National Curriculum for

GENERAL SCIENCE

Grades IV-VIII

2006

GOVERNMENT OF PAKISTAN
MINISTRY OF EDUCATION
ISLAMABAD

Table of Contents

1 Introduction

Pakistani society is experiencing rapid and fundamental economic, social, and cultural changes that are drastically affecting our ways of life. Pakistanis are also becoming aware of an increasing global interdependence and the need for sustainable environment, economy, and society. The emergence of a highly competitive and integrated international economy, rapid technological innovation, and a growing knowledge base will continue to have a profound impact on people's lives. Advancements in science and technology are playing an increasingly significant role in everyday life. Therefore, science education will be a key element in developing scientific literacy and in building a strong future for Pakistan's young generation.

Learning in science is fundamental to understanding the world in which we live and work. It helps people to clarify ideas, to ask questions, to test explanations through measurement and observation, and to use their findings to establish the worth of an idea. Science is not seen as merely objective and value free but is recognized as being part of human experience. As such it is an integral part of daily life and relevant to everyone.

Science, technology, and society are responsive to each other. While science may act as a catalyst for change, it is also influenced by technological advances and social and economic pressures. The applications of science affect our environment and the way we live our lives.

The Ministry of Education, Government of Pakistan, Islamabad, constituted Curriculum Review & Development Committees/Groups whereby these Committees/Groups has been assigned to review the existing Curricula of all core Science and Humanities Subjects (Grades I-XII) as well as to provide the revised Curricula for these Subjects.

For the General Science Curriculum the committee held several meetings & deliberations on various issues pertaining to the current state of science education in the country including science curriculum, textbooks, teaching, assessment, and schools' infrastructure. The sole purpose of holding such deliberations has been to review the existing science curriculum in the light of ground realities, and to develop a National Science Curriculum Framework that will serve as a foundation document for the promotion of school science education in Pakistan according to the required standards of education in the 21st century.

The committee went through a number of national and foreign case studies encompassing the needs assessment on which the existing Pakistan science curricula should be revised and a new Science Curriculum is developed. Also a need assessment was carried out through interactive consultations with various science teachers, scientists & science educators, school administrators, textbooks writers and other stakeholders. And subsequently, the following goals for the school science education in Pakistan have been determined:

- *Encourage students at all grade levels to develop a critical sense for wonder and curiosity about scientific and technological endeavors;*
- *Enable students to use science and technology to acquire new knowledge and solve problems, so that they may improve the quality of their own lives and lives of others;*
- *Prepare students to critically address social, economic, ethical, and environmental issues related to science and technology;*
- *Provide students with a foundation in science that creates opportunities for them to pursue progressively higher levels of study, prepares them for science-related occupations, and engages them in science-related activities appropriate to their interests and abilities; and*
- *Develop in students, of varying aptitudes and interests, and the knowledge of wide variety of careers related to science, technology, and the environment.*

The overall goal of science education in Pakistan is therefore to develop scientific literacy. The accomplishment of this goal within the school context can take place only if certain opportunities are presented. The Science Curriculum, inter alia, is fundamental to the science education, which provides a systematic approach to the students' learning in science in a well-defined and organized framework. While teachers shall play the most significant role in helping students achieve scientific literacy, they will need support from the rest of educational system in terms of necessary training in teaching science, teaching aids/material, and most importantly an enabling and conducive environment, if the challenge of science education is to be met.

Therefore this General Science Curriculum is to act as a foundation document for achieving the goal of developing scientific literacy in a systematic way for all students, which will:

- Address the three basic scientific fields of study – life, physical, and earth and space science. From Grades IV to VIII, all students will be exposed to all fields. At the secondary and/or higher secondary school levels students may opt to take specific

science subjects. However, in all cases attempts have been made to develop the connections among the basic sciences;

- Engage students in inquiry, problem solving, and decision-making situations and contexts that give meaning and relevance to the science curriculum. These include the process of science such as predicting and formulating hypothesis, higher-level skills such as critical thinking and evaluating, and manipulative skills such as use of the microscope or a balance;
- Promote the use of learning materials - print and non-print resources and textbooks developed in an interesting and interactive style, laboratory equipment, internet and computer, which will provide a substantial part of the students' experience;
- Exhibit the character of science to be open to inquiry and controversy, and free of dogmatism; promote student understanding of how we came to know what we know and how we test and revise our thinking;
- Provide students the opportunities to construct the important ideas of science, which are then developed in depth, through inquiry and investigation;
- Encourage students' own experiences and interests by frequently using science learning activities and hand-on experiences that are integral to the instructional sequence; and
- Incorporate assessment approaches that are aligned with the science teaching instructions and correlate with the intended learning areas such as learning strands, content standards, benchmarks and student learning outcomes.

However, students' achievements in science and in other subjects like, mathematics, social studies, English and Urdu languages, and Islamic/religious studies are to be enhanced by coordination between and among the science teaching programs. Such coordination will maximize use of time in a crowded school schedule.

General Aims and Objectives

Following aims and objectives have been defined to achieve the above mentioned objectives of science education at the primary and middle schools level:

Aims: This curriculum aims to promote scientific literacy among the students by:

- Helping students to develop knowledge and a coherent understanding of the living, physical, material, and technological components of their environment;

- Encouraging students to develop skills for investigating the living, physical, material, and technological components of their environment in scientific ways;
- Providing opportunities for students to develop the attitudes on which scientific investigation depends;
- Promoting science as an activity that is carried out by all people as part of their everyday life;
- Portraying science both as a process and a set of ideas, which have been constructed by people to explain everyday and unfamiliar phenomena;
- Encouraging students to consider the ways in which people have used scientific knowledge and methods to meet particular needs;
- Developing students' understanding of the evolving nature of science and technology;
- Assisting students to use scientific knowledge and skills to make decisions about the usefulness and worth of ideas;
- Helping students to explore issues and to make responsible and considered decisions about the use of science and technology in their environment;
- Developing students' understanding of the different ways people influence and/or are influenced by science and technology;
- Nurturing scientific talent to ensure a future scientific community; and
- Developing students' interest in and understanding of the knowledge and processes of science that will form the basis of their future education in science & technology and careers.

Objectives: Main objectives of this document are to:

1. Emphasize scientific literacy for all students;
2. Promote inquiry-based and student-centered science education;
3. Emphasize understanding, not content coverage;
4. Promote learning that is useful and relevant;
5. Promote interdisciplinary learning;
6. Promote spiritual and moral development of the students; and

7. Act an effective instrument for a systematic and lifelong learning of the students of Grades IV-VIII and for all stakeholder of the Pakistan school education system including administrators, teachers, students, parents, and civil society.

Nevertheless, this document is intended to encourage all students to continue their participation in science education beyond the Grade-VIII. It is expected that many students with ability and interest in science will further continue their science education in the senior school. Some will continue to study science as an integrated subject, some will study specialist science subjects, and others may do both.

And therefore, this document has been divided into the following components in order to achieve the desired aims and objectives:

- Curriculum Focus
  - The Inquiry-based Curriculum
  - The Student-centered Curriculum
  - An Outcomes-focus Curriculum
- The Conceptual Map for the Curriculum Outcomes
- Criteria for the Selection of:
  - Content Strands and Standards, and Benchmarks
  - Students' Learning Outcomes (SLOs), Grades IV-VIII
  - SLOs and Benchmarks Achievement Objectives
- The Content Strands, Standards, and Benchmarks, Grades IV-VIII
- Grade-wise Learning Units Distribution Matrix, Grades IV-VIII
- Learning Contents and the Students' Learning Outcomes, Grades IV-VIII

2 Curriculum Focus

2.1 Inquiry-based Curriculum

Science is a systematic process of inquiry about natural phenomena. It is through this systematic process of inquiry that the content of scientific knowledge is derived. When science is taught as a process of inquiry, students learn how to be scientists. When students use inquiry to discover content, they not only learn a great variety of facts and concepts, but they also learn how these are related to each other, and how it is that we human beings come to understand our world and add to the great body of information we call knowledge.

Inquiry-based approaches to science education focus on student constructed learning as opposed to teacher-transmitted information. An Inquiry-based Curriculum literally dictates inquiry approaches in teaching, if the development and enhancement of students' ability to think scientifically, critically, and creatively is an expected outcome. Therefore, this Curriculum presents a paradigm shift from the characteristics of traditional approaches to inquiry-based approaches in the following manner:

	TRADITIONAL	**INQUIRY BASED**
Principle Learning Theory	*Behaviorism*	***Constructivism***
Student's Participation	*Passive*	***Active***
Student's Involvement in Outcomes	*Decreased Responsibility*	***Increased Responsibility***
Student's Role	*Direction Follower*	***Problem Solver***
Curriculum Goals	*Output Oriented*	***Process Oriented***
Teacher's Role	*Director/Transmitter*	***Guide/Facilitator***

Therefore this Science Curriculum, which strives for scientific literacy, is intended to engage students in asking and answering meaningful questions. The teacher will pose some of these questions, while the students will generate others. Generally these questions are: "Why…?" "How…?" and "Should…?" And there are three basic processes used to answer these questions. ***Scientific Inquiry*** addresses "why" questions. "How" questions are answered by engaging in the ***Problem Solving*** process and "should" questions are answered by engaging in ***Decision Making***.

***Scientific Inquiry*:** The first of the three processes, scientific inquiry, is a way of learning about the universe. It involves the posing of questions and the search for explanations of phenomena. Although there is no such thing as "scientific method", students will require certain skills to participate in the activity of science. There is general agreement that skills such as **questioning, observing, inferring, predicting, measuring, hypothesizing, Classifying, designing experiments, collecting data, analyzing data, and interpreting data** are fundamental to engaging in science. These skills are often represented as a cycle, which involves the posing of questions, the generation of possible explanations, and the collection of evidence to determine which of these explanations is most useful in accounting for the phenomena under investigation. Therefore teachers are required to engage students in scientific inquiry activities to develop these skills.

***Problem Solving*:** The second process, problem solving, seeks solution to human problems. It is also often represented as a cycle. In this Curriculum the cycle represents the **proposing, creating, and testing of prototypes, products, and techniques** in an attempt to reach an optimum solution to a given problem. The skills involved in this cycle often called the design-technology (DT) cycle, facilitates a process, which has different aims and different procedures from the inquiry process. Nevertheless students have been provided an ample opportunity in this science curriculum **to propose, perform, and evaluate solutions to problem solving or technological tasks or questions.**

Effective science instruction will help students develop certain habits of mind as well as higher-level thinking skills. Research has shown that teaching methods and techniques are as important as the science being taught. Problem solving is intimately related to scientific investigation. Advances in medicine, communications, transportation, and industry are examples of progress in society due to citizens possessing essential scientific knowledge and skills. Today's world is linked via the media and sharing of information in many arenas. Science instruction, therefore, needs to include the processes that foster these skills that are critical to everyday living.

***Decision Making*:** The third process is decision making. It is the determination of what we as global citizens, should do in a particular context or in response to given situation. Increasingly, the types of problems that we deal with, both individually and collectively require an understanding of the process and products of science and technology. The actual process of decision making involves **the identification of the problem and situation, generation of possible solutions or courses of action, evaluation of the alternatives, and a thoughtful decision based on the information available**.

Therefore students are desired to be actively involved in decision making situation as they progress through the Science Curriculum. Decision making situations not only are important for their own rights, they also often provide a relevant context for engaging in scientific inquiry and/ or problem solving.

An example of the questions "Why", "How" and "Should"

Questions	**WHY does my tea cool so quickly?** ***(Science Question)***	**HOW can I make a container to keep my tea hot?** ***(Technology Question)***	**SHOULD we use Styrofoam cups or Ceramic mugs for drinking tea?** ***(STSE Question)***
Process involved in answering the Question:	Scientific Inquiry	Technological Problem Solving	Decision Making
Response:	Heat energy is transferred by conduction, convection, and radiation	A Styrofoam cup will keep liquids warm for a long time	Personal health, the environment, cost, and availability must be considered along with science and technology information
Problems arise from:	Curiosity about events and phenomenon in the natural world	Copying with every day life, practices, and human needs	Different views or perspectives based on different or the same information
Types of Questions:	What do we know? How do we know?	How can we do it? Will it work?	What alternatives or consequences are there? Which choice is best at this time?
Solutions result in:	Knowledge about the events and phenomena in the natural world	An effective and efficient way to accomplish a task	A defensible decision in the particular circumstances

(Modified from the Science Curriculum of Canada)

2.2 The Student-centered Curriculum

The student is the centre of science learning. Learning experiences in science need to be relevant to students' daily living. Students are more interested and easily engaged in learning, which uses everyday materials, when they can make decisions about issues that relate to their immediate environment and discover the 'science' of how things work. In this way students learn to become people who use science and scientific information in their lives.

Science and technology are major influences in many aspects of our daily lives, at work, at play, and at home. Therefore quality learning in science has been promoted uniformly at national level, by focusing on all students irrespective of their gender and socio-economic & cultural diversity, living in urban or rural areas of Pakistan so as to cohesively satisfy their current needs and expectations of the future.

Nevertheless it is aimed to present a uniform approach to the science education at primary and middle schools level, so as to:

1. Improve the quality of education for all students through shared expertise and resources;
2. Ensure that the education students receive throughout Pakistan is equitable; and
3. Meet the needs of student and socio-economic development of the Country.

Also a need was recognized to provide a set of well-defined **General Curriculum Outcomes (Learning Strands and Content Standards), Key Stage Curriculum Outcomes (Benchmarks), and Specific Curriculum Outcomes (Students' Learning Outcomes – SLOs)** for the students of Grades IV-VIII, which will provide a consistent framework for science education at primary and middle schools level so that all students should be:

- Knowledgeable about the important concepts and theories of the three major branches of scientific study: earth and space, life, and physical sciences;
- Able to think scientifically and use scientific knowledge to make decisions about real–world problems;
- Able to construct new knowledge for themselves through reading, discussion, and science learning activities;
- Familiar with the natural world, and respectful of its unity, diversity, and fragility;

- Able to make informed judgments on statements and debates claiming to have a scientific basis; and
- Able to reflect in an informed way on the role of science in human affairs.

2.3 An Outcomes-focused Curriculum

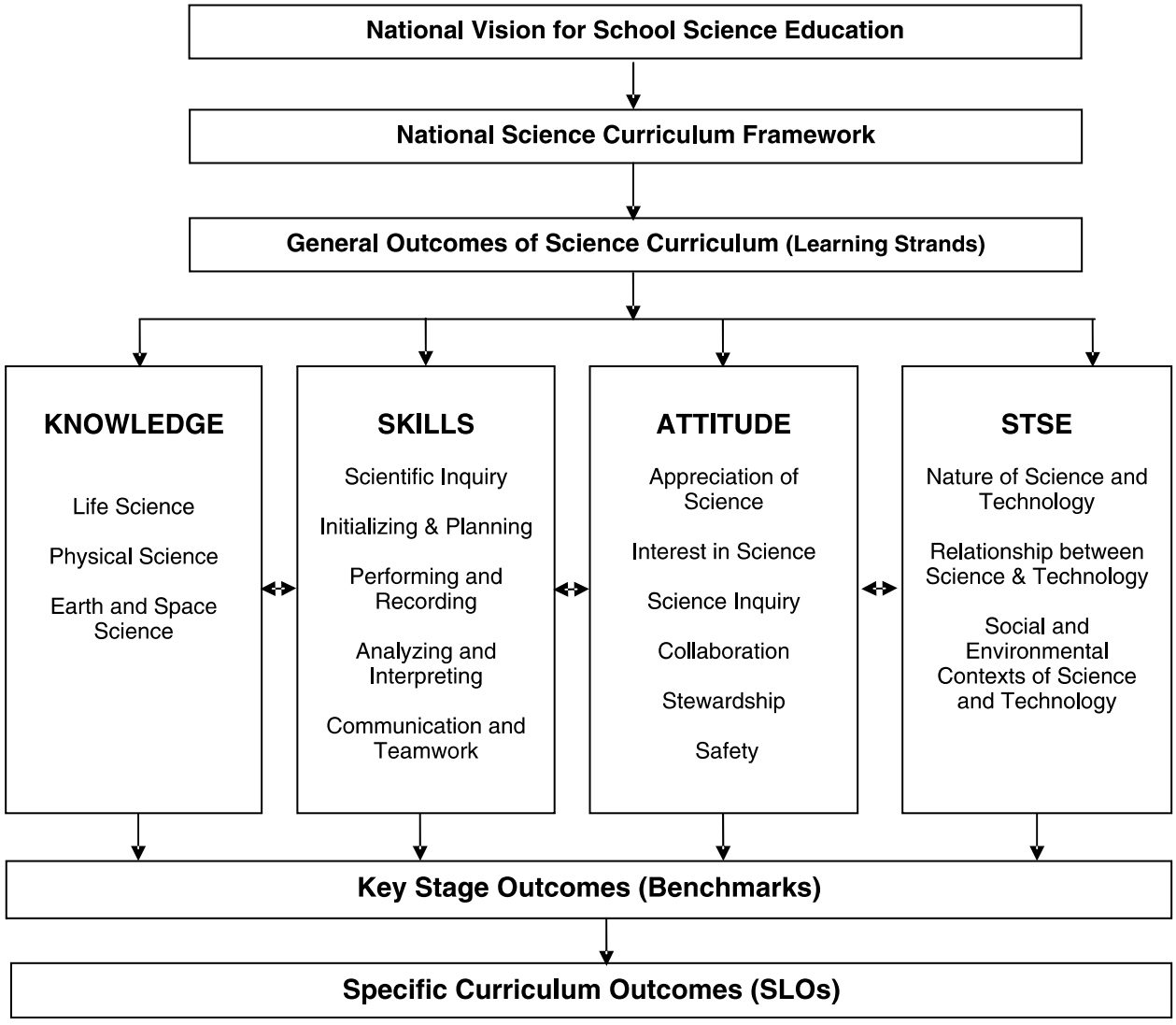
This Science Curriculum is an Outcomes-focused framework for the school science education and intended to:

1. Specify a set of well-defined outcomes in the form of Essential School Graduation Learnings (after Prep & 12 years of schooling), Conceptual Map for the Curriculum Outcomes, General Curriculum Outcomes (Standards), Key-stage Curriculum Outcomes (Benchmarks) and Specific Curriculum Outcomes (Students' Learning Outcomes) that have been presented hereunder, for both students and teachers to achieve;
2. Provide a basis for study programs that will challenge all students and offers all students opportunities to achieve these outcomes;
3. Recognize and value the different knowledge and experience of different students; and
4. Take into account the diversity among children and young adults in Pakistan: in terms of gender, language, culture, learning capacity, socio-economic background, and geographic location.

However, a small number of students with specific physical and/or intellectual disabilities may not be able to participate fully in the learning activities and programs to achieve certain outcomes in this curriculum document.

2.4 The Conceptual Map for the Curriculum Outcomes

The conceptual map below provides the blueprint of the outcomes framework and is the basis from which general and key-stage outcomes (benchmarks) have been developed. At all times when making use of this Curriculum, educationists and teachers must keep in mind that the outcomes are intended to develop scientific literacy in students. The core objective of scientific literacy in this document sets out the need for students to acquire science-related Knowledge, Skills and Attitudes, and emphasis that this is best done through the study and analysis of the interrelationship among Science, Technology, Society and Environment (STSE).



Criteria for the Selection of:

- **Learning Strands, Content Standards, and Benchmarks**
- **Students' Learning Outcomes (SLOs), Grades IV-VIII**
- **SLOs and Benchmarks Achievement Objectives**

Learning Strands (General Curriculum Outcomes)

Learning Strands are the major learning areas, for example, knowledge, skills, attitude, and application, that student will be educated to in a curriculum framework.

In this Science Curriculum, following six (6) learning strands have been selected for the students of Grades IV-VIII:

1. Life Science,
2. Physical Science, and
3. Earth and Space Science.

These strands will cover the first part of the General Curriculum Outcomes, i.e., Knowledge.

1. Skills,
2. Attitudes, and
3. Science, Technology, Society, and Environment (STSE).

These are called the Integrating Strands, which will cover the remaining three parts of the General Curriculum Outcomes.

This division into six strands is a convenient way of categorizing the outcomes for science education in primary and middle schools. It emphasizes that there are a number of aspects to science, all of which are important. The division does not mean that learning in each strand is to be developed independently from learning in other strands.

Science is both a process of inquiry and a body of knowledge; it is an integrated discipline. The development of scientific skills and attitudes is inextricably linked to the development of ideas in science. Similarly, as students' ideas evolve, they should be acquiring an understanding of the nature of science and its relationship to technology, society, and the environment. Consequently, when planning and implementing a science curriculum, the

integrating strands should be interwoven with the three contextual strands (knowledge). Teachers should also seek ways to reflect the integrated nature of science by linking achievement objectives and learning experiences across the three contextual strands with that of the other objectives of the National Science Curriculum.

Content Standards

Content Standards are basically the descriptions of the Contextual or Content Strands. Content Standards outline what students should know and be able to do in Science.

This curriculum focuses on the subject matter of science, including the learning units/theories, concepts, and principles that are essential to an understanding of each science area. Therefore, following widely accepted science disciplines has been selected as Content Standards for the Science Curriculum (Grades IV-VIII):

Life Science

Students will understand, explain and differentiate between the structure, characteristics and basic needs of living things, the processes of life, and will also investigate the diversity of life and how living things interact with each other and their environment.

Physical Science

Students will describe and explain common properties, forms, and interactions of energy and matter, their transformations and applications in chemical, physical, and biological systems.

Earth and Space Science

Students will be knowledgeable of the structure, processes, and interactions among the earth's systems. They will also understand the solar system and scientific theories about the origin of the solar system, and explain how we learn about the universe.

Benchmarks (Key Stage Curriculum Outcomes)

Benchmarks are the statements that identify the learning outcomes of students what they are expected to know, be able to do, and value by the end of, for example, Grades V, VIII, X and XII as a result of their Grade-wise cumulative learning experiences.

Also Benchmarks represent what is intended or what learning outcome is expected from students at the end of a grade-cluster. At the end of a particular key-stage or grade-cluster

majority of the students will have fully achieved the intended Benchmarks while others may not.

In this curriculum, two sets of Benchmarks have been selected. First, the benchmarks for the grade-cluster of IV-V, - what learning outcomes will be expected from all students at the end of Grade-V in the six (6) Learning Strands. While the second set of benchmarks is for the grade-cluster of VI-VIII, - what learning outcome will be expected from all students at the end of Grade-VIII in the six (6) Learning Strands (Life Science, Physical Science, Earth and Space Science, Skills, Attitudes and STSE).

These Benchmarks are intended for all students. However it is acknowledged that different students will achieve these Benchmarks in different ways and to different depth and breadth depending on interest, ability, and context.

Also at the same time, the selected Benchmarks will present opportunities and challenges for teachers to be able to help their students in achieving the desired learning outcomes at the end of Grade-V and Grade-VIII.

Students' Learning Outcomes – SLOs (Specific Curriculum Outcomes)

Students' Learning Outcomes are the learning statements, specifically describing what students are supposed to learn and able to do at each Grade level in order to achieve the specified Benchmarks for every Grade-Cluster. In other words, SLOs are the incremental steps toward accomplishment of Benchmarks, which are organized around the Standards and listed for each grade level as students advance in their knowledge, skills, attitudes, and applications.

Therefore well-defined SLOs for the Grades IV-VIII have been provided in the following pages, which reflect the desired learning outcomes towards achieving the required Benchmarks for grade-cluster IV-V and VI-VIII for the six (6) learning strands.

SLOs' and Benchmarks' Achievement Objectives

This Science Curriculum provides well defined Students' Learning Outcomes and Benchmarks for the students of the Grades IV-VIII, for planning and making decisions about a school's science curriculum implementation. Teachers should note that benchmarks are broad, and may embody a mixture of knowledge, skills, and attitudes. Consequently, the attainment by students of any particular benchmark will often be dependent upon more than one unit of study, and on units based on several learning strands. For the average student, attainment for benchmarks will involve around two years of SLOs for each level in Grades IV to V, and three years of SLOs for each of Grades VI to VIII.

The attainment of the broader and more complex Benchmarks, like developing Skills and Attitudes will typically require a longer period of time and involve a wide range of learning experiences.

Although the Benchmarks are prescriptive, other aspects of the students' learning described in the SLOs are not. However sample learning contexts, possible learning experiences will provide ideas for schools and teachers, which they may, or may not, incorporate into their own science teaching schemes and syllabuses. The whole purpose is to indicate the scope and depth of students' learning.

It is equally valid for teachers and students to approach a unit of study from the objectives in any strand or, in some cases, from another subject. However, it is expected that the "science and its relationship to technology, society and environment (STSE)" strand, and the skills and attitudes strands, will be integrated into learning contexts within the other three strands, life science, physical science, and earth and space science. Integration will often extend to other subject areas and is also encouraged. Whenever this is done, the science objectives must be specified, and their attainment by students monitored.

Thus, the achievement objectives for the SLOs and Benchmarks require a number of school-based decisions and actions. In making these decisions, schools and teachers should make full use of the flexibility that exists in how the Benchmarks may be approached. This will result in each school providing a unique science programme that recognizes the particular character of their student population, that makes effective use of local resources, and that fits in with other decisions relating to the whole of the schools' curriculum.

What will be common across all schools is that their Science Curriculum will target the attainment of the same SLOs and Benchmarks, and will describe processes to monitor, for every student, the learning described by these objectives.

At appropriate times the routine and/or annual assessment information are required to be processed by teachers to enable the school to report on students' learning in science in relation to the SLOs and Benchmarks, and to provide themselves with one type of feedback on the effectiveness of the school's science programme vis-à-vis this Science Curriculum.

4 Content Strands, Standards, and Benchmarks

Strand-1: Life Science

Rationale

The Life Science strand focuses on the life processes of plants and animals and the specific needs of each. This strand begins and builds from basic to more complex understandings of a system, both at the level of the cell and at the ecosystem level. The major topics developed in the strand include basic needs and life processes of organisms, their physical characteristics, orderly changes in life cycle. The concept of kingdoms of living things and a general Classification of organisms is also presented. The other major topics developed in this strand include the types of relationships among organisms in a food chain, different types of environments and the relationship between organisms and their non-living environment.

The Life Science strand includes the relationship of knowledge and skills with science and technology, as well as the impact of technological changes on the environment and the need for sustainable development.

In all grades, students will develop the ability to use appropriate vocabulary and scientific terminology related to the life sciences to communicate clearly.

Content Standard

Students will understand, explain and differentiate between the structure, characteristics and basic needs of living things, the processes of life, and will also investigate the diversity of life and how living things interact with each other and their environment.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Identify the needs and characteristics of plants and animals;
2. Compare major plant and animal structures and their functions;
3. Describe the diversity among organisms;

4. Explain the food groups necessary to maintain a healthy body;
5. Compare and group plants and animals according to similarities and/or differences;
6. Examine the habitats of plants and animals and determine how basic needs are met within each habitat; and
7. Describe interaction or interdependence between animals and plants.

By the end of Grade VIII, students will be expected to:

1. Show that living things have different level of organization;
2. Describe the basic processes and functions of plants and human body systems and their importance to life;
3. Describe the role of chromosomes and genes in heredity;
4. Explain the diversity of living things and the threat to it by human activities;
5. Describe the importance of the food pyramid and food webs;
6. Explain the interaction and interdependence of nonliving and living components within ecosystems; and
7. Identify biotechnologies used in prevention, diagnosis, and treatment of diseases and disorders as well as in agriculture and environment.

Strand-2: Physical Science

Rationale

This strand focuses on students' understanding of what force, motion, and energy are and how these concepts are connected. Major topics developed in this strand include magnetism, types of motion, simple and compound machines, and energy forms and their transformations. It also focuses on the description, physical properties, and basic structure of matter. The major topics developed in this strand include concepts related to the basic description of objects, states of matter (solids, liquids, and gases), phase changes, and the classification of matter.

Students will increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the various ways

energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

In all grades, students will develop the ability to use appropriate vocabulary related to physical world to communicate clearly about scientific and technological concepts.

Content Standard

Students will describe and explain common properties, forms, and interactions of energy and matter, their transformations and applications in chemical, physical, and biological systems.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Classify objects by properties that can be observed, measured, and recorded including colour, shape, size, weight, volume, texture, and temperature;
2. Describe the properties of the different states of matter and identify the conditions that cause matter to change states; explain the processes associated with it;
3. Identify changes when matter experiences an external influence in terms of push or pull;
4. Measure properties of objects using appropriate materials, tools, and technology, and to observe safety;
5. Investigate physical phenomena commonly encountered in their daily life, including light, heat, electricity, sound, and magnetism;
6. Investigate and communicate that magnetism and gravity can exert forces on objects without touching the objects; and
7. Describe simple energy transformations and the uses of energy at school and home, and to observe safety.

By the end of Grade VIII, students will be expected to:

1. Identify characteristic properties of matter such as density, solubility, and boiling point and understand that elements are the basic component of matter.
2. Describe the formulas, chemical equations, symbols and its relationship to molecules, atoms, and ions;
3. Describe the structure of the atom and identifying the particles that compose it including the structure of isotopes;

4. Explain the relationships among temperature, molecular motion, phase changes, and physical properties of matter;
5. Recognize different forces and describe their effects and how different structures overcome the effect of force;
6. Observe and describe the interactions of light and matter;
7. Investigate and describe the movement of heat and the effects of heat in objects and systems;
8. Describe the types of energy that can be involved, converted, or released in electrical circuits; and
9. Manipulate and analyze quantitative data using the SI system.

Strand-3: Earth and Space Science

Rationale

In Earth and space sciences, students recognize the relationship between the Earth, our solar system, and the universe. They know that the moon, sun and other stars appear to move relative to the Earth and that these movements correspond to the pattern of day and night, the seasons. Students are naturally interested in everything around them. This curiosity leads them to observe, collect, and record information about the Earth and about objects visible in the sky.

In Grades VI-VIII, students' attention shifts from the properties of particular objects toward an understanding of the place of the Earth in the solar system. Students grapple with the importance of and methods of obtaining direct and indirect evidence to support current thinking. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world. By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live. They recognize that new technologies and observations change our explanations about how things in the natural world behave.

Content Standard

Students will be knowledgeable of the composition, structure, processes, and interactions among the Earth's systems; they will compare and contrast our planet and sun to other planets and star systems; and explain how we learn about the universe.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Observe and describe the characteristics of objects in the sky;
2. Observe and record the changing appearances and positions of the Moon in the sky at night and determining the monthly pattern of lunar change;
3. Model changes that occur because of the rotation of the Earth and the revolution of the Earth around the Sun;
4. Understand that the Sun, a star, is a source of heat and light energy and identifying its effects upon the Earth;
5. Compare celestial bodies in our solar system; and
6. Demonstrate how the relationship of the Earth, Moon, and Sun causes eclipses and Moon phases.

By the end of Grade VIII, students will be expected to:

1. Identify the characteristics of the Sun and other stars;
2. Compare and contrast the celestial bodies in our solar system;
3. Investigate the force of gravity and the ways gravity governs motion in the solar system and objects on Earth;
4. Model the position of the Earth in relationship to other objects in the solar system; and
5. Understand that space exploration is an active area of scientific and technological research and development.

Strand-4: Skills

Rationale

In everyday life, we find ourselves wondering about nature, gathering information, devising and evaluating possible explanations for how things work, and discussing ideas with others. These characteristically human activities reflect in many ways how scientists think and work.

Scientific inquiry is a way of learning about the natural world and the environment we live in. It involves the use all of the senses to develop the skills of observing, labeling, comparing, describing and sorting, and to wonder about the differences and changes in

everyday world. Students will be encouraged to communicate their findings in a variety of ways, including labeled drawings, pictorial graphs, oral and written forms. As their investigative skills develop, they will learn to predict, redesign their investigation, find solutions to their problems, collect data, analyze and interpret data and tell whether the result is expected or not. Students should be encouraged to reflect on their investigations, identify difficulties and suggest improvements.

It is therefore intended that students will develop necessary skills, as they are encouraged to think scientifically rather than simply memorize and/or study scientific facts. Also it is expected from teachers that they will engage students in scientific inquiry activities to develop such skills.

Content Standard

Students will develop the skills required for science and technology inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Ask questions about objects and events in the immediate environment; and develop ideas about how those questions might be answered;
2. Observe and explore material and events in immediate environment and record the results;
3. Identify patterns and order in objects and events studied;
4. Develop solutions to problems through reasoning, observation and investigation;
5. Work with others, share, and communicate ideas about their explanations; and
6. Take safety measures during experiments.

By the end of Grade VIII, students will be expected to:

1. Ask questions about objects and events in local environment and develop plans to investigate those questions;
2. Observe and investigate the local environment and record the results;
3. Use appropriate tools, techniques, and measurement units for gathering observations and presenting the same in an organized way/form;

4. Design and conduct scientific investigations;
5. Interpret findings from investigations using appropriate methods;
6. Work collaboratively to carryout science-related activities and communicate ideas, procedures and results; and
7. Take safety measures during scientific investigations.

STRAND-5: Attitudes

Rationale

This strand refers to the students' need for developing the attitudes or "habits of mind" that are considered essential for a meaningful study of science and its relationship to the society. These include: a commitment to the pursuit of knowledge and achievement of potential, resulting in a disposition towards striving to understand the world and how best one can make a positive contribution towards it; respect and concern for others and their rights, resulting in sensitivity to and concern for the well-being of others; social and civic responsibility, resulting in a commitment to exploring and promoting the common goal; and environmental responsibility, resulting in a respect and concern for the natural and cultural environment and a commitment to regenerative and sustainable resource use.

These attitudes have been incorporated into the student learning outcomes so as to enable them in making informed decisions and demonstrating responsible behaviours.

Content Standard

Students will display a sense of curiosity and wonder about the natural world; they will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge for the mutual benefit of self, society, and the environment.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Show interest and curiosity about objects and events with in the immediate environment;
2. Willingly observe, question, and explore;
3. Appreciate the importance of accuracy;
4. Be open-minded in their explorations;

5. Be sensitive to the needs of other people, living things and the local environment;
6. Work and cooperate with others in exploring and investigating;
7. Consider their own observations and ideas after comparing the same with other's when drawing the conclusions;
8. Undertake personal actions to care and preserve the immediate environment;
9. Show concern for their own safety and that of others in carrying out scientific activities; and
10. Recognize the role and contribution of science in their understanding of the world.

By the end of Grade VIII, students will be expected to:

1. Show interest and curiosity about objects and events within different environments;
2. Willingly observe, question, explore, and investigate;
3. Show interest in activities of individuals working in scientific and technological fields;
4. Consider their own observation and ideas as well as those of others during investigation and before drawing conclusions;
5. Appreciate the importance of accuracy and honesty;
6. Demonstrate perseverance and desire to understand;
7. Appreciate the role and contribution of science and technology in the understanding of natural world;
8. Realize that the applications of science and technology can have both intended and unintended effects;
9. Work collaboratively while exploring and investigating;
10. Be sensitive to and develop a sense of responsibility for the welfare of own, other people, living things, and the environment; and
11. Show concern for their own safety and that of others in planning and carrying out science activities and to become aware of potential dangers while choosing and using materials, tools, and equipment.

Strand-6: Science, Technology, Society, and Environment (STSE)

Rationale

Students' natural curiosity about how things work is clear to any adult who has ever watched a child tenaciously work to improve the design of a paper airplane, or to take apart a toy to explore its insides.

Science tries to understand the natural world. While the emphasis in science is on gaining knowledge of the natural world, the emphasis in technology is on finding practical ways to apply that knowledge to solve problems. Technology works in conjunction with science to expand our capacity to understand the world.

Our world is shaped in many ways by scientific advances, technology and human activity. Because scientific advances and technology effect all living and non-living systems, it is vital that students understand the interrelationship of science, technology, and society.

Content Standard

Students will develop an understanding of the nature of science and technology, of the relationship between science and technology, and of the social and environmental context of science and technology.

BENCHMARKS

By the end of Grade V, students will be expected to:

1. Recognize that science and technology develops over time;
2. Identify devices that are normally used to solve everyday problems;
3. Describe how science and technology affect their lives and those of people and other living things in the society;
4. Identify careers that use science and technology;
5. Describe ways of using materials and tools to help answer science questions and to solve practical problems; and
6. Investigate objects and event in their immediate environment, and use appropriate language to develop understanding and to communicate results.

By the end of Grade VIII, students will be expected to:

1. Describe ways that show science and technology work together in investigating questions and problems in meeting specific needs;

2. Describe applications of science and technology that have developed in response to human and environmental needs;
3. Describe positive and negative effects that result from applications of science and technology in their own lives, the lives of others, and the environment;
4. Describe how people use science and technology in their professions;
5. Demonstrate that science and technology develop overtime;
6. Demonstrate ways of using materials and tools to help answer science questions and to solve practical problems;
7. Investigate objects and event in their immediate environment, and use appropriate language to communicate results; and
8. Undertake personal actions to care for the immediate environment and contribute to responsible group decisions.

5 Grade-wise Learning Units Distribution Matrix

Crit. Strands / Grades	LIFE SCIENCE	PHYSICAL SCIENCE	EARTH AND SPACE SCIENCE
GRADE-IV	• Understanding Ourselves • Characteristics and Needs of Living Things • Food and Health • Living Things and their Environment	• Matter and its States • Heat and its Measurement • Force and Machines • Introduction to Sound • Investigating Electricity and Magnetism	• Movements of the Earth
GRADE-V	• Classification of Living Things • Seeds: Structure and Germination • Microorganisms • Environmental pollution	• Matter and Changes in its States • Force and Mechanisms • Properties and Behaviour of Light • Electricity and Magnetism • Soils	• Solar system
GRADE-VI	• Cellular Organization of Plants and Animals • Sense Organs • Photosynthesis and Respiration in Plants • Environment and Interactions	• Atoms, Molecules, Mixtures and Compounds • Solutions and Suspensions • Air • Forces and Machines • Energy and its Forms • Investigating Sound • Properties of Light	• Space & Satellites

Grade-wise Learning Units Distribution Matrix

Cnt. Strands / Grades	LIFE SCIENCE	PHYSICAL SCIENCE	EARTH AND SPACE SCIENCE
GRADE-VII	• Human Organ Systems-I • Reproduction in Plants • Transport System in Human and Plants • Environment and Feeding Relationships	• Structure of an Atom • Physical and Chemical Changes and Processes • Water • Transmission of Heat • Sound Waves • Dispersion of Light • Circuits and Electric Current	• Investigating the Space
GRADE-VIII	• Human Organ Systems-II • Heredity in Organisms • Biotechnology • Pollutants and the Environment	• Chemical Reactions • Acids, Alkalis and Salts • Measurements of Physical Quantities • Force and Pressure • Sources and Effects of Heat Energy • Refraction of Light • Lenses • Electricity in Action	• Exploring Space

6 Learning Contents and Students' Learning Outcomes

6.1 Grade - IV Learning Contents and Students' Learning Outcomes (Knowledge, Skills, Attitudes and STSE)	
Contents	***Students' Learning Outcomes***
UNDERSTANDING OURSELVES • Introduction to Human Body • Major Body Parts and their Functions (Teeth, Bones Muscles, Brain, Lung, Heart, Stomach, Skin, Eye and Ear) • Common Disorders of Some Parts of Human Body (Skin, Teeth and Stomach)	*All the students will be able to:* • Identify major parts of human body. • State functions of major parts of the body. • Describe how bones and muscles work together to produce movement. • Identify common disorders of various parts of body and their causes. • Suggest ways to keep parts of their body healthy.
CHARACTERISTICS AND NEEDS OF LIVING THINGS • Need Food, Sunlight, Air & Water to Survive • Move, Grow, Reproduce and Maintain the Continuity of life (Characters are inherited, Similarities and Differences within a Single Species) • Animal Life Cycles (Frog, Butterfly, Bee) • Plant Life Cycle (Germination of Seed to the Production of a Flower)	• Identify factors necessary for both animals and plants to survive. • Compare physical characteristics of animals and plants. • Perform an experiment to show that living things can grow while non-living things cannot grow. • Explain that many characters are inherited from parents. • Explain the similarities and differences within a single species by giving examples. • Draw and label key stages in the life cycle of a plant and an animal. • Compare the life cycles of two different animals. • Conduct a simple experiment to show growth in plants.

Contents	*Students' Learning Outcomes*
FOOD AND HEALTH • Sources of Different Food Groups (Fruits, Vegetables, Meat, Pulses & Cereals) • Main Groups of Food (Carbohydrates, Proteins, Minerals, Vitamins and Fats) and their Properties • Balanced Diet and its Importance • Hygiene and Basic Principles	• Identify the sources of common food. • Explain the properties of major food groups. • Classify different food into their basic groups. • Interpret a food pyramid to show the relative importance of various food groups. • Differentiate between balanced and unbalanced diet. • Suggest a balanced meal from the given list of foods and give reasons to explain why each food was chosen. • Explain the effects of unbalanced diet on health. • Explain hygiene and its basic principles.
LIVING THINGS AND THEIR ENVIRONMENT • Environment and its Components (Living and Nonliving) • Types of Environment (Land, Water, Air) • Classification of Animals according to Eating Habits (Herbivores, Carnivores, Omnivores) • Introduction to Simple Food Chain (Producers, Consumers and Decomposers)	• Define environment. • Explain components of environment with examples. • Differentiate between various types of environment. • Explain the characteristics of animals and plants, which enable them to survive in a particular environment. • Classify animals on the basis of food they eat. • Differentiate between carnivores, herbivores, and omnivores with the help of examples. • Define producers, consumers and decomposers. • Explain the importance of producers, consumers and decomposers in a food chain. • Make a simple food chain to show the relationship between producers, consumers and decomposers.
MATTER AND ITS STATES • Introduction to Three States of Matter (Shape and Volume) • Effect of Heat on Solids, Liquids and gases. • Mixing of Materials • Soluble and Insoluble Solids	• Define matter and give examples. • Identify three states of matter with examples. • Compare solids, liquids and gases on the basis of shape and volume. • Demonstrate and explain how matter changes its state on heating. • Explain how one state of matter (solid, liquid, gas) dissolves in other.

Contents	*Students' Learning Outcomes*
• Separation of Insoluble Solids from Water (by Decantation and Filtration)	• Predict and demonstrate how various materials mix with water. • Demonstrate separation of insoluble solids from water by decantation and filtration.
HEAT AND ITS MEASUREMENT • Heat and Temperature • Common Scales of Temperature (Centigrade and Fahrenheit) • Measurement of Temperature (Laboratory and Clinical Thermometers) • Safety Measure in using Thermometers	• Define heat and temperature. • Draw and label the device for measuring temperature. • Measure and record the body temperature using a laboratory thermometer and a clinical thermometer. • Suggest the safety measures required in using thermometers.
FORCE AND MACHINES • Force (Push and Pull) • Effects of Forces (in Changing Position & Shape) • Speed (Relation with Distance and Time) • Introduction to Simple Machines (Scissors, Hammer, Pulley, Wheel Barrow)	• Define force by giving examples. • Investigate the ways in which motion of an object can be changed. • Demonstrate how force can change the position and the shape of an object. • Explore that greater the force, greater the change in the distance covered by the object. • Design experiments to demonstrate that some objects can return to their original shape after the release of force. • Define speed and give its relation with distance. • Define simple machines by giving examples of commonly used machines from the environment. • Design an experiment to show how simple machines make-work easier.
INTRODUCTION TO SOUND • Sound • How Sound is produced?	• Investigate that sound is produced by vibrating objects. • Differentiate between low and high sounds.

Contents	*Students' Learning Outcomes*
• Intensity of Sound (high, low) • Medium (Solids, Liquids and Air) for Sound to Travel • Noise & its Effects on Human Health • Measures to Reduce/Control Noise Pollution	• Demonstrate that sound can travel through solids, liquids and gases but cannot travel through a vacuum. • Interpret that the explosions in the core of the sun are not heard, as sound cannot travel through vacuum. • Differentiate between noise and other sounds. • Explore the effects of noise on human health. • Suggest ways to reduce noise pollution and plan an awareness campaign on any one.
INVESTIGATNG ELECTRICITY AND MAGNETISM • Introduction to Conductors and Insulators • Simple Circuit • Switches (Open & Closed) • Natural and Artificial Magnets • Magnetic and Non Magnetic Materials • Properties and Uses of a Magnet • Methods of Magnetizing Material • Demagnetizing • Temporary and Permanent Magnets	• Distinguish between insulators and conductors. • Identify examples of conductors and insulators in their environment. • Make a simple electric circuit. • Differentiate between an open and closed electric circuit. • Investigate using a magnet that some materials are magnetic and some are non magnetic. • Recognize that a magnet has poles. • Demonstrate that like poles repel each other and unlike poles attract each other. • Investigate that a freely suspended magnet always points in the N - S direction. • Identify the various uses of magnets and magnetic materials in daily life. • Demonstrate that how magnets can be formed and stored. • Differentiate between temporary and permanent magnets.
MOVEMENTS OF THE EARTH • Earth • Earth's Spin • Day and Night • Revolution • Seasons	• Describe the shape of Earth. • Relate the Earth's spin with the occurrence of day and night. • Define the term revolution. • Identify that the distance between the Earth and the sun effects the time Earth takes to revolve around the sun. • Explain that the Earth is tilted on its axis and this tilt causes seasons.

6.2 Grade - V

Learning Contents and Students' Learning Outcomes (Knowledge, Skills, Attitudes and STSE)

Contents	*Students' Learning Outcomes*
CLASSIFICATION OF LIVING THINGS • Introduction of the Main Kingdoms (Bacteria, Algae, Fungi, Plants, Animals) • Classification • Classification and Characteristics of Animals (Vertebrates and Invertebrates) • Classification and Characteristics of Plants (Flowering and Non-Flowering Plants) • Classification of Flowering Plants (Monocotyledonous & Dicotyledonous Plants) • Characteristic of Monocot and Dicot Plants (Leaf Shape, Venation, Seed and Number of Floral Leaves)	*All the students will be able to:* • Define classification. • Explain the need and importance of Classification. • Differentiate between vertebrates and invertebrates according to key characteristics. • Identify vertebrates and invertebrates from their surroundings. • Classify vertebrates into mammals, reptiles, fish, birds and amphibians on the basis of their characteristics. • Identify key characteristics of worms and insects. • Compare flowering and non flowering plants. • Classify the flowering plants into two major groups and give examples of each group. • Compare the structure of a monocot and a dicot seed. • Compare the structure of a monocot and a dicot leaf in terms of its shape and venation. • Differentiate between the structure of monocot and dicot flower in terms of number of floral leaves.
MICROORGANISMS • Virus, Bacteria and Fungi • Usefulness (for Food, in Laboratory) and Harmfulness of Microorganisms (Infection, Transmission and Protection)	• Define microorganisms. • Identify the main groups of microorganisms and give examples for each. • Describe the advantages and disadvantages of microorganisms in daily life. • Define infection. • Identify ways by which microorganisms can enter the human body. • Suggest ways to avoid infections.

Contents	*Students' Learning Outcomes*
SEEDS: STRUCTURE AND GERMINATION • Structure and Germination of French Bean Seed • Structure and Germination of Maize Seed • Functions of Cotyledons • Conditions Necessary for Germination	• Compare the structure and function of French bean and Maize seed. • List the functions of cotyledons. • Identify the conditions necessary for germination. • Predict what would happen to plant, if conditions necessary for germination are not fulfilled; Conduct an investigation to assess your prediction.
ENVIRONMENTAL POLLUTION • Pollution • Kinds of Pollution (Water, Air and Land) • Main Sources of Pollution (Smoke, Sewage Water, Solid Wastes, Industrial Wastes) • Measures to Reduce Pollution • Biodegradable and Non-Biodegradable Materials	• Define pollution. • Describe different kinds of pollution. • Explain main causes of water, air and land pollution. • Explain the effects of water, air and land pollution on environment and suggest ways to reduce them. • Plan and conduct a campaign to bring awareness to a problem of environmental pollution in their surroundings. • Differentiate between biodegradable and non-biodegradable materials. • Explain the impact of non-biodegradable materials on the environment. • Suggest ways to reduce the impact of non-biodegradable materials.
MATTER AND CHANGES IN ITS STATES • Matter • Arrangement of Particles in Solids, Liquids and Gases • Effect of Heat on Arrangement of Particles • Processes Involving Change in States (Melting, Freezing, Boiling, Evaporation and Condensation)	• Describe the properties of the three states of matter on the basis of arrangement of particles. • Demonstrate the arrangement of particles in the three states of matter through models. • Investigate the effect of heat on particle motion during a change in states. • Demonstrate and explain the processes that are involved in the change of states. • Describe the role of evaporation and condensation in the water cycle.

Contents	*Students' Learning Outcomes*
• Application of Condensation and Evaporation in Nature (Water Cycle)	• Identify and describe forms of moisture in the environment (e.g. dew, snow, fog, frost, rain).
FORCES AND MACHINES • Friction • Advantages and Disadvantages of Friction • Methods to Reduce Friction • Gravitational Force • Mass and Weight • Balanced and Unbalanced Forces • Inertia • Simple Machines (Wedge, Inclined Plane) • Lever • Kinds of Lever (Scissors, Hammer, Pliers, Wheel-Barrow, Tweezers, Tong) • Uses of Lever in Daily Life	• Describe friction and its causes. • Explain the advantages and disadvantages of friction. • Suggest methods to reduce friction. • Identify what cyclists; swimmers and parachutists do to reduce friction. • Explain the gravitational force using different examples. • Distinguish between mass and weight. • Differentiate between balanced and unbalanced forces. • Describe the effects of balanced and unbalanced forces on the motion of an object. • Describe the term inertia. • Demonstrate how wedge and inclined plane are used to move the objects. • Compare the three kinds of levers using examples. • Describe how lever makes work easier by giving examples of its uses from daily life.
PROPERTIES AND BEHAVIOUR OF LIGHT • Luminous and Non Luminous Objects • Transparent, Opaque and Translucent Objects • Light Travels in Straight Lines • Shadow Formation • Eclipse Formation • Pinhole Camera • Phases of Moon	• Differentiate between luminous and non-luminous objects. • Identify and differentiate between transparent, opaque and translucent objects in their surroundings. • Investigate that light travels in a straight line. • Explain the formation of shadows and eclipses. • Predict the location, size and shape of a shadow from a light source relative to the position of objects. • Explain the scientific principle that works in a pinhole camera. • Identify different phases of moon.

Grade – V

Contents	*Students' Learning Outcomes*
ELECTRICITY AND MAGNETISM • Electric Current • Electrical Circuits & its Components • Fuse & its Uses • Static Electricity (Lightening as an Example) • Charges and their Properties • Magnetic Lines of Force & Magnetic Field • Electromagnets • Earth's Magnetism • Magnetic Compass	• Describe flow of electric current in an electrical circuit. • Describe fuse and its importance in any electric circuit. • Explain the phenomenon of lightening. • Explain the production of static electrical charges in some common materials. • Conduct an experiment to show the magnetic field of a bar magnet. • Make an electromagnet with the help of a cell, iron nail and wire and show its working. • Explore different electromagnetic devices used in their daily life. • Describe the relationship between electricity and magnetism in an electromagnetic device. • Explain the earth's magnetic field and relate it with the use of a magnetic compass. • Make a magnetic compass and show it's working.
SOILS • Characteristics of Soil • Types of Soil • The Decomposers • Life in the Soil	• Describe the characteristics of soil. • Identify similarities and differences among the different types of soil. • Investigate and describe soil components. • Describe the effect of moisture on soil characteristics (e.g. how it hold together, texture, colour). • Compare the absorption of water by different soils. • Observe and describe the effects of moving water on different soils. • Investigate and describe how living things affect and are affected by soils.
SOLAR SYSTEM • Stars and Planets • Solar System (Sun and Planets)	• Differentiate between a star and a planet. • Explain that the Sun is a star.

Contents	***Students' Learning Outcomes***
• Natural Satellites in Solar System	• Describe the solar system and its planetary arrangement showing position of Earth in our solar system. • Explain the relative size of the planets and their distance from the sun using a model. • Compare the sizes of Earth, sun and moon. • Investigate the moons of different planets of the solar system.

6.3 Grade - VI
Learning Contents and Students' Learning Outcomes (Knowledge, Skills, Attitudes and STSE)

Contents	*Students' Learning Outcomes*
CELLULAR ORGANIZATION OF PLANTS AND ANIMALS • Cell • Microscope • Animal Cell and Plant Cell • Unicellular and Multicellular Organisms • Tissues • Plant and Animal Tissues • Organs • Plant (Leaf and Flower) and Human Organs (Liver, Lungs and Heart) • Introduction to Plant Systems (Root & Shoot System) and Major Human Systems (Digestive, Respiratory, Circulatory, Excretory, Nervous Systems)	*All the students will be able to:* • Define cell. • Describe the different parts of a light microscope and its working. • Identify different kinds of cells using a microscope. • Draw, label and describe the basic structure of an animal cell and a plant cell. • Compare and contrast an animal cell with a plant cell. • State the function of each part of the cell to indicate how the cell supports life. • Differentiate between unicellular and multicellular organisms. • Distinguish between tissues and organs. • Recognize root and shoot systems in plants. • State the functions of the major systems of the human body. • Describe the cellular hierarchy from cell to organ systems in animals and plants.
SENSE ORGANS • Nose, Tongue, Ear, Eye, Skin	• Explain the structure and function of nose, tongue, ear, eye and skin.
PHOTOSYNTHESIS AND RESPIRATION IN PLANTS • Internal Structure of a Leaf • Photosynthesis • Benefits of Photosynthesis • Factors Necessary for Photosynthesis (Water, Carbon Oxide, Light, Temperature and Chlorophyll)	• Describe the internal structure of a leaf. • Define photosynthesis. • Explain the importance of photosynthesis in plants. • Describe the effects of different factors on the process of photosynthesis. • Explain that the structure of leaves facilitates photosynthesis.

Contents	*Students' Learning Outcomes*
• Respiration in Plants (Process and its Importance)	• Prove with the help of an experiment that photosynthesis takes place in a leaf. • Explain the importance and process of respiration in plants. • Compare and contrast the processes of photosynthesis and respiration in plants.
ENVIRONMENT AND INTERACTIONS • Introduction • Biotic Components (Producers, Consumers and Decomposers) • Abiotic Components (Light, Air, Soil, Temperature and Water) • Relationships in Organisms (Predator-Prey, Parasitism, Mutualism)	• Identify the components of environment. • Compare the physical factors, which make up the environment of a desert and a rain forest. • Describe the relationship between biotic and abiotic components of the environment. • Explain how abiotic factors affect the ability of plants to create their own food. • Describe that living things depend on one another for food, shelter and protection. • Explain the different relationships between organisms. • Give examples of how organisms interact with each other and with nonliving parts of their environment.
ATOMS, MOLECULES, MIXTURES AND COMPOUNDS • Introduction to Atoms and Molecules • Some Common Elements and their Symbols. • Classification of Elements. (Metals and Non-Metals) • Uses of Some Common Elements. • Compounds and Mixtures • Uses of Compounds and Mixtures	• Differentiate between an atom and a molecule. • Recognize the symbols of some common elements. • Classify elements into metals and non-metals. • Relate the physical properties of elements to their uses. • Differentiate between elements and compounds and compounds and mixtures. • Identify examples of compounds and mixtures from their surroundings. • Explain uses of common mixtures in daily life. • Explain why air is considered as a mixture of gases. • Identify the sources of carbon dioxide and how its level can be maintained in nature.

Contents	*Students' Learning Outcomes*
• Air as a Mixture of Gases • Separating Mixtures (Filtration, Sublimation, Distillation and Paper Chromatography).	• Separate mixtures using a variety of techniques. • Choose a technique to separate and identify different components in dyes. • Demonstrate with an experiment to separate soluble solids from mixtures. • Use safety measures to conduct science experiments.
AIR • Air and its Importance • Composition of Air • Properties and Uses of Gases in the Air	• Recognize the importance of air. • Identify the composition of air. • Relate the properties and uses of gases in air with the composition of air.
SOLUTIONS AND SUSPENSIONS • Solution and its Components • Particle Model of Solution • Aqueous Solution • Water as a Universal Solvent • Dilute and Concentrated Solutions • Saturated and Unsaturated Solutions • Solubility and Effect of Temperature on Solubility • Solutions and Suspensions and their Uses	• Differentiate between solute, solvent and solution. • Identify solute and solvent in a solution. • Explain the formation of solution by the particle model. • Distinguish between aqueous, dilute and concentrated solutions. • Demonstrate the use of water as a universal solvent. • Prepare saturated and unsaturated solutions. • Define solubility. • Investigate the effect of temperature on solubility using a variety of compounds. • Differentiate between solutions and suspensions. • Identify uses of solutions and suspensions in daily life.
ENERGY AND ITS FORMS • Energy • Forms of Energy (Potential, Kinetic, Heat, Electrical, Light, Sound)	• Explain that energy provides the ability to do work and can exist in different forms. • Identify different forms of energy with examples.

Contents	*Students' Learning Outcomes*
• Conversion of Different Forms of Energy • Conservation of Energy • Energy Converters (Radio, TV, Lamp, Drill, Washing Machine, Calculators) • Renewable Energy Sources • Energy in Our Lives	• Differentiate between kinetic and potential energy. • Demonstrate how one form of energy is converted into other form of energy. • Identify that energy is dissipated in atmosphere. • Explain that energy is conserved during conversion of different forms of energy. • Explain the importance of energy in improving the quality of life. • Identify energy converters in their surroundings. • Illustrate energy conversion to other forms using an energy converter. • Explain the term renewable. • Describe the advantages of using renewable energy sources. • Describe the form of energy stored in the human body. • Identify energy transfer in an environment.
FORCES AND MACHINES • Wheel and Axle • Pulley • Types of Pulley • Characteristics of Pulleys and Gears (Changes in Direction, Speed and Force) • Pulley Systems and Gear Systems (Flag-Poles, Cranes Bicycles, Hand Drills, Wind-Up Clocks)	• Recognize wheel and axle and identify their uses. • Describe pulleys and their kinds. • Identify the uses of pulleys in daily life. • Describe the functions of pulley systems and gear systems. • Describe how motion in a system of pulleys of different sizes is transferred to motion in another system of various gears in the same structure. • Investigate with the help of an experiment the effort required by different gear systems to lift the same load. • Find out how the action of a pulley system is altered by changing the tension of the band connecting two pulleys. • Design and make a system of pulleys and/or gears for a structure that moves in a prescribed and controlled way and performs a specific function. • Identify and make modifications to their own pulley and gear systems to improve the way they move a load. • Describe how a bicycle functions.

Contents	*Students' Learning Outcomes*
	• Identify common devices and systems that incorporate pulleys and/or gears.
PROPERTIES OF LIGHT • Transmission, Absorption and Reflection of Light • Law of Reflection • Types of Reflecting Surfaces • Regular & Diffused Reflection • Images Formed by a Plane Mirror • Uses of Reflecting Surfaces (Periscope, Telescope and Microscope) • Multiple Reflections (Kaleidoscope) • Types of Mirrors (Plane, Convex and Concave Mirrors) and their Uses • Image Formation in Convex and Concave Mirrors	• Differentiate between transmission, absorption and reflection of light. • Demonstrate the law of reflection. • Demonstrate the difference between smooth, shiny, and rough surfaces. • Compare the regular and diffused reflection. • Identify everyday applications, which involve regular reflection and diffused reflection. • Draw ray diagrams for light reflected from a plane mirror at different angles of incidence. • Describe image formation by a plane mirror. • Compare characteristics of the images formed by a plane mirror and a Pinhole camera. • Explain the use of reflecting surfaces in different devices. • Design an experiment to make an optical instrument using mirrors. • Explain the principle of reflection in a kaleidoscope. • Describe the relationship of angles between two mirrors and the number of images they can see in a kaleidoscope. • Explain types of mirror and their uses in our daily life. • Investigate the image formation by convex and concave mirrors.
INVESTIGATING SOUND • Production of Sound in Different Mediums (Solid, Liquid and Gas) • How does Sound Travel? • How does Human Ear Receive Sound?	• Describe sound as a form of energy. • Compare the speed of sound in solids, liquids and gaseous mediums. • Identify a variety of materials through which sound can travel. • Explain that how does a human ear receive sound waves.

Contents	*Students' Learning Outcomes*
SPACE & SATELLITES • Satellites • Natural Satellites (Asteroids, Comets, Meteors) • Artificial Satellites and Geostationary • Kinds of Artificial Satellites (Sputnik, Explorer 1, Geostationary, Landsat, Communications, Polar, Earth Orbit, Global Positioning System)	• Define the term satellite. • Compare the physical characteristics of comets, asteroids and meteors. • Describe the different kinds of meteors. • Inquire into the sighting of Halley's Comet; describe what would they feel if they saw it. • Define the terms artificial satellites and geostationary. • Explain the key milestones in space technology. • Describe the uses of various satellites in space. • Investigate how artificial satellites have improved our knowledge about space and are used for space research. • Explain that how do satellites tell us where we are.

6.4 Grade - VII

Learning Contents and Students' Learning Outcomes (Knowledge, Skills, Attitudes and STSE)

Contents	*Students' Learning Outcomes*
HUMAN ORGAN SYSTEMS • Digestive System • Disorders of Digestion (Constipation & Diarrhea) • Respiratory System • Common Diseases of Respiratory System	*All the students will be able to:* • Describe various components of human digestive system. • Describe digestion and its importance. • Describe how digestive system helps in the digestion of various kinds of foods. • Identify common disorders of the digestive system. • List the factors that lead to constipation and diarrhea and the measures that can be taken to prevent them. • Describe the mechanism of respiration in humans. • Differentiate between breathing and burning processes. • Identify the common diseases of respiratory system and discuss their causes and preventive measures.
TRANSPORT IN HUMAN AND PLANTS • Transport in Humans (Circulatory System, Heart and Blood Vessels) • Some Disorders (Diabetes, Heart Problems, and Asthma) • Transport in Plants • Translocation	• Explain the transport system in humans. • Describe the structure and function of heart and blood vessels. • Explain the working of the circulatory system. • Identify scientific developments that provide alternatives for dysfunctional body parts such as artificial tissues and organs, and their transplantation. • Find out that some disorders in human transport system can be affected by diet. • Describe absorption of water in plants through roots. • Explain how the structure of the roots, stem, and leaves of a plant permit the movement of food, water, and gases.
REPRODUCTION IN PLANTS • Pollination • Kinds of Pollination (Self and Cross-Pollination)	• Define pollination. • Compare self and cross-pollinations in plants.

Contents	*Students' Learning Outcomes*
• Agents of Pollination • Kinds of Reproduction in Plants (Asexual and Sexual Reproduction) • Process of Fertilization • Formation of Fruit and Seed	• List various factors involved in cross-pollination. • Investigate plants, which are cross-pollinated. • Differentiate between sexual and asexual reproduction • Describe fertilization. • Describe seed and fruit formation.
ENVIRONMENT AND FEEDING RELATIONSHIP • Ecosystem • Habitat • Kinds of Habitat • Biotic Components and their Relation with Food Chains and Food Webs	• Explain the ecosystem. • Define the term habitat. • Compare the different kinds of habitats. • Investigate the various features that allow animals and plants to live in a particular habitat. • Identify the factors that cause daily and yearly changes in a habitat. • Explain how living things adapt to daily and yearly changes in their habitat. • Explain the ways in which living things respond to changes in daily environmental conditions such as light intensity, temperature and rainfall. • Explain why food chains always begin with a producer. • Illustrate the relationship between producers and consumers. • Describe two food chains in the environment around them. • Explain a food web.
WATER • Water for Life • Sources of Water • Impurities of Water • Cleaning of Water (Distillation, Water Treatment Plant)	• Describe the ways in which clean water are vital for meeting the needs of humans and other living things. • Identify the sources of water. • Recognize the substances present in water that makes the water impure. • Suggest different ways to clean the impure water.

Contents	*Students' Learning Outcomes*
• Uses of Water (Drinking, Source of Energy – Hydroelectricity, Cooling of Heavy Mechanical Complexes)	• Describe the various uses of water in our country. • Investigate the consumption of water in our daily life and suggest ways to reduce wastage of water.
STRUCTURE OF AN ATOM • Structure of an Atom (Protons, Neutrons and Electrons) • Atomic Number and Mass Number • Distribution of Electrons in Shells (KLM Only) Using $2n^2$ Formula (1-18 Elements) • Valency and Ions • Isotopes and their Uses • Chemical Formulae • Law of Constant Composition	• Describe the structure of an atom. • Differentiate between atomic number and mass number. • Draw diagrams of the atomic structure of the first eighteen elements in the periodic table. • Define valency. • Explain formation of ions. • Differentiate between cations and anions. • Describe isotopes and their uses in medicines & agriculture. • Identify the types and number of elements present in simple molecules and compounds. • Make chemical formulae from list of anions and cations. • State the law of constant composition and give examples.
PHYSICAL AND CHEMICAL CHANGES AND PROCESSESS • Physical and Chemical Changes • Applications of Chemical Changes and Processes (Changing Raw Materials Into Useful Products Hydrocarbons, Fats, Fertilizers, Plastics) • Reversible and Non-Reversible Changes	• Differentiate between physical and chemical changes. • Identify the physical and chemical changes taking place in environment. • Explain the use of hydrocarbons as fuels. • Explain the physical and chemical properties of fertilizers, which make them useful in agriculture. • Discuss harmful effects of improper use of fertilizers. • Describe the chemical process in which vegetable oil changes into fat. • Describe the simple process for the manufacture of plastics.

Contents	*Students' Learning Outcomes*
	• Distinguish between reversible and non-reversible changes in materials. • Identify a variety of reversible and non-reversible changes in materials in their surroundings.
TRANSMISSION OF HEAT • Transfer of Heat • Conduction • Good and Bad Conductors • Everyday Application of Conduction of Heat • Convection Currents in Liquid and Gases • Ocean Currents and Winds • Everyday Application of Convection Currents • Radiation • Experiments on Radiation and Absorption • Good and Bad Radiators and Absorbers of Heat • Everyday Application of Radiation • The Vacuum Flask	• Explain the flow of heat from hot body to cold body. • Explain conduction, convection and radiation through experimentation. • Recognize the three modes of transfer of heat from environment. • Suggest how birds can glide in the air for hours. • Identify examples of appliances that make use of different modes of transfer of heat. • List heat-conducting materials in their surroundings. • Describe the working and principle of vacuum flask. • Explain how a vacuum flask reduces the transfer of heat.
DISPERSION OF LIGHT • Refraction • Refraction in Different Mediums (Glass and Water) • Laws of Refraction and Refractive Index • Real and Apparent Depth • Critical Angle (Glass and Water) • Total Internal Reflection	• Explain refraction of light and its causes. • Discuss the effects of refraction with examples. • List the colors of light using a prism. • Describe the dispersion of light by a prism. • Identify different uses of lights of different colours at home, school and country and explain the relationship of choice of colours to their purpose. • Define spectrum of light.

Contents	*Students' Learning Outcomes*
• Applications: Reflecting Prisms, the Periscope, Mirages, Fish Eye View • Dispersion of Light (Spectrum and Rainbow Formation) • Colours of Light (Primary & Secondary Colors) • Colours of Objects	• Identify primary colours and show how they are combined to form secondary colours. • Identify a device in their surroundings that uses different combinations of colours. • Demonstrate how spinning of a rainbow results in the appearance of white disc. • Explain why an opaque or non-luminous object appears to be of certain colour.
SOUND WAVES • Transverse and Longitudinal Waves • Introduction to Terms (Wavelength, Speed, Amplitude and Frequency) • Pitch and Loudness • Audible Frequency Range • Applications of Different Sounds in Our Daily Life (Doorbells, Sirens, Telephones, Radios, Stereos, Smoke Detectors, Security System Alarms)	• Explain the wavelength, frequency and amplitude of sound and give their units. • State factors on which sound depends. • Investigate objects in home and surroundings that are designed and made to produce different sounds. • Compare audible frequency range of humans and different animals. • Design a musical instrument to explain the relation between its sound and shape. • Identify the applications of different sounds in daily life.
CIRCUITS AND ELECTRIC CURRENT • Flow of Current (Direction) • Types of Electric Circuits (Parallel and Series Circuits) • Energy Transfer in an Electrical Circuit • Effects of an Electric Current (Heating, Chemical, Magnetic Effects)	• Define current. • Make parallel and series circuits. • Investigate about types of circuits used for different purposes. • Identify a disadvantage of a series circuit. • Differentiate between current and energy. • Explain the effects of electric current in daily use appliances. • Describe voltage.

Contents	*Students' Learning Outcomes*
• Safety Precautions: Fuses and Earth, the Three-Pin Plug, Household Circuits, KW Hour and Charges for Electricity • Measuring Current, Voltage and Resistance (Ammeter, Voltmeter and Resistors) • Electricity at Home • Electricity and Safety (MCB, ELCB, Earth Wires)	• Explain the resistance as an opposition to the flow of current. • Describe the relationship between voltage and resistance. • Measure current by using different devices. • List the major uses of electricity in homes. • List electrical hazards and precautionary measures to ensure the safe use of electricity at home. • Describe why electricity is dangerous to humans.
INVESTIGATING THE SPACE • What's Beyond Our Solar System? • Stars, Galaxies, Milky Way and Black Holes • Star Distances • The Life of Stars (The Birth and Death of Our Sun) • Looking at Stars	• Explain the Big Bang Theory of the origin of the Universe. • Describe a star using properties such as brightness and colour. • Identify bodies in space that emit and reflect light. • Suggest safety methods to use when observing the sun. • Define the terms star, galaxy, Milky Way and the black holes. • Explain the types of galaxies. • Explain the birth and death of our sun. • Evaluate the evidence that support scientific theories of the origin of the universe. • Identify major constellations visible at night in the sky. • Describe the formation of back holes. • Explain the working of a telescope.

6.5 Grade - VIII Learning Contents and Students' Learning Outcomes (Knowledge, Skills, Attitudes and STSE)	
Contents	***Students' Learning Outcomes***
HUMAN ORGAN SYSTEMS • Nervous System (Central and Peripheral) • Reflex Action • Excretory System (Structure of Kidney and its Role in Excretion)	*All the students will be able to:* • Describe the structure and functions of the nervous system. • Describe the working of the nervous system through a model. • Explain reflex action with an example. • Differentiate between voluntary and involuntary actions they have experienced. • Define excretion. • Draw and label human excretory system. • Describe the role of kidney in excretion of waste. • Investigate the possible causes of the malfunctioning of kidneys. • Suggest techniques to cure problems of kidneys.
HEREDITY IN ORGANISMS • Cell Division • Heredity • Basis of Heredity (Chromosomes, DNA and Genes in Plant and Animal Cells)	• Differentiate between mitoses and meiosis. • Identify DNA and chromosomes in the cell diagram. • Define heredity and recognize its importance in transferring of characteristics from parents to off springs. • Identify the characteristics that can be transferred from parents to off springs. • Compare characteristics related to ear and eye colour.
BIOTECHNOLOGY • Biotechnology • DNA Replication • Introduction of Gene Into Bacterium	• Define biotechnology. • Explain how DNA is copied and made. • Describe the relationship between DNA, genes and chromosomes.

Contents	*Students' Learning Outcomes*
• Genetic Modifications (Microorganism Resistance, Improved Nutrition and Quality of Food) • Biotechnology Product Saving Lives (Insulin, Vaccines) • General Applications (Agriculture, Environment, Health, Food Production and Preservation)	• Define bacterium. • Explain how genes are introduced into a bacterium. • List some biotechnological products used in daily life. • Explain that genetic modification in different foods can increase the amounts of essential nutrients. • List general applications of biotechnology in various fields. • Explain how biotechnology allows meeting the nutritional needs of growing populations.
POLLUTANTS AND THEIR EFFECTS ON ENVIRONMENT • Air Pollutants (Sulphur Dioxide, Carbon Monoxide, Oxides of Nitrogen, Chlorofluorocarbons) • Sources (Natural and From Human Activities) • Harmful Effects (on Human Organ Systems: Lung Diseases, Brain Damage, Breathing, Headaches) • Effects of Human Activity on Environment (Greenhouse Effect, Ozone Depletion and Global Warming, Acid Rain, Wild Life, Deforestation, Lack of Energy Resources) • Saving the Earth (Solid Waste Management, Recycling of Materials, Conservation of Resources, Environmental Campaigns, Responsibility for All)	• Explain the sources, properties and harmful effects of air pollutants. • List problems in human organ systems caused by air pollutants. • Plan and conduct a campaign that can help to reduce air pollution in their local environment. • Explain the Greenhouse effect. • Describe the causes and effects of ozone depletion. • Carry out a research to explain global warming and its likely effects on life on earth. • Design a model to explain the Greenhouse effect. • Explain the formation of acid rain and identify its consequences on living and nonliving things. • Define deforestation. • State the effects of deforestation on the environment. • Identify human activities that have long-term adverse consequences on the environment. • Explain the importance of local and global conservation of natural resources. • Suggest ways in which individuals, organizations and government can help to make earth a better place to live.

Contents	*Students' Learning Outcomes*
CHEMICAL REACTIONS • Chemical Reactions (Definition & Applications) • Chemical Equation and Balancing • Law of Conservation of Mass • Types of Chemical Reactions (Addition and Decomposition) • Energy Changes in Chemical Reactions (Exothermic and Endothermic)	• Define chemical reactions and give examples. • Explain the rearrangement of atoms in chemical reactions. • Explain the balancing of a chemical reaction. • Define the law of conservation of mass. • Identify the nature of a chemical change in various reactions. • Describe changes in the states of matter in a chemical reaction. • Explain the types of chemical reactions with examples. • Explain the energy changes in chemical reactions. • Describe the importance of exothermic reactions in daily life.
ACIDS, ALKALIS AND SALTS • Introduction to Acids, Alkalis and Salts • Properties of Acids, Alkalis and Salts • Uses of Acids, Alkalis and Salts • PH and its Range (1-14) in Aqueous Medium • Indicators and their Uses (Natural Indicators from Fruits and Vegetables)	• Define the terms acid, alkali and salt. • Describe the properties of acids, alkalis and salts. • Explain the uses of acid, alkali and salt in daily life. • Define indicators. • Use indicators to identify acids, alkalis and neutral substances. • Investigate the colour changes in the extracts of various flowers and vegetables by adding acids and alkalis.
FORCE AND PRESSURE • Pressure, Force and Area • Units (N/m2 and Pascal) • Hydraulics and Hydraulic Systems • Water Pressure • Pneumatics (How Gases Behave under Pressure?)	• Define the term Pressure. • Identify the units of pressure. • Explain hydraulics and hydraulic system by giving examples. • Explain how gases behave under pressure. • Describe the causes of gas pressure in a container. • Explain the working of aerosols.

Contents	*Students' Learning Outcomes*
• Gas Pressure in a Container • Aerosols • Atmospheric Pressure	• Identify the application of gas pressure. • Describe the term atmospheric pressure.
MEASUREMENTS OF PHYSICAL QUANTITIES • Physical Quantities (Length, Volume, Mass, Time) • System International Units (Meter, Liter, Kilogram, Second) • Instruments for Measurements (Meter Rule, Measuring Cylinder, Flasks, Pipette)	• Define a physical quantity with examples. • Apply the prefixes milli-, kilo-, centi-, and interpret the units. • Interconvert smaller units and bigger units. • Select and use measuring instruments. • Interpret SI units in the daily life. • Investigate why it is desirable for a scientist to use the SI units in their work. • Measure the volume of liquid by reading correct meniscus.
SOURCES AND EFFECTS OF HEAT ENERGY • Sources and Effects of Heat • Thermal Expansion and Contraction (Solids, Liquids and Gases) • Applications of Expansion and Contraction of Solids (Riveting, Fixing a Metal tyre into Wheel, Fixing Axle of a Wheel, Fire Alarms and Electric Iron) • Effects of Expansion and Contraction of Solids in Everyday Life (Concrete Road Surfaces, Railway Tracks, Bridges, Overhead Powers, Telephone Lines, Pipelines)	• Describe the sources and effects of heat. • Explain thermal expansion of solids, liquids and gases. • Explore the effects and applications of expansion and contraction of solids. • Describe the uses of expansion and contraction of liquids. • Explain the peculiar behaviour of water during contraction and expansion. • Investigate the processes making use of thermal expansion of substance. • Identify the damages caused by expansion and contraction in their surroundings and suggest ways to reduce these damages. • Investigate the means used by scientist and engineers to overcome the problems of expansion and contraction in every day life.

Contents	*Students' Learning Outcomes*
• Uses of Expansion and Contraction of Liquids • Peculiar Behaviour of Water during Contraction and Expansion	• Describe the working of a thermometer.
LENSES • Lenses • Types of Lenses (Converging and Diverging Lenses) • Image Formation by Ray Diagram • Image Formation in Simple Camera and Human eye • Uses of Lenses	• Define lens. • Differentiate between the different types of lenses. • Describe the image formation using a lens by ray diagram. • Compare and contrast the working of a human eye with the lens camera. • Explain how eye focuses by altering the thickness of the eye lens. • Investigate how eyes get used to darkness after some time. • Explain how lenses are used to correct short sightedness and long sightedness. • Identify the types of lenses used for various purposes in daily life.
ELECTRICITY IN ACTION • Generating Electricity (Model Generator) • Portable Generator (Bicycle Dynamo) • Problem of Generating Electricity • Working of Power Station • Other Sources of Electricity • Introduction to Electronic Systems • Uses of Components (Input, Processor, Output)	• Design an experiment to generate electricity. • Explain the working of the model generator. • Identify the simple devices that generate electricity in daily life. • Design and demonstrate the working of a power station. • List types of energy being used in power stations. • Relate problems involved in generating electricity. • Describe basic component of an electronic system. • List components that would be needed to turn A.C. to D.C. • State how output component in various devices could be used in their schools and surroundings.

Contents	*Students' Learning Outcomes*
EXPLORING SPACE • Telescope, Space Crafts, Spectroscopes • Space Exploration	• Describe development of tools and technologies used in space exploration. • Analyze the benefits generated by the technology of the space exploration. • Explain that how do astronauts survive and research in space. • Suggest the ways to solve the problems that have resulted from space exploration. • Identify the technological tools used in space exploration. • Identify new technologies used on earth that have developed as a result of the development of space technology. • Design a spacecraft and explain the key features of design to show its suitability as a spacecraft.

7 Teaching and Learning

The purpose of the Science Curriculum is not to make a scientist out of every student, but it is aimed at helping all students develop two things, scientific literacy and positive attitudes about using science as a way of obtaining knowledge. Students will be expected to learn how to do science, how to communicate the results of science inquiries to others, and how to use their knowledge of science concepts and principles to reason about science and to solve problems in real life situations. The vision of science education, calls for a shift in the focus of teaching and learning context. This can only be accomplished by providing students with opportunities to explore the context of science and its applications, and to develop an understanding of the interconnections among science, technology and society and environment.

Promoting Scientific Literacy in Teaching and Learning Process

Being scientifically literate requires that a person have essential understanding of key science ideas, along with a fluency in the language and terms used to describe them. The Science Curriculum will give special attention to the age-appropriate critical thinking, or inquiry, skills that are presented as Students' Learning Outcomes for each of the content standards. Further, limiting the number of content standards required to be taught, the Science Curriculum will encourage the implementation of a hands-on/minds-on students' learning strategies in which students and teachers have opportunities for in-depth explorations that build understanding of the way in which scientific knowledge is created, validated and communicated. This will assist students not only to understand science principles but also to relate these to personal, social and global issues and technologies rather than the traditional organization around life, physical and earth sciences. Acquiring these concepts students will become confident and capable lifelong learners, equipped with the skills needed to access, understand, evaluate and apply information in various contexts.

Improving the Teaching and Learning of Science

The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. In this regard the Standards and

Learning Outcomes described in this curriculum demand changes in emphasis for science teaching and learning process. It gives:

LESS EMPHASIS ON:

- Knowing scientific facts and information;
- Studying subject matter disciplines (physical, life, earth sciences) for their own sake;
- Separating science knowledge and science process;
- Covering many science topics;
- Performing lab activities; and
- Implementing inquiry as a set of process.

MORE EMPHASIS ON:

- Understanding scientific concepts and developing abilities of inquiry;
- Learning subject matter disciplines in the context of inquiry, technology, personal and social perspectives, and history and nature of science;
- Studying in depth a few fundamental science concepts;
- Collecting and using evidence to build explanations; and
- Implementing inquiry as instructional strategies, abilities and ideas to be learned.

Enhancing Learning in Science

The purpose of the Science Curriculum is to provide direction for learning in science.

Learning is enhanced when:

- Students have the opportunity to clarify their ideas, to share and compare, ask question, evaluate, and modify these ideas, leading to scientific understanding;
- Scientific knowledge, skills, and attitudes are introduced in contexts which are relevant and familiar to the students;
- Students have opportunities to use their new ideas and skills, first in a variety of familiar contexts and later in other challenging and unfamiliar situations;
- Students see the relevance and usefulness of science to themselves and to society;

- Teachers and students work within a supportive atmosphere of mutual respect where all the experiences, ideas, and beliefs, which students bring into the learning situation are acknowledged as a basis for learning;
- Learning environments are visually stimulating and reflect contemporary science; and
- Teaching strategies respond to a diversity of learning styles.

Note: Appropriate time, facilities, and resources are important for teaching and learning science and need to be considered in relation to the above factors.

Classroom Teaching Strategies

Teaching strategies should relate to the outcomes of the science curriculum and be consistent with the teaching role to be adopted. For students to achieve the identified outcomes of science learning, a variety of learning and teaching roles and strategies will need to be adopted. The student will be the centre of the learning process. This entails negotiated, cooperative and interactive learning where the teacher needs to:

i. Work with and take an active role in the students' learning;

ii. Take into account what students already know and understand about science rather than determining what they do not know; and

iii. Ensure that key science concepts and processes are treated in an increasingly complex way as students' progress through the bands of learning.

Examples of effective instructional strategies include, but not limited to, the following:

- Inquiry
- Questioning and discussion
- Investigation and problem solving
- Demonstration and laboratory work
- Utilizing whole class, group, and individual work
- Incorporating literacy strategies (reading, writing, speaking, & listening)
- Using student work to inform instruction

In the classroom, learning of concepts should be integrated with the learning of language, and the learning of processes. It should be linked to applications in the context of human

purpose. Science teaching should lay a foundation for future science studies and help students integrate their science learning with other knowledge and to use it outside school.

Inquiry-based Science Learning

Inquiry/investigation is a process of framing questions, gathering information, analyzing it and drawing conclusions. An inquiry classroom is one where students take responsibility for their learning and are required to be active participants, searching for knowledge, thinking critically and solving problems. There are two main types of inquiry: ***Knowledge-based inquiry and Problem-based inquiry/investigation.*** Knowledge-based inquiry enables students to use science process skills (detail in Appendix B.) to gather, organize, analyze, and present their information, which will enhance their knowledge and understanding of content. Problem-based inquiry/investigation encourages learning of social, economic, ethical, and environmental, and other science and technology related problems.

There are a number of steps involved for conducting an inquiry such as:

- Start with an open-ended question or demonstration (as opposed to beginning a lesson with definitions and explanations).
- Gather responses and subsequent questions from students with little comment or direction.
- Involve students to collaborate on designing experiments or methods of inquiry.
- Ask students to conduct experiments and/or gather data.
- Students analyze and interpret the data.
- If time allows, re-evaluate question based on new data and repeat experiment or collect new data based on revised question.
- Present findings as an oral presentation, a poster presentation, charts, tables, graphs or an evaluative write-up.

Teaching science as inquiry involves using strategies that ensure:

- **Learning is Student-focused.**

  Inquiry shifts ownership of the learning process from teacher to student, making the process through which students learn concepts and develop skills as important as the science content. Teacher acts as a facilitator in the process.

- **Students engage in scientific inquiry by asking questions and devising answers.**

  Inquiry requires students to describe objects and events, ask questions and devise answers, collect and interpret data and test the reliability of the knowledge they've generated. They also identify assumptions, provide evidence for conclusions and justify their work.

- **Teachers ask questions that encourage inquiry and stimulate thinking.**

  To guide students through inquiry, teacher engages in open-ended questions such as "How do you know?" and "How does your activity data support your conclusions?" in order to encourage further probing and discovery.

- **Students are engaged in problem solving, constructing meaningful experiences.**

  Because students act as scientists, engaging in meaningful problem solving, they can construct meaning out of their experiences. Science endeavors include hands-on exercises as well as critical and logical thinking activities.

- **Students gain a greater understanding of the purpose of learning.**

  Inquiry lets teachers create a framework where students understand how and why to ask questions. Students reflect on the lesson and explain why it is important-and gain a greater understanding about the inquiry process and how it relates to learning.

- **Inquiry is a creative learning environment using both group and individual discovery techniques.**

  Inquiry involves setting short- and long-term goals and adapting them to students' interests. Within this framework teacher might involve students in hands-on activities, whole class instruction, or group collaboration. This learning environment allows students the freedom to explore and investigate while making connections and drawing conclusions.

- **Students interact purposefully with each other and the teacher, leading to effective communications.**

  Inquiry teaching encourages students to collaborate with one another, communicate ideas and thoughts, ask questions, justify answers and seek advice from others.

Problem-based Learning

Problem-based learning (PBL) is the type of classroom organization that supports a constructivist approach to teaching and learning. Guided by teachers acting as cognitive coaches, students develop critical thinking, problem solving, and collaborative skills as they identify problems, formulate hypotheses, conduct data searches, perform experiments, formulate solutions and determine the "best fit" of solutions to the conditions of the problem. Problem-based learning will enable students to embrace complexity, find relevance and enjoyment in their learning, and enhance their capacity for creative and responsible real-world problem solving. Teachers will assume the role of cognitive coach rather than knowledge-holder and disseminator and students will be the active problem-solvers, decision-makers, and meaning-makers rather than passive listeners. To design a problem-based learning experience for the students various sequential steps are required such as:

- Identify a problem suitable for the students.
- Connect the problem with the context of the students' world so that it presents real/authentic opportunities.
- Organize the subject matter around the problem, not the discipline.
- Give students responsibility for defining their learning experience and planning to solve the problem.
- Encourage collaboration by creating learning teams/groups.
- Expect all students to demonstrate the results of their learning through a product or performance.

Benefits of Problem-based Learning

Problem-based learning offers students to develop:

- Motivation
- Relevance and Context
- Higher-Order Thinking
- Learning How to Learn

STSE in the Classroom

One of the General Curriculum Outcome (STSE) states that students will develop an understanding of the nature of science and technology, their application and implications, and the relationship among science, technology, society, and the environment.

STSE places the scientific endeavor in the context of a current societal or environmental situation, question, or problem. The desire to investigate the situation, answer the question or solve the problem creates in the students a meaningful context in which to address the skills, concepts, and understanding of the course content. The STSE in the teaching and learning allows the learners to reflect more accurately their understanding of the science, the nature of technology, society and their interrelationship.

The students' understanding of science concepts and principles is clarified and strengthened when they attempt to apply their existing knowledge in the context of complex STSE situations. This will allow students to be exposed to STSE issues and make the types of connections between science, technology, society, and the environment that were previously identified.

Attitudes and Values in the Classroom

Attitudes refer to generalized aspects of behavior that are modeled for students by examples and reinforced by selective approval by the teachers. Attitudes are not acquired in the same way as skills and knowledge. However during the classroom learning experiences science education will contribute to attitudinal growth when students are:

- Involved in science investigation and activities that stimulate their interest and curiosity, thus increasing their motivation for learning and encouraging them to become interested in preparing for potential science- related careers of furthering other science-related interests;
- Provided with opportunities for development, reinforcement, and extension of attitudes that support scientific inquiry such as open- mindedness and respect for evidence, initiative and perseverance, and creativity and inventiveness;
- Provided with opportunities to work in groups' situations and on real-life problems, thus developing a sense of interpersonal responsibilities, openness to diversity, respect for multiple perspectives, and an appreciation of the efforts and contributions of others;
- Involved in activities that encourage responsible action toward living things and the environment, and when students are encouraged to consider issues related to sustainability from a variety of perspectives; and
- Encouraged to assess and manage potential dangers and apply safety procedures, thus developing a positive attitude towards safety.

Homework

Homework is an essential component of the science program as it extends the opportunity for students to think scientifically and to reflect ideas explored during class time.

Meaningful and positive homework experiences can:

- Contribute to personal growth, self- discipline, and learning responsibility;
- Reinforce the ideas and processes students have learned or developed at school;
- Develop students' confidence in their ability to work without others' help; and
- Provide opportunities for students to reflect on what they are learning and how well they are learning it.

Science Equipment and Supplies

The use of hands-on activities is an essential learning strategy in all science programs. Hands-on activities can range from simple demonstrations to complex scientific investigations or experiments. At any level of activity, in any learning environment, there exists a need for specific items of equipment or supplies. Such equipment should be appropriate to the grade level. Many items can be made low or no cost material or improvised using everyday items.

Print Resources

There could be a number of categories of print materials available to science teachers and students—teacher reference materials dealing with science teaching, student textbooks and accompanying teacher resources, science activity books containing ideas for experiments an/or demonstrations, science trade books and reference books (e.g., science encyclopedias), and supplementary science books that supplement or complement science textbooks.

Non-Print Resources

There are an increasing variety of resources in other formats such as video, computer software, CD-ROM, and videodisk. Compute software and CD-ROM disks offer simulations and models of real-life situations that permit the investigation of phenomena that are not available because of cost, safety, or accessibility.

Use of Technology

Computers and related technology offer students a very important resource for learning the concepts and processes of science through simulations, graphics, sound, data manipulation, and model building.

The following guidelines are proposed for the implementation of computers and related technology in the teaching and learning of science:

- Tutorial software should engage students in meaningful interactive dialogue and creatively employ graphs, sound and simulations to promote acquisition of facts and skills, promote concept learning, and enhance understanding.
- Networking among students and teachers should be encouraged to permit students to emulate the way scientists work and, for teachers, to reduce teacher isolation.

In order to effectively implement computers and other technology in science education, teachers should know how to use effectively and efficiently the hardware, software, and techniques described above.

Field Trips and Guest Speakers

Investigate activities include a variety of activities, for example, a quick field trip to the schoolyard or nearby field/park. All such activities are characterized by active student involvement in attempting to find answers to questions about the natural and constructed world. In order that students know the real nature of science, there is a need to acquaint, expose and fascinate them to the scientific and technological advancement. For achieving this, visits can be organized to science laboratories, factories, universities and other related institutions and organizations or guest speakers from these departments can be invited to the school in the science educational endeavors that could make students interested in science (this can be done even once in their school life).

Instructional Skills and Teachers Training

Instructional skills are the most specific category of teaching behaviors. These are used constantly as part of the total process of instruction. They are necessary for procedural purposes and for structuring appropriate learning experiences for students. No matter how experienced or how effective a teacher may be, the development and refinement of instructional skills and processes is a continual challenge. Instructional skills include such activities as explaining, demonstrating, and questioning.

The curriculum revision and development is a dynamic process and it requires the teachers to be updated not only in acquiring the science contents/concepts but also to become familiar with the modern trends of teaching and learning process. It is therefore recommended that in-service as well as pre-service teachers training need to be provided at all levels to assist them to stay abreast of the latest knowledge, skills, and attitudinal objectives. In teacher training programs, it is helpful if pre-service teachers are taught to promote inquiry by participating in inquiry experiences similar to those they will eventually provide for their students. This would help teachers to understand the difference between "inquiry science" and traditional "cookbook" science activities.

Teacher preparation programs play an essential role in improving a quality educational program in science by:

- Providing pre-service teachers with a comprehensive program of challenging and meaningful science courses that develop understandings of scientific concepts, processes and ways of thinking;
- Providing pre-service teachers with knowledge about human cognition and learning theories;
- Providing pre-service teachers with instruction in science-specific classroom pedagogy, including the use of educational and scientific technology, aligned with Science Curriculum standards; and
- Providing pre-service teachers with opportunities to practice teaching in a safe and supportive environment.

8 Assessment and Evaluation

Assessment

Assessment is a systematic process that measures the outcomes of students' learning in terms of knowledge acquired, understanding developed, and skills gained. It determines their progression through their learning experiences and enables them to demonstrate that they have achieved the intended learning outcomes. Assessment provides all stakeholders with information as to how well students, schools and programs are succeeding, and it identifies areas that need improvement. Thus, the focus of assessment shifts from judgment to continuous improvement.

Evaluation

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered. Evaluation is effective when it is integrated into the teaching-learning process and carried out regularly and comprehensively through the use of a variety of assessment techniques.

Assessment and evaluation are essential components of teaching and learning in science. Without effective assessment and evaluation it is not possible to know whether students have learned, whether teaching has been effective, or how best to address students' learning needs.

Assessing Student Learning in Science

The Science Curriculum emphasizes having a classroom environment in which students will be encouraged to learn scientific processes and knowledge within meaningful contexts. It is important that assessment strategies reflect this emphasis and are consistent in approach. An assessment program, which provides regular feedback, and is part of the learning process, is important to both student and teacher. Feedback tells students if they demonstrate understanding of scientific concepts and if their actions display expected performance levels for inquiry, decision making, and problem solving. Regular feedback inspires confidence in learning science and in becoming scientifically literate.

Therefore the assessment of student learning must be aligned with curriculum outcomes. The Science Curriculum provides suggestions for developing student learning across the four general curriculum outcome areas: knowledge; skills; attitudes; and science, technology, society and environment (STSE). These outcomes describe a balance of inquiry problem solving, and decision making, within a suggested social-environmental context, for a given set of scientific knowledge.

Objectives of Assessment

The assessment objectives are classified into the following three major performance expectations:

I Understanding Science Principles

Students should be able to:

- Describe knowledge and understanding of Scientific phenomena, facts, and principles
- Develop relationships among science principles
- Use scientific vocabulary, terminology and conventions.

II Conducting Scientific Inquiry

Students should be able to:

- Follow and carry out instructions accurately and safely
- Locate, select, organize and present relevant information from a variety of sources
- Identify patterns, report trends and draw inferences
- Make predictions and hypotheses and deduce relationships
- Identify the problem, plan and carry out an investigation to solve the problem
- Conduct scientific investigation using appropriate tools and technologies
- Apply and communicate information through science process skills.

III Applying Science Principles

Students should be able to:

- Apply science principles to both familiar and unfamiliar situations/problems

- Shows understanding of connections between science and technology and the world outside the school as well as their implications
- Propose solutions to problems with respect to science & technology and its relation with society and environment.

Incorporating Assessment into the Learning Process

Assessment of student learning must be part of every teaching and learning experience. Students should learn to evaluate their own learning. Traditional student testing programs, which rely on final, one-time evaluations, provide data that is of limited use to students as they construct knowledge. Meaningful assessment, like meaningful learning, must be authentic and connected to real-life problems.

A constructivist approach to learning and teaching has profound implications for the way learning is measured. Traditional classroom practice relies heavily on paper-and-pencil tests to measure students' learning and ability to apply knowledge. Learning is a process of connecting prior understanding with new learning. Consequently, an assessment strategy that measures the acquisition of facts and elements cannot serve a constructivist model.

Linking assessment to instruction - embedding it in the process of learning - is vital for an effective implementation of the "Inquiry based and Outcome focused" Science Curriculum.

To allow students to construct learning in the classroom through authentic experiences, assessment must be:

1. Valid, leading to attainment of multi-dimensional science learning;
2. Open-ended, allowing for discussion and revision of new understanding;
3. Tolerant of divergent thinking and promote the notion of no "one right answer";
4. Presented in alternative modes, not just paper-and-pencil responses to limiting questions;
5. Designed to promote analysis, comparison, generalization, prediction, and modification;
6. Capable of promoting collaboration and team effort in demonstration of competence; and
7. Ongoing and cumulative, showing development over time.

Types of Assessment

Assessment serves many important purposes. For example:

- Diagnostic (to plan instruction to fit the student's prior knowledge)
- Formative (to improve performance and adapt instruction)
- Summative (to report on final performance)

Purpose of Assessment

1. **To guide instruction**

   Assessments should provide continuous data about student learning so teachers can identify student needs and plan appropriate instructional strategies by obtaining feedback on their own practice, finding out the gaps between teaching (what was taught) and learning (what has been learned).

2. **To inform progress of students**

   The purpose of assessment is to provide information and feedback on students' progress to the students and their parents.

3. **To provide information on the effectiveness of curriculum**

   The purpose of assessment is to provide information on the effectiveness of science curriculum to all stakeholders in order to improve curricula, teaching standards and students' learning environment. Teachers, students, and parents need feedback on student progress. School administrators, educational planners, and the community need information to determine the overall effectiveness of the science program.

Classroom Assessment

The primary purpose of classroom assessment is not only to evaluate and classify students' performance but also to inform of teaching methods and learning environment, and to monitor student progress in achieving year-end learning outcomes. Therefore, classroom assessment is used for various purposes:

i. Assessment AS learning

ii. Assessment FOR learning

iii. Assessment OF learning

Each of the purpose requires a different role for teachers and different planning (for details refer Appendix A.). Traditionally, the focus of classroom assessment has been on assessment of learning (summative assessment). Assessment for learning has been used only for diagnostic processes and for feedback. In order to enhance science learning of all students the role of *assessment as learning* must provide an opportunity to students whereby they become critical and analysts of their own learning.

Classroom Assessment Strategies

Teachers learn about student progress not only through formal tests, examinations, and projects, but also through moment-by-moment observation of students. To assess students' science knowledge, skills, and attitudes, teachers require a variety of tools and approaches, such as:

- **Selected Response**

  Multiple-choice, true/false, matching, and completion tests, etc.

- **Constructed/Created Response**

  Fill-in-the-blank word(s)/phrase(s), essay (restricted and extended response), reports, procedures, explanations, short answer sentence(s), paragraph(s), label a diagram, and graph/table, etc.

- **Performance Assessment**

  Presentation, illustrations, science lab, demonstration, process skills, enactment, project, debate, model, exhibition, table, graph, and portfolios, etc.

- **Personal Communication**

  Oral questioning, observation, interview, conference, process description, and checklists, etc.

Students' Self-Assessment

Students recognize the relationship between content achievement, skill proficiency, and assessment opportunities by setting their sights on their own demonstration. They can do self-assessment if they are provided with the Knowledge-related checklists as well as checklists specific to applications and attitudes. Students assume the role of a researcher and use critical thinking skills as they find facts and make inferences to reach more conclusions about their learning. They are not receiving information passively and then simply giving it back to the teacher after memorizing it. Assessment should allow students to monitor their progress in various scientific skills: initiating and planning; performing and

recording; analyzing and interpreting; communication and teamwork. The curriculum calls for students to be actively involved in their learning, using the tools of science and of information processing during classroom/ laboratory activities.

Quality in Assessment

Assessment of science learning must change as science instruction moves from a focus on facts to a focus on in-depth understanding of major concepts and processes of science. Whereas the Quality Assessment will have the following major objectives:

- Measurement of what students should know and are able to do according to the Learning Outcomes of science;
- Objective verification of the application of scientific principles to familiar and unfamiliar situations; and
- Alignment with the Learning Outcomes and the Teaching/Learning Strategies.

Therefore, assessment and evaluation of the students' learning of science according to pre-determined Standards and Benchmarks will ensure the quality of their academic achievements.

Construction of Test Items

Written test items (selected response and creative response) should adhere to the following criteria:

1. Items should be clearly written.
2. Each test items should be written on the understanding level of learners.
3. Test items should cover what learners have had opportunities to learn.

Too frequently, these test items measure students' gains in recall of factual information. There are other relevant facts for students to acquire. These are higher levels of thinking or cognition that students should also develop.

These test items should measure students' achievement in:

- Understanding basic science concepts and acquired learning;
- Evaluating contents in terms of criteria or standards;
- Problem-solving skills;
- Analytical and creative thinking;
- Positive attitudes developed toward science and scientific methods of thinking;

- Ability to work together will with others;
- Relevant concepts and generalizations developed; and
- The ability to manipulate and utilize science equipment.

Results from achievement tests may be utilized, along with other data-gathering techniques, to appraise students' progress in the science curriculum.

Reporting

Reporting on student learning should focus on the extent to which students have achieved the curriculum outcomes. Reporting involves communicating the summary and interpretation of information about students' learning to various audiences who require it. Teachers have a special responsibility to explain accurately what progress students have made in their learning and to respond to parents' and students' inquiries about learning.

Narrative reports on progress and achievement can provide information on students' learning that letter or number grades alone cannot. Such reports might, for example, suggest ways in which students can improve their learning and identify ways in which teachers and parents/ guardians/ caregivers can best provide support.

Effective communication with parents/ guardians/ caregivers regarding their children's progress is essential in fostering successful home-school partnerships. The report card is one means of reporting individual student progress. Other means include the use of conferences, notes, and phone calls etc.

Guiding Principles for Reporting

In order to provide accurate, useful information about the achievement and instructional needs of students, certain guiding principles for the development and use of assessment must be followed. For example:

- Assessment strategies should be appropriate and compatible with the purpose and context of the assessment.
- Students should be provided with sufficient opportunity to demonstrate the knowledge, skills, attitudes, or behaviours being assessed.
- Procedures for judging or scoring student performance should be appropriate for the assessment strategy used and be consistently applied and monitored.
- Procedures for summarizing and interpreting assessment results should yield accurate and informative representations of a student's performance in relation to the curriculum outcomes for the reporting period.

- Assessment reports should be clear, accurate, and of practical value to the audience for whom they are intended.

Attitudes and Values

Attitudes and values cannot be assessed directly. They are embedded in what students do and say. Teaching methods and learning activities that encourage students to recognize the value and relevance of what they are learning go a long way towards motivating students to work and to learn effectively.

Activities that involve students in investigating issues related to science and technology outside the school environment provide them opportunities to develop the attitudes and values so as to make informed and responsible decisions.

A summary of assessing science learning is presented as follows.

What?	When?	How?	Recording
Science Knowledge and Understanding:			
• Biological science • Earth and space science • Physical science	• Ongoing during and after Science lessons • On completion of units • On completion of projects or practical investigations	• Observation • Student work samples • Oral reports • Talking with students • Diagnostic tasks • Student designed tests • Self-assessment • Modeling • Teacher-constructed tests	• Anecdotal records • Annotated class lists • Knowledge-related checklists • Science journals • Cumulative checklists • Photographs, video
Application of Scientific Knowledge:			
• Explaining • Predicting • Analyzing	• Ongoing during and after Science lessons • On completion of units • During class discussions	• Concept mapping • Open-ended questions • Problem-solving activities • Debates • Teacher-constructed tests	• Anecdotal records • Annotated class lists • Checklists specific to applications • Student folios containing samples of student work

What?	When?	How?	Recording
Skills, Processes and Procedures:			
• Observation • Posing questions or hypothesizing • Identifying and controlling variables • Planning investigations • Classifying • Using equipment correctly • Justifying measurement procedures • Collecting and recording data • Drawings • Presenting data • Analyzing data • Drawing conclusions	• During and after practical sessions • When planning and carrying out investigations • During and after excursions	• Observation • Practical tests • Fieldwork • Practical investigations • Surveys and interviews • Practical reports	• Annotated class lists specific to processes identified • Anecdotal records • Folio of student practical reports • Photographs, video, audio recordings
Scientific Attitudes and Acting Responsibly:			
• Flexibility • Curiosity • Respect for evidence • Critical reflection	• Ongoing during and after Science lessons • During individual and group projects	• Science journals • Questionnaires • Talking informally with students • Practical reports • Library research tasks, including using the Internet and authoring tools	• Anecdotal records detailing attitudes • Folio of student practical reports • Checklist specific to attitudes listed
Scientific Communication:			
• Appropriate language and vocabulary	• Ongoing during discussions • Following completion of project reports • During individual or group presentations	• Oral presentations • Practical reports • Drawing • Research project reports • Role-plays, performances • Peer-assessment • Creative writing • Using authoring tools for accessing presenting and communicating information	• Video, audio recordings • Anecdotal records • Folio of students' practical and research reports

9 Guidelines for Developing Teaching Learning Resources

In most schools the textbook is the only teaching-learning tool. Rarely do teachers use other resources to support the learning. However, many other resources that can be available, accessible and affordable must be used to achieve desired outcomes.

These are:

- Textbooks
- Teachers guides
- Students workbooks
- Reference books
- Visual aids such as charts, models etc.
- Videotapes
- Computers (Computer software & Internet websites; online libraries etc.)
- Community (Field trip & Guest speaker)

Guidelines to the Textbook Authors

A textbook is an important teaching and learning resource and one of the most extensively used resources in our classrooms. The textbooks provide science information for the acquisition of knowledge. Writing a textbook is an extremely important and technical task in the sense that it requires the translation of curriculum learning outcomes at the proper cognitive level of the students. Textbook authors need to consider, among others, following guidelines.

- Introduction to textbook explaining the structure and format of the book, organization of concepts in connection with the curriculum objectives, and directions to use the textbook must be stated in the beginning of the textbook.
- The textbook must have accurate, authentic, and up-to-date material.
- The language structure should be written in such a way as if talking to audience.

- The material must be sufficient to give students the knowledge they need to understand the concepts, develop the inquiry skills and engage in higher order thinking.
- The material should help students understand the world in which they live, and prepare for life long learning.
- The material must be error free so it can be trusted.
- The material must be unbiased.
- The book must be attractive and engaging.
- The textbook should be well Illustrated i.e., illustrations are clearly, accurately, appropriately and neatly drawn. These must be properly labeled and captioned.
- The textbook should have variety of practical and thinking activities to engage students in learning.
- The textbook should be made user friendly by developing colour coding, different levels of headings and subheadings, tidbits and examples from real life applications.
- Exercises should be included to encourage students to think, develop skills, and use information for a variety of purpose.
- The textbook must contain Table of contents, Index and Glossary.
- The textbook must be contextually relevant (feasible to use in Classrooms, affordable, examples from context to increase relevance and meaning).

Guidelines for Writing a Chapter

To make the learning of science interesting and exciting and to provide a strong foundation for higher learning, each chapter in the science textbooks must have, among others, the following features.

- **Specific Learning Outcomes** at the beginning of each chapter clearly describing the objectives and tasks to be achieved in the chapter.
- **Key words, terms and definitions** to be highlighted in the text.
- **Science tidbits** to provide snippets of interesting and useful knowledge.
- **Attractive and colorful illustrations** to captivate students.
- **Do You Know?** Questions to recall, think and apply what they have learnt as well as to reinforce the learning of key concepts and principles.

- **Mini-exercise** to provide questions involving scientific investigations and relating science contents with the technology, society and environment.
- **Awareness beyond the classroom** to widen the horizon of the students by providing interesting information and introducing related, more advanced concepts according to grade level in an understandable way.
- **Key Points** to provide a summary of the concepts and principles in the chapter.
- **Review Questions** at the end of each chapter to
    - Recall and integrate previous learning
    - Engage students and develop their creativity
    - Move from lower to higher order thinking
    - Develop process skills
    - Develop multiple intelligences
- **Think-Tank/Investigate** to include open-ended questions to provoke students' thinking, creatively and investigation skills.
- **Test review/Theme Reinforcements** after 2-3 units, as an additional drill to include interactive and useful activities, strengthening students'
    - Vocabulary
    - Understanding
    - Critical thinking
    - Process skills
    - Performance Assessment

Criteria for Analysis of the Textbook

Following criteria must be considered for selecting learning material for the textbook.

Answers to most of these questions, if in the affirmative, will indicate a good quality textbook.

1. Is the content accurate and up to date?
2. Are important skills developed?

3. Do the illustrations (pictures, drawings, graphs, etc.) help to understand the contents better?
4. Do the end-of-the chapter exercises encourage students?
    a. To think;
    b. To develop their skills; and
    c. To be creative.
5. Are learning activities suitable for the needs of the learner?
6. Do learning activities include student participation in real life issues and promote scientific inquiry or investigation?
7. Are a variety of assessment strategies suggested?

    (e.g., fill-in-the-blank, multiple choice, project work, exhibitions, open-ended and divergent responses, think tank etc.)
8. Do the text, questions and suggested activities stimulate interest that would lead to further study?
9. Are there biases? a) Religion b) nationality c) gender d) occupation e) Class
10. Is it related to the goals of the curriculum?
11. Is a teacher's guide included?
12. Is it attractive and appealing to children?
13. Is the language readable, understandable, and easy to follow? Appropriate for the children who will use it?
14. Are the following adequate?
    - Page size
    - Line spacing
    - Titles and sub-titles
    - Font size
15. Are the contents relevant to the needs, age and level of understanding of the students?
16. Is there an introduction and key points/summary?

17. Does it have

    a. An introduction explaining its organization;

    b. Table of contents;

    c. Glossary; and

    d. Index?

Teacher's Guide

Teacher guides provide detailed explanation of key concepts. Textbooks usually come with a teacher's guide aimed at informing teachers of how the textbook is written and how best to use it to facilitate student learning. It is a way to teach a particular topic, provide further activities and examples that could be given to facilitate learning.

Guidelines for Writing Workbooks

Workbooks are books that contain writing activities and exercises that are related to each chapter in the textbook. Workbook exercises help to develop students' conceptual understanding of the concepts dealt within the text, to develop skills and to apply knowledge to new situations. Workbooks should have:

- Many exercises and activities for each chapter, topic, subtopic.
- Exercises and activities that will enable student to develop and practice the content knowledge, skills and higher order thinking.
- Accurate exercises.
- Clear instructions i.e., easy for students to understand and follow.
- Clear illustrations/ examples/ explanations.
- Enough space for students' responses (where appropriate).
- Relevant material and age appropriate vocabulary.
- Exercises and activities with a variety of purposeful, stimulating, challenging and innovative items to encourage students to review and practice the knowledge and skills they have learnt.
- Exercises that include constructed and restricted response items.

Appendices

A. Planning Classroom Assessment

	Assessment as Learning	Assessment for Learning	Assessment of Learning
Why Assess?	• To guide and provide opportunities for each student to monitor and critically reflect on his or her learning, and identify next steps	• To enable teachers to determine next steps in advancing student learning	• To certify or inform parents or others of student's proficiency in relation to curriculum learning outcomes
Assess What?	• Each student's thinking about his or her learning, what strategies he or she uses to support or challenge that learning, and the mechanisms he or she uses to adjust and advance his or her learning	• Each student's progress and learning needs in relation to the curricular outcomes	• The extent to which students can apply the key concepts, knowledge, skills, and attitudes related to the curricular outcomes
What Methods?	• A range of methods in different modes that elicit students' learning	• A range of methods in different modes that make students' skills and understanding visible	• A range of methods in different modes that assess both product and process
Ensuring Quality	• Accuracy and consistency of student's self-reflection, self-monitoring, and self-adjustment • Engagement of the students in considering and challenging their thinking • Students record their own learning	• Accuracy and consistency of observations and interpretations of student learning • Clear, detailed learning expectations • Accurate, detailed notes for descriptive feedback to each student	• Accuracy, consistency, and fairness of judgments based on high-quality information • Clear, detailed learning expectations • Fair and accurate summative reporting
Using the Information	• Provide each student with accurate descriptive feedback that will help to develop independent learning habits • Have each student focus on the task and learning (not on getting the right answer) • Provide each student with idea for adjusting, rethinking, and articulating learning • Provide the conditions for the teacher and student to discuss alternatives • Students report about their learning	• Provide each student with accurate descriptive feedback to further his or her learning • Differentiate instruction by continually checking where each student is in relation to the curricular outcomes • Provide parents or guardians with descriptive feedback about student learning and ideas for support	• Indicate each student's level of learning • Provide the foundation for discussions on placement or promotion • Report fair, accurate, and detailed information that can be used to decide the next steps in a student's learning

B. Developing Science Skills and Processes

The development of science skills and processes allows students to solve problems, think critically, make decisions, find answers, and satisfy their curiosity. The following skills and processes are central to the presentation of all content and the delivery of instruction and assessment activities in classrooms.

Science Skills and Processes

Observing	Observing involves obtaining information about objects, situations, or events using as many senses as possible. Observations may be qualitative or quantitative in nature. Observing provides both a basis for new inferences or hypotheses and a tool for testing existing inferences and hypotheses.
Measuring	Observations are quantified using non-standard and then standard units. Length, area, volume, mass, time intervals, and force are among the measurements used. Appropriate measurement instruments and units within the metric system are selected.
Classifying	Classifying involves grouping objects, concepts, or events on the basis of observable properties to show similarities, differences, and inter-relationships.
Inferring	Inferring means suggesting more about a set of conditions than is observed. Inferences are based on observed data and past experience. Inferences may evolve from both direct and indirect evidence and are modified on the basis of new evidence.
Predicting	A forecast is made about future events on the basis of ordered data. Predictions on the basis of ordered data, extrapolation beyond observed patterns of events, and tests of predictions can be made.
Communicating	Communicating is the process of organizing and processing data that occurs between the observation stage and the interpretation or generalization stage. It usually involves organizing "rough" data in a more compact and meaningful way (ordering, rearranging, comparing), depicting the data pictorially or graphically, and processing it mathematically (finding slopes, tangents) to facilitate interpretations.

Hypothesizing	Hypothesizing is an "educated guess" made about an expected relationship between two variables in an attempt to explain a cause-and-effect relationship. Hypotheses are based on observations or inferences about a set of events. A hypothesis should be testable.
Designing Experiments	Experimenting is a cause-and-effect test between two variables. All processes may be involved. This can begin with setting a problem to be solved, identifying the variables to be controlled, making operational definitions, devising the test to be carried out, and following the prescribed procedure.
Controlling Variables	Controlling variables involves the process of deciding which variables or factors will influence the outcome of an experiment, situation, or event, and deliberately controlling all recognized variables in a systematic manner.
Interpreting Data	Interpreting is the process by which sense is made of the observations in the form of inferences, generalizations, or explanations. It is usually a direct response to the problem under investigation and therefore includes judgments about the interpretation to fit with proposed hypotheses, and the limitation of the new knowledge.
Formulating Models	This process involves the use of physical or mental models to describe the behaviour of something that is unfamiliar. Constant vigilance is necessary to ascertain the validity of the model or analogy to the phenomenon modeled. Models often need revision to accommodate new facts.

Glossary

This glossary is intended to ensure that terms commonly used in the context of learning out comes are appropriately interpreted. Words and terms defined in the glossary are found throughout the document. The curriculum review committee provided definitions for users to ensure that the meaning of each term is consistent. These definitions are not vocabulary words to be taught to students in isolation; they represent the terminology students will learn through the lessons prepared by the teacher.

Carry out	Carry out requires the students to put into practice or effect.
Classify	Classify requires the students to arrange or organize according to the Grade or category.
Compare	Compare requires the students to provide both similarities and differences between things or concepts.
Define	Define requires the students to give a formal statement or equivalent paraphrase being required.
Demonstrate	Demonstrate requires the students to show clearly their learning.
Describe	Describe requires the students to state in words (using diagrams where appropriate) the main points of the topic.
Determine	Determine requires the students to make a firm decision to do something, often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula.
Differentiate	Differentiate requires the students to perceive or show the difference in or between discrimination.
Discuss	Discuss requires the students to involves close examination of a subject with interchange of opinions, to give a critical account of the points involved in the topic.

Distinguish	Distinguish requires the students to make noticeable or difference such a pass.
Draw	Draw enables the students to formulate or devise from evidence and data at hand.
Explain	Explain requires the students to give reasoning or some reference to theory, depending on the context.
Find out	Find out is general terms that may variously be interpreted as calculate, measure, determine, etc.
Illustrate	Illustrate requires the students to draw.
Inquire	Inquire requires the students to seek for information by asking question, investigating a question or questioning.
Interpret	Interpret requires the students to conceive significance of what to present or conceptualize the meaning of, by mean of art.
List	List requires the students to give a sequence of points, generally each of one word, with no elaboration. Where a given number of points are specified, this should not be exceeded.
Measure	Measure requires the students to obtain quantity concerned from a suitable measuring instrument, e.g. length, using a rule.
Plan an experiment	Plan requires the students to identify and perform the steps necessary to find the answer to a question.
Predict	Predict requires the students to state a likely future event, process, or situation based on the given information.
Recognize	Recognize requires the students to know or identify from past experience or knowledge.
Relate	Relate requires to bring or link of logical or rational association.

Show	Show requires the students to demonstrate a procedure, concept.
State	State requires the students to give a concise answer with little or no supporting argument.
Suggest	Suggest requires the students: a. To provide ideas to problem or a situation. b. To apply knowledge to new situation.
Use	Use requires the students to apply the concept, idea, and knowledge.
Write	Write requires the students to put words, figures or signs on something on paper with a pen or pencil.

Acknowledgements

General Science Curriculum-Writing Team

Dr. Firdous Zahra Bashir	Consultant (Science) National Curriculum Council Curriculum Wing, Islamabad.
Ms. Farah Huma	Head Habib Public School Development Centre Karachi.
Ms. Shahnaz Rashid	Assistant Professor Islamabad Model College for Girls F-10/2 Islamabad.
Mr. Muhammad Riaz	Associate Professor Post Graduate College Abbottabad.
Dr. Waheed-uz-Zaman	Assistant Professor Islamabad Model College for Boys G-6/3, Islamabad.
Mr. Syed Waqar Ashraf	Assistant Professor Islamabad Model College for Boys F-8/4, Islamabad.
Dr. Anila Jaleel	Professor Zia-ud-Din Medical University Karachi.
Ms. Samia Dogar	Assistant Professor Federal College of Education H-9 Islamabad.

General Science Curriculum Framework-Team of Advisors

Dr. Masoom Yasinzai	Director / Dean University of Balochistan Quetta.
Dr. Anila Jaleel	Professor Zia-ud-Din Medical University Karachi.
Dr. Tayyaba Siddique	Principal F.G. Post Graduate College for Women F-7/2 Islamabad.
Dr. Kausar Jamal Cheema	Dean of Natural Science Lahore College for Women University Lahore.

Dr. Arshad Iqbal	Chairman University of AJ&K Islamabad Campus Islamabad.

General Science Curriculum - Panel of Experts

Dr. Muhammad Ijaz	Assistant Professor GIK Institute of Engineering Science & Technology Swabi.
Dr. Hasan Mahmood Khan	Incharge National Centre of Excellence, Physical Chemistry University of Peshawar Peshawar.
Dr. Muhammad Akhtar Memon	Professor University of Sindh Jamshoro.
Dr. Abdul Salam Khan	Professor University of Balochistan, Quetta.
Dr. Muhammad Illyas	Associate Professor University of Peshawar Peshawar.
Dr. Muhammad Haleem	Professor University AJ&K Islamabad Campus Islamabad.
Dr. Muhammad Younas	Chairman Bahauddin Zakaria University Multan.
Ms. Samina Ibrahim	Frobels' International School F-7/2, Islamabad.
Ms. Noreen Razzaq	Assistant Professor PAF College for Women Chaklala Rawalpindi.
Ms. Tahira Afzal	Assistant Professor Rtd. IMCG F-10/2, Islamabad.
Ms. Atiqa Amjad	Assistant Professor University of AJ&K Islamabad Campus Islamabad.

In addition, National Curriculum Council, Curriculum Wing, Ministry of Education, Islamabad, highly appreciates the involvement and valuable contribution of all Stakeholders including Educationists and Science Educators, School Teachers, Students and Parents at various levels of Review and Development process for General Science Curriculum.

References

1. California Department of Education. (1990). Science Framework for California Public Schools (K-12). Sacramento, CA.
2. Michigan Department of Education. (1991). Michigan Essential Goals and Objectives for Science Education (K-12). Lansing, MI.
3. NAEP Science Consensus Project. Science Framework for the National Assessment of Educational Progress.
4. Queensland School Curriculum Council (QSCC) 2002, guidelines on assessment and reporting.
5. Entertaining science: A forum for the promotion of science and scientific literacy in popular culture. http://www.scientificliteracy.org/.
6. Theory of educational assessment: Manitoba Education.
7. Education Policies and Curriculum, National Council of Educational Research and Training, India.
8. National Academy of Sciences. (1995). National Science Education Standards.
9. The New Zealand Curriculum Framework. Ministry of Education, New Zealand Wellington.
10. Ontario, Ministry of Education. The Common Curriculum: Policies and Outcomes 1995.
11. The Review of the National Curriculum in England: the Consultation Materials, 1999. London.
12. Quality assurance in Education: Successful Approaches for Improving Quality in Schools, Colleges and Universities.
13. Lower Secondary Curriculum, Ministry of Education. Singapore.
14. UNESCO. Report to UNESCO of the International Commission on Education for the Twenty-First Century –Learning: the Treasure Within. Paris: UNESCO, 1996.
15. Asia-pacific Regional Workshop on Bridging the gap between Scientists and Science Educators, 2004 (UNESCO) in Shanghai, China.
16. "Curriculum Framework" Curriculum Council of Western Australia.
17. Curriculum Development Centre, Ministry of Education, Malaysia.

18. Critical Thinking Design Model, Harvard Education.

19. Active Learning Practices for Schools. http://learnweb.harvard.edu/alps/.

20. United Nations Educational, Scientific and Cultural Organization (UNESCO). [Online]. http://wwww.unesco.org/.

21. Outcomes-based education: Policy context, Assessment issues and Practice. Curriculum reform: Recent trends and issues. Schooling for the twenty-first century, Paris, OECD.

22. Quality Assurance for Higher Education (http://www.qaa.ac.uk.htm).

23. The Learner-Centered Curriculum, Cambridge University Press.

24. Major Categories in the Taxonomy of Educational Objectives – Blooms' 1956.

25. The Revised Bloom's Taxonomy (1990) by Lorin Anderson.

26. http://www.fundestanding.com/learning.com/learning-styles.cfm.

27. http://www.fundestanding.com/learning.com/ (Theories on learning).