to identify the causes behind a particular environmental issue upon reading the book. For example, Activity 15.7 given on page 263: • Find out what happens to the waste generated at home. Is there a system in place to collect this waste? • Find out how the local body (panchayat, municipal corporation, resident welfare association) deals with the waste. Are there mechanisms in place to treat the biodegradable and non-biodegradable wastes separately? Another example is Activity 15.8 on page 263: • Find out how the sewage in your locality is treated. Are there mechanisms in place to ensure that local water bodies are not polluted by untreated sewage. • Find out how the local industries in your locality treat their wastes. Are there mechanisms in place to ensure that the soil and water are not polluted by this waste? Such activities not only enable the students to analyse the causes of the issues related to our environment but they also help them understand how society comes to play a role in the environmental issues.
5. Evaluation (Evaluating)		
5.1 Does the textbook provide the space for the expression of students own opinions about the environmental issues	There are some questions given in the text through which the students could express their opinions about the environmental issues. Some of them are: Question No 5 (Pg. 202).	Some questions are given in between the text as well as at the end of the chapters through which the students may express their own opinion about the various issues related to our environment. Such as [pg. 273]:

– by the exercises at the end of the chapter? – by the questions in between the text contents?	We know that many human activities lead to increasing levels of pollution of the air, water-bodies and soil. Do you think that isolating these activities to specific and limited areas would help in reducing pollution? Question No 3. (pg.194). Do you know of any activity which may be polluting this water source? Question No 5. (Pg. 193). List any three human activities that you think would lead to air Pollution. These activities provide the scope to the students to think and be evaluative in the manner that could help them in shaping their thoughts and opinions.	1. Why should we conserve forests and wildlife? 2. Suggest some approaches towards the conservation of forests. Questions (1, 2, 3 & 7) at the end of the chapter on page nos. 278 and 279: – What changes would you suggest in your home in order to be environment-friendly? – Can you suggest some changes in your school which would make it environment friendly? – We saw in this chapter that there are four main stakeholders when it comes to forests and wildlife. Which among these should have the authority to decide the management of forest produce? Why do you think so? – On the basis of the issues raised in this chapter, what changes would you incorporate in your lifestyle in a move towards a sustainable use of our resources?
5.2 Whether the textbook provides contents/ activities where the students get opportunity to critique or opine about the information based on a set of valid criteria? – through classroom discussions – through debates – by taking surveys, interviews	There is a scope for some content for the students to get opportunity to critique or opine about the information based on a set of valid criteria through classroom discussions or through debates or by taking surveys and interviews.	The following contents of the text enable the students to find opportunity to defend their opinions by making judgments' about the information, validity of ideas or the quality of work based on a set of criteria in the textbook. Activity 16.7 (pg.273) Debate the damage caused to forests by the following – (a) Building rest houses for tourists in national parks. (b) Grazing domestic animals in national parks. (c) Tourists throwing plastic bottles/ covers and other litter in national parks. Another example is Activity no 16.8, on page no 273:

		Villages suffering from chronic water shortage surround a water theme park in Maharashtra. Debate whether this is the optimum use of the available water. Such debate related activities helps the students to think and give their views on some larger issues of human-animal conflict, biodiversity etc and enable them to evaluate the gravity of the situation.
6. Creation		
6.1 Does the textbook provide opportunities for the students to enhance their creativity by inventing, designing, modifying some models that could contribute effectively to the environment?	The textbook provides some opportunity for some model designing activity which could further encourage the students for some more innovative ideas. Such as Activity 14.1 [pg. 190] • Measure the temperature of the following: Take (i) a beaker full of water, (ii) a beaker full of soil/sand and (iii) a closed bottle containing a thermometer. Keep them in bright sunlight for three hours. Now measure the temperature of all 3 vessels. Also, take the temperature reading in shade at the same time. Activity 14.2 on page 190. • Place a candle in a beaker or wide mouthed bottle and light it. Light an incense stick and take it to the mouth of the above bottle. • Which way does the smoke flow when the incense stick is kept near the edge of the mouth? • Which way does the smoke flow when the incense stick is kept a little above the candle? • Which way does the smoke flow when the incense stick is kept in other regions?	The textbook provides some activities to the students for enhancing their creativity. Such as Activity 16.11 (p. 277): • Coal is used in thermal power stations and petroleum products like petrol and diesel are used in means of transport like motor vehicles, ships and aeroplanes. We cannot really imagine life without a number of electrical appliances and constant use of transportation. So can you think of ways in which our consumption of coal and petroleum products be reduced? One more such activity can be found on page no 263, Activity 15.7 • Calculate how much waste is generated at home in a day. • How much of this waste is biodegradable? • Calculate how much waste is generated in the classroom in a day. • How much of this waste is biodegradable? • Suggest ways of dealing with this waste.

	These activities not only help the students in understanding the role of atmosphere in climate change and the movement of air but they also help in igniting the spirit of creative learning.	Such activities help the students to think alternative ways and methods for calculating and controlling the waste generation at their immediate environment.
6.2 Does the textbook give the scope to the students for some original, new thinking or a new outlook for the same environmental concerns given in the text?	A few questions are given in the text, which tries to instigate some new thoughts. For example, Question 5 on page 202: We know that many human activities lead to increasing levels of pollution of the air, water-bodies and soil. Do you think that isolating these activities to specific and limited areas would help in reducing pollution? Activities like these help the students to think out of the box and develop a new way to look at the most common day-to-day issues.	Some activities seem to promote original, new thinking which can be demonstrated by the given Activity 16.2 (p. 267): • There are a number of organisations that seek to spread awareness about our environment and promote activities and attitudes that lead to the conservation of our environment and natural resources. Find out about the organisation(s) active in your neighbourhood/ village/town/city. • Find out how you can contribute towards the same cause. Stimulating the students to think of their own ways to solve the environmental issues and contribute to their share of duties would definitely be said to be a very creative activity.

Comparative Analysis of Textbooks along with Interpretation

Descriptors	Comparison of textbooks
1. Remembering	
1.1 Does the textbook provide enough illustrations, examples to list, define, identify recognise the environmental concerns?	The textbook of Class IX as well as of Class X provide enough illustrations for the students to list, define, identify, recognise the environmental concerns, but the Class X textbook could be said to be more enriched in the activities and information regarding the environmental topics.
1.2 Does the text provide scope for the children to perform simple tasks or experiments in groups, so that they can share their experiences with each other that helps them to develop a holistic understanding of their environment?	The Class X textbook contains some activities which give opportunities to the children to perform simple tasks or experiments in groups, so that they can share their experiences with each other and develop a holistic understanding of their environment, whereas in the Class IX textbook

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	there is a scope for the inculcation of more such activities and contents.
1.3 Does the textbook provide enough scope for the students to construct and internalize the knowledge through personal experimentation and observation?	There are several activities in both the textbooks so that the students could construct and internalize their knowledge on the environment. Although, while the Class IX textbook focused more on learning through observing, the Class X textbook involved the students in personal experiences and experimentation.
2. Understanding	
2.1 Does the textbook provide an understanding about the facts mentioned in the book regarding environment so that the learner can describe, explain, paraphrase, give their own examples, summarise, interpret and discuss those issues? – through group discussions – through some assignment – through internet search	The Class X textbook provides some opportunities for these through internet search and the Class IX textbook also addresses these by providing the student with some questions to ponder upon these issues.
3. Applying	
3.1 Does the text provide opportunities to the students to predict certain situations about the environment upon reading the content?	Both the textbooks of Classes IX and X provide the students with some activities which could assist them in predicting what could happen next, after doing the activities. The contents would have been more enriched by providing the students with an opportunity to think upon the direct relation of science and scientific contents with the different types of pollution and pollutants around.
3.2 Are the students getting opportunities to apply or relate the concepts to real life contexts?	Both the textbooks of Classes IX and X have some activities, upon doing which the students might be enabled to apply or determine the real life situations.
4. Analysing	
4.1 Is there enough content that enables the students to classify, categorise the different changes that are taking place in our environment?	Both the textbooks of Classes IX and X could have more contents or activities to categorise the different changes that are taking place in our environment. They have been covered briefly in both the textbooks. For example, discussing sound pollution in the chapter “Sound” of Class IX would have made the chapter more responsive to the students and their abilities to analyse the different changes that are taking place in our environment.

4.2 Do the contents enable the students to draw inferences that may help them to identify the causes behind a particular environmental issue upon reading the book? – through field visits or interviews – through activities given at the end of the chapter or between the text – through debating	The Class IX textbook contains a few activities through which the students could identify, make inferences and then support generalisations about issues related to the environment. The Class X textbook also encouraged and instilled in the minds of the students to be analytical about certain environmental issues.
5. Evaluating	
5.1 Does the textbook provide the space for the expression of students' own opinions about the environmental issues? – by the exercises at the end of the chapter – by the questions in between the text contents	The Class IX textbook contains a few contents through which the students could shape their opinions or become predictive or evaluative about their views on a certain environmental issues. The Class X textbook contains some exercises and activities for the same.
5.2 Whether the textbook provide contents/ activities where the students get opportunity to critique or opine about the information based on a set of valid criteria? – through classroom discussions – through debates – by taking surveys, interviews	The Class IX textbook provides some questions in the exercises through which the students could opine their views on the environmental issues. The Class X textbook also contains some questions which require expressing one's own view and opinion on the topics.
6. Creation	
6.1 Does the textbook provide opportunities for the students to enhance their creativity by inventing, designing, modifying some models that could contribute effectively to the environment?	Both the textbooks of Classes IX and X provide the students with some model preparing activities through which the students could give their imaginative minds a way to create and accomplish something new on their own.
6.2 Does the textbook give the scope to the students for some original, new thinking or a new outlook for the same environmental concerns given in the text?	The Class X textbook seems to have more activities and exercises than the Class IX textbook which could foster some new, original, thinking or a new outlook for the environmental concerns given in the text.

Discussion, Conclusion and Suggestions

The major findings of this study show that the NCERT science textbooks at the secondary level are responsive towards the

environmental concerns and issues to certain extent. Based on the content analysis it can be argued that there is still a lot of scope for inclusion and integration of the environmental contents. The analysis showed that in some chapters of the NCERT science textbooks the environmental issues and concerns were

discussed very meaningfully but the activities and exercises related to the environmental issues were found mostly from the knowledge, comprehension and application domains. Both the textbooks contain such contents which could help the students in applying their understanding of the environment in real-life situations. They also have activities through which the students can be encouraged for scientific inquiry and experimentations for sustainability of the environment. As we know that environmental issues and concerns require that the individuals should be prepared to take action in future and question the changes around them. Mere understanding of the related concepts or their application may not empower them to become responsible citizens that are able to think critically and creatively. Thus, although some activities have been found in the analysis that provide opportunities to the learners for imagining and creating designs that are environment friendly but more such activities can be included. It is also suggested that some chapters in the textbook could be enriched with discussion and debate based activities with respect to the environmental issues. For example, the chapter 'Diversity in Living Organisms' of Class IX, could discuss the threats that the biodiversity is facing due to the habitat destruction caused by deforestation and other human activities. It could involve some case studies from specific regions that have proved that any interference in the natural environment disturbs the natural processes of a region thereby affecting the diversity. Hence, how 'no action' on the part of human proved to be the best action. Some evidences/instances and/or activities could be added through which the student gets sensitised about issues of the biodiversity getting threatened because of

the human activities. Similarly, the chapter 'Sound' of Class IX could discuss the idea of sound pollution and the various causes of it in our environment. The chapter 'Why Do We Fall Ill' of Class IX could include the influence of environmental conditions on the human health. This should bring the case of those diseases that have emerged in the contemporary world due to the changes in the environmental conditions ranging from the use of various gases that add to the air around us, to the use of pesticides/insecticides that we are slowly consuming through our food to the use of other chemicals that we are using in our day-to-day lives. So, some more topics presenting the relation of health and environment could be included in this chapter which could also include some debates and discussions on the present environmental conditions and the frequent outbreak of some diseases. The chapter 'Matter in Our Surroundings' discusses concepts related to the three states of matter. This chapter could also have discussed about the water scarcity that we face today despite the fact that 70 per cent of the earth is covered with water. There could have been discussions related to the fact that most of the fresh water is frozen as ice at the polar areas and hence not available for use by the common people. If we discuss the Class X science textbook, the textbook included activities and exercises related to environmental issues and concerns from knowledge, understanding, application, evaluation and synthesis domains but it was noticed that some more chapters could have had some environment related topics. For example, in the chapter 'Metals and Non-metals' extraction, enrichment of ores, refining have been discussed and the contents could have been enriched if the fact that mining has a severe effect on the environment

in the areas where mining is done and subsequently on the health of the resident people, would have been discussed. A whole chapter named "Our Environment" has been included in this, which although includes several topics related to the environmental concerns but some more discussion and debate based activities and questions could have included in this which could have debates and discussions on the current affairs like the ongoing global summits, etc., included in it. Inclusion of some stories from the tribal communities or the rural areas where people depend on the environment and directly use the natural resources will enhance the understanding of the students. It would also help them to understand that environmental concerns could not be addressed from outside but a close association with one's immediate environment while being a part of it goes a long way in sustaining the environment. The chapter 'Management of Natural Resources' included some relevant topics on environmental issues and sustainable development and has enriched content from various domains. The chapter 'Sources of Energy' should definitely include issues related to use of certain fuels and the possibilities of using alternative fuels. While studying the various opportunities that secondary science textbooks offer to learners for developing their thinking about environment and environmental issues, it was observed that the content related to environmental issues should include more activities, cases/instances from the past, contemporary ongoing concerns that would provide the learners to opportunities to think analytically, critically and creatively.

The Class IX textbook could include many activities and exercises related to environment which could help nurturing the curiosity and creativity of the children towards it. It could contain activities or exercises for the students to discuss environmental issues in groups. Although, the textbook has given opportunities for personal experimentation and observation, some more activities related to promoting the students to explore more about the present environmental conditions and enhance their understanding about the same through internet search or discussions could prove to be beneficial for the students. The Class X textbook represents environmental issues in more effective way than the Class IX textbook; still there is need for some more activities and exercise to be included in it. But to some extent both the textbooks contain such contents which could help the students in applying their understanding of the environment in their real life situations. The curriculum also needs to include such topics which could give the students the understanding about how science can play a role in defining the environmental issues and how they both are related. Only some of the popular environmental issues and concerns such as air pollution, water pollution, etc., are frequently discussed whereas some of the global environmental concerns such as nuclear accidents, biotechnology risks, and significance of biodiversity conservation are discussed only to a certain extent. Inclusion of some more local as well as global issues would bring the secondary science textbooks at par with the criteria prescribed by the *NCF-2005*.

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