Handbook for Science Teachers

REFORMING SCIENCE CURRICULUM AND TEACHING

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PREFACE

In recent years science and technology have emerged and a force and hence it is at the forefront of our thinking. This very concern combined with wide spread attention on the development of individuals have paved way to the shifts in our educational priorities. The imminent educational reforms make it imperative to help stakeholders who deeply and genuinely share concerns about the improvement of science education programmes in the country.

Science in terms of its educational value, is a frontline subject but it has yet to earn its due status in the primary science curriculum. Blaming teachers for all malaise in education is a common practice. If students are not learning science, it is concluded as the fault of the teacher. It is easier to blame teachers rather than to rethink and identify predominant factors which are the root cause of these problems. Science education is being criticized for its confusion in goals and purposes, non implicit with respect to its scope, assorted concepts, inadequate preparation of syllabus, insufficient scientific experiences, lacking proper guide lines for writers, individual choice-based subject matter rather than research-based, non specification of learning out-comes, poor communication between planners and implementers, etc. Teachers only cannot be made scapegoat for all these deficiencies and charged with for not producing scientifically literates. It is a recognized fact that one cannot teach what one does not know. Moreover, to translate posh statements of others into classroom practices. Requires proper competencies where professional training of teachers leaves much to be desired.

This book is for curriculum planners, developers; writers, administrators and teachers who are involved in primary science education. It is assumed that this book will assist of the teachers who want to teach science effectively in order to help the students to grow and become scientifically literate citizens but are handicapped by inadequately prepared curriculum and poor communication. It is also anticipated that this format will be followed given due consideration for future curricular prescriptions in science. It provides directions to curriculum planners and developers on how to organize science for primary schools. It describes

the multidimensional nature of science education and presents developmental curriculum model to facilitate level-wise contexts of curriculum stages. It defines aims and objectives, presents major topics and concepts having bearing on each area of science for developing instructional material for different classes, outlines some representatives learning activities for guidance, identifies methods of instruction and supporting resources, highlights assessment procedures and specifies the educational outcomes that should result from the study of science at primary school level.

Deepest gratitude is expressed to group of teachers for their valuable suggestions and sincere appreciation to Mr. Zulfiqar Ali Joya for composing the manuscript.

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INTRODUCTION

Science is one of the key discipline and vital learning area in the primary school curriculum of Pakistan but yet to be recognized as part of the core curriculum. The initiation of science as school subject from Class-I lends its support from the view that science can be taught at any level in terms of its appropriateness to the level of understanding and pace of the children (Bruner). Moreover, the concept that education is for the development of the individual and society demands a curriculum, which respond to the developmental stages based on structural components derived from the discipline. These educational views offer sufficient basis to rethink and develop systematically a science education programme that begins from primary level and continues through secondary leading to tertiary level. Appropriate directions for the science education programme are also imminent for students to be adequately prepared for life in the 21st century.

Science education is not only a need of a special group but it is a need of the "all" including both male and female children belonging to both urban and rural areas. Nations have made progress not because of money, scientists and engineers but because of scientifically literate society. This implies that all the individuals of the society should have minimum essential knowledge and understanding of science that make them capable of using it wherever situation arises. Therefore, the primary science education programme focuses all students who either want to continue science or leave science/school. Thus the key of primary school science programme has to be promoted scientific literacy to enable all individuals to be useful citizens of the society.

Traditional science education curriculum are predominantly subject biased. The subject matter is selected with reference to the requirement of the discipline comprising mainly universally accepted information, concepts, principles and theories. The child, the centre of interest, his/her environment and society are given least desired considerations. Moreover, the curriculum developers and science teachers have responded to the increasing size of scientific knowledge-base by trying to cover more and

more content in the same amount of class time. The recent studies in science education clearly reflect that these strategies are highly inappropriate, as it leaves no choice for the students except to memorize. Too much emphasis on theoretical mode in science education also tends to confine the study to mere textbooks and children subsequently feel science as something isolated from the daily life and real world.

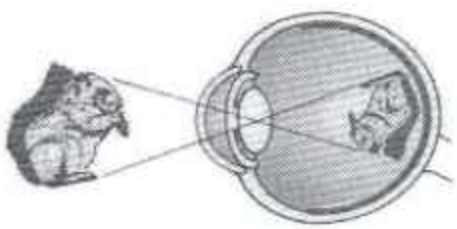
The recent shift in trend categorically emphasizes that curriculum and selection of subject matter shall focus the child, surrounding environment and society. The real world contexts are advocated to emphasize particularly those aspects, which can be referred through scientific activities. The curriculum has to give due consideration to important elements of science education such as scientific processes, scientific skills, scientific attitudes, values, interests and appreciation. The goal remains to contribute towards the betterment in quality of life. It implies selection of learning experiences for curriculum which not only develop inter- relationship between the activities of home and school but also promote scientific thinking and useful skills. It should nurture qualities like curiosity and investigation. The learning experiences shall have harmony with social values and propagate use of natural resources without effecting the environment.

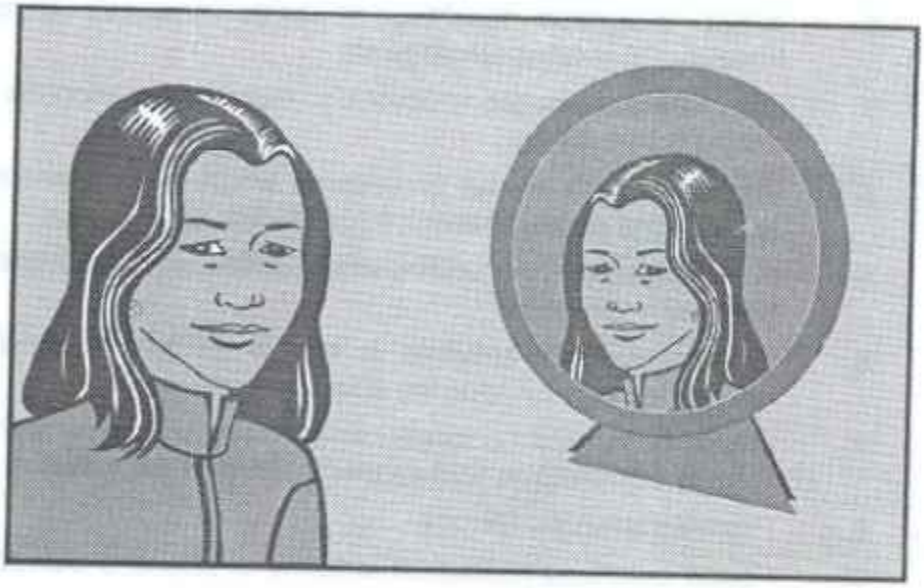
The development plans of Pakistan and vision 2030 envisage a strong science and technology base in its own soil. Therefore, there is no more urgent priority than to reform science and mathematics education. The science is a vast, complex and continuously expanding discipline having bearing on the technological and socio -economic development of the country. The knowledge of science enables to find out about, describe and explain natural as well as man made world. It also develops the capacity to change the world around us to meet the perceived needs. Science being a vast and complex field no individual can hope to understand it all as well as develop mastery over its all aspects. It is also a well-established fact that no society can prosper without scientifically literate citizens who can fully participate in the socio -economic and political activities. It implies that the purpose of science education particularly at primary level should be mainly to promote scientific literacy encompassing awareness and understanding of those essential aspects of science that ensure full participation of all individuals in the society.

The needs and requirements of vision 2030 demand quality education in the institutions. Science education programme can fulfill

educational requirements and national aspirations only if schools:

1. Provide quality science education on priority basis.
2. Adopt integrated teaching of basic sciences Biology, Physics, Chemistry, Geology etc.
3. Offer relevant science education to daily life experiences and interests of children.
4. Present subject matter of science, which have appropriate applications and usefulness for individual and society.
5. Provide ample opportunities where child can be facilitated to discover knowledge.
6. Present scientific activities to enable children to construct new knowledge by applying acquired knowledge.
7. Impart terms and concepts, which have relevance with the level of schooling as well as mental level of the children.
8. Promote scientific literacy
9. Follow balanced curriculum in terms of scientific knowledge, activities and skills.
10. Organize teaching to offer opportunity of training in reasoning, logical arguments, enquiry and critical thinking.





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WHAT IS SCIENCE?

Science is a broad field of knowledge that deals with facts about the real world and universe and interrelationships of these facts. Where as social science deals with people, groups of people and their institutions (such as families, government) that make up human society and focus on human relationships and interaction among them.

Historically, man has been curious about the world from the early days. During early civilization man, learned counting, studied about sun and moon and acquired some knowledge of animals and plants. The Greeks stressed developing general theories about the workings of world and separated scientific ideas from superstitions. They made great advances in many areas of science. The Romans though made a few contributions in science but consolidated scientific knowledge in the form of encyclopedias including Natural History (37 volumes). The Arabs made important contributions in astronomy, mathematics, medicines, optics, life and physical sciences. Muslim they left greatest scientific heritage which served as foundations for the rebirth of science in Europe. These scientists emphasized the importance of experimentation and mathematics. This realization helped human beings to bring the revolution in science. In this way man made his remarkable journey from cave era to agricultural era, industrial era, technology era and entered into present day era -information technology.

With the advent of formal educational system important disciplines earned their place in the school timetable. The science was first introduced as Nature Study as a school subject. The scientific knowledge grew and became complicated which lead to the emergence of branches of science, disciplines, specialties and subspecialties. Similar changes also took place in the list of school subjects, which we see today.

The scientific knowledge is expanding with a great pace never experienced in the history of mankind. The advances in knowledge of sciences as well as behavioral sciences have enormous influence in the evolution of science as school subject. In the beginning science focused on the study of facts predominantly about the living components of the

environment. With the increase in knowledge the coverage of science also increased along with the emphasis on study of relationships and interactions of these facts. The definition of science emerged as body of organized knowledge. The Sputnik era resulted into the addition of scientific processes (key operations). The curriculum. Searched out a balance between knowledge and the ways and methods of obtaining knowledge. The knowledge remained mainly confined to the books and journals and very few people had appropriate access. The modern information technology era along with other things made information available to all living on every corner of the earth. Now the race is who ever uses the information first earns the credit. Generating, storing and use of information enjoys the status of key operations now. It reflects departure from old trend of filling knowledge in a bag (child) to develop the awareness of resources of information and related competencies to retrieve and use the information.

Science is the systematic study *of* nature and how it affects our environment and us. It is an organized body *of* knowledge and systematic process *of* investigation and interpretation. This definition *of* science is not just restricted to a body *of* knowledge but it is also concerned with finding out about the world in systematic way (scientific method) and retrieval *of* information from appropriate sources.

Science and technology are closely related. However nature *of* relationship can vary depending upon the learning experiences and level *of* treatment. Technology is concerned with the application of scientific information to meet the perceived needs.

Technology is a component *of* the science education programme but unfortunately it is treated as a separate identity. There is no second opinion that socio -economic development is not possible without technology. The technology has also played a significant role in the development *of* science. Technology is an applied form *of* information, principles and concepts *of* science. The impact *of* technology is visible in every day aspects *of* individuals as well as in the environment. The knowledge *of* science helps us to use natural resources purposefully and creatively in order to meet the requirements *of* daily life. It extends beyond the tools and technological inventions *of* society. The manipulations *of* resources, however, require the understanding *of* natural and man made world. Keeping in view these facts technology can not be isolated from science as both are interdependent and any science programme for young children devoid *of* technology will be perceived as incomplete eventually.

3

NATURE OF SCIENCE EDUCATION

People perform different functions and activities in home, work place and society. In these activities they make use of their knowledge as well as construct new knowledge. These daily life functions and experiences formulate basis for the educational directions and needs. The science has four fold prominent dimensions -knowledge, activities, contexts and attitudes, which serve as diagnostic features of primary science education programme:

3.1 Knowledge

The foundation of scientific knowledge is based on the idea that no thing can be either studied in isolation or separated from other things. Obviously isolated and fragmented information can not formulate basis of proper knowledge and understanding and hence students will have no choice except to memorize. To develop understanding of any concept, its relationship with other concepts and information is explored. It is observed how other concepts support or oppose the concept under study. Inter-relationship and comparison of characteristics unfold the meaning and description of concepts. For example, for understanding a concept of matter we study its characteristics particularly with reference to weight (mass) and volume. A meaningful relation of factual characteristics is established and inferences are derived from this relationship: Following basic elements of education specify different components of knowledge:

i) Awareness of natural and man made environments

ii) Awareness of bio-diversity and unity in the natural world

iii) Understanding of important physical phenomena

iv) Processes of investigation and constructing new knowledge

v) Science being a human activity includes both marvelous achievements and shortcomings

The status of knowledge in science education is distinct. However emphasis remains on quality rather than quantity particularly with reference to child and environment where it is operational. Preference is given to in depth understanding of concepts rather than extensive coverage of subject matter. Unnecessary technology and information need to be avoided as much as possible to make presentation and organization of subject matter effective. Integrated approach is advocated for science education. The nature of knowledge and quantum of requirement is determined keeping in view the child, society and science discipline. The knowledge of science refers to the following major aspects, which are to be focused while formulating primary science education programme:

- Nature of science
- Basic facts, principles and concepts
- Unified and integrated themes
- History of developments
- Scientific processes and skills
- Products and services of science and technology
- Islamic teachings

3.2 Activities

People equip themselves with knowledge. They not only perform various functions by using their knowledge but also construct new knowledge during their activities. Sometime activities are carried out individually and sometime jointly or in collaboration with others. In this way people seem to be engaged in solving various problems related to individuals and society. The concept of science education cannot be perceived fully without activities. This clearly defines the status of scientific activities in science education, which has to be translated appropriately in the science education programme. The nature of scientific activities is both intellectual and manipulative. The activities in science education has following three major functions:

3.2.1 Using Knowledge

Children develop awareness and understanding of various aspects of their environment by using their scientific knowledge. Learning activities of school provide them opportunities where students can use acquired

knowledge and develop understanding of various concepts. The use of knowledge assists in describing various objects, events and systems. The focus of education is to enable children to use and apply their knowledge for observing, measuring and estimating correctly, predicting appropriately, explaining and analyzing their observations and experiences and solving problems at their own. If these intentions are to be realized then activities in science education are to be recognized as compulsory component of the curriculum. That is why it is considered essential to include ample opportunities of activities in science education curriculum, as one or two activities cannot be instrumental to achieve all the desired objectives. The major scientific processes/methods, which facilitate the use of knowledge of science, are as under:

- Observation
- Measurement
- Classification
- Experimentation
- Investigation
- Analysis
- Prediction
- Communication
- Communicating
- Manipulation
- Synthesis
- Evaluation etc.

3.2.2 Constructing New Knowledge

Children are not only receivers of knowledge but at the same time they are users as well. By using knowledge they increase their knowledge further. The activities which provide them opportunities to develop awareness and understanding of objects, events and systems also enable them to construct new knowledge. While performing scientific activities, children gather new information and experiences, which result into formulation of new knowledge. The science activities discourage rote memorization instead emphasize understanding. The scientific processes and skills and exploitation of appropriate resources of information facilitate in constructing new knowledge. When children forget something they can also perform related activity again in order to reconstruct their knowledge. During activities following aspects support and assist in the construction of new knowledge:

- Asking questions
- Solving problems

- Making connections, establishing relationships, identifying differences and similarities, inferring pattern
- Interpreting text, diagrams, graphs, models, tables, maps etc.
- Identifying and using appropriate resources
- Reconstructing previous knowledge

3.2.3 Developing Skills

As pointed out earlier science is not a just body of knowledge but also encompasses the ways -scientific processes or key operations of science. The major scientific processes as mentioned earlier, are observation, measurement, classification, experimentation, investigation, collection and interpretation of information, application, communication, manual operations etc. These processes lead to range of scientific skills, which are required to be developed through science activities. Science skills are both cognitive and psychomotor. The intentions of science activities are to facilitate and develop competencies in scientific skills. Following are the major scientific skills, which are addressed, in an educational programme:

- Observing
- Classifying
- Measuring
- Conducting experiments
- Recording
- Analyzing
- Interpreting
- Making inferences
- Communicating
- Manipulating such as handling apparatus, using tools, improving, working safety etc.

3.2.4 Reflecting on Knowledge

Education is a life long process. People and children continuously increase their knowledge through various activities and experiences. However, they seldom tend to reflect on the knowledge whether what has been obtained is right or wrong, design of experiment appropriate or otherwise. Every person is responsible for his/her own actions. One has to go back rethink about actions, cause and affects, which enable children to develop a habit of justifying their actions. They have to question themselves whether this obtained knowledge is essential for them and

society or not. They assess reed to the affects and implications of scientific knowledge on other individuals and society. They discover the relevance of the knowledge with social values. They should discuss the

affects of scientific discoveries with respect to national development and contribution towards humanity and environment. Obviously such science activities need to be selected in the curriculum, which offers opportunities for children to present positive and negative arguments, analyze and criticize, establish relationships with others and explain the interaction between science and society.

Following elements can help to develop ability to reflect on knowledge and scientific activities:

- Analyzing
- Criticizing
- Justifying
- Developmental contexts of science
- Impacts of human activities on the environment
- Interrelationship among human, science and society
- Describing limits of knowledge

3.3 Real World Contexts

The basic ethos of science is to know the real world. Therefore it cannot be treated and taught in an isolation. The knowledge of science is based on the real world having both natural and human contexts where we live in and the earth and universe where there are many physical and biological systems. Science is also related to technology, which has become an essential part of our daily life. The scientific knowledge is based on facts whether they are related to animals and plants, environment and universe, physical phenomena and systems or society. These situations formulate real-world contexts and are used for understanding, describing and explanations. In physical sciences contexts mainly focus physical phenomena such as Physical change, Chemical change, Energy, Motion, Friction etc. In biological sciences we use various systems of living things, cells, ecosystem etc. as contexts for teaching Geo-sciences contexts are described in terms of geo-sphere, atmosphere, solar system and universe. Whereas in technology we refer to different systems of technological devices such as refrigerator, TV, Radio,

Computer etc. Moreover, we also make use of historical and social aspects as contexts in teaching science. However, some contexts are not real but abstract such as atom, which can not be seen and are illustrated through models and charts. In science education we make use of both real-world contexts and abstract contexts. The major contexts in science education are as under:

- Universe, solar system and space
- Earth: atmosphere, hydrosphere, geo-sphere, etc.
- Society
- Living systems: cells, organisms, life processes, Eco system, etc.
- Physical phenomena: motion, fraction, changes in matter, rain, carbon cycle etc.
- Technological systems and devices: T.V, refrigerator, Computer, Radio, etc.

3.4 Attitudes, Interests, Values and Appreciations

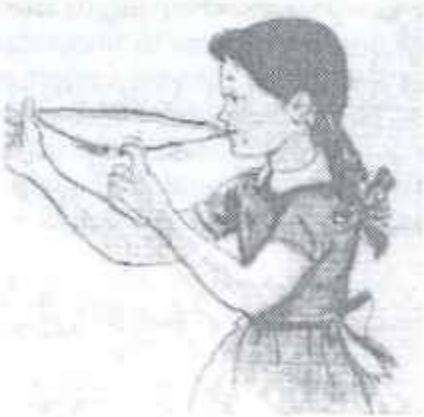
The development of scientific attitudes takes place when the child is involved in learning process. These are behavioral pattern develop through knowledge, understanding and processes of science. The scientific attitudes include different behavioral out comes such as curiosity, open mindedness, making decisions on reliable evidence, respect and tolerance for others ideas, reluctance to believe superstitions, willingness to cooperate and shoulder responsibilities, avoid to make generalizations on the basis of little knowledge or unreliable evidences, etc.

Interests are positive emotions, which are nurtured through learning experiences. The interest of the child develops through variety of learning opportunities and activities. Interest is reflected from responses such as liking for science and science activities, extension and repetition of science activities, full participation, reading other science books and journals etc.

Appreciations are emotional responses and are evolved while child is engaged in learning experiences. The knowledge of science helps to formulate basis for appreciating the creations of God, the contributions of scientists and various discoveries of science. Science education develops knowledge and awareness of the nature, contributions of science and technology and scientists as ingredients of appreciation such as natural

phenomena and systems, the role of science in daily life, the impact of science and technology on society, the role of science towards socio-economic development, contribution of scientists, creation of nature, orderliness of naturally phenomena and laws, methods of science etc.

Values are feelings and believes what one tends to hold and what one wants to protect. During learning activities child learns how other people perceive a situation or interact and also learns to understand own feelings. The scientific knowledge and activities provide opportunities to the children to explore and react to it. These situations can be generated from attributes such as the science is nonviolent, science is non-manipulate, conservation of wild animals and natural resources, use of drugs, adoption of mechanized farming, conservation of energy.



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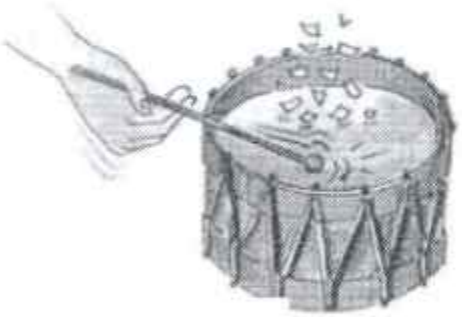

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ارتعاش سے آواز

4

DEVELOPMENTAL SCIENCE CURRICULUM: A MODEL

Unlike traditional and contemporary curricula, the science education programme is considered appropriate if based on a developmental curriculum approach. The developmental curriculum represents an important aspect of progressive education designed to infuse science accordingly into all levels of schooling. However, this approach also sets a direction to be transformed into a comprehensive model for all disciplines and whole education. The model as proposed emphasizes rethinking and formulation of education structure based on developmental nature of scientific concepts, learning theories, relevance to the developmental stages of the child and facilitating a comprehensive framework for a vertically progressive educational programme. Ultimate goal is to foster progressive education based on the developmental nature of scientific concepts. Research studies are evident that there is a continuous loss in communication from planning to implementation of curriculum. The developmental curriculum model ensures to minimize the loss in communication and exploits developmental nature of scientific concepts. It also provides sufficient reference in order to interpret the posh statements of aims and objectives into behavioral terms more clearly at school. The developmental curriculum model has following major features:

- The model is based on the view that the whole education can be divided into vertically progressive developmental curriculum stages in relation to the levels of schooling.
- It holds that the whole curriculum development activity can be divided into manageable parts that continue to relate progressively to that whole.
- The model considers the child as centre of interest and focuses the essential areas of individual's growth by relating curriculum to developmental stages of the learner.

- It views that science education has identifiable developmental concepts and can provide direction to the curriculum planners and developers for stage-wise curriculum framework.
- It is based on the view that if the structure of education is divided into stages, educational elements of the individual's developmental growth are defined and learning experiences activities are broken down into manageable parts. Moreover, the communication between planners and teachers (implementers) can be facilitated more appropriately.

These components prompt systematic thinking and are vital for comprehensive framework and directions for a developmental science curriculum. In this model, five different developmental curriculum stages are proposed with respect to our levels of schooling as under:

Level of Schooling	Developmental Curriculum Stage
i) Elementary • Primary (Class I-V) • Middle (Class VI-VIII)	 Awareness Orientation
ii) Secondary • Secondary Class IX-X) • Higher Secondary (Class XI-XII)	 Exploration Pre-preparation
iii) Tertiary (Class XIII-VI)	Preparation

4.1 Developmental Curriculum Stages

The developmental curriculum stages as identified correspond to specified levels of schooling and specification of each stage focuses desired goals. Following are the developmental stages of curriculum:

4.1.1 Awareness Stage

There is a wide-spread recognition and acceptance by educationists and psychologists that science education programme can be introduced from the earliest level i.e. Class-I. Children start their formal education when they enter into school at primary level (Class I-V). The developmental curriculum model considers this level as first educational developmental stage of the child and is named as Awareness Stage. At this early stage children begin to form concepts which are mainly based on their concrete experiences. These characteristics help to form bases for the teaching - learning process and lay foundations for higher concepts to be followed in

other grades. Hence, the children at this stage needs to be exposed to the meaningful ingredients of concept i.e. concrete properties of the objects and their inter relationship. This exposure enables the children to evolve precise, stable and complete conception. The awareness stage predominantly focuses on the surrounding environment, its major components and their relationship to facilitate children in perceiving the real world. The requirements for the curriculum implies involvement and encouragement of children in science activities based on their familiar surroundings and its relevance with self, home and society.

4.1.2 Orientation Stage

The second stage of the developmental curriculum model is the "Orientation Stage" which corresponds with the middle level of schooling (Classes VI-VIII). This stage focuses on the characteristics of children ranging from 10+ to 12+ years when they start longing for the feelings of real world and direction. At this age the child progresses from concrete to formal operational thinking and has the ability to think back mental operations(reflection). The orientation stage addresses the child with these characteristics and focuses to cater the needs by providing a wide variety of experiences and activities. Learning by doing and first hand experiences remain central in terms of the long-term progression of specified understandings, skills and attitudes.

School Levels	Grade	Curriculum stages
UNIVERSITY AND PROFESSIONAL EDUCATION	16, 15, 14, 13	PREPARATION
HIGHER SECONDARY	12, 11	PRE-PREPARATION
SECONDARY	10, 9	EXPLORATION
MIDDLE	8, 7, 6	ORIENTATION
PRIMARY	5, 4, 3, 2, 1	AWARENESS

DEVELOPMENTAL CURRICULUM

The science programme for Classes (VI-VIII) can be based on a thematic approach. At this stage science is not broken up into separate

subjects but presented as a whole. The learning experiences are selected and integrated into a unified theme e.g. Our Environment. It includes conceptual schemes and scientific processes as considered essential for orientation and inculcating the true spirit of science about the real world. Science activities play pivotal role in this programme, which enable the children to develop a good knowledge and understanding of science and scientific processes, and much emphasized scientific or process skills. The real life learning experiences enable them to develop positive attitudes, interest, values and appreciations.

4.1.3 Exploration Stage

The exploration stage of the developmental curriculum model corresponds with the secondary level of schooling i.e. classes IX-X. During this stage the children tend to advance their operational skills further and are more capable of thinking abstractly. They can examine the consequences of various combinations of factors in a systematic way. At this stage children needed to be exposed to different sub-stages of exploration i.e. search, experimentation, investigation and trials. They also tend to find. Out reaction of various experiences in terms of liking and disliking on the basis of their interests, abilities and potentials.

These stages prompt systematic thinking and directions for the development of science education curriculum for each level. Science education has identifiable developmental levels of concepts, which can help curriculum developers and teachers to define purposes of science education and desired outcomes with reference to the developmental stages of the curriculum.

4.2 Educational Elements

The developmental curriculum model considers the growth and development of the learner as a planned activity. The model spells out various dimensions and areas of individual's growth which covers almost whole of the education. These broad educational elements of the science programme, as identified below, are intended to be achieved through school, home and society:

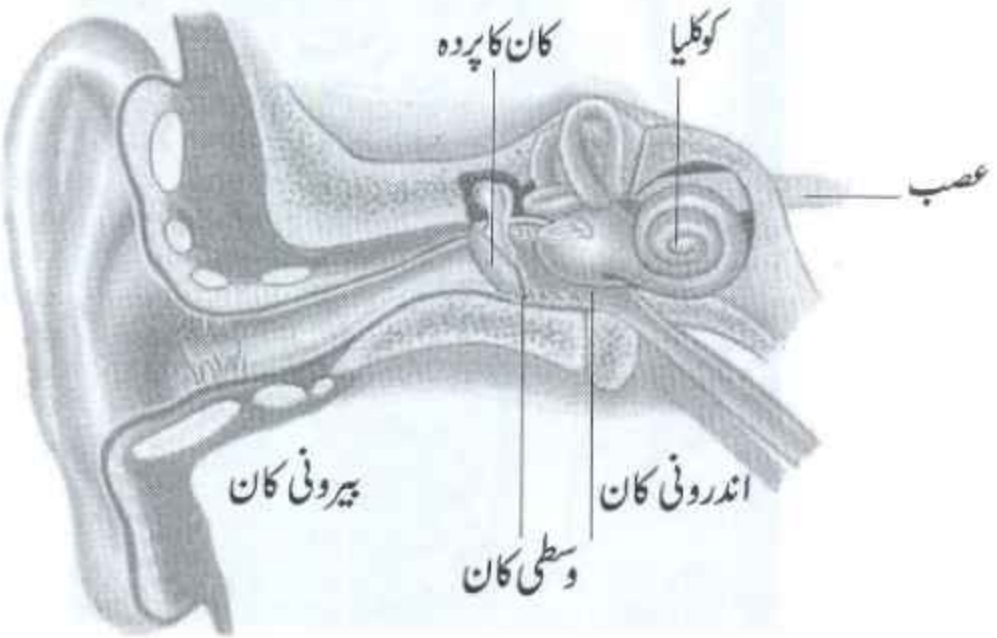
- Self-awareness
- Religious and national awareness
- Academic competencies
- Educational and career

awareness

- Attitudes, values and appreciation
- Socio-economic awareness

These educational elements of individual growth represent areas, which are to be translated into educational goals and cognitive, affective and psychomotor behavioral objectives. These broad educational elements also facilitate to establish and identify outcomes consistent with the developmental stages awareness, orientation and exploration.

The primary science programme is based on the developmental curriculum approach covering an "Awareness Stage" for classes I-V and aims at development of awareness, real feelings and experiences of fundamental concepts and principles of science and technology in real world context.



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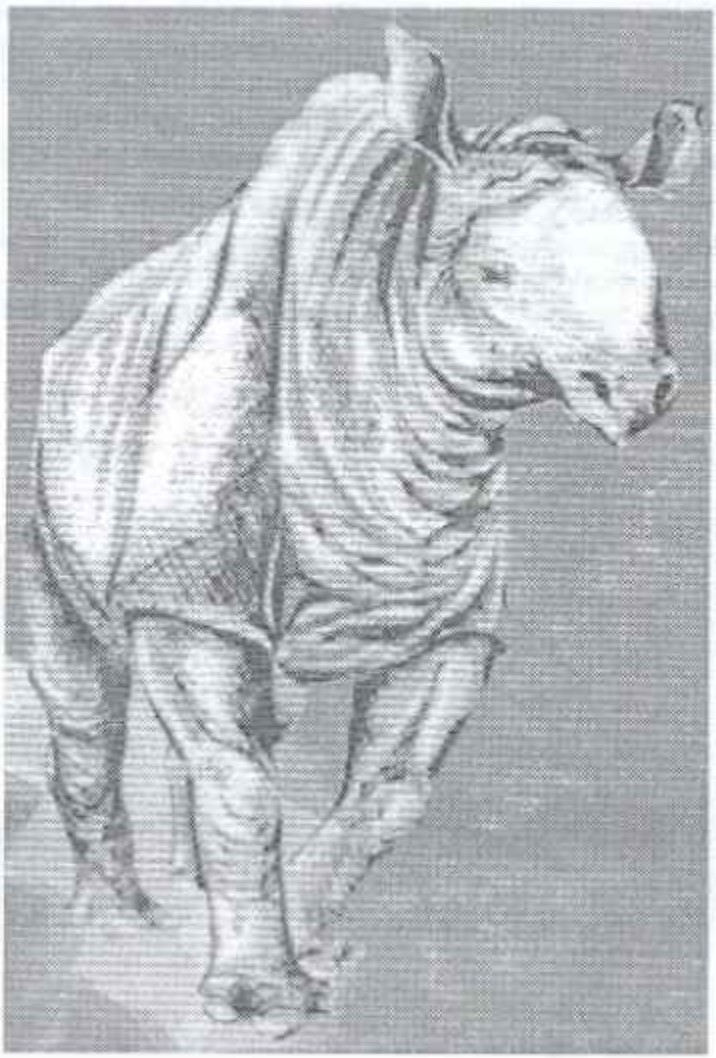

5

AIMS OF SCIENCE EDUCATION

The knowledge of science and its application is influencing the life of every citizen. Hence all students need to understand science if they are to fulfill their responsibilities as future adult citizens and their personal need, as individuals. The science programme can serve all students if it emphasizes scientific knowledge which is useful to all so as to develop scientifically literate citizens. It has to offer opportunities to develop awareness and understanding of concepts, skills, using and constructing knowledge, attitudes, values, appreciation and social implications of science. The focus has to be on learning how to learn, how to inquire, how to acquire knowledge, how to utilize knowledge, how to retrieve information from related source and how to solve problems. The student as adult should be able to use all which has been learned, in daily life as well as to interact with other persons, science and environment.

Children have inquiring minds. A good science programme aims to encourage children to question and to look for the cause and effect of things that are happening around them. The learning experiences can promote science learning in school that develop linkages with the real world outside the school by emphasizing activities and contexts they encounter in their environment. Children also learn from their own mistakes. Nurturing of this innate quality of children lead to real learning and eliminate rote memorization. The science programme must address the techniques and skills that scientists use to answer a question or solve problems. The engagement of children in activities which require the use of these techniques and skills should help to develop scientific approach among them.

Science is knowledge of the real world and science programme should help children to develop understanding about the world around them. The learning experiences, if wisely selected, enable them to understand science concepts and their interrelationships. They become familiar that use of acquired knowledge assists to construct new

knowledge. Facts are important for understanding concepts but should not be treated as a fragment of information instead be related and used for the development of concepts. A scientifically literate citizen has understanding of key concepts and principles of science, interactions and interrelationships of vital components of the environment, nature of environmental problems and means for controlling them. Moreover he/she is well oriented with scientific processes and skills.

The knowledge of science is expanding with a great pace and new technologies are appearing day by day. Science and technology are producing visible impacts on the physical, economic and social aspects of human life. The science programme needs to focus the interactions and interdependence of science, technology and society. As we are living in a rapidly changing world it also is imperative to prepare children to adjust and live successfully in a changing world.

Considering the above mentioned priorities and challenges of the 21st century the aims of the science education programme for primary level has to focus the development of individual so as to develop essential knowledge and necessary skills and competencies leading to enriched view of students about themselves, science and real world around them. Hence primary science education programme need to aim at:

- To produce scientifically literate citizens and active participants in the society.
- To enable students to interact with scientific knowledge and to adjust in the rapidly changing world.
- To develop awareness and understanding of natural and man made world.
- To foster awareness and understanding of interactions and interdependence among science, technology and society.
- To inculcate scientific approach to investigate and solve problems.
- To enable to respond to the Islamic teaching and ideology of Pakistan.
- To develop enthusiasm for further learning of science and technology.

6

OBJECTIVES OF SCIENCE EDUCATION

The statements of objectives are developed from aims and offer guidelines for the selection of content. They cover spelt out domains i.e. knowledge, processes, skills, and attitudes. Objectives of science education programme have been expressed in terms of performance behaviors as desired and have been categorized under six prescribed elements of science education.

6.1 Self-Awareness

The student:

1. Begins to formulate generalization about self.
    - Identifies uniqueness
    - Recognizes and provides examples of own characteristics
    - Differentiate self from others
2. Understands how interest develops through examples
    - Recognizes how people become interested in an activity Identifies primary areas of interests
    - Recognizes the tendency that interests may change with growth, learning and new experience
    - Assesses others (social-self) contributions for more accurate self understanding
    - Plans for strengthening of self-image
3. Adopts identity as a 'Scientist'
    - Performs variety of tasks regularly
    - Recognizes that in accepting a task, he/she also accepts certain responsibilities
    - Identifies how role of a student is similar to that of scientist
    - Describes how work undertaken at school can affect him/her in the future

4. Understand that he/she is in-charge of becoming him/her self
    - Identifies possible sources of information for self-appraisal
    - Rates own physical and mental abilities
    - Expresses interests and develops aspirations
    - Recognizes that he/she is responsible for his/her own behaviour
    - Appraises his/her decisions in daily life
    - Recognizes that he/she can develop his/her potentials

6.2 Academic Awareness

The student:

1. Understands science as a body of knowledge
    - Differentiates science from other areas of knowledge
    - Identifies various subject areas of science
    - Recognizes that scientific knowledge helps to understand, describe and explain real world.
    - Explains the contributions of science in achieving better living conditions
    - Develops awareness that science has a lot to offer for the benefit of mankind
2. Understands science as an activity
    - Lists various science related activities in his/her environment
    - Identifies the works of famous scientists
    - Recognizes that various steps are to be followed in an activity
    - Recognizes that knowledge and skills are required to perform activities
    - Develops awareness that scientific activities largely involve team work
    - Recognizes appropriate to be observed in scientific work
3. Understands science as the means to solve problems
    - Identifies various problems in the environment
    - Examines problems which may be answered through application of science
    - Recognizes that some problems requires investigation to provide an answer and for some solutions are readily

available
- Knows the sources from which help can be obtained to solve problems

4. Possesses fundamental knowledge and information
   - Recalls facts and understands concepts, principles, theories
   - Develops awareness of scientists and their discoveries
   - Develops scientific vocabulary
   - Knows the sources of information
5. Relates knowledge and information
   - Relates appropriate apparatus and instruments to scientific experiment/activity.
   - Relates scientific principles and theories to phenomena
   - Develops awareness of inter-relationship of human activities and environment
6. Comprehends scientific information
   - Communicates by using scientific vocabulary
   - Describes concepts and observations in his/her own words
   - Interpret various phenomena in his/her own words
   - Values scientific advice in relation to such areas as personal health, agricultural practices, conservation of natural resources, protection of wild life, conservation of environment etc.
   - Identifies references to scientific matters in mass media
7. Demonstrates the ability to apply the scientific information
   - Understands basic concepts in science and applies them in daily life (familiar situations)
   - Selects relevant knowledge and applies in new situations
   - Correlates knowledge and understanding of various human activities and physical phenomena with their effects in every day life and environment
8. Becomes aware of the scientific skills
   - Identifies that some skills are necessary to perform scientific tasks
   - Recognizes that these skills develop over a time from simple to complex

- Develops and applies scientific skills
- Uses simple tools
- Demonstrates experimental techniques involving several scientific skills

9. Demonstrates success in performing science activities
   - Follows prescribed instructions
   - Makes right decisions.
   - Completes assigned job
   - Practices prescribed standards
   - Practices responsible safety habits
10. Develops awareness of the nature of science
   - Identifies that the body of scientific knowledge is not static
   - Understands science as human endeavor and have room for improvement
   - Recognizes the interdependence of all the branches of science in scientific progress
   - Understands interdependence of science and technology
11. Develops ability to retrieve information
   - Recognizes the nature of information
   - Identifies the relevant sources of information
   - Understands the methods of gathering information
   - Uses information in appropriate contexts

6.3 Attitudes, Values & Appreciations

The student:

1. Understands the spirit of scientific inquiry
   - Exhibits willingness to know and understand
   - Questions things instead of accepting blindly
   - Searches facts and relationship to drive meanings
   - Thinks and acts creatively
   - Demands for objective verification
   - Assesses things on merit
   - Demonstrates open mindedness
   - Chooses best among the available alternatives
   - Reports facts accurately without bias
   - Accepts social responsibility

2. Develops positive feeling for science
    - Exhibits interest in studying science
    - Enjoys investigating the real world
    - Shows feelings of achievement after the accomplishment of task
    - Recognizes and supports dignity in labour
    - Aspires to pursue a career in science
3. Develops a habit of solving problem in the school and in daily life like a scientist
    - Identifies problem
    - Designs experiment
    - Collects, analyses and interprets data
    - Draws conclusions
    - Recognizes benefits of such behavior in social life particularly to overcome superstitious beliefs.
4. Develops appreciation for science and scientific work
    - Recognizes that successful accomplishment of a task has associated reward
    - Appreciates the contributions of science in economic and social life
    - Appreciates the ideas, skills and abilities of others
    - Appreciates the God's creations, nature and the work of scientists
    - Develops appreciation and concern for issues of national and international importance

6.4 Socio-Economic Awareness

The student:

1. Understands social roles and demands required in school
    - Contributes positively to group efforts
    - Participate in class discussions
    - Expresses a shared responsibility for success or failure of the group
    - Identifies characteristics of others that make them attractive
    - Takes responsibility for the effects of his /her actions/decisions

2. Understands basic principles of socio-economics
    - Examines own family unit and immediate community to understand the principle of interdependence
    - Identifies different types of jobs and related services in the society
    - Explains how work satisfies both individual needs and needs of the society
    - Recognizes the role of science and technology in economic development
3. Contributes positively to group efforts
    - Identifies activities which depend on cooperative relationship
    - Recognizes the effects of cooperation
    - Develops ability to play and work together

6.5 Religious and National Awareness

The student:

1. Understands the religious obligations to educate one self
    - Upholds God's command -read in the name of God
    - Prays to God for blessing in seeking knowledge
    - Knows that God grants due appreciation to the educated
    - Knows that educated and uneducated are not equal in the eyes of God
    - Recognizes that understanding raises the man's dignity
    - Always thanks God for the capacity and gifts granted to him/her
2. Understands and follows Qur'anic instructions
    - Does not utter things of which he/she has no knowledge
    - Does not follow what he/she does not know
    - Does not dispute in matters of which he/she has no knowledge
    - Reasons with others in most courteous manners
3. Understands the significance attached to education in Islam (sayings of Prophet)
    - Engages in activities to learn,
    - One learned man is better than thousand ignorant worshippers

- Learned men are considered heirs of the prophet
- Explains that the ink of a scholar is more precious than the blood of the martyr
- Recognizes man is learned as long as he seeks knowledge
- Understands that education prepares for the time to come

4. Becomes aware that Qur'an welcomes and supports scientific activity
   - Identifies that man alone has been given the capacity to use names for things
   - Recognizes that scientific knowledge comes from the study of natural phenomena
   - Exhibits interest and enjoyment in the study of nature
   - Learns that Qur'an invites man to investigate and conquer all that is in the heaven and the earth

5. Understands the contribution of Muslims in science
   - Lists prominent Muslim scientists and their discoveries
   - Explains the benefits of these discoveries to the mankind
   - Knows that some modem scientific information is based on the work of Muslim scientists
   - Appreciates the scientific contributions of Muslim scientists
   - Plans to follow the footsteps of his /her forefathers
6. Understands the contribution of science in national development
   - Identifies the major scientists of the country and their field of work
   - Knows major scientific organization of national importance
   - Explains the contribution of science in economic and social development of the country
   - Develops appreciation and concern for issues of national importance
   - Recognizes the need of scientific manpower for the development of the country and to compete with the world
   - Develops plan to be a part of the scientists community

6.6 Educational & Career Awareness

The student:

1. Understands the significance of education
   - Describes the importance of education in daily life
   - Appraises the importance of education for the development of individual and of the country
   - Recognizes that there are certain basic education and skills important for all areas of work and society
2. Develops awareness of available choices in the curriculum
   - Identifies various academic courses in the school curriculum
   - Plans to pursue courses of his /her preferred choice
3. Relates benefits to the level of education
   - Explains the relationship between jobs and education
   - Compares personal status to the level of education completed
   - Understands why more educated are preferred
   - Develops awareness of careers
4. Understands people perform different roles in the society.
   - Examines different types of human activities in the society
   - Differentiate between work and leisure activities
   - Observes the various workers in and out of school and differentiates their roles
   - Recognizes that the world of work is composed of different units - agriculture factories, industries, health, defense, institutions, etc. to meet various needs
   - Identifies the wide range of different careers in the world of work
   - Aspires for an individual career

7

CONTENT: MAJOR TOPICS & CONCEPTS

The components of content and course outline (syllabus) specify that students will be engaged in learning experiences involving scientific knowledge, processes and skills. The specification of content also determines the scope and depth of treatment. Widely accepted approach for organization of learning experiences for students is the integration of basic sciences -Life Sciences, Physical Sciences, Earth Sciences, duly blended with aspects of technology. The organization of content on the basis of traditional division of sciences into Life Science, Physical Sciences, Earth Sciences, and Astronomy etc. is not an appropriate strategy and, therefore, it is to be reformed. Non-traditional ways need to be searched out which can help students to develop understanding of relationships and connections between and within scientific disciplines as well as with the real world. It requires encouraging experimentation with alternative ways such as integrated and interdisciplinary courses, organizing learning experiences around themes (Environment) or important activities and problems (Look around, Hot and cold, What's alive, People communicate, Growing up, Our Pakistan, Cycles around us, Best place to live etc.). The learning experiences for primary science programme can be selected and integrated covering following areas:

- Environment both natural and man made
- Living and other things around us
- Physical phenomena associated with matter, energy, motion, waves and vibrations
- Information and communication
- Products and services of science and technology
- Geo-sphere
- Hydrosphere
- Atmosphere
- Solar system and universe

Following major terms and concepts along with contexts and references have been identified for consideration during the development of science curriculum syllabus for primary classes:

Major Terms & Concepts	Contexts & References
Environment	
Surroundings and environments composition	Home, School, Town, City, Country
Living and non living things	Common plants and animals
Living: Animals and plants	
Non living: Objects of wood, plastic, glass etc Water, air(oxygen, carbon dioxide), soil and rocks Energy: Heat, light, electricity, magnetism	Local examples of non living objects
Interaction of various components of environment	Examples from surrounding environment
People respond to their environment: People change their environment	Building towns, deforestation, killing wild life dams, industry, use of buses and cars, fridge T. V. Computer
Life	
Biodiversity: all organisms differ from each other. Characteristics of living things/ life processes functions: Growth, need food, respiration, response to environment, movement, reproduction, excretes wastes	Examples of familiar animals and plants
Bounty: All parts of living things are made up of cells, cell is a basic living unit of organization and all cells arise from preexisting cells.	Selected animals and plant cells Charts and models showing specialized cells
All life functions are carried out by cells.	Onion skin cells Hand lens, microscope Charts
Reasons of biodiversity: Differences among living things are attributed to differences in number and nature of cells	Local Examples

Classification of organisms into major groups (on the basis of observable physical characteristics)	Vertebrates and non vertebrates Flowering and non flowering plants Local representatives of each group
Parts of animals and plants: Backbone, skin, - shell, limbs, roots, leaves, stems, flowers, seeds, fruits	Examples of common plants
Characteristics of vertebrates: skin, fur, scales, feathers, horns, claws, beaks, teeth, skeleton, muscles	Examples of common vertebrates Charts, Visit of Zoo
Life requirements: Food, air, water, sunlight	Germinating seeds, needs of human beings
Environmental needs: Spaces and habitat	Living habit at of common animals
Uses of plant parts: Roots, stems, leaves, flowers, fruits, seeds	Common edible plants
Storage of food in plants grown under different conditions	Potato, onion
Life processes and products of food in plants	Food storage in plants -potato, charts and models
Photosynthesis, carbon-dioxide, water, sunlight, starch, sugar, oxygen	
Life processes/systems in animals Digestion, circulation, respiration, Reproduction, skeletal, nervous, excretion, growth and repair	Charts and models
Cell level activities: photosynthesis, respiration	Activities Charts and models
Transport of materials in plants and animals	Mechanism of transportation
Living things maintain internal environment	Body temperature, disease control, waste excretion
Interrelationship of body systems	Common contexts: Playing ball game, physical exercise
Life cycles in plants and animals: egg, young adult, flowers, fruits, seeds	Germinating seeds, such as chick peas, beans
Inheritance of traits: Characteristics of living things are passed on from parents to their young ones (generation to generation) such as hair colour, eye colour, skin colour, leaf shape, flower colour	Examining nature and young animals and plants
Recombination of characters: New crops for more yield, pest resistance crops	Examples of new varieties of wheat, cotton Dolly sheep

Fossils as evidence of past life	Charts and models of animals and plant fossils
Adaptations: characteristics of animals and plants to survive in their environments such as wool, fur of sheep, sharp teeth and claws to catch and kill prey, colour for camouflage, migration, communication of danger, Thick fleshy leaves and stem, thorns in desert plants, aerial roots	Dog, cat, chameleon, dull colour of females in birds, white polar bear, camel Examples of common plants
Interrelationships/interdependence in the environment	
Basic requirements of all living things to maintain their existence: Sunlight, water, air, food, minerals, shelter	Common examples
Feeding relationships: Food chains producers, consumers, (predators, prey), decomposers	Food chains including human
All organisms acquire energy directly or indirectly from sunlight	Common food chains
Distribution/flow of energy in environment	Charts of energy flow
Interdependence among living things: Symbiotic, parasitic	Insects & flowering plants, birds eating fruits and spreading seed, humans & mosquitoes
Cycling of materials in the environment: Water, carbon, soil nutrients cycles	Mechanism of cycling
Uses or benefits from animals and plants: wood, paper, cotton, medicines, food (cereals), rubber, oils, wool, Meat (protein), leather, wax, milk, fats	Objects made of animal and plant materials
Human activities that alter the environment: Agriculture, deforestation, industry, hunting, transport, use of resources, development of towns and cities, living habits, Greenhouse effect	Pollution from transport, industrial toxic wastes, fertilizers, insecticides, hunting of animals, soil erosion, habitat destruction.
Other things around us	
Characteristics/Properties of materials Size -large, small, larger, smaller Colour - common colours shapes: triangle rectangle, oval Smell -pleasant, unpleasant	Common objects/materials Scientific processes Observation, classification Skills: observing, classifying, Investigating

Weight -heavy, light, heavier, lighter Texture -rough, smooth Hardness -hard, soft Temperature -hot, cool Flexibility -strong, stiff, flexible Buoyancy -sink, float Magnetic properties -attract, repel, pull, push States of matter -solid, liquid, gas Durability breakable, unbreakable Conductors and non conductors of heat, , electricity	Common substances Solids -wood, plastic, iron, stone Liquids-milk, water, juice Gases -water vapours, air
Measurements: time, weight, volume, temperature and dimensions (length, width, height) Units of measurements Tools of measurements Watch, ruler, balance, scale, thermometer, graduated cylinder	Use of common devices
Properties of useful materials fireproof, waterproof, heat and electricity conductors, unbreakable	Aesthetic and functional factors of common materials
Classification of substances: Elements compounds, mixtures	Common substances elements copper, iron, aluminum Compound-water, sugar, carbon dioxide mixtures-salty water
Preparing mixtures: Solutions Techniques of separating mixtures: filtration, dissolving soluble substances, evaporation, distillation, using magnet, using sieves	Mixtures of various kinds Tools: filter paper, funnel, magnet, beaker/cup
Physical changes in materials/matter Changes in shape and size-breaking, bending, tearing Changes in states of matter-melting, freezing, dissolving, evaporation and condensation, expansion and contraction	Common examples, ice, melting wax Drying clothes, cold wind on panes Thermal expansion in rail tracks, bridges
Chemical changes in materials/matter: burning paper, rusting iron, sugar formation in photosynthesis	Local examples
Physical and chemical changes in nature: Water cycle, erosion, corrosion, photosynthesis, respiration	Mechanism

Recycling of materials: Plastic, glass, paper	Examples of recycled objects
Composition of materials: matter consists of small particles atoms bond together to form molecules	Model
Geo-sphere	
Major features of earth's surface: Lakes, rivers, oceans, mountains, plains, deserts	Major features in Pakistan Maps showing major features
Types of earth materials: soil, sand, clay, rock, minerals	Samples of local materials
Natural causes of changes on earth: volcanoes, earthquakes, erosion, rivers, rain, waves, landslides, sand dunes	Places in the surroundings
Uses of earth materials: Oil, coal, gas, water for transportation, electricity, energy, drinking water, Sand for glass, ores for metals, building materials, salt, diamonds	Examples of uses of earth materials
Conservation of natural resources.	
Hydrosphere	
States of water: solid, liquid, gas.	Water, ice, water vapours, local examples
Water forms: spring, lake, river, oceans, snow, glacier, dew, polar cap, clouds, steam, water vapours	
Sources of drinking water: Well, hand pump, tube-well, spring, lake, river	Examples of sources
Methods of making water drinkable: filtering, chlorination	Various techniques
Water supply system	
Path of rain/snow from Mountains to Arabian sea	Map to trace path
Uses of water: drinking, agriculture, fishing, transport, industry, energy production, cleaning, ice for cooling, steam for running engines, making solutions	Examples of uses
Effects of human activities: household waster disposal, industrial waste, Agricultural run off, garbage, oil spill, sewage, disposal of toxic wastes.	Examples of human activities
Conservation of water resources	Examples of means

Energy	
Energy related phenomena: Sun's heat and light, movement (car, bus, animal, machine), work, heating, lightning, sound, magnetic pull and push, winding up of watch and toy, nutrition (food)	Selected energy related common phenomena
Forms of energy: heat, light, sound, mechanical, electrical, chemical, magnetic, nuclear, food energy	Common examples
Conservation of energy	Appropriate means
Motion of objects	
Motion: speed and direction	Slow, fast, slower, faster right, left, east, west, south, north
Moving objects by force: speeding slowing, stopping, turning	Throwing stone, ball, sliding and moving objects
Paths: up, down, curved	Common examples
Friction and gravity	
Moving objects by simple machines: lever, pulley, inclined plane, wedge wheel ,Machines make work easier	Use of simple machines Local examples
Electricity	
Uses of electricity	Common appliances and sources
Sources of electricity ' Materials: Conductors and non conductors	Examples of objects
Interaction of charged materials	Behaviour charged and non-charged objects
Charging by rubbing, Attraction and repulsion	
Simple electric circuit	Wire, battery, bulb, wiring in school and home
Electric hazards and safety	Commonly applied means
Magnetism	
Interaction of magnet with materials	Common objects
Magnetic attraction and repulsion	Behaviour of two magnets
Magnetic compass for direction: north south, east, west	Magnetic compass
Use of magnet in daily life	Crane, bell, motor, doors, speaker of TV and Radio
Heat	
Sun as major source and other sources	Examples of sources
Use of heat in daily life	Appropriately selected examples

Effects of heat on materials	Selected materials
Mechanism of heat transfer Convection, conduction, radiation	Common examples
Light	
Light travels	Wave, straight line
Sources of light	Sun, stars, bulb, candle, fire, firefly
Properties of light: bright, dim	Prism, rainbow
Colours of light: Violet, indigo, blue, green, yellow, orange red	Opaque, transparent materials
Path of light	
Shadow formation	
Reflection, absorption, transmission	Mirror, lens
Seeing objects and their colours	Mechanism
Sound	
Sound: Vibrations	Buzzing, vibrating objects
Sound transmission, recording and reproducing	Common devices
Echo	Echo in room Uses of echo by bat
Sound travel through different materials	Wall, water, thread, iron rod
Atmosphere	
Atmosphere: Composition -air, water vapours, temperature changes, air pressure, dust particles	Selected examples
Weather conditions	Daily changes in weather
Temperature -hot, warm, cool	
Cloud Cloudy, partly cloudy, lightning, fog, rain, snow	
Wind -windy, breeze, calm, Thunderstorm,	
Seasonal changes in weather: Winter spring, summer, fall	Evidences of changes
Climate: Plain, mountains, desert	Local examples, pictures of areas
Relationship of human activities and weather	Effects of summer, winter flooding, dry season (no rain) Evidences of climatic change and their reasons and effects.
Earth and Universe	
Earth as part of solar system	Star, moon, planets
Structure of earth	Charts and models
Comparison of sun, earth, moon	Charts and models

Motions of earth: around sun and its own rotation, day and night formation, seasons	Charts and models showing motions of earth, globe

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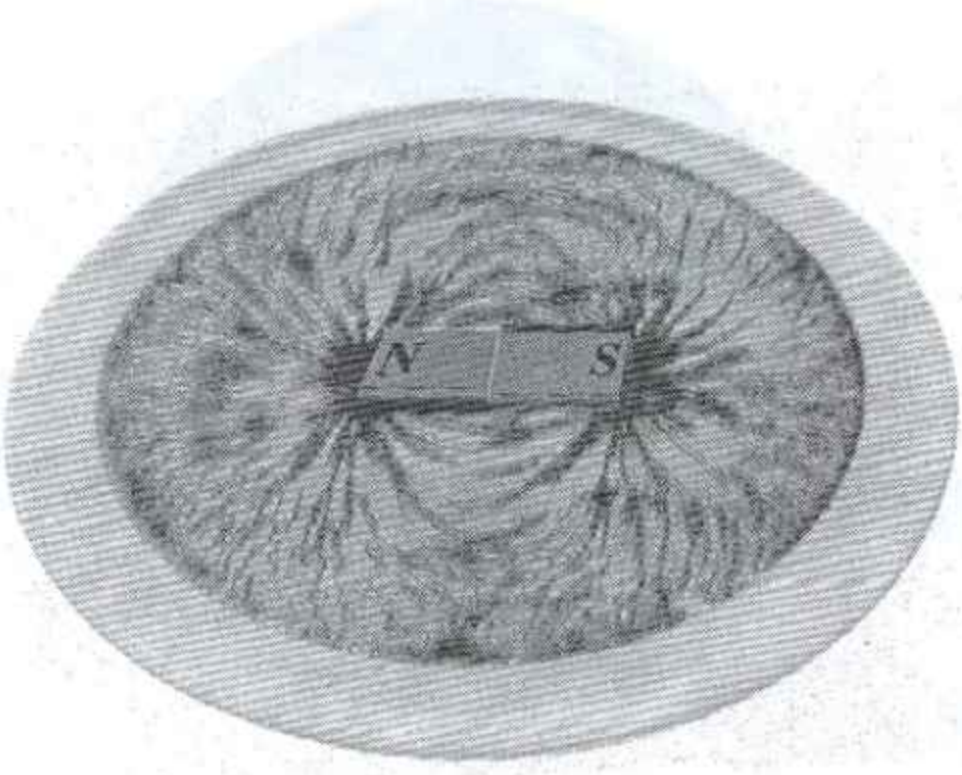
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ACTIVITIES: SOME EXAMPLES

Activities are essential component of science education. Following is a list of some examples of activities *for* primary classes:

1. Study of Flowers - shapes, size & colour
2. Study of leaves -size, shape of leave
3. Study of Animals: Birds, fish, mammals -physical characteristics, *food,* habitat.
4. Let's grow a plant (study *from* seed to a plant)
   - Soil preparation
   - Study of growth stages
5. Study of insects - Living places, food, movements (Ants, honey bee, butterfly, fly etc). .
6. Preparation of models of insects - paper, clay
7. Observing flowering in plants
8. Observing differences among flowers
9. Observing types of animals, which visit flowers
10. Observing types of animals visiting water pond
11. Observation of adaptations in plants and animals
12. Observing how plants grow -different stages from seed to a plant
    - Measuring the length of plant every week
    - Counting number of leaves every week
    - Making chart
13. Observing living places of different animals
14. Observing what different animals eat: Throw different type of foods - sugar, bread, water, leaves, biscuit, meat, sweets etc in the open and observe the types of animals visiting them.
15. Visit to a water pond/lake/river: Observing different animals and plants

16. Collecting different types of seeds
17. Some animals hide themselves in their surrounding environment due to their colour resemblance -grasshopper etc.
18. Observing how animals move
19. Study of essential things for life in plants and animals
20. Using microscope
21. Do the plants have diseases? .
22. How many times your heart beat and you breath in a minute?
23. Collection and preservation of different leaves and flowers.
24. Study of life cycles in plants and animals (been, frog, birds etc.)
25. Study of modes of dispersal of different seed
26. Collecting insects of grass land
27. Comparing roots
28. Observing that the stem carries water to all parts of plant
29. Making leaf prints
30. Discover that air enters a plant through leaves
31. Examining that leaves need sunlight for photosynthesis
32. Discover that leaves give off water
33. Investigate conditions necessary for germination
34. Observe life processes in plants -photosynthesis, transpiration, respiration, digestion, circulation, growth, excretion, reproduction and tropisms
35. Observe plants respond to light and water
36. Observe effects of seasons on plants
37. Observe body organs
38. Collecting and observing insects
39. Mount and display insects
40. Observe and compare fish, bird, frog, lizard/snake, man
41. Examining cells
42. Identifying body organs and systems
43. Comparing finger prints
44. Examining human hair and wool
45. Observing skeleton and bones
46. Compare food of various animals
47. Making a stethoscope
48. Discover how we breath?

49. Observe the effect of exercise on pulse rate and rate of breathing
50. Examine the excretion of carbon dioxide
51. Observe reflex action
52. Investigate senses
53. Discover that the retina holds an image for a short time
54. Water and soil
    - Flow of water (From up to down surface)
    - Where does water disappear?
        - Three pots of different shapes, sizes (evaporation)
        - Two self-made different sizes of ponds
    - Effect of water on soil -flow of water in small canals (brings sediments)
    - Drying time of different types of soils (water holding capacity)
    - Comparison of rain, river, drinking water -sun light test
    - What is a mud?
    - Sub-surface water -(in depressions water appears)
    - Study of water from different sources: well, pond, river (colour, filtration, evaporation)
55. Playing with clay/sand (wet)
    - Making shapes with molds like glass, bucket and other pots
    - Making burrows
    - Observing water and wet clay shape up with pots
56. Playing with different types of soil
    - Making balls and observing what happens when thrown in bucket with water
    - Observing how different types of soil behave while drying - note drying time, note shapes of balls after drying
    - Observing that some types of soil absorb water more quickly than others (sand and clay)
    - Observing that some types of soil mix with water and some settle down by slowly throwing them in water pot.
57. Making model of water way from mountain to plain land to sea -drains, small steams, lakes, rivers, sea
58. Visit to a river bed
59. Preparing a stone garden -collecting different types of stones

60. Study of different rocks
61. Weighing and measuring things
    - Comparing things (estimation)
    - Making a balance using common objects
    - Use of various devices
62. Playing with water
    - Identifying uses of water in daily life
    - Floating and sinking objects
    - Observing water dissolves materials
    - Does water dissolve all materials -soap, sugar, salt, nails, stones, wood, paper etc?
    - Does stirring helps in dissolving materials?
    - Observing some materials dissolve easily or quickly and some slowly,
    - Does hot water also dissolve materials? '
    - Do hot and cold waters behave differently while dissolving materials?
        - Time
        - Capacity
    - Illustrating water table in a glass
    - Purifying water by filtering
    - Investigating water pressure
    - Moving water and steam can do work
    - Comparing buoyancy of fresh and salt water
    - Observing water pollution
    - Making waves in a water filled pan
    - Observing water evaporate and effect of surface area
    - Comparing evaporation in soil and artificial pond
    - Discovering cooling effect of evaporation
    - Observing water vapour condensation
    - Making chart of rain cycle
    - Preparing a rain gauge
63. Making bubbles from soap water
64. Observing clouds
65. Identifying acid or base nature of things through litmus paper Juices of various fruits, water, soup water).
66. Play with Air
    - Air is around us? (filling of empty plastic bag)

- Blowing balloon and common polythene bags –play as volleyball
- Pressing flatted balloon and bag in water -tub
- Pinning a flatted balloon or bag and observing in water - (water bubbles coming out)
- Pressing empty glass in water -tub and tilting it
- Pressing empty plastic bottle with cotton made cork
- Pressing dry sponge in water
- Make holes in plastic bottle, put inside water - tub and press the bottle
- Making cushion of flatted plastic bags
- Blowing air through a pipe in water
- Fix a balloon on the mouth of bottomless plastic bottle and then pressing bottle in water.
- Playing with syringe
- Observing presence of air in the soil and water
- Observing presence of water vapours in air
- Observing presence of dust in air
- Observing air occupies space and has weight
- Observing that air exerts pressure
- Observing the effect of heating and cooling on the air in a container/flask
- Discover how decreased and increased air pressure operates a soda straw and dropper
- Discover how decreasing the air pressure causes a can to collapse
- Making an air gun with paper tube
- Making a balloon act like a jet plane.

67. Investigating elasticity: rubber band, cycle tubes, string from cycle tube, ball, stone throwing and flying paper aero plane with rubber string (force & elasticity).
    - Elasticity in different materials
    - Making with rubber bands a card board cart
68. Study friction and machines
    - Discover that friction produces heat

- Observe the effect of nature of surfaces of materials on friction
- Compare friction between wide surfaces and narrow surfaces
- Discover making surface smoother, lubrication, rollers, wheels, reduce friction
- Observe machine transfer force and increase the amount of force
- Discover how levers work
- Investigate how pulley works

69. Discovering about matter
    - Investigate states of matter
    - Compare physical and chemical changes
    - Making model of atom
    - Investigate properties of mixtures and compounds
    - Observe some substances are more soluble in water than others
70. Investigate examples of kinetic and potential energy
71. Study of Sun (please do not encourage children to see sun with naked eyes)
    - Sun as source of light
    - Effect of the sun by placing water pot in the shade & one in the sun
    - Tracing shadow of a stick after different intervals
    - Effect of sun on room temperature -room facing sun and room not facing sun.
72. What happens when a metal rod and a wooden rod is heated?
73. How air behaves when it is heated?
74. How water behaves when it is heated?
75. Do the temperature varies from place to place?
76. Do the temperature varies during different months of the year? (Keeping daily record)
77. Observe various sources of heat
78. Discover effect of heat on the states of matter
79. Discover that solids expand when heated and contract when cooled

80. Discover that water is an exception to the rule of expansion and observe that metals are good conductors of heat
81. Discover that heat travels in water by convection
82. Discover that fire needs oxygen
83. Discover that burning produces carbon dioxide.

84. Discover that friction produces static electricity
85. Observe the effect of charged materials upon uncharged and charged materials.
86. Playing with electricity
    - Light a bulb by a battery (circuit)
    - Make toy-house from empty box and light
    - Identifying materials, which allow electric current to pass
    - Lighting two bulbs in different orders '
    - Discover uses of electricity
87. Light travels -Torch
88. How light behaves when it enters in water, pass through water?
89. Playing with mirror (image, reflection of light)
90. Investigate light travels in straight line
91. Comparing transparent, translucent and opaque materials
92. Observe that light can be reflected by mirror
93. Discover light can be reflected again and again
94. Observe light is refracted when it enters water
95. Investigate images formed by plain mirror and convex lens
96. Discover that water can act as a lens
97. Observe when light pass through prism
98. Discover spectrum recombines to form white light
99. Observing coloured materials
100. Light energy changes into heat energy? (Heat a tin by reflecting light through mirror)
101. Standing in sunlight or against light source -shadow formation
102. The size of shadow changes with time or distance from light source
103. Playing with magnet:
    - Testing different materials
    - Separating iron filling from sand

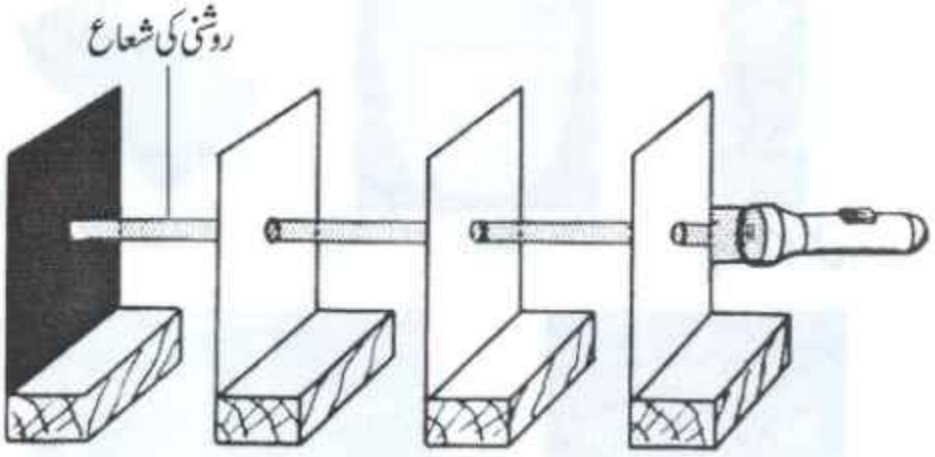
- Making train/car (bottle tops) and paper clips moving it on polythene track. '
- Making a neckless/shapes -balls, nails, paper pins
- Making and moving animal shapes in water (by putting nail in them) -Fishing by magnet
- Clustering burning candles (drawing pins) in water

- Playing with paper shapes -short story
- Behaviour of two magnets (attraction and repulsion)
- Finding direction (Compass)
- Discovering attraction is strongest at poles
- Making a temporary magnet
- Making a floating compass

104. Producing different sounds
    - Blowing at the mouth of empty bottle
    - Hitting empty bottle with stick
    - Blowing through straw
    - By putting stone or seeds in a box, bottle
    - Hitting different pots with stick -glass, can, mug, bowl, plate
    - Rubbing balloon & releasing air in empty box
    - Playing with Stretched rubber band around empty box
    - Hitting iron-rod
    - Observing small balls/stones on the surface while beating drum
    - Playing with a stretched strings
105. Sound travels
    - Hitting one balloon and listening from other attached balloon
    - Listening through two stringed balloons
    - Hitting one end of long bar and listening from other end and also attaching a string and listening from cup-phone.
    - Linking two empty ice cream cups with thread and talking to each other.
    - Can sound travel through wall/water?
    - Observing sound comes back
106. Understanding earth and solar system

- Preparing models of sun and planets
- Observing sky at night
- Demonstrating how earth rotates on its axis
- Formation of day and night
- Measuring and comparing shadows
- Making model of earth's layers
- Examining sedimentary rocks

- Making artificial sedimentary rock
- Observing wear away rocks (Water, wind erosion)



روشنی خط مستقیم پر سفر کرتی ہے

ہوا کا غبارہ

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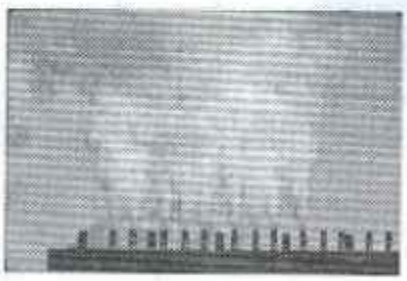


دھواں

مادہ کی مختلف حالتیں

9

TEACHING LEARNING PROCESS

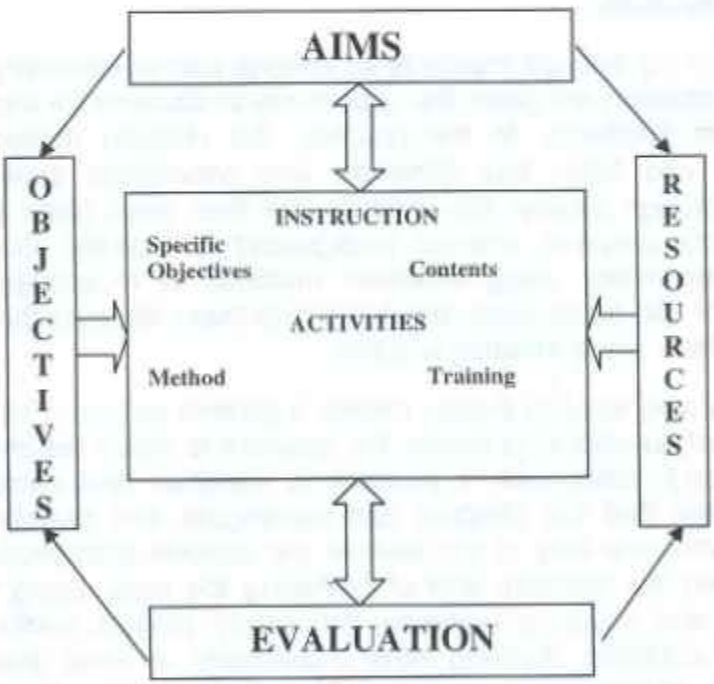
Teaching is a heart of the educational process. Widely recognized and accepted approach of science teaching is that it should be taught as a process of inquiry. It implies that teaching learning process should be made wherever possible, activity oriented ensuring active participation of the learner as well as discoverer of the knowledge. However, no single method or strategy is self sufficient to accomplish the desired objectives of science education.

Learning through inquiry is an integral part of discovery learning, in which the children are given the opportunity to discover for themselves the answers to problems. In the process, the children develop desirable behaviors and learn key concepts and conceptual schemes. When learning through inquiry, the children use their skills (both physical and mental) and previous science background to actively search for and collect information, using whatever methods of investigation that are available or can be devised, which will help them discover the solutions to problems they are attempting to solve.

Learning through inquiry follows a general pattern. First, a question (or series of questions) is raised, the answers to which the children do not know. Though discussion a problem is identified and narrowed until it seems likely that the children can investigate and possibly solve the problem. With the help of the teacher the children then propose ways of investigating the problem and of gathering the data, using their mental resources and whatever materials (laboratory, printed, audio-visual, etc.) those are available. Working either individually, in small groups, or as a class, the children now conduct investigations which produce new conclusions and this procedure is then repeated over and over again.

The teacher plays an equally important role while the children are in the process of learning through inquiry. The teacher provides a variety of

thought-provoking questions that start inquiry learning and keep it moving along. The teacher directs the learning activities so that the children can discover for themselves the answers to their questions and problems. This means that the teacher is a guide and a counselor, not a source or dispenser of knowledge. When inquiry learning bogs down, the teacher does not supply answers, but offers cues instead that will help the children continue with the investigation. The teacher is constantly on the alert to keep the children from jumping to hasty conclusions or getting side-tracked into other problems that are either barely related or unrelated to the original problem being investigated. Finally, the teacher participates actively in the enthusiasm that prevails during the investigations, and shows both excitement and delight when the children discover the answers to their problems.



Conceptual Model for Instruction Adapted

Teaching is considered appropriate only if it addresses all the objectives of science education which are spread over knowledge domain,

affective domain (behaviours) and psycho-motor domain (skills). Inspite of this classification the domains are interdependent. The teaching process delivers important information of facts, concepts and principles so as to develop understanding, increase the knowledge and orientation with scientific processes. This process not only helps to use the knowledge but also construction of new knowledge. The scientific processes themselves identify the desired skills such as observing, measuring, classifying, analyzing, experimenting, communicating, manipulating etc. During the teaching process focus is also on the development of behavior such as attitudes, interests, values, appreciations etc. These elements of affective domains develop during teaching learning activities.

The much advocated method of science teaching is through inquiry method. Children come across various experiences in their daily life and the innate quality of children is to question and search answers. Teaching process ought to consider this innate quality of children and accordingly provide opportunities by designing scientific activities -experimenting, investigating. finding-out relationships, differences and similarities, analysis, interpretation and making inferences. In the inquiry method all the surrounding environment of the students serve as a laboratory to find-out and understand the real world in a systematic way. The child is placed in the position of a discoverer. When a child obtains or gathers knowledge by self (himself/herself) it not only develops a sense of achievement but also develops satisfaction, interest and motivation. The knowledge thus gained is retained by the child for a quite longer period. The inquiry method facilitates to make use of variety of teaching strategies. The questioning and answering strategy play central role which assist to develop curiosity, to find-out the reasons and other indicators related to their observations and events. The inquiry method is not only limited to the science activities but it also directs to gather information from books, journals, newspapers, radio, T.V. and even from various peoples belonging to different professions. This is not restricted to construct and increase new knowledge but special consideration is given to the application of obtained knowledge and exploitation of relevant information sources. The major strategies, which can be utilized in teaching of science, are as under:

- Questioning answering
- Discussion '

- Demonstration
- Field visits
- Making models
- Concept mapping
- Predict, observe and explain
- Problem solving
- Projects
- Games
- Reports
- Assignments
- Drill, etc.

10

TEACHING LEARNING RESOURCES

The local environment offers a wide variety of experiences and opportunities for teaching and learning science. These local resources have lot to offer and relate science to the surroundings as well as every day life of the child. However these resources are often neither recognized nor used. Some of these resources may be within walking distance from the school and others may be further away. Following is a list of some such resources, which can help teachers to develop more awareness of surroundings and to make teaching learning process more effective. This list may not be considered comprehensive because every place has its own characteristics.

10.1 Inside School (Formal)

For teaching science schools have formal resources housed in the science room, resource room or classroom. The science room contains a variety of materials which are identified on the basis of science curriculum. Below is a list of basic as well as low cost materials, which can be used to enrich and supplement teaching learning process:

- Rope, thread, needle, glue, solution tape, vaseline, grease.
- Boxes of various sizes of plastic, cardboard and tin
- Papers, newspapers, cardboard, aluminum sheet, cotton, packing foam
- Cage, plastic tub (for fish)
- Empty plastic bottles, empty ice cream cups, envelops, balloons, used syringes
- Measuring tape, ruler, stop watch, balance, scale, thermometer spring balance
- Battery cells, bulb holder, torch, copper wires, switch, fuse, torch
- Cycle wires, air pump, tube, bell
- Boards of foam and wood, wooden blocks
- Candle, spirit lamp, tripot, match box, iron gauze
- Baking powder, sodabicarb, vinegar, lime water, iodine, food colours

pieces of marble, sulfuric acid, hydrochloric acid
- Magnet, magnetic compass, iron fillings
- Beakers, flask, test tubes, funnel, empty jam and pickle jars, graduated cylinder, dropper, glass and plastic tubes
- Common pins, nails, forceps, scissors, sand paper, hammer, pliers, saw, cutter
- Filter paper, litmus paper, PH paper
- Lens, mirror, microscope, slides, prism
- Basket, bucket, tray, spoon, brush, sieve, plastercene, net for catching butterflies and insects
- Pulleys, wedge, spring, cork, bottle opener
- Charts, maps, models, globe etc.

10.2 Inside School (Non-Formal)

- Pupils
- Water supply
- Building
- Electricity supply
- Plants and trees
- Furniture
- Garden
- Drains
- Playground
- Waste disposal
- Hand pump ,etc.

10.3 People and Their Working Places

- Farmers
- Engineers and Mechanics
- Crafts men
- Butchers
- Shopkeepers
- Teachers
- Specialists
- Builders
- Elders
- Professionals etc.

10.4 Natural Resources

- River
- Desert
- Sun
- Stream
- Hill
- Sky
- Lake
- Ditches
- Soil
- Pond
- Fields
- Spring
- Cave
- Sand Dune
- Animals
- Canal

- Delta
- Plants
- Sea
- Moon
- Mountains
- Stars, etc.

10.5 Institutions and Places

- Hotel
- Bank
- Museum
- Radio station
- Zoo
- T.V. Station
- Circus
- Oil Field
- Planetarium
- Meteorological station
- Universities
- Rubbish dump
- Schools
- Drains
- Parks and Gardens
- Dam
- Forest
- Homes
- Power station
- Stadium
- Farm etc.

10.6 Media

- Newspapers
- Magazines
- Radio
- Letters
- VCR
- Films
- T.V.
- Books etc.

10.7 Technological Appliances

- Hand pump
- Air Condition
- Tin opener
- Telephone
- Tube well
- Scissors
- Electric fan
- Plough
- Electric Heater
- Butter making
- Electric iron
- Sewing machine
- Cars
- Washing machine
- Bus
- Fodder cutter
- Tractor
- Toys etc.

10.8 Industries

- Chemical
- Beverage
- Electronics
- Textile
- Communication
- Leather
- Transport
- Agriculture
- Glass
- Cement
- Plastics
- Kilns
- Mining
- Oil refineries
- Poultry farm
- Wastes etc.

10.9 Cultural

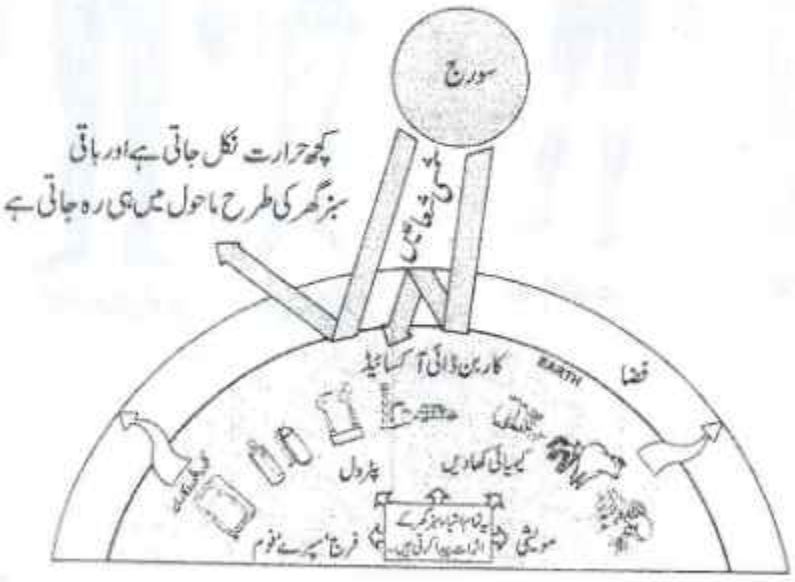
- Customs
- Rituals
- Clothes
- Traditions
- Music
- Food preparation
- Architecture
- Food storage
- Values
- Games and sports
- Fairs etc.

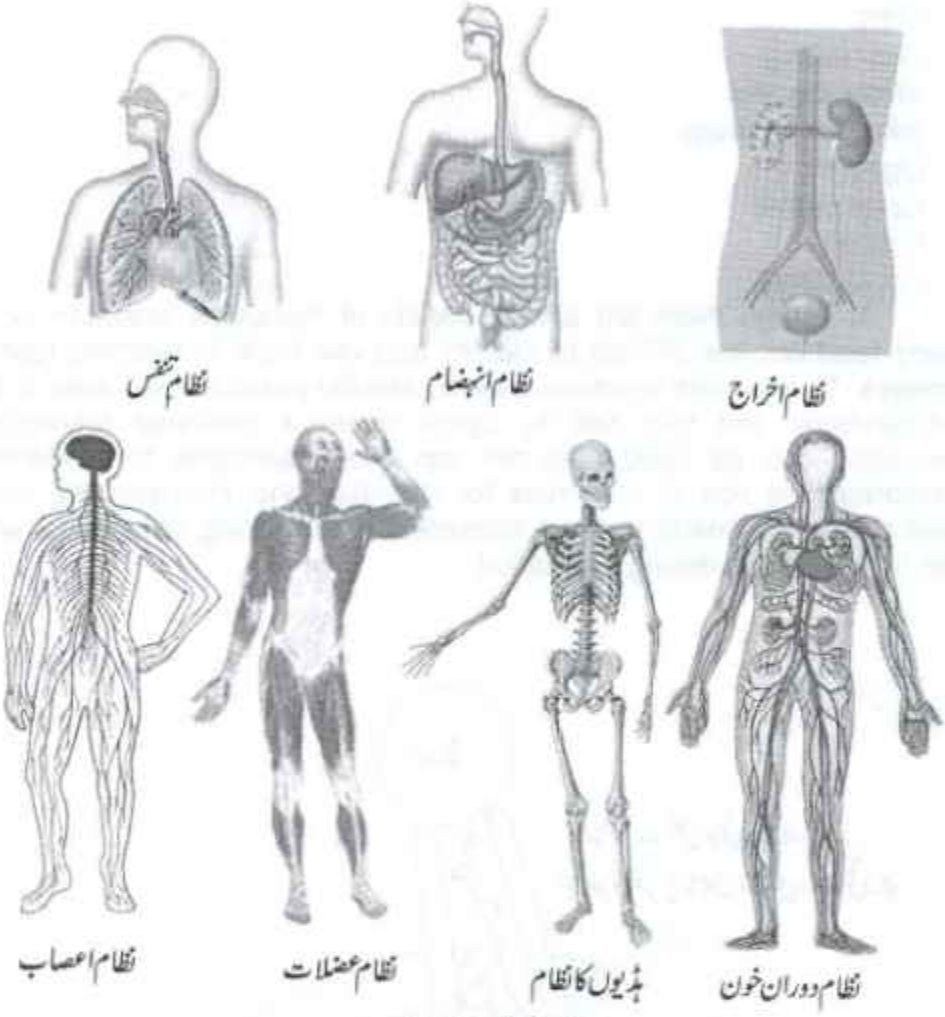
10.10 Real Life Situation

- Improved quality of crops and vegetables
- Muddy water during rainy season
- Common diseases and their prevention
- Fire and protection
- Use of gas and electricity
- Making room airy
- Preserving foods and grains
- Precautions from earthquakes
- Supply of safe drinking water
- Shortage of water in summer
- Cutting down of trees
- Over population
- Soil erosion by wind and water
- Earache with the change of altitudes
- Electrical system and appliances in the house
- Harmful gasses in the smoke
- Bad Breath

- Echo
- Over eating
- Water logging
- Influence of drugs
- Lightning
- Open drains
- Eclipse
- Ecosystems

Al though there are a wide variety of resources available locally, many teachers feel difficult to identify and use them in teaching-learning process. To start with teachers need to identify possible resources in their surroundings and then link to topics where a particular resource or resources can be used. Teacher can pose questions to students to encourage the use of resources for investigations. However the use of local resources needs to have relevance with learning objectives, which can help teachers during evaluation.





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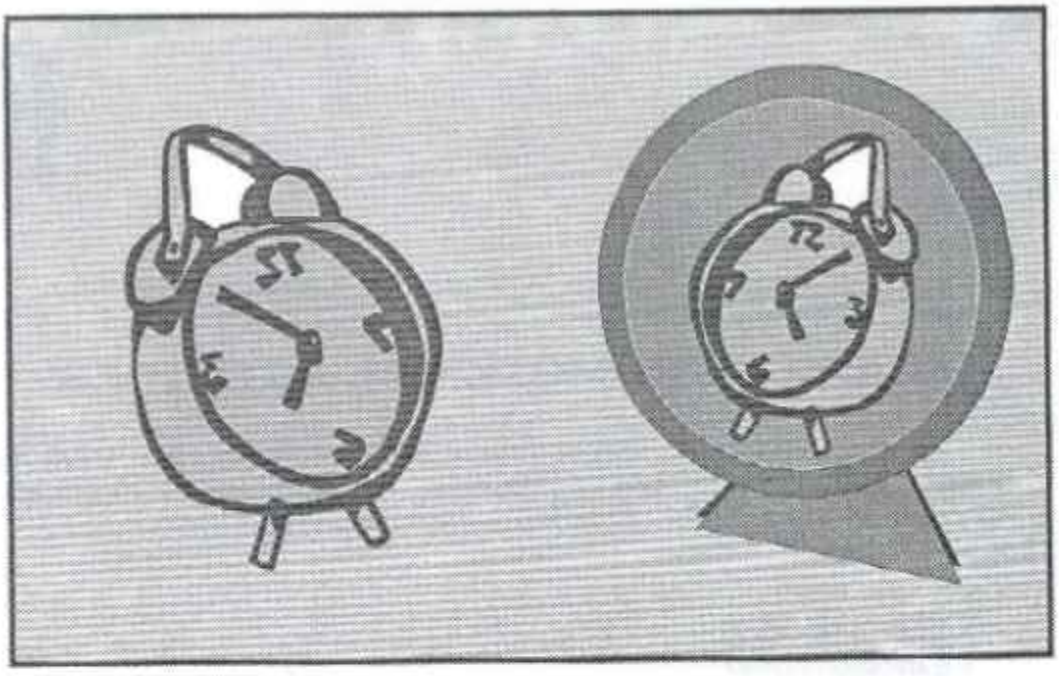
11

SCIENCE PROMOTIONAL ACTIVITIES

During education various co-curricular activities are used to develop and promote interest, positive attitudes and commitment. Following activities can be utilized to promote science education:

- Science club
- Bulletin board
- Exhibition corner
- Display of projects
- Quiz contests
- Science exhibition
- Science fair
- Science Olympiad etc.



12

ASSESSMENT

Assessment is carried out to determine the effectiveness of teaching and learning. It provides evidence in making judgments about student's achievements, abilities, attitude and interest, strength and weaknesses. The assessment also assists in making judgments about the effectiveness of curriculum, instructional material and teaching methods. Assessment should be curriculum based rather than textbook. It should address all the three domains - cognitive, affective and psychomotor as per set objective. It implies that assessment would have the same boundary as of teaching. Moreover, assessment should have the same ingredients as of teaching and learning i.e. purposeful interesting and challenging. Before embarking every teacher has to define purposes, identify areas and make selection of appropriate techniques.

12.1 Why to Assess?

The major purposes of assessment are as under:

- To determine the extent of achievement of students
- To determine the extent of progress of student's learning
- To determine the achievement of level of outcomes
- To provide feedback to each student about his/her progress in skills, attitudes and other desired aspects
- To obtain feedback about the effectiveness of teaching strategies, curriculum materials and assessment procedures
- To determine learning difficulties of students
- To determine remedial actions
- To motivate students
- To grade students for promotion and certification
- To direct the students in accordance with their abilities and interests.

- Some life processes differ among living things
- The senses are used to receive messages from all around
- Plants and animals live in environments that fulfill their needs
- Changes occur during the life time of living things
- Living things depend on other living things to survive (food chains)
- Living things show variations within their groups
- Groups of living things have changed over a long period of time
- Living things can be classified into groups on the basis of observable physical characteristics
- Different living things have different life cycles
- Living things obtain and use energy
- Different parts of living things are adapted to carry out specific functions
- Living things pass on their characteristics to next generations (from parents to young ones)
- Living things adapt special characteristics to survive in their environments
- Some materials cycle through the environment.

13.1.3 Other Things Around Us

- World around us is made up for many things
- Things around us can be described on the basis of physical attributes/properties such as colour, size, shape, smell, hardness, texture, flexibility, volume, length, width, weight, buoyancy, states of matter, temperature, electrical and magnetic properties, elements, compounds and mixtures, etc.
- Matter changes from one form to an other
- Freezing, dissolving, evaporation, condensation, expansion and contraction are major types of physical changes of matter
- All the substances can be divided into three classes elements, compounds and mixtures.
- Mixtures can be separated into component parts
- How common materials are made, disposed of and recycled
- Materials can be used to make products and goods
- Systems are used to deliver and distribute the products and goods

13.1.4 Hydrosphere

- Water is one of the essential material for life
- Water covers 75 percent of the earth
- Water is used in many activities of life
- There are many sources of water and all water is not drinkable
- Water exists in three states
- The rain water follows a path after it falls
- Water sinks into the earth and upper level of ground water is called water table
- Water is a universal solvent
- Water picks up many impurities
- Water is purified by different methods
- Dissolved minerals make water hard
- Water exerts pressure
- Moving water and steam can do work
- Some bodies float and some sink in water
- As population grows, the need of water increases
- All oceans are part of one great sea
- 45 kg of sea water contains 1-1/2 kg of dissolved salts and minerals
- Oceans waves are made by winds
- The surface water of oceans are constantly moving in the form of currents
- Fresh and sea water have all necessary conditions to support animal and plant life
- All the water on earth is constantly evaporating and condensing to form water cycle
- Human activities affect the quality of water in the environment

13.1.5 Atmosphere

- Air is around us and has specific moving pattern
- Air has specific composition and characteristics
- Human activities affect air in the environment
- Things move around in our environment

- Air exerts pressure
- Many activities are carried out by increasing or decreasing pressure
- Air expands when heated and contracts when cooled
- The atmosphere is heated by the sun
- Every day air goes through a cycle of heating and cooling
- The unequal heating of earth's surface produces winds
- Monsoons are seasonal winds
- Changes in air cause changes in weather
- Weather is a condition at particular time and place whereas climate is the average weather over a year
- Different places can have different climates

13.1.6 Friction and Machines

- Whenever there is friction, heat is produced
- We can control the motion of objects
- Machines make work easier or multiply force
- Simple machines help to move heavy loads easily or speed up work
- Push and pull make things move and stop
- Living things and machines need energy to do things
- Machines convert raw materials into useful products.

13.1.7 Energy

- Energy is associated with common phenomena
- The sun is the major source of energy on earth
- There are various forms of energy
- Energy changes from one form to another
- Energy is needed to do work, change state of matter, to move something, etc.
- Some things feel hotter and some colder than our bodies.
- Heat is the energy of moving molecules
- Heat energy can be produced from mechanical energy (friction, rubbing), chemical energy (burning), electrical energy, radiant energy (sun) and nuclear energy
- State of material can be changed by heating and cooling

- The effect of heating and cooling result into expansion and contraction respectively
- Heat can travel by convection, conduction and radiation
- Light travels
- Light help us to see
- Light can pass through some materials and not others
- Objects reflect, refract, transmit and absorb light.
- Image is reflected back light by mirror
- Curved mirrors form different kind of images
- White light is a mixture of seven colours
- How shadows are formed
- Static electricity is produced by friction
- Interaction of charged materials with other charged and uncharged materials.
- Lightning is a huge electric spark produced by static electricity
- Electricity can be used to produce heat, light, motion and power as well as in many forms of communications
- A complete circuit is needed for an electrical device to work
- Electricity has hazards to be avoided at home and school.
- Interaction of magnet with other magnetic and non magnetic materials
- Magnets attract some materials but not others
- The force of magnet is strongest at its ends
- The space around magnet act like a magnet
- The force of magnet can pass through many materials
- It is possible to make temporary and permanent magnets
- Magnet can lose their magnetism
- The earth behaves as magnet
- Sound are produced by vibrating objects
- Sound can travel through materials
- How sound comes back and how echoes are used
- Sound can be recorded and reproduced

13.1.8 Technologies

- There are different ways of communicating

- Information can be presented in different forms -textbook, graphs and tables, sounds, pictures etc.
- People use different technologies in different ways to communicate
- Information can be generated, stored, made available to others for use
- Computers are machine that store and process information
- Technologies offer new ways of sending messages

13.1.9 Earth & Universe

- Earth is a member of the solar system
- There are many physical phenomena which change the surface of earth
- Earth's surface has characteristic features which change with place and time
- Most materials come from earth and its surroundings
- Natural resources are limited and need conservation
- There are various parts of physical environment such as stars, planets, earth, moon, air and water.
- Environments on earth have been affected by technology.
- Time can be measured through changes and events on earth
- The sun, moon and earth are different from each other
- Earth spins and move around the sun
- Sun causes the year, day and night and seasons on earth

13.2 Attitudes, Interests, Values And Appreciation

The student will:

- Long to know more
- Show curiosity
- Find answers
- Work independently or in groups
- Take decisions on the basis of reliable evidences
- Avoid personal bias in working
- Not to believe in superstitions
- Verify the information if possible himself/herself
- Share responsibility both in failure and success

- Read other science books and journals
- Consider knowledge of science as non manipulative
- Avoid drugs
- Play individual role in the conservation of environment and natural resources
- Value mechanized farming and industry which are environment friendly
- Exhibit confidence in their pursuits
- Follow activities till completion
- Deal honestly with others
- Show curiosity about natural and man made environments
- Feel responsible for improving the quality of the environment
- Listen and respect views of others
- Take responsibility for the decisions
- Gain satisfaction in solving problems
- Appreciate the contributions of scientists
- Consider science as fun
- Work cooperatively in groups
- Show equal and fair treatment to all
- Demonstrate open mindedness
- Appreciate God and His creations
- Appreciate science as a means for acquiring information and understanding the real world
- Appreciate science as a process of discovering.

13.3 Skills

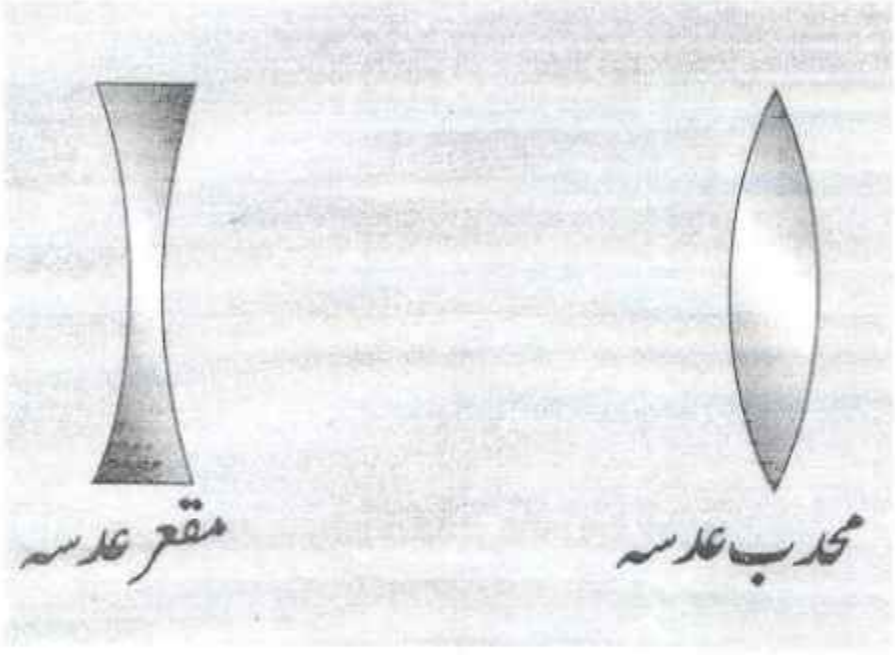
The student will:

- Recognize that some skills are required to perform scientific activities
- Make detailed observations
  - Collect relevant information
  - Use all senses
  - Use appropriate devices for observations
  - Generate questions based on observations
- Classify things and information

- Identify criteria
- Use specified criteria
- Classify into groups and categories

- Weigh and measure things
  - Identify appropriate measuring devices and standards
  - Use measuring devices carefully
  - Make accurate readings
  - Make good estimates
- Record observation and information
  - Use tables
  - Draw diagrams
  - Register accurately
  - Prepare charts
- Analyze and interpret information/data
  - Identify data which support prediction or Pattern
  - Describe pattern
- Make inferences accurately
  - Recognize the need of evidences in making Decisions
  - Evaluate the strengths and weakness
  - Predict on the basis of pattern established
  - Draw conclusions
  - Justify explanations
  - Show willingness to retest
  - Modify understanding in the light of investigation
- Manipulate things properly.
  - Use instruments and devices accurately
  - Use simple tools where necessary
  - Select apparatus and materials appropriate to activity
  - Assemble apparatus
  - Make use of available facilities and resources
  - Manipulate simple mechanical devices
  - Handles plants and animals carefully
- Communicate properly
  - Use information presenting techniques
  - Discuss problem findings and inferences with others
  - Use available information sources

  - Write clear report or present orally
  - Admit limitation of the activity.
- Perform activities and experiments
  - Follow instructions step by step
  - Design simple experiments
  - Identify appropriate materials and equipment
- Assemble apparatus
- Conduct activity and experiment
- Make accurate observations
- Record observation properly
- Interpret data
- Infer results from available information
- Follow safety procedures
- Observe cleanliness
- Report the activity comprehensively.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