Transaction of Science Curriculum towards Sustainable Development

[Sustainable Wheel of Science Curriculum]

*Fouzia Khanam,**Nikhat ,***Dr. Zebunnisa Khan

Curriculum is the medium of instruction for the formal education system addressing the future generation of a country. As we know that social change is a dynamic phenomenon, as is the medium through which it is instructed. So curriculum is always in a dynamic state, understanding this curriculum should always be with the pace of time dynamics. Hence curriculum should fulfil the need of the present generation and prepare them for future. We know that preparing the present generation such that it looks after the need of future generation, is what known as the concept of sustainability. In present world dogmas and belief has no worth if it has no reason to support it, the reason which is the basis of science and its education. So, the reasoning ability is the basis of construction or destruction of the societies' future, and thus the concept of sustainability should be at the very centre of reasoning and consequently at the core of science curricula. The objectives of the study are;1) to analyse the structure of revised blooms taxonomy in its various domains(i.e. cognitive, affective and conative),2) to study the components of education for sustainable development(ESD, i.e. knowledge, skills, perspectives, values, and issues), 3) to find out these components in the secondary school science curriculum(NCERT) through content analysis and 4) to suggest new science curriculum model that transacts to promote sustainable development in India.

In this study, a descriptive methodology had been followed in which data were gathered by document analysis and were analysed in the line with the determined constituents of sustainable development(i.e., Environment, Economic and Social).In this study we are not proposing something big but just trying to give an impetus to academician, curriculum developer and policy maker to imbibe the concept of sustainability at the core of curriculum in form of structure of learning taxonomies to attain sustainable development through classroom instruction in the cycle of local to global level("Think locally, Act Globally").

*Research scholar, **Research scholar and *** Associate professor

 Department of Education, Aligarh Muslim University, Aligarh

1. INTRODUCTION

Learning is the acquisition of knowledge. Knowledge which grew with a word, slowly accumulation of words developed into understanding, and gradually to its application in different field and then finally becoming specialist in the related field. This pattern of knowledge acquisition is classified in form of taxonomy with the help of learning objectives.

It was first published in 1956 under the title ,*Taxonomy of Educational Objectives: The classification of Educational Goals: Handbook I:Cognative Domain(Bloom, Engelhart, First, Hill, & Krathwohl,1956).*After 45 years this taxonomy was developed which came to be known as revised taxonomy. The original taxonomy has cognitive levels that were categories as: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. The categories were ordered from simple to complex and from concrete to abstract. This taxonomy was in cumulative hierarchy and the mastery of each simpler category was prerequisite to master the next more complex one (Krathwohl, 2002). Learning objectives using verbs from the taxonomy have at least two parts: (i) A noun or noun phrase identifying who is performing the action and (ii) A verb phrase describing the required behaviour. The verb associated with each cognitive level met the learning objectives but this learning only fulfil the lower order skills, to attain the higher order and to attain mastery over it, there was a need to construct learning objectives at the level that you expect learners to perform and this was the fatal flaw of original Blooms taxonomy.

The revised taxonomy shifted from what teacher does to what student experience through classroom instruction. So the revision of Blooms taxonomy was published by Lorin Anderson in 2001, *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's taxonomy of Educational Objectives.* In revised taxonomy, evaluation is no longer the highest level of the pyramid, a new category *creating* is mounted on the highest level of the pyramid. This category was originally known as synthesis. The instruction in earlier taxonomy was limited to the knowledge level; and the verbs associated with each cognitive level describe behaviours, which embodied both noun and verb aspects, but knowledge is a category of dual nature which is also a subject matter and something which is to be attained, hence it has a dual nature and thus it is different from the other taxonomic categories. "This anomaly was eliminated in revised Taxonomy by allowing these two aspects, the noun and verb, to form separate dimensions, the noun providing the basis for knowledge dimension and the verb forming the basis for the Cognitive Process dimension"(Krathwohl,2002,p.213).And now the knowledge was categories according to the type of content; factual, conceptual, procedural and metacognitive. These four categories of knowledge are arranged from the most concrete to the most abstract. The most abstract level of knowledge, *metacognitive* knowledge is about cognition in general, as well as awareness, and knowledge about one's own cognition. In the cognitive process dimension, the six original numbers of categories was retained. The knowledge category was replaced with lower order of thinking skills, knowledge in form of verb i.e., *Remember.* The cognitive process dimension expressed in form of verb is not behaviour that was in original Taxonomy but thinking skills, from lower to higher order cognitive skills, from the most basic to the most complex. The other categories like; Comprehension was renamed *Understand,* Application,

Analysis, and Evaluation was retained, but in their verb forms as *Apply, Analyse and Evaluate.* Synthesis place was changed and was renamed, as mentioned earlier, as *Create*. The 19 specific cognitive processes within six major categories, that helps to characterize each category's breadth and depth are recognize, recalling, interpreting, exemplifying, classifying, summarizing, inferring, comparing, explaining, executing, implementing, differentiating, organizing, attributing, checking, critiquing, generating, planning and producing. And thus the revised taxonomy is entirely based on expansion of the cognitive process; it is based on the broader vision of learning that includes acquiring knowledge but also being able to use it to the optimum level.

A taxonomy of learning teaching and assessing: A revision of Bloom's taxonomy of Educational Objectives

The Knowledge Dimension	Metacognitive	Identify	Predict	Use	Deconstruct	Reflect	Create
	Procedural	Recall	Classify	Carryout	Integrate	Judge	Design
	Conceptual	Recognize	Classify	Provide	Differentiate	Determine	Assemble
	Factual	List	Summarize	Respond	Select	Check	Generate
		Remember	Understand	Apply	Analyze	Evaluate	Create
	The cognitive Process Dimension						

2. SIGNIFICANCE OF STUDY

The Bloom's taxonomy is the basis of majority of curriculum construction, but theories of curriculum is unable to tap energy within, as there is more to do always. Benjamin S. Bloom motivated educationist by his opinion that this taxonomy should not be considered as final framework, it should not freeze with time, and it needs continuous reframing and remoulding the structure to reach the goal of education. He also suggested that each stream should have its own curriculum. Keeping the dynamic nature of curriculum in consideration and need of the present hour, tapping the hand on the two most needed and talked about in today's world, Science Education and ESD(Education for sustainable development) we are trying to give a way to search something new.

As per National Focus Group on Teaching Science, published in 2006, the textbook is the diverse tool for curriculum transaction, so there is need of basic idea of a model curriculum at the national level that should only be seen as a way to set uniform general standards of education throughout the country. "A common syllabus (or small variations of it) and common

textbooks are certainly not to be expected for the country as a whole. School systems in different states must devise their own curriculum. The larger states particularly need to reflect their diversity in their curricula". The most important consideration while developing a science curriculum is to ensure a reduced emphasis on mere information and provide greater exposure to what it means to practice science.

To bring theory into practise, we need something very fundamental in nature, science by nature is very natural which has now created an artificial world around us, and is now blamed to be so much unsustainable. So there is need to see transaction of science curriculum towards sustainable development.

EDUCATION FOR SUSTAINABLE DEVELOPMEMT (ESD)

Education for sustainable development reorients education to teaching and learning of knowledge, skills, perspectives, and values that will guide and motivate people to pursue sustainable livelihoods, to participate in a democratic society, and to live in a sustainable manner. Something which is natural is sustainable, and the nature exists in its laws, the natural laws which are the cause of our existence, we studied these laws with help of science, so the attitude through which we study science should be sustainable attitude. So what is the science that connects natural science and sustainable attitude? We the human beings are common medium through which nature and science interacts, and our thoughts in its pure form is the transactional medium, our thoughts become words, words becomes action, and actions are our behaviours. Education is a journey from this thought to our behaviour pattern, and sustainable development is like wheel, having three spokes; economic development, social development and environmental development, having education at its centre. Economic sustainable development is a means, Social sustainable development is a medium, and environmental sustainable development is the goal of sustainable development, and education is a chain that binds all three together. Although education increases the income of people, they consume more resource than the poor who is less educated and has poor income. For example, the United States, more education has not led to sustainability, meeting these challenges depends on reorienting the curriculum to address the need for more sustainable production and consumption. ESD carries an inherent idea that the implementing programmes are locally relevant and culturally appropriate. ESD when introduced by Chapter 36 of Agenda 21. This chapter identifies four major thrust to begin the work of ESD: (1) Improve education (2) reorient existing education to address sustainable development, (3) develop public understanding, awareness, and (4) training.

In reorienting education, ESD relates the knowledge not only with the three dimensions of sustainable development, but also with the learning skills, perspective and values that promote sustainable development. ESD involves studying local, and when appropriate, global issue. There are five components that are focussed to reorient the curriculum; Knowledge, Issues, Skills, Perspectives and Values.

Knowledge here means, the base that support sustainability goals, like some of the authors consider peace, equity and justice necessary for sustainable society. Although, better quality

of life for all, in just and equitable manner is sustainability (Agyeman, J.) in a manner but communities must choose culturally appropriate and locally relevant sustainability goals.

Skills are not only learning global issues but an also practical skill that enables them to continue learning and help them to live sustainable lives. The ability to communicate effectively, the ability to think, forecast, plan, criticize, etc. The skill and knowledge both span under the three realms of sustainable development.

It is found that topics of ESD are inherent in the part of the formal education curriculum, but these topics are not identified as the part which contributes sustainable development. The strength model associated with each discipline's pedagogical content teaches us creativity, critical thinking, and all mental habits that support sustainable development. So the cadre of educators and administrators are urged through educational development toolkit, that the trans-disciplinary concepts inherent in ESD to pull together the pedagogical pieces to build a comprehensive ESD program. This knowledge and skill together if considered in cognitive domain of Bloom's Taxonomy could fulfil the above intention of the framers of ESD.

3. METHODOLOGY

The content analysis of each chapter of the NCERT Science textbooks was based on the action verbs used in Science as well as needed for potential sustainable development. Firstly, we searched for the adjective used for Science from National Focus Group on Teaching Science(NCERT,2006), and then converted these adjective to verb form, which are the same as action verb for framing learning objective in cognitive domain. The verbs found were, imagine, inquire, hypothesis, reason, verify, falsify, design, create, plan, speculate, conjecture, predict, explain, inform. Some more verbs were also found, for example; neutrality, objectify, wisdom, tolerate and observe, but they were discarded as they were action verb of affective domain.

The verbs defining the goals of sustainable development were taken from the books of ESD, the verbs are; think, forecast, criticize, differentiate, know, inquire, act, judge, imagine, connect, chose, create, innovate adopt, diversify and decide. The other words which either did not fall in the category of cognitive domain, or it cannot be converted in verb form, for example; co-operate, stewardship, accountability, cohesiveness, tolerance and novelty.
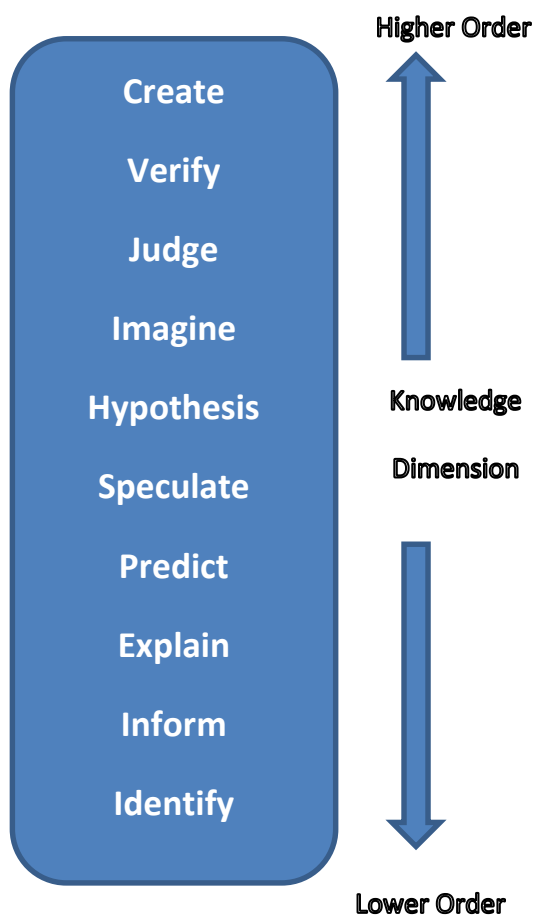
The common verbs from both the lists were taken out, and the words which were synonyms were simplified and counted in each of the cognitive process dimension according to the new Bloom's Taxonomy. A similar interpretation was done according to the level of knowledge. The significant work was to see these common verbs in the context it is used, whether it is used for pure science and technology or whether it is helpful in the field of sustainable development according to the ESD key concept(citizen and stewardship, sustainable change need and rights of future generation interdependence diversity quality of life equity and justice uncertainty and precaution (kandangama,K.G.C,2015).Using percentage and simple calculation method the interpretation was drawn out.

4. ANALYSIS AND INTEPRETATION

Interpretation of Table No.1: Common action verb of Cognitive Skills present in knowledge dimension of science and technology and sustainable development.

Cognitive Skills / Knowledge	Remember	Understanding	Apply	Analysis	Evaluation	Create
Science and Technology	Recall, Naming, Define, Listing	Explore, Judge, Indicate, Classification	Imagine, Predict, Speculate, Resemble	-	Verify, Determine	-
Sustainable Development	Naming, Inform	Judge, Classification	Resemble	-	Determine	-

1. In this table the investigators first of all find out all the common action verb of cognitive dimension from remember to create of both science and technology and sustainable development and prepare a list then did content analysis of class 9th and 10th textbook of NCERT to measure how many action verb are towards science and technology and how many are towards sustainable science.
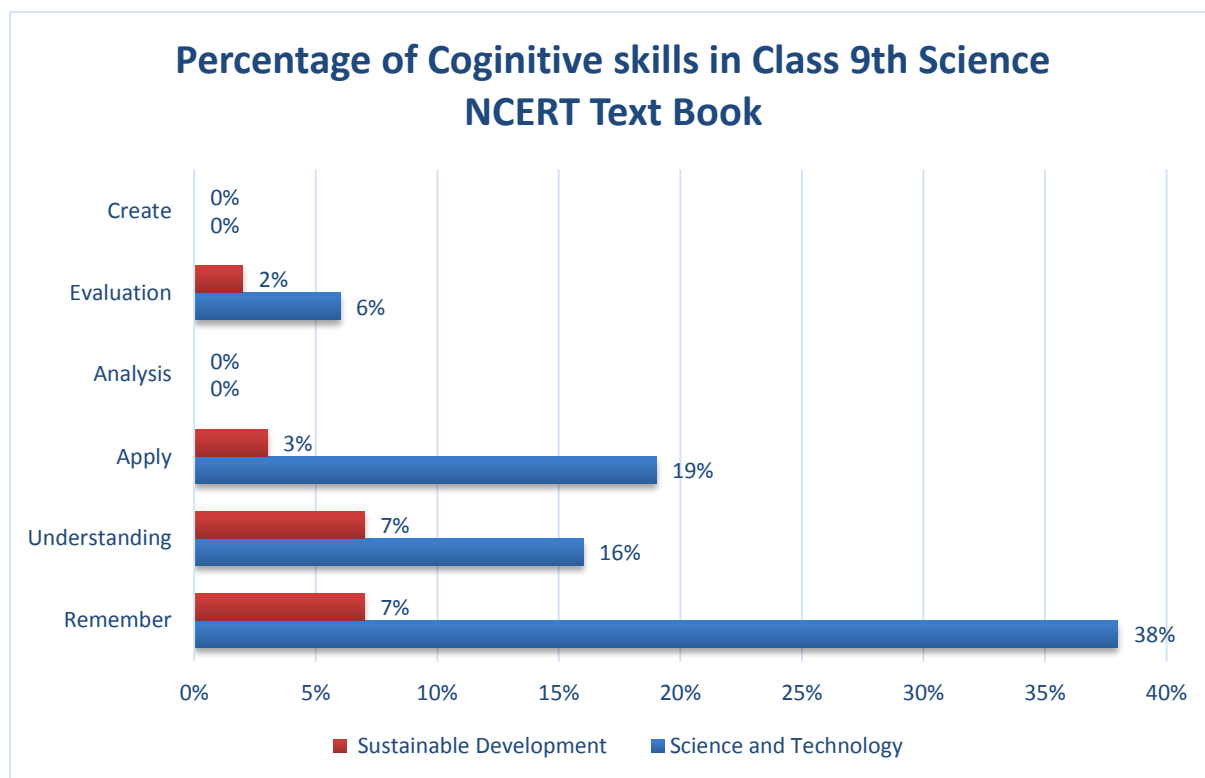

Common Action verb of Cognitive Dimension in Science and Technology and Sustainable Development

Interpretation of Table No.2: Percentage of Cognitive Skills present in NCERT 9th class Textbook:

Knowledge \ Cognitive Skills	Remember	Understanding	Apply	Analysis	Evaluation	Create
Science and Technology	38%	16%	19%	0%	6%	0%
Sustainable Development	7%	7%	3%	0%	2%	0%

2. After content analysis of NCERT of class 9th science textbook it was found that more weightage is given to Remember (38 %), Understanding (16%), apply (19%) and Evaluation (6%) dimension of cognitive skills but the ability of Analysis and Create is present in least amount in knowledge context of science and technology and Remember (7 %), Understanding (7%), apply (3%) and Evaluation (2%) dimension in knowledge context of sustainable development dimension of Analysis and Create is least present at all. This study attempts to explore the ways in which science textbooks structured to promote higher order of cognitive skills and the content should be more and more towards sustainable science.

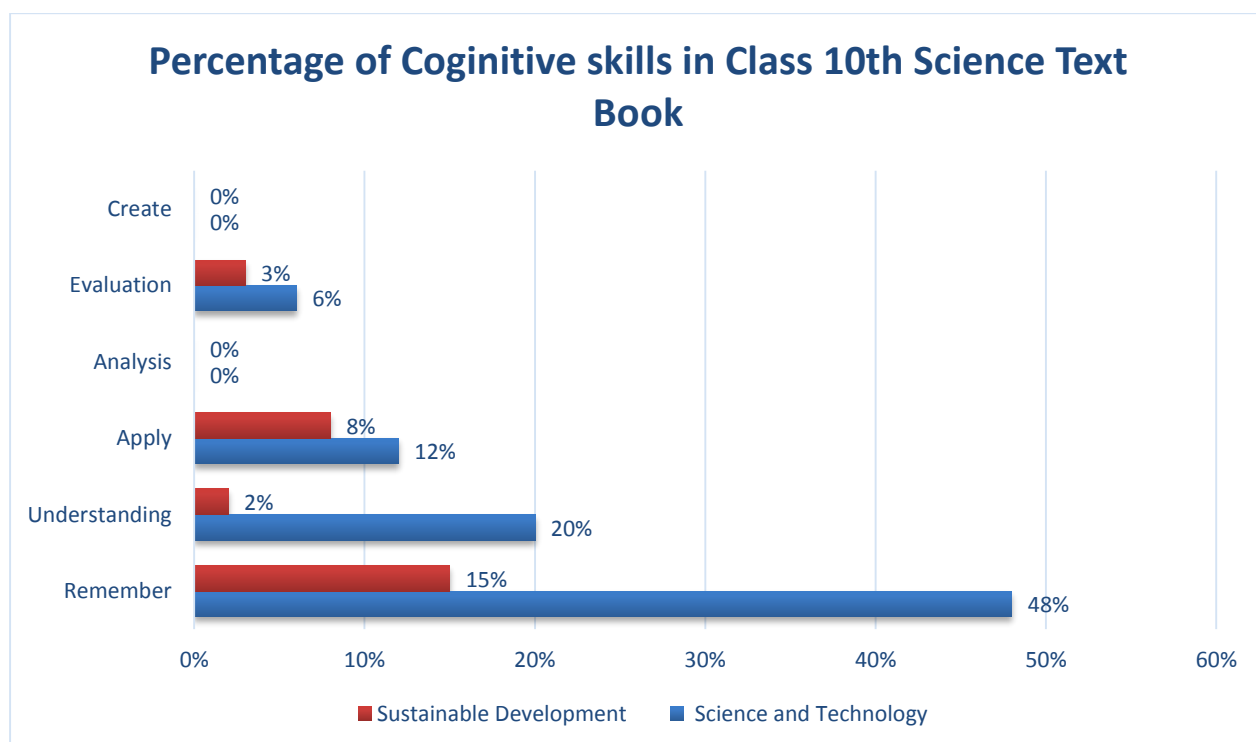**Fig.2:** Showing Percentage of cognitive Skills present in NCERT 9th class science textbook:

Percentage of Coginitive skills in Class 9th Science NCERT Text Book

Interpretation of Table No.3: Percentage of cognitive dimensions present in NCERT 10th class science textbook:

Cognitive Skills / Knowledge	Remember	Understanding	Apply	Analysis	Evaluation	Create
Science and Technology	48%	20%	12%	0%	6%	0%
Sustainable Development	15%	2%	8%	0%	3%	0%

1. After content analysis of NCERT of class 10TH science textbook it was found that more weightage is given to Remember (48 %), Understanding (20%), apply (12%) and Evaluation (6%) dimension of cognitive skills but the ability of Analysis and Create is present in least amount in knowledge context of science and technology and Remember (15 %), Understanding (2%), apply (8%) and Evaluation (3%) dimension in knowledge context of sustainable development dimension of Analysis and Create is least present at all. This study attempts to explore the ways in which science textbooks structured to promote higher order of cognitive skills and the content should be more and more towards sustainable science.

Fig.3: Percentage of cognitive dimensions present in NCERT class 10thscience textbook:

5. DISSCUSSION:

In this study we took the sample of NCERT class 9th and 10th science textbook. In the textbooks content analysis was done and investigators tried to identify the component of cognitive skills in the content of textbook. The investigators consider that the knowledge of sustainable development is taken into 5 dimensions viz, knowledge, skill, issues, perspective and values. But the investigators choose only knowledge and skill for content analysis of NCERT of class 9th and 10th science textbook.

1. The analysis of the NCERT textbook of class 9th reveals that the very low weightage has been given to higher order domain of cognitive skills like analysis, evaluation and create for knowledge context of both science and technology dimension and sustainable development dimension of science textbook.
2. After analysis of the NCERT textbook of class 10th the same result found that there was very low weightage has been given to higher order domain of cognitive skills like analysis, evaluation and create knowledge context of both science and technology dimension and sustainable development dimension of science textbook.

6. CONCLUSION:

Content analysis of NCERT Textbook of class 9th and 10th concluded that contents of sustainable development and Science and technology in science textbook were not fulfilling the objectives of ESD.Both NCERT of class 9th and $10^{th\ of}$ Science Textbook, more stress is given only on enriching the lower order of cognitive ability that is Remember, Understand and Apply. Objectives of higher order of cognitive skills that is Analyse, Evaluate and Create was fulfilled partially. The content materials of the class 9th and $10^{th\ of}$ Science Textbook were not sufficient to develop sustainable science and ability to solve problems of daily life scientifically. The contents integrated in NCERT of class 9th and $10^{th\ of}$ Science Textbook should be given more weightage to higher order of cognitive skills that is analysis, evaluation and create. More projects activities need to be included in NCERT of class 9th and 10th of Science Textbook.

7. DELIMITATIONS

Some delimitation was necessary to direct the topic in particular direction.

1) This paper is limited to the cognitive domain of the taxonomy,
2) The content analysis is done of only one each of the chapter of NCERT Science book of Class IX and Class X, respectively.
3) Even the action verbs related to technological advances are include in the scientific skill

8. BIBLIOGRAPHIC REFERENCES

www.celt.iastate.edu retrieved on 26/12/2015

Craciun, D. (2012).Journal of Science and Arts: *From to science in arts to the art of teaching science,*1(18),93-98.

Krathwohl, D.R.(2002). A Revision of Bloom's Taxonomy: An Overview. *Theory into Practise,* 41(4), 212-218.

Kandangama,K.G.C.(2015)*Education for sustainable development(ESD)key concepts included in the schools textbook and teacher manual for secondary core subjects in Srilanka,*3RD Global summit on Education GSE 2015,Kulalumpur,Malaysia.

Pintrich, P.R.(2002).The Role of Metacognitive knowledge in Learning, Teaching, and Assessing. *Theory into Practise,* 41(4), 219-225.

Mayer, R.E. (2002). Rote Versus Meaning Learning. *Theory into Practise,* 41(4), 226-232.

Mangal, S.K.,& Mangal, S. (2009). *Teaching of Physical Science*. Meerut: Bhagwati Printers.

www.esdtoolkit.org. retrieved on 25/12/2015

Hargreaves, A., & Fink, D. (2006). *Sustainable Leadership.* U.S.A: Jossey-Bass.S

www.elearningGuild.com retrieved on 10/12/2015

NCERT(2006). *Science Textbook for Class IX*. New Delhi: National Council of Educational Research and Training (NCERT).

NCERT(2006). *Science Textbook for Class X*. New Delhi: National Council of Educational Research and Training (NCERT).